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Headquarters
JOINT TASK FORCE SEVEN
Washington 25, D. C.

AG 319.1

1_ April 1953

SUBJECT: Change No. 1 to Operation IVY Final Report

TO: Chief of Staff, U.S. Army
Executive Agent
Department of the Army
Washington 25, D. C.
ATTN: ACofS, G-3

1. The following change to CJTF 132 final report on Operation IVY is hereby made a matter of record and is effective upon receipt.

Page 2 - Under RECOMMENDATIONS, paragraph 9, 2nd line, change the word "approve" to "note".

Page 20 - Last line, change the word "MIKE" to read "KING".

2. By separate action, five (5) copies of this change have been forwarded to the Chairman, Atomic Energy Commission.

FOR THE COMMANDER:

A. R. WALK
Brigadier General, USA
Chief of Staff

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Declassified By: Chief, ISCM w/deletions
on 15 FEB 90

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[illegible]nuary 1953

FINAL REPORT BY THE COMMANDER, JOINT TASK FORCE 132

to the

JOINT CHIEFS OF STAFF AND CHAIRMAN, ATOMIC ENERGY COMMISSION

on

ARMED FORCES PARTICIPATION IN THE 1952 NUCLEAR AND THERMONUCLEAR EXPERIMENTAL WEAPON AND DEVICE TESTS

OPERATION "IVY"

References:
- a. J.C.S. 2179/13
- b. J.C.S. 2179/15
- c. J.C.S. 2179/26
- d. J.C.S. 2179/32

THE PROBLEM

1. To present a report of the activities of Joint Task Force 132 in operation IVY to the Joint Chiefs of Staff in compliance with paragraph 8 of Enclosure "C" to J.C.S. 2179/15; and to the Atomic Energy Commission pursuant to the delegation of authority contained in a letter from the Chairman, AEC, to the Commander, JTF 132, dated 20 August 1952.

DISCUSSION

2. See Enclosure.

CONCLUSIONS

3. The mission of Joint Task Force 132, as delineated in J.C.S. 2179/15, was successfully accomplished.

4. The design principles incorporated in the thermonuclear device were successfully confirmed.

5. A high yield fission weapon in the 500 to 600 Kiloton range [redacted]

6. The delegation of authority to the Task Force Commander as a special representative of the Atomic Energy Commission facilitated overseas operations by establishing a single authority for operational control.

7. On-site Task Force operations would be greatly simplified if all [illegible] and devices in the megaton range were detonated at locations [illegible] circumstances that precluded evacuation during the detonation [illegible]

[redacted]

JA84-263 CX 1A 1600

[redacted]

8. In programming for operation CASTLE, the military Services should consider the savings which would accrue through reassigning to the Task Force certain ships and aircraft already modified for IVY at substantial expense.

RECOMMENDATIONS

9. That the Joint Chiefs of Staff and the Atomic Energy Commission ~~approve~~ Note the above conclusions.

10. That a joint ATOMIC ENERGY COMMISSION-DEPARTMENT OF DEFENSE statement be released to the public immediately after each detonation to preclude premature announcement of such information through personal mail or through other uncontrollable or unforeseen circumstances.

11. That the Joint Task Force organization for overseas atomic tests be maintained as a permanent command providing for rotation of the Executive Agent and Commander at such times as may be considered appropriate by the Joint Chiefs of Staff.

[redacted]

ENCLOSURE

DISCUSSION

INTRODUCTION

1. Joint Task Force 132 (JTF 132), commanded by Major General P. W. Clarkson, United States Army, was activated on 9 July 1951, with Headquarters at Washington, D.C. The command post of the Commander was opened on Parry Island, Eniwetok Atoll, at 0300Z, 17 September 1952 and was closed at 0001Z, 21 November 1952. These latter dates indicate the period of the operational (on-site) phase of operation IVY.

2. One very high yield thermonuclear device (MIKE) and one high yield nuclear weapon (KING) were detonated. In conjunction with these detonations, eleven experimental programs were conducted. This report describes the device and weapon and experimental programs, giving as many preliminary conclusions as can be drawn from early analysis of data. More definitive conclusions will appear in the fifty-four volumes of technical reports planned and referred to in paragraph 50a(3). This report also covers in summary the operational, security, logistical and fiscal aspects of JTF 132. Detailed information regarding these subjects will be included in the History of Operation IVY and in the Technical Report on Communications contemplated in paragraphs 50a(1) and (2).

3. The planning date of 1 October 1952 was established for detonation of the MIKE device per J.C.S. 2179/13 and J.C.S. 2179/15. The scheduled shot date of MIKE was changed to 1 November 1952 per J.C.S. 2179/26. In the report by the Commander, Joint Task Force 132 (CJTF 132), to the Executive Agent, dated 21 August 1952, CJTF 132 stated that the Task Force was prepared to conduct its first test (MIKE) on schedule, 1 November 1952, and that the KING weapon would be detonated as soon after 1 November 1952 as possible, probably by 15 November 1952.

a. Actual detonation dates occurred as follows:

(1) MIKE - 1 November 1952

(2) KING - 16 November 1952

b. The ability of the Task Force to meet the operational dates as scheduled is attributed to the following important factors:

[redacted]

(1) The successful prognostication of favorable weather on the scheduled dates. (Paragraph 26 deals with the details in this respect).

(2) The ability of the Task Force to conduct the operation as planned in all its essential features.

4. The conduct of operation IVY indicates the effectiveness of planning in considerable detail an operation of this nature well in advance and then initiating the operational phases by brief operational directives.

DETONATIONS

5. MIKE Device

a. Objective of Detonation. The objective of MIKE shot was to test by actual detonation the theory of design for a thermonuclear reaction on a large scale, the results of which could be used to design, test and produce stockpile thermonuclear weapons.

b. General Description. The MIKE device was [redacted] 20' 3 5/8" in length by 6' 8" in diameter. This device, weighing approximately eighty-two tons, consisted of several major components or functional parts. They were:

[redacted]

(5) the external cast steel case; and

(6) the associated cryogenics system external to the device itself.

c. Critical Materials. [redacted]

[redacted] [redacted]

d. Operation. [redacted]

e. Yield. The yield of the MIKE device is considered to be within the range of six to twelve Megatons (MT). A better yield figure is not available at this date pending a more complete analysis of test data.

f. Remarks. It is desirable to point out that the thermonuclear device tested was not a weapon. All of the diagnostic experiments were designed to measure certain specific reactions in an effort to confirm the predictions of theories that went into the design of this device. This type of thermonuclear device may be adaptable to a major redesign for weapon purposes. It is believed that the overall size and weight can be reduced and that the cryogenics system can be simplified to make a usable weapon.

6. KING Weapon **BEST AVAILABLE COPY**

a. Objective of Detonation. The objective of the KING shot was to [redacted]

b. General Description. [redacted] The KING shot was air-dropped using a modified fusing system on the bomb to permit a 1,500 foot height burst.

[redacted]

c. Critical Materials. [redacted]

[redacted] d. Operation. The standard implosion system [redacted] caused the large mass of active material within the pit to be compressed into a super-critical mass which fissioned. [redacted]

e. Yield. The preliminary estimates of yield are given by radiochemistry to be 550 ± 50 KT, while the photographic analysis indicates the yield to be 570 ± 30 KT. It therefore seems probable at this time that the yield for the KING shot lies in the range of 530 to 600 KT.

f. Remarks. [redacted] The KING shot provided valuable information on thermal, blast and radiation effects of high yield fission weapons.

EXPERIMENTAL PROGRAMS

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7. Introduction. The following paragraphs present an outline of the objectives, methods and general results of the experimental programs. At such an early date only the most preliminary results can be presented. For some projects, in fact, the only result than can be presently stated is that data was or was not obtained. It should be stressed that conclusions based on the information contained herein may be inaccurate since more extensive data reduction often leads to different results. Attached to this report are Appendices A through K covering the results of the scientific projects in as much detail as is available at present, together with statements on the objectives of each test and methods of obtaining the information. Effort has been made to give more detailed information on projects having opera- [illegible] ving purely diagnostic information are presented in much simpler form. This has been done to increase the operational value of this report.

8. Program 1 - Radiochemistry. The objective of this program was the collection and radiochemical analysis of atomic debris samples, the primary purpose of the analysis being the determination of yields. For MIKE shot, an attempt was made to obtain pertinent diagnostic information (whether or

[redacted]

not, and to what extent, the desired thermonuclear reaction took place and propagated) by means of further analysis designed to detect activity in selected "tracer" materials [redacted] quantities of which were built into or placed in the vicinity of the device.

The quantity of gaseous and particulate atomic debris samples collected from the detonation induced clouds, utilizing collectors mounted on manned F-84G aircraft, was adequate. The aircraft were based on Kwajalein and required inflight refueling to accomplish their mission. Shielded flight clothing to reduce radiation exposures was effectively used on MIKE shot by the pilots of these aircraft. Instrumentation of the clothing indicated that low energy gamma radiation was present in the MIKE cloud during some of the penetrations. The radiation exposures received by these pilots were in all cases well within the prescribed limits. Laboratory analysis, which is being accomplished at Los Alamos Scientific Laboratory (LASL) is not complete as of this writing. Preliminary analysis, however, indicates the yield of MIKE shot as 5-7 MT and of KING shot as 550 ± 50 KT. The discrepancy between this yield for MIKE shot and that given by ball-of-fire photography (see the discussion of Program 3 herein) has not yet been resolved. At present, however, it appears that the ball-of-fire result is more reliable.

9. <u>Program 2 - Progress of the Nuclear Reaction</u>. This program was designed to analyze the performance of the device and the weapon, utilizing various diagnostic measurements. New and untested experimental techniques were used on MIKE shot; hence the large amount of data obtained was very gratifying. For MIKE shot, measurements were made of alpha (logarithmic rate of rise of the nuclear reaction) of the [redacted] trigger" bomb; the time from the [redacted] reaction to the beginning of the thermonuclear reaction; the time characteristics of the thermonuclear "burning" [redacted] of the device; the rate of propagation of the thermonuclear reaction; and the energy spectrum of the neutron flux. The data for these measurements was recorded in a concrete bunker 9,000 feet from the device, and connected to the device cab by a helium filled tunnel through which gamma ray and neutron signals could pass with little attenuation. [redacted] All other MIKE shot

[redacted] [redacted]

[redacted]

measurements were highly successful.

For KING shot, alpha and transit time (time from firing signal to first nuclear reaction) were measured, the latter by a remote measurement technique capable of tactical utilization. [redacted]

[redacted]

10. Program 3 - Scientific Photography. This program had many objectives, each of which involved photographic documentation of some aspect of the detonations. Ball-of-fire growth, cloud development and illumination versus time were measured for both shots. For MIKE shot, an indirect measurement of the internal temperature distribution was made by observing the light signals from selected spots on the outer surface of the steel case. The very early MIKE case disintegration was observed by high speed photography and the MIKE crater structure was documented by pre-shot and post-shot aerial photography. For KING shot, the precise position of the burst was measured. In addition, Bhangmeters (devices designed to obtain a remote and quick yield result from light signal observation) were utilized for both shots.

Generally speaking, three types of cameras were used to accomplish the above - one type producing a record made up of a number of discrete photographs or frames; another producing a continuous "streak" record; and a third producing a single picture at a known time after detonation. Depending upon the phenomenon being photographed, film speeds from sixteen frames per second to 3,500,000 frames per second were utilized.

A great amount of data was obtained in spite of some equipment failures. Most of the film records have yet to be completely analyzed, but preliminary analysis of the fire ball growth films indicates the following yield values:

a. MIKE Shot 12 ± 1 MT

b. KING Shot 5[illegible]0 ± 50 KT

The KING shot burst position was determined to be:

a. Circular Error 570 ± 35 feet

b. Height of Burst 1480 ± 20 feet

c. Designated Height of Burst 1500 feet

11. Program 4 - Neutron Measurements. Program 4 was primarily devoted to the measurement of total numbers of neutrons, in various known energy

[redacted]

[redacted]

[redacted]

ranges, arriving at fixed points on the ground. Such neutron "counting" is accomplished by laboratory analysis of the neutron induced radioactivity in selected "threshold detector" materials such as gold, tantalum, indium, iodine, zirconium and others. For each shot, many detector stations were established in radial lines extending outward from ground zero. In addition, an attempt was made to measure the total number of neutrons arriving at a few selected points as a function of time, utilizing a device known as a "Fission-Catcher Camera". The basic difference between these two measurements should be noted. The first allows only a counting of neutrons and provides no information as to when a particular neutron arrived, whereas the second does allow such a time separation.

Since the detector station positions for MIKE shot were selected on the basis of an expected relatively low yield, many of the samples were lost. Thirty-five samples were recovered, however - some from within the weapon crater - and are being analyzed at the present time. Thirty-eight of the KING shot samples were recovered and are also undergoing analysis. All of the "Fission-Catcher Cameras" were destroyed by the blast.

The relatively large amount of measurement station destruction and resulting potential data loss suffered by this program is not indicative of a poorly designed experiment. The high attenuation of a neutron signal passing through air dictates that such stations must be relatively near ground zero and the value of such close-in data is well worth the risk of losing an inexpensive station. One of the great potential values of these neutron measurements is to explain why a device failed or detonated with a yield much lower than predicted.

12. <u>Program 5 - Gamma Ray Measurements</u>. This program was devoted to studying the phenomenology of a detonation. Measurements were made of the gamma ray intensity as a function of both time and distance, including that due to fall-out and of the total gamma ray dose as a fu[illegible] The close-up instrumentation was also designed for diagnostic studies and studies of shock wave effects upon gamma radiation. The more distant instrumentation was concerned largely with fall-out and included utilization of several newly developed collection and recording devices.

Total dose was measured with film badges on both shots, many badge

[redacted]

[redacted]

[redacted]

stations being established on radial lines extending from ground zero. Close-in intensity versus time (one ten-millionth of a second time resolution) was measured with phospor-photocelloscilloscope-camera combinations for the first few seconds. More distant intensity versus time measurements (few seconds time resolution) were made with ionization chamber-recorder combinations. Fall-out samples were collected both over land and over water at selected points ranging from a few to several hundred miles from ground zero.

For MIKE shot, the film badge stations were nearly all destroyed. Meager data will be extracted, however, from those more than 4,500 yards from ground zero. High resolution intensity records were obtained in sufficient quantity to indicate the pronounced effect of the shock wave and to measure the time [redacted] Lower time resolution intensity records were obtained on seven islands of Eniwetok Atoll. Thus far no such data has been recovered from the off-atoll stations, although fall-out has been recorded on Kusaie Island and Ujelang Atoll. Usable fall-out samples (some of them as a function of time) were collected on the islands of Eniwetok Atoll, on rafts in the lagoon, on buoy-type sea stations and at other atolls. It is expected that analysis of these samples and the ionization chamber-recorder data will definitely augment understanding of the overall fall-out hazard problem, particularly because of the time dependence of portions of the data.

For KING shot, the film badge stations out to 1,200 yards were destroyed, apparently by a large block of concrete which rolled down the line wrecking both film badge and neutron detector stations. The remainder of the badges were recovered and are undergoing analysis. Usable intensity versus time data was obtained with both slow and fast time resolution. It is interesting to note that the peak radiation level on Runit (2,000 yards from ground zero) was 5,000 roentgens (r) per hour five seconds after zero, and had dropped to one-half r per hour approximately one minute later. No significant fall-out was recorded on any other island of the atoll and none was reported at any off-atoll station at this writing. Samples were obtained from twenty-four fall-out collector stations on islands on the atoll. These samples exhibited extremely low activity, however, indicating from very slight to no fall-out.

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[redacted]

[redacted]

13. Program 6 - Blast Measurements. This program was designed to study the characteristics of the MIKE and KING blast waves, their propagation through air, water and earth, and their transient effects upon these media. In particular, data was sought to document pressure versus time as a function of distance from zero at the surface; material velocity behind the shock front at known positions in space; shock wind, afterwind and sound velocity before, during and after blast wave passage; water surface motions in both deep and shallow water; sub-surface earth accelerations; sub-surface pressures in both deep and shallow water, to include acoustic pressure waves at great distances; air density versus time before, during and after shock wave passage; and air pressure versus time at known positions in space. The tremendous energy release associated with MIKE shot and the quasi-operational nature of the KING shot air-drop assured that great interest would be shown in this program by both the AEC and DOD.

The experimental techniques utilized to accomplish the above were too many and varied to allow description in a summary of this type. As an example, they included tiny self-recording "indenter" gauges and completely instrumented bomber-type (B-36D and B-47B) aircraft.

A large amount of usable data was obtained, every project reporting at least partial success in its cursory report in spite of unforeseen difficulties due to inclement weather. Some tentative conclusions that can be drawn are:

a. The basic blast pattern from nuclear explosions now appears to be established on quite firm theoretical and empirical grounds in a self-consistent theory beginning with the growth of the ball-of-fire and extending to pressures less than one pound per square inch.

b. Atmospheric inhomogeneities markedly affect the blast variables at great distances for large yield weapons. In particular, under normal temperature lapse rate conditions, peak pressures at great distances are markedly reduced.

c. Blast hydrodynamics offer considerable immediate promise as a diagnostic tool on tests of atomic weapons.

The following facts of interest have resulted from preliminary inspection of the data:

[redacted]

[redacted]

a. Water surface displacement was two to four feet at Runit Island and one to three feet at Parry Island for MIKE shot. The waves produced by this shot were, generally, much smaller than predicted, being approximately one-tenth of those expected within the lagoon and nonexistent in the open sea.

b. A newly devised light and inexpensive deep sea mooring, utilizing the top of under-sea mountains rising to some 5,000 feet under the surface, was proven highly successful. This ability to establish semi-rigid reference points in mid ocean may well offer a valuable contribution to ocean studies in general.

c. On MIKE shot, the B-36D horizontal tail bending moment was approximately sixty-two per cent of design limit, although bending moments in the wing due to gust were very low. At shock arrival, this aircraft was approximately 22.7 nautical miles from ground zero at an altitude of 40,000 feet.

d. Identical peak pressures were measured on Parry Island for MIKE and KING shots - 0.36 pounds per square inch. This anomaly appears to be due to a refraction effect.

14. Program 7 - Long Range Detection. Program 7 was designed to aid in the development of and obtain calibration data for specialized equipment and techniques for the detection (an analysis, to whatever degree is feasible) of a nuclear explosion at great distances. The techniques utilized were extremely diverse in nature, covering the fields of electromagnetic radiation transport; airborne low frequency sound; seismic wave propagation; the detection of fire ball light; and the tracking, collection and analysis of airborne debris samples.

The quantity and general characteristics of the data and samples collected by this program are indicative of a successful operation, but practically no data has been reduced and analyzed in detail at this writing. Existing cloud cover and smoke obscuration make the Bhangmeter results appear questionable. Final conclusions, however, must await film analysis. Communication difficulties lessened the effectiveness of KING shot air sampling operations, but the samples obtained are adequate for at least partial analysis. MIKE shot air sampling was more successful. Most remote stations reported reception of excellent signals in conjunction with MIKE shot. For

[redacted] [redacted]

KING shot, no reports have yet been received from these stations, but no difficulty is anticipated.

15. Program 8 - Thermal Radiation Measurements. This program was designed to investigate the thermal radiation emitted by an atomic detonation. Near the earth's surface, attempts were made to measure the total thermal energy received as a function of distance from ground zero; the time variation of thermal intensity received; and the energy spectrum exhibited by this radiation. In conjunction with these measurements, and to aid in the interpretation of results, the atmospheric attenuation (transmission property) along light paths of interest was studied. Instrumented bomber-type aircraft (B-36D and B-47B) were employed to study, in free air and at altitudes significant to delivery aircraft, the thermal intensity versus time and the associated radiation induced aircraft skin temperatures. The latter information is essential to studies of safe aircraft delivery techniques. The instrumentation utilized to accomplish the above included thermocouples, bolometers, photocell-recorder combinations, high speed spectrographs and skin patches.

Results were most gratifying, the only serious loss of data occuring in the "total thermal" project for KING shot. A great amount of data, the quality of which appears to be excellent, was obtained on both shots. Cursory analysis points out the following facts:

a. The apparent thermal energy of MIKE shot was at least 0.7 MT. This value is uncorrected for clouds and dust and hence is somewhat low.

b. On MIKE shot, the left wing access door of the B-36D experienced a temperature rise of 93°F. The thickness of the aluminum was 0.025 inches and the aircraft was approximately fifteen nautical miles slant range from zero at an altitude of 40,000 feet. This aircraft received a relatively high thermal flux of 46.9 BTU per square foot. The predicted value based on a 6 MT yield was 36 BTU per square foot.

c. The apparent thermal energy of KING shot was at least 48 KT.

16. Program 9 - Electromagnetic Phenomena. This program was concerned with the detection and measurement of various electromagnetic phenomena associated with nuclear detonations. One project studied the correlation between nuclear explosion induced ionospheric disturbances and the

interruption of radio communications. Another made a feasibility study of radar scope photography as an Indirect Bomb Damage Assessment (IBDA) technique. In addition, two projects concerned themselves with documentation of the broad band electromagnetic signal given off by the exploding detonation - one being particularly interested in selected "standard" radio frequency (20 kilocycle and 4.215 megacycle) bands; the other devoted to testing the feasibility of this technique for making remote diagnostic measurements, and hence being particularly interested in the early (first few millionths of a second) signal characteristics.

The techniques used to obtain data for the above included airborne radar scope photography, the reception and recording of selected radio transmission and the documentation of ionospheric height and continuity. Quantitative measurements of the gross explosion induced electromagnetic signal were made possible by first displaying portions of that signal on the faces of cathode ray tubes.

The results of this effort were excellent. All projects obtained usable data on both shots, the detailed reduction of which is being carried out at present. For MIKE shot, the early electromagnetic signal was displayed in sufficient detail to allow a rough measurement of the time delay between primary and secondary fission reactions. A Navy P2V aircraft flying 200 miles west of Eniwetok and transmitting a continuous wave signal to Bikini was able to contact Bikini approximately two hours after MIKE shot, indicating no long time disruption of the ionosphere. Also, for this shot, the radar scope photographs show both fire ball growth and shock progress.

17. <u>Program 10 - Timing and Firing</u>. The timing and firing program was primarily one of support rather than experimentation. As its name implies, it was devoted to furnishing the various experimental projects with required timing signals (for starting equipment) on both shots and with supplying the arming and firing signals to the MIKE device. In addition, vital information was telemetered from the vicinity of the MIKE device to the control room aboard the USS ESTES (AGC-12).

With the exception of a number of "Blue Boxes", which failed to trigger for MIKE shot, this program can be considered highly successful. A complete photographic record of the MIKE shot television monitoring was obtained.

18. <u>Program 11 - Preliminary Geophysical and Marine Survey of Test Area</u>

This program was designed to obtain detailed information as to the configuration and structure of Eniwetok Atoll in order that the effects of MIKE shot (and other high yield shots presently planned for future tests) upon that structure might be more readily and reliably interpreted. In addition, it included a study of the biological contamination effects resulting from an atomic burst near water.

Prior to MIKE shot, both acoustic soundings and seismic refraction surveys were conducted on and around the Eniwetok reef. Ground shock tests were accomplished in conjuction with high explosive detonations and two deep-drill holes were sunk to unaltered basement rock. In addition, samples of marine life were collected both before and after the shot in order that the biological effects of radiation contamination might be subsequently analyzed in the laboratory.

The only appropriate preliminary statement of results for this program is that usable data was recovered and is being reduced.

<u>OPERATIONS</u>

19. <u>Organization and Command Relationships</u>

a. Joint Task Force 132 was organized into a Headquarters and four functional task groups designated as:

(1) Task Group 132.1 (Scientific Task Group)

(2) Task Group 132.2 (Army Task Group)

(3) Task Group 132.3 (Naval Task Group)

(4) Task Group 132.4 (Air Force Task Group)

b. The basic plan for operation IVY was set forth in J.C.S. 2179/15. Forces were drawn from the Atomic Energy Commission and its contractors, and from the three Services. Appendix L depicts the general organization for operation IVY. Appendix M depicts the organization of the Headquarters, Joint Task Force 132. The peak task force strength overseas numbered approximately 11,000. Appendix N indicates the phasing of task force elements overseas.

c. Task Group 132.1 (TG 132.1), activated on 2 January 1951, was commanded by Mr. Stanley W. Burriss of LASL. TG 132.1 was responsible for designing and constructing all test facilities in the forward area and

[redacted]

conducted the experimental programs. The "J" Division of LASL, formed after operation SANDSTONE in 1948 to provide continuity in weapons tests activities and headed by Dr. Alvin C. Graves, formed the nucleus of TG 132.1. Actual design and construction of facilities and the operation of 31 boats and small craft were accomplished by the firm of Holmes & Narver, Inc., Los Angeles, California, which reached a peak strength of about 1,250 on Eniwetok Atoll. Other elements of TG 132.1 were drawn, under AEC contractual arrangements, from certain universities and from private industry or through assignment by CJTF 132 from military sources and Service laboratories. Approximately 113 officers and 171 enlisted men of the military Services were assigned to TG 132.1 to assist in administration or the conduct of experiments, as well as to receive special training. TG 132.1 was organized along military lines and at peak strength numbered about 2,124. The organization and missions of TG 132.1 are shown in Appendix O.

d. Task Group 132.2 (TG 132.2), activated on 1 August 1951, was commanded by Colonel George E. Burritt, USA. TG 132.2 operated all base facilities on Eniwetok Island; provided off-atoll communications, less Airways and Air Communications Service (AACS); and provided land security throughout the atoll. A force of 167 military police was assigned to accomplish this latter function. In addition, all military personnel on Eniwetok Atoll were organized and trained into a ground defense force capable of resisting hostile action, if such an emergency occurred. The peak overseas strength of TG 132.2 during the operational phase was approximately 1,230. The organization and missions of TG 132.2 are shown in Appendix P.

e. Task Group 132.3 (TG 132.3), activated on 8 February 1952 at Washington, D.C., was commanded by Rear Admiral Charles W. Wilkins, USN. The Task Group consisted of nineteen ships and thirty-five small craft. Naval air participation consisted of Patrol Squadron TWO based at Kwajalein with [illegible] USS RENDOVA (CVE-114). TG 132.3 conducted security operations in the forward area, served as an afloat base during MIKE shot evacuation and provided logistical and technical support to TG 132.1. All vessels were fully operational at the time of reporting to the Task Group and at peak strength the Task Group overseas numbered 5,437 personnel. The organization and missions of TG 132.3 are shown in Appendix Q.

[redacted]

f. Task Group 132.4 (TG 132.4), activated on 2 January 1952 at Kirtland Air Force Base, was commanded by Brigadier General F.E. Glantzberg, USAF. The Strategic Air Command (SAC), the Air Research and Development Command (ARDC) and the Military Air Transport Service (MATS) augmented the Special Weapons Center (SWC) in the organizing, manning, equipping and training of subordinate task units. The Air Materiel Command (AMC) provided technical and logistical support to the Task Group. TG 132.4 operated experimental and liaison aircraft and provided, in collaboration with other Task Force elements, such services as weather information, communications, search and rescue and documentary photography. During the training period, simulated operations were conducted and a complete, detailed rehearsal of IVY air operations was staged at Bergstrom Air Force Base in August, 1952. One F-84 was lost during the operational phase at Eniwetok, resulting in the death of the pilot. One RB-50 was destroyed with no personnel casualties. At peak strength the Task Group overseas numbered 2,518 personnel. The organization and mission of TG 132.4 are shown in Appendix R.

g. It is believed that a permanent Joint Task Force organization would result in more expeditious and economical progression of effort from one overseas operation to the next. A permanent organization would eliminate many of the following repetitive activities which have typified previous test operations due to the lack of continuity from one task force to another:

(1) Assignment, post-operation release and subsequent reprocurement of staff personnel indoctrinated in joint planning.

(2) Assignment, post-operation release and subsequent reprocurement of specialists and units specially trained for atomic energy test operations.

(3) Time consuming and costly processing of new AEC "Q" security clearances. **BEST AVAILABLE COPY**

(4) Activation, post-operation deactivation and subsequent reactivation of Naval small craft used in off continental tests.

(5) Modification, post-operation demodification and subsequent remodification of ships, aircraft and equipment employed in these test operations.

20. <u>Planning and Training</u>

a. Shortly after the organization of the JTF 132 Headquarters, Training Memorandum No. 1 established the policies for the familiarization and training of Headquarters personnel. The memorandum outlined a required background reading and orientation course; emphasized utilization of appropriate courses of instruction and orientation in the atomic field offered at Sandia Base, Albuquerque, New Mexico, and later at Maxwell Air Force Base, Alabama; and emphasized the importance of staff visits to installations and organizations concerned with the activities of JTF 132. Following this, Training Memorandum No. 2 set forth the military training policy of CJTF 132 for the personnel assigned to the Garrison Force at Eniwetok. This memorandum had as its purpose the welding into a combat unit all the various occupational grades making up the Garrison Force, as well as the orderly conduct of Task Force matters in the forward area.

b. As the mission and concept of operation IVY became known, Operation Order No. 1-52 was issued for the purpose of guiding the formation and early training of the Navy, Air and Scientific Task Groups. As the concept became more firm, Operation Plan No. 2-52 was issued. This plan was designed to cover final training throughout the Task Force and the movement overseas.

21. On-Site Operations and Rehearsals

a. Joint Task Force and Task Group command posts were established in the forward area by 17 September 1952. This marked the beginning of the operational (on-site) phase. Task Groups then prepared to receive and take operational control of major air and surface components allocated for IVY. Arrival of major components in the forward area was phased in accordance with the immediate operational needs of the Task Force. For example, the security vessels and aircraft assigned began arriving on 15 September 1952 to correspond with the arrival of RESTRICTED DATA materials; drop aircraft and aircraft instrumented for effects began arriving on 25 September 1952 for on-site rehearsals; and evacuation transports arrived on 20 October, in sufficient time for preliminary loading. Meanwhile, the following on-site activities commenced to increase in tempo by mid September:

(1) Construction of test facilities progressed substantially as scientific personnel arrived with instrumentation equipment and supervised its installation and calibration. Concurrently, basic survey and

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construction work was begun at Bikini in preparation for operation CASTLE.

(2) Port operations and air traffic reached a peak as a result of the influx of materiel and personnel.

(3) Assembly of the MIKE device components and preparation of its circuitry and cryogenics systems commenced.

(4) Electronics and communications check-outs were conducted with aircraft and vessels involved in the scientific measurement programs.

(5) Security surveillance and weather reconnaissance activities were intensified.

(6) Refinement of operational procedures for inter-atoll and intra-atoll air and surface lift was made to effect maximum utilization of capabilities provided.

b. By 20 October, all Task Force elements had arrived and Task Groups were near peak operational strength. Rehearsals for individual phases of the overall operation had already been taking place preparatory to a full Task Force final rehearsal, MIKE XRAY Day (MX Day). The conduct of a full rehearsal was complicated by the need for remaining time to be devoted to actual preparation for the test without interrupting the effort with rehearsal; the requirement for an inflexible period of three days between MX Day and MIKE Day (M Day) for cryogenic servicing of the MIKE device; and exceedingly poor weather conditions. However, on 28 October, the Task Force final rehearsal was conducted with limited air participation due to unfavorable weather at Kwajalein. The MX Day rehearsal was successful with no serious discrepancies disclosed in any phase of the operation. The MIKE device was successfully detonated as scheduled on 1 November 1952. The magnitude of detonation did not pose any serious obstacles to completion of scientific tests or data recovery, nor did it result in any significant damage to installations on Parry and Eniwetok Islands. On 9 November, a final rehearsal for the KING event, KING XRAY Day (KX Day), was conducted. As pre-shot evacuation of the Task Force was not necessary for the KING event, and as there were no thermonuclear or cryogenics problems involved, the KING shot phase of the operation was handled as a conventional air-drop test. Experience gained by air elements during MIKE shot and perfect weather conditions on KX Day contributed to the complete success of the KING

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rehearsal. After two postponements due to unfavorable weather the KING weapon was successfully detonated on 16 November 1952, three days beyond the 13 November date planned at the time of reentry after MIKE shot.

22. Operations Afloat **BEST AVAILABLE COPY**

a. Because of unknown factors involved in a detonation of the magnitude of MIKE, complete evacuation of Eniwetok Atoll was required for this phase of the operation. The CJTF 132, CTG 132.1 and the weapons party established their command posts for this period aboard the USS ESTES (AGC-12); CTG 132.2 established his command post on the USNS COLLINS (TAP-147); and CTG 132.3 was in his flagship, the USS RENDOVA (CVE-114).

b. With the exception of the small weapons party and an upper air sounding team, evacuation -- begun on M-4 days -- was practically completed by 2000 on M-1 day. CTG 132.4 boarded the ESTES at 1700 to act as Staff Air Controller. The weapons party boarded the USS CURTISS (AV-4) by 0125. The evacuation fleet, under the operational command of CTG 132.3, was clear of the lagoon by 0315 and the last ship was on station by 0445.

c. At the time of detonation all ships were in a sector bearing northeast to south, at a distance of thirty miles or more from ground zero. The exact position of several of the ships was dictated by their use as recording and measuring stations in various scientific programs.

d. The ships remained at sea until a radiological safety survey of the lagoon was made. Upon completion of this survey on the morning of M/1, reentry into the lagoon was commenced. With the completion of surveys of the camp areas the movement of personnel ashore was begun.

23. Post-Shot Reentries

a. Within one hour after the MIKE detonation, reentry operations commenced by helicopter launched from the RENDOVA at sea. Movement of the Task Force ashore was geared to reactivation of facilities and was completed by M/4 days. On M/1 day, radiological safety (RadSafe) conditions permitted general reentry into the atoll by the Task Force and on M/2 days the Task Force moved ashore. As radiation levels on the instrumented islands decreased, recovery operations progressed. By M/12 days all significant data was recovered.

b. Recovery operations following KING shot posed fewer obstacles than those following MIKE. As the KING detonation was an air-drop, radiation levels were almost negligible. Thus, recovery schedules were advanced and recovery work was completed by K/7 days with excellent data obtained.

24. <u>Disposition of Forces and Equipment</u>

a. As tasks were completed, units of the Task Force were deployed and individuals returned to the ZI or reassigned in a normal phasing out process immediately after KING shot. As operation CASTLE had been programmed to follow IVY after only a short interval of time, the roll-up of IVY was planned in such a manner as to provide for continuity of operations and for economical, expeditious support of CASTLE.

b. Consideration was given to the savings which would accrue through reassigning to the Task Force certain ships, boats and aircraft already activated and modified for IVY at substantial expense. Retention of planning staffs and certain troop elements was also accomplished.

25. <u>Search and Rescue</u>. Throughout the operation, search and rescue (SAR) responsibility for the Task Force was assigned to CTG 132.4. This proved to be a workable arrangement in view of his proximity to the Kwajalein Area SAR Coordination Center during the less critical periods and the versatility of control facilities available to him during rehearsals and shot periods in his Air Operations Center in the Combat Information Center (CIC) aboard the ESTES. Winch and float equipped helicopters, radar equipped P2Vs, destroyers and AVR crash boats combined with airborne control aircraft and the latest type fixed radar equipment of the ESTES provided superior SAR capabilities. To provide a margin of safety appropriate to extensive over water jet fighter operations, including inflight refueling, two "dumbo" equipped SB-29s and two SA-16 amphibious aircraft were assigned to remain airborne throughout critical periods.

26. <u>Weather</u>

a. The weather problem in operation IVY was one of the most difficult in the history of meteorology. Total requirements for weather; the absolute demands with respect to terminal conditions at Eniwetok and Kwajalein plus the air route between the two locations; and the rigorous conditions of minimum acceptability of upper wind structure controlling radioactive fall-out throughout the Marshall Islands created a problem with only

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a remote probability of all conditions being favorable.

b. The fact that the problem was solved successfully should not be permitted to obscure one important fact. MIKE was detonated on the only day during a period of almost a whole month on which acceptable conditions prevailed. Conditions were unacceptable for the fourteen days preceding and the nine days following 1 November. The fact that the weather organization was able to recognize and predict conditions for that one day reflects great credit on the Task Force Weather Central and its supporting components on the outlying islands. KING shot was no less complicated because of the added requirement for a visual drop.

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c. It is clear that more flexibility must be built into subsequent overseas tests in order to prevent costly delays which commit key scientific and military personnel and equipment for long periods of time. First, consideration should be given to planning for the most favorable period of the year, January - April. Secondly, all participating programs such as sampling, photography and scientific diagnosis must be made aware of the fact that imposition of individual weather requirements can eventually create an insolvable problem. It is vital, therefore, that demands be held to a minimum. In this respect, all efforts should be extended to simplify the cloud sampling problem. Finally, an effort should be made to schedule all shots not earlier than noon in order that weather reconnaissance aircraft may be effectively employed during the forenoon hours in formulating the final command decision, especially with respect to weather in the local area.

27. Radiological Safety. (See Appendix S).

28. Documentary Photography. Operation IVY was documented by the utilization of both still and motion pictures depicting the scope and conduct of the operation. The motion picture film depicts on-site operations and those activities of pre-operational nature which were necessary to give it proper continuity. Lookout Mountain Laboratory (LML), an Air Force organization, fulfilled all the film requirements and functioned as the documentary photographic unit of Task Group 132.1.

29. Official Observers

a. As a result of the difficulties experienced by previous task forces with their respective official observer programs, it was hoped that the program for IVY would preclude two of the most serious pitfalls, namely, the nomination of official observers too late to make adequate preparations for their orientation and the nomination of individuals as observers who [illegible]

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not invited principals but administrative or officer assistants. In spite of early planning it was not possible to secure firm lists of nominations from DOD and AEC agencies. Also, similar to past experience, not all the principals invited could make the trip with the result that assistants were designated as the official observers.

b. The official observer program in the forward area included inspections of the shot island, the MIKE device and related instrumentation as well as briefings regarding Army, Navy and Air Force operations and participation in the scientific programs.

c. Notwithstanding the difficulties experienced during IVY and by previous task forces, it still appears a sound concept to attempt to secure the names of the nominated observers well in advance of the event so that planning may proceed on an orderly and timely basis. Efforts should be extended to insure the participation on a need-to-know basis of the very important people nominated and not their administrative assistants.

d. It is clear that the Task Force must accept the responsibility for the conduct of the official observer program as it is futile to attempt to have any other agency assume this responsibility. The Task Force can best recommend the number of observers who can be accommodated with the available facilities, the schedule of orientation, the transportation involved and the housekeeping required as well as the handling of all the preliminary arrangements.

30. Hostile Action Alert Plans. CJTF 132 was charged by the Commander in Chief, Pacific (CINCPAC) with the responsibility for security of the Eniwetok Atoll area. During the absence of CJTF 132 from the forward area during the planning phase of IVY, the Commander, Army Task Group, as Atoll Commander, Eniwetok, discharged this responsibility. Hostile action alert plans during the pre-operational phase took cognizance of the probability that direct enemy interest in the Eniwetok area would more likely manifest itself during the operational phase when sensitive materials were present and critical operations were underway. However, during the pre-operational period all military personnel of the Garrison Force (TG 132.2 Service troop elements, augmented by small Navy and Air Force detachments) were trained as a ground defense force. The nucleus of this force was a mobile, company

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size unit capable of rapid employment against an enemy reconnaissance landing, a sabotage effort or limited ground attack. During the operational phase, CINCPAC provided Navy forces consisting of an escort aircraft carrier, six F4U fighter aircraft, four TBM aircraft, four destroyers, a P2V patrol squadron and an underwater detection unit for harbor defense. These forces provided adequate surveillance of the Eniwetok Danger area.

SIGNAL COMMUNICATIONS AND ELECTRONICS **BEST AVAILABLE COPY**

31. Introduction. Principal administrative communication facilities for JTF 132 consisted of a direct radio teletype circuit to Los Alamos, N.M., and to the Army Primary Relay Station at Oahu from the Parry Island communications center, the latter of which served as a minor relay center in the Army Command and Administrative Network. The control and keying of all circuits was at Headquarters, JTF 132, Parry Island, with transmitting and receiving equipment on Eniwetok Island. When the command was moved afloat for MIKE shot, communications equipment of the ESTES replaced the land based equipment which was closed during the period of operations. The lower power of the ship's transmitters made it necessary for Honolulu to take over the control of the Los Alamos direct circuit. The close proximity of so many relatively high power transmitters and such sensitive receivers as were necessary for the operation generated considerable mutual interference. Ionospheric disturbances temporarily interrupted communications at infrequent periods of relatively short duration. The transfer of communications from land based to water based and return was rehearsed several times to insure smooth operation. After MIKE shot, administrative communications remained land based. With the departure of Headquarters, JTF 132, from the forward area, the control of all circuits reverted to CTG 132.2 on Eniwetok Island.

32. Signal Security. The Signal Security Detachment of Headquarters, JTF 132, monitored all Task Force circuits for security violations and for traffic analysis. Particular attention was given to voice radio circuits. Security violations which were detected were handled in accordance with existing security regulations.

33. Command Communications.

a. During the pre-operational period, communications were established as shown in Appendix T. During the operational period for MIKE shot,

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communications were converted to those shown in Appendix U. The use of discone antennas enabled the AN/TRC to be used between shore and ship without respect to the heading of the ship. Extensive use was made of SCR 508 radio sets for communications for transports and small craft. For KING shot, operations were conducted from Parry Island. Headquarters, JTF 132, with the Joint Operations Center, RadSafe Center and Weather Office, was reestablished ashore. Movement of communications facilities from ship to shore was conducted in accordance with prior planning which proved sound inasmuch as communications for KING were adequate and efficient. The Weather Central and TG 132.2 were reestablished on Eniwetok Island, while TG 132.1 was reestablished on Parry Island and Headquarters, 132.3 remained in the RENDOVA. The CIC Air Operations Center was maintained aboard the ESTES. Messages routed over the long haul communications channels suffered some delay due to misrouting. Also, the time required in the communications center for encrypting messages appeared excessive.

b. It appears that the wide separation between CJTF 132 and CTG 132.4 was detrimental to cohesive staff action, lowered the administrative and operational efficiency of the Task Force and contributed to security violations due to the exchange of planning information over the air. It is further concluded that the operation of the Task Force afloat was less efficient than it would have been had the facilities been established ashore. This was due to the wide dispersion of JTF 132 Staff personnel among the several ships, the inclusion of scientific personnel in the crowded quarters afloat, the congestion of operating facilities and the radio interference generated by the close proximity of the numerous relatively high powered transmitters and sensitive receivers. It is also concluded that more space should be provided ashore for cryptographic and communications center facilities.

34. Scientific Electronics. The various scientific projects engineered their own communications facilities utilizing frequencies assigned through Headquarters, JTF 132. There were no reported failures of these facilities and interference to them was negligible.

35. Test Measurement Communications. Test measurement communications were conducted over telemetered radio circuits and over landlines to recording

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equipment on Parry and Eniwetok Islands. During MIKE shot these facilities were operated unattended.

36. Firing Circuits. Firing circuits were installed and operated by Program 10 personnel as previously described.

37. Timing Signal Net. Local time signals to aircraft and scientific projects were broadcast by Headquarters, TG 132.1, on 126.18 Mcs. Headquarters, JTF 132, monitored, recorded and relayed these signals to each of the major ships. These signals were then disseminated over the general announcing systems of these ships. Long range timing signals were broadcast over two frequencies simultaneously by Headquarters, JTF 132. The circuit was keyed by the automatic keying device known as ARPACAS and was relayed by USARPAC employing a 15 KW transmitter at Honolulu. The output of the relay transmitter was beamed toward San Francisco and Alaska for ultimate receipt by using agencies.

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SECURITY, INTELLIGENCE AND PUBLIC INFORMATION

38. Security

a. Security for operation IVY was maintained in accordance with applicable AEC and DOD regulations and directives. Fourteen Security Letters were published by Headquarters, JTF 132, to provide specific instructions for the Task Groups in such matters as personnel clearance, security indoctrination, badge identification and security couriers. All personnel who required access to RESTRICTED DATA from AEC contractors were processed for "Q" clearances. All other members of the Task Force were processed for National Agency Check clearances. The CJTF 132 was not authorized to impose censorship of personal mail. However, self-censorship was stressed throughout the entire operation.

b. Coordination was maintained with the FBI, CIC, CID, OSI and ONI in all areas in which elements of the Task Force operated. Security plans for such activities as the shipment of nuclear material to and from the forward area involved all of the above agencies as well as military protection provided by CINCPAC and JTF 132.

c. Three instances involving breaches of security are as follows:

(1) On 1 November 1952, a SECRET-SECURITY INFORMATION message giving time and detonation of MIKE was transmitted in the clear from the

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USNS DAVID SHANKS (TAP-10). Though the reasons underlying the breach of security are not clear-cut, it was not intended that any message relating to test programs be sent from transports to destinations outside the area. However, this was done through error by the officer in charge of a test program.

(2) There were sixteen separate newspaper accounts describing MIKE shot. These "eyewitness" accounts derived from letters written by personnel in the forward area to friends, relatives or families. All personnel, who have been identified, have admitted they were indoctrinated in security precautions and self-censorship. Censorship of personal mail was studied during the planning phase of operation IVY and was not used for a number of reasons peculiar to the nature of the Task Force and its mission. Primarily, considerations were logistical and legal. The logistical aspects of the operation demanded that personnel be returned to rear areas by increments both before and immediately after each shot. After departing the forward area the personnel comprising these increments would seldom remain under Task Force administration or operational control nor be subject to Task Force censorship. Such an absence of the means for consistent control over personnel would, in a large measure, serve to defeat the intent of any censorship regulations which might have been applied, the net effect being merely a delay in the opportunity to send an uncensored letter. With respect to the legal aspects of censorship, it should be noted that peacetime censorship of personal mail cannot be established except by the President or Secretary of Defense. Considering the unusual status within the Task Force organization of the many civilians - both scientific and contractor - complete Task Force censorship for civilians could have been established only through recourse to special legislative action. It is doubtful if this could have been secured. Censorship of personal mail in previous atomic test operations overseas has never been applied nor was it being used in Korea. If it had been established for operation IVY, it was felt in many quarters that it would have invited attention to the operation in such a manner as to indicate that special significance was attached to JTF 132 activities. Such attention might possibly highlight the Eniwetok tests in a manner considered undesirable and inconsistent with AEC public announcements. Censorship would serve only to delay disclosure of information. It is believed that a

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prompt AEC-DOD announcement immediately after each test would remove the extremely difficult problem of trying to keep from public knowledge unauthorized information of the fact that a test had occurred.

(3) A briefcase containing information classified up to and including SECRET-RESTRICTED DATA-SECURITY INFORMATION was left in the Officers' Quarters at Fort de Russy, T.H., by a member of the Scientific Task Group. The incident became known to the press in Hawaii and caused considerable undesirable press comment. The briefcase was determined to have been in military custody at all times until delivered to AEC authorities.

(4) All instances related above are presently under investigation by the Service agency concerned, the FBI and the AEC.

39. Intelligence

a. Intelligence summaries, as well as estimates and comments received from intelligence departments and Service agencies, were evaluated and collated so as to determine their effect upon the plans and operations of the Joint Task Force.

b. Contact reports in the forward area received immediate evaluation. None of the several reports received were determined to have derived from an enemy source.

40. Public Information

a. The public information policy was tempered by the realization that the IVY tests would exert greater impact upon United States foreign and domestic policies than previous tests. Consequently, the policy as resolved by the National Security Council called for a minimum of public reporting on the tests. This reporting was to be limited to one brief announcement after the tests in addition to the two brief pre-test announcements on the organization and timing.

b. Prior to receipt of the National Security Council decision on the Public Information Plan for operation IVY, the CJTF recommended to the Chief of Staff, U.S. Army, Executive Agent, that an AEC-DOD announcement be made immediately after each shot. Two reasons appeared pertinent at that time. First, personnel in large numbers would be released for return to the ZI immediately after MIKE shot, thereby increasing the danger of uncleared statements reaching the public. Secondly, if the press learned of the [illegible]

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prior to final announcement, the Commander, his Deputies and high ranking observers would be constantly beseiged for statements. Subsequent events have proven the desirability of an official announcement after each shot.

LOGISTICS

41. Transportation

a. Shortly after activation of the Task Force, CINCPAC published directives outlining broad policies and procedures for control of MATS airlift and Military Sea Transportation Service (MSTS) surface transportation allocated for JTF 132 use. Personnel and cargo space requirements via air and surface were submitted by the task groups, including AEC and its contractor, to CJTF 132 for screening, consolidation and submission through normal channels to the Executive Agent.

b. Shipment of personnel and equipment from the West Coast to the forward area and return was accomplished primarily by MATS aircraft and MSTS ships, exceptions being shipments via vessels of the Naval Task Group, aircraft assigned to the Navy and Air Force Task Groups and Special Missions. Special Air Mission (SAM) flights were requested for key Staff personnel, VIPs, return of radiological samples and critical priority material.

c. Phasing of personnel to the forward area began in March 1952, and was completed in October. Shipment of supplies and equipment proceeded on a continuous basis. The required types of equipment presented a problem in that more deck stowage was necessary than was normally available and vessels calling at Eniwetok Atoll had to be self-sustaining inasmuch as heavy lifts could be discharged only when adequate ship's gear was available.

d. To facilitate and expedite the processing and movement of Task Force personnel and equipment through transshipment points, liaison officers were stationed at Naval Supply Center, Oakland, California; Travis AFB, California; Hickam AFB, Oahu, T.H.; and a Movement Control Agency which was established at the Naval Station, Kwajalein Island, M.I. (NAVSTAKWAJ). The three liaison officers first noted above were further designated as Movement Control Agents to insure that security policies were carried out in accordance with CINCPAC instructions.

e. During operation IVY some 157 vessels were employed to transport 2,662 passengers and 143,447 measurement tons of west and eastbound cargo, exclusive of personnel and cargo carried in Navy Task Group ships. A total of 12,235 passengers and 2,225 short tons of freight were airlifted west and eastbound. Appendix V indicates the number of personnel and tons of cargo moved by air and water transportation to and from the operational area.

f. The transportation organization at Eniwetok consisted of a small Port Command, a transportation stevedore company (less one platoon), a transportation truck company and a small MATS terminal detachment.

g. Inter-atoll transportation was provided between Eniwetok and Kwajalein Atolls and the weather islands of Bikini, Ponape, Kusaie and Majuro. This service was provided by the USS LST 836, the USS OAK HILL (LSD 7), two PBM-5As of the Navy Task Group and four C-47s of the Air Force Task Group.

h. Intra-atoll transportation consisted of small craft, liaison aircraft and helicopters. The requirement and utilization of this equipment was based on essential operational needs only. Appendix W shows the performance data on this type of transportation for the months of July through November 1952.

42. Shot Phase Evacuation

a. Preliminary planning for operation IVY envisaged the evacuation of all personnel and movable equipment from Eniwetok Atoll prior to MIKE shot. Based on a later evaluation of probable shot effects, this concept was revised to cover all personnel and only equipment of a delicate or costly nature.

b. To accomplish this mission, an Evacuation Committee was established, composed of designated representatives from each element of the Task Force. The committee formulated the evacuation policies and procedures and monitored the execution thereof. Some of the major problems confronting the committee were the loading and stowage of equipment; movement of personnel and equipment from the northern islands to Eniwetok or Parry Islands; securing of vehicles, small craft and aircraft against possible damage; coordinating the movement of evacuation craft; establishing communications from shore to ship and between vessels; and the rehearsal, actual embarkation, billeting and mustering of personnel aboard ships.

c. The evacuation proceeded as planned, commencing 1300 hours on

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M-4 days. Approximately 3,000 personnel were evacuated to eleven Naval vessels, including two MSTS transports. Fifty percent of this number were embarked by 1800 hours on M-2 days and the remaining personnel were aboard by 2000 hours on M-1 day. All vessels proceeded to sea on schedule. Reentry into the atoll commenced on M/1 day and was handled as expeditiously as facilities ashore became available. All personnel were debarked by M/4 days.

43. Supply

a. Supply support of operation IVY was divided into two distinct but concurrent phases. One phase covered the period of organization, planning and training in the ZI and the other entailed the supply build-up in the forward area.

b. In the ZI, normal support of the military elements of the Task Force was provided by the respective Services through the appropriate field commanders while support of AEC elements was provided by LASL and associated activities.

c. In the forward area, military elements were provided routine support by ZI activities with the exception of POL supplies. The Army Task Group was supported by the Overseas Supply Division, San Francisco Port of Embarkation (SFPE); the Navy Task Group by Naval Supply Center (NSC), Oakland, California; and the Air Force Task Group by Sacramento Air Material Area (SMAMA), Sacramento, California. Emergency support was provided by USARPAC, COMSERVPAC and Hickam AFB. The AEC elements in the forward area were supported in the same manner as in the ZI, utilizing military port and shipping facilities. All POL support in the forward area was provided by Commander, Service Forces, Pacific Fleet (COMSERVPAC).

d. Technical and non-standard items peculiar to operation IVY were obtained from commercial, AEC or Service sources by special arrangements in each instance.

e. No major problems of consequence were encountered in the supply of the Task Force with the exception of the usual difficulties encountered in the fulfillment of late requirements. There was considerable delay in obtaining certain items of Air Force technical equipment due to the inadequacy of the precedence rating initially assigned by Headquarters, USAF. This resulted in delivery of large quantities of equipment and spares to the

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West Coast late in the operational phase which, in turn, resulted in heavy airlift requirements to meet operational dates in the forward area.

44. Hospitalization, Evacuation and Sanitation

a. Medical facilities and procedures in the forward area were adequate. All emergencies were met without difficulty and facilities could have been readily expanded in the event of an epidemic or catastrophe. Cases requiring lengthy hospitalization and those which could not be properly treated in the forward area were evacuated by air to Tripler General Hospital, Honolulu, T.H. During the operational phase fourteen patients were evacuated.

b. Sanitation in the forward area was maintained at a high standard by continuous liaison and close cooperation between the medical authorities and the operating activities.

c. The health of the command was superior. Personnel in hospital or on quarters status never exceeded 0.4% of total strength and average between 0.2% and 0.3%.

45. Maintenance

a. Maintenance of the fixed plant in the forward area was a responsibility of AEC on Eniwetok Atoll and COMNAVSTAKWAJ on Kwajalein Island. Due to prior mutual agreement with AEC and with COMNAVSTAKWAJ, no problems of consequence were encountered.

b. Organizational and field maintenance of Air Force aircraft in the forward area was the responsibility of CTG 132.4. There were eighty Air Force aircraft (eighteen different types) based at Eniwetok and Kwajalein during the operation. Maintenance at Kwajalein posed a definite problem due to the large number of aircraft (fifty-nine), the diverse types (fifteen) and the limited facilities and equipment. The establishment of a central maintenance control system proved effective in minimizing this problem by integrating and coordinating the activities of all Air Force maintenance units and detachments based at Kwajalein. No difficulties of consequence were experienced with the three types of light aircraft based at Eniwetok. Prior to the operational phase, however, critical delay was experienced in the return from overhaul in the ZI of engines, props and carburetors for L-13 aircraft. Naval aircraft in the Eniwetok area were maintained by the RENDOVA

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under the supervision of CTG 132.3. Maintenance of Naval patrol aircraft based at Kwajalein was coordinated by CTG 132.3 utilizing facilities provided by COMNAVSTAKWAJ.

c. Naval small craft were maintained by the OAK HILL under the supervision of CTG 132.3. AEC small craft were maintained by the AEC contractor. Scheduled maintenance insured adequate craft availability at all times.

d. Field maintenance of motor vehicles was accomplished in central motor pools located on Eniwetok, Parry and Kwajalein Islands. The Eniwetok facility was operated by TG 132.2 and the Parry facility by the AEC contractor. The Kwajalein maintenance pool was operated by COMNAVSTAKWAJ with augmentation personnel provided by CTG 132.4.

e. Excess material retained in the forward area for use in subsequent operations is being processed for tropical storage. It is anticipated that in-storage maintenance of materiel on Eniwetok Island will be difficult due to the questionable condition of the World War II buildings at that installation.

PERSONNEL AND ADMINISTRATION

46. Personnel

a. At the time JTF 132 was activated, a number of personnel were present in the Headquarters as members of JTF THREE and needed only to be transferred to the new organization to occupy similar positions on the JTF 132 Staff. After activation, however, Headquarters, JTF 132, had to procure additional personnel to fill spaces established in T/Ds for both the Headquarters and for the task groups in accordance with established Army, Navy and Air Force procedures.

b. For morale purposes, and in addition to the normal welfare and recreational activities, arrangements were made through COMSERVPAC for USO shows to visit Eniwetok during non-operational periods. This activity is still in effect.

c. Civilian and criminal law enforcement for Eniwetok Atoll was coordinated with the Department of Interior. On 1 July 1951, administration of the Trust Territory of the Pacific Islands was transferred from the Navy to the Department of Interior. Certain lands and facilities were reserved for use by the Armed Forces, though it was indicated by the Navy that such

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reservation of land and facilities was not intended to affect the responsibilities of the High Commissioner, Trust Territory of the Pacific Islands, pertaining to civil and criminal law enforcement as established by the transfer agreement. After a conference between representatives of the Department of Interior and the Task Force Headquarters, it was agreed that the responsibility for civil and criminal law enforcement at Eniwetok was a function of the Department of Interior and the High Commissioner was authorized to deputize two Holmes & Narver employees as Deputy U.S. Marshals.

d. The ceiling of twenty official observers of each IVY detonation was recommended by CJTF 132 and concurred in by the Executive Agent and AEC. Of the total number of spaces allocated, the Department of Defense and AEC each received ten spaces for each shot. The Executive Agent, through the office of the Assistant Chief of Staff, G-3, Department of the Army, monitored the selection of official observers and CJTF 132 issued appropriate instructions and guidance to DOD and AEC agencies, covering such matters as security instructions, invitational travel orders and transportation. The official observer program in the forward area included inspection of the shot sites, the device and related instrumentation and information regarding Army, Navy, Air Force and Scientific operations and participation in the tests.

e. In general, the personnel and administrative procedures of operation IVY were satisfactory and with a few adjustments can be used for future operations of this nature.

FINANCIAL

47. Funding Operations. Expenses of conducting operation IVY were shared by the Armed Forces and AEC in accordance with the fiscal and accounting principles enumerated in Annex K to J.C.S. 2179/15. All normal operating expenses, such as pay, subsistence and medical care of personnel were borne by the three military departments and AEC utilizing regularly budgeted funds. Above normal or "extra military" operating expenses incident to Armed Forces participation were borne from funds made available to the Task Force Commander by the Secretary of Defense. Obligations against "extra military" funds totaled $2,931,135 as of 31 December 1952 (see Appendix K). Direct costs of the eleven scientific programs were shared by the Armed Forces and AEC in accordance with the degree of interest. Programs 1, 2 and

10 were sponsored solely by AEC while Programs 7, 9 and 11 were funded entirely by the Armed Forces. Programs 3, 4, 5, 6 and 8 were of joint interest and received financial support from both major participants. Appendix Y provides details of the Armed Forces financial support of the scientific programs, which totaled $5,041,322 in obligations as of 31 December 1952. Funding of the Armed Forces interest was through advance to the Task Force Commander from the Emergency Fund of the Secretary of Defense, utilizing the appropriation Research and Development, Army, as provided by law, and based upon recommendations submitted by the Chief, Armed Forces Special Weapons Project (AFSWP) and approved by the Chairman, Research and Development Board, Office of the Secretary of Defense and the Assistant Secretary of Defense, Comptroller.

48. Cost Accounting. A cost system was placed in effect in compliance with the provisions of Public Law 216, 81st Congress. Inasmuch as neither the military departments nor AEC utilized a cost system which could easily be adopted in its entirety for this operation, a modified system was established which accounted for the total cost of the operation by operating and capital costs, by test programs and projects, by departments and by task groups. This modified system, although patterned somewhat along the lines of the cost reporting system used by the Air Force, was a compromise between established Service cost accounting systems; the system utilized by AEC; and the ultimate system desirable for joint operations, which only time and future experience can produce. The total reported costs of operation IVY amounted to $65.9 million as of 31 December 1952. This figure was comprised of $49.7 million operating costs and $16.2 million capital costs. Of the total reported costs, $34.9 million was borne by AEC and $31.0 million by the Department of Defense. See Appendix Z.

49. Reporting and Graphic Procedures. A reports control system was operated to facilitate the timely and economical submission of all reports to the Headquarters. A statistical file was maintained of selected reports which enabled the Task Force Comptroller to present graphically and publish periodically control documents for the command.

50. Reports

a. A series of detailed reports on operation IVY are being

[redacted]

prepared for distribution within AEC and the Department of Defense. These reports, described below, will constitute the IVY library which will be officially deposited with LASL and AFSWP.

(1) History of Operation IVY, one volume.

(2) Technical Report on Communications, Operation IVY, one volume.

(3) Technical Reports on Scientific Projects, Operation IVY, fifty-four volumes.

b. The History, the Communications report, and the Security, Intelligence and Public Information report are scheduled for publication and distribution by early Spring, 1953. The majority of the scientific projects reports are scheduled for submission to editing agencies during the Spring and Summer of 1953. Final publication and distribution dates are relatively indeterminate at this time.

[redacted]

[redacted]

[redacted]

APPENDICES

A. Program 1 - Radiochemistry

B. Program 2 - Progress of the Nuclear Reaction

C. Program 3 - Scientific Photography

D. Program 4 - Neutron Measurements

E. Program 5 - Gamma Ray Measurements

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P. Organization and Mission, Army Task Group (TG 132.2) - Chart

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S. Radiological Safety

T. Communications Chart, Signal Circuits, CJTF 132 (Ashore)

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V. Air and Water Logistical Support Chart

W. Intra-Atoll Transportation Statistical Table

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Y. Financial Statement (Research and Development funds)

Z. Overall Cost Charts

[redacted] [redacted]

[redacted]

APPENDIX A

PROGRAM 1: RADIOCHEMISTRY

1. Project 1.1 - Yield Measurements (MIKE-KING) (AEC)

a. Object

(1) Any experimental program built around an atomic detonation is clearly dependent upon post-shot yield knowledge. Regardless of whether the weapon or device is a stockpile model or a radical new design, its actual yield is essential to the theoretician.

(2) This experiment is concerned with the radiochemistry analysis of post-shot radioactive samples, the only absolute method of efficiency determination available at present.

b. Method

(1) For fission shots, the energy released by an explosion and the nuclear efficiency of the bomb in utilizing the most valuable ingredients of its core, is rather directly (by means of established conservation of energy principles) related to the number of fissions which take place during the explosion. In order to get the number of fissions occuring in the bomb or device during detonation, one recovers a sample (see the discussion of Project 1.3) representing some small fraction of the bomb or device and determines the number of fissions which took place in the material represented by the sample. This quantity is arrived at by radiochemical analysis to determine the efficiency from the ratio of fissioned to unfissioned active material or to examine one of the active products of nuclear fission. In the latter case, the radioactivity of such a product at any given time after the explosion is proportional to the number of fissions which have taken place, and the constant of proportionality is capable of laboratory determination.

(2) For fusion shots, the problems are esentially the same but somewhat more complex in detail. For present purposes, it is sufficient to state that the MIKE shot yield will be determined in the following manner, if possible:

(a) The fission yield will be determined by the method outlined above.

(b) The fusion yield will be found by radiochemical

[redacted] [redacted]

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[redacted]

determination of the neutron-induced activity of properly collected gas and particulate samples, this activity being theoretically related to the total number of neutrons arising from all nuclear processes. From the total population, that portion due to the fissions will be subtracted. The remaining population will be theoretically related to the energy released by the thermonuclear reaction.

(c) The sum of the fission and fusion yield will give the total energy release.

c. Results

(1) MIKE Shot

[redacted]

(2) KING Shot

(a) Preliminary yield estimates have been made on the basis of total uranium analysis on two samples and by U^{235} analysis on four samples. The following assumptions were made in calculating the results from U^{235}.

[redacted]

[redacted]

2. Project 1.2 - Internal Nuclear Detector Measurements (MIKE) (AEC)

a. Object

This project was designed to document various processes of the detonation, using the following techniques. Selected amounts of various substances are included in, or placed in the immediate vicinity of the device. These substances have little or nothing to do with the primary nuclear processes of the explosion, but serve only as remote indicating "tracers". The existence of a tracer substance in or near the exploding device is assurance that such a tracer will be bombarded with neutrons and gamma rays. If the substance has been properly selected, and if the tracer has been located sufficiently near the device to be thoroughly mixed with the device debris, such a bombardment will result in easily detectable activity in every sample subsequently analyzed. Hence, careful positioning of tracer substances can furnish information as to the detailed action of some particular portion or component of the device design.

b. Method

The experimental procedures involved are essentially the laboratory analysis techniques used on samples taken from the atomic cloud.

c. Results - MIKE Shot

The complete results of this project are not available at this time. Continuing studies are in progress to gather, by this method, diagnostic information as to the detailed thermonuclear processes of the device during the detonation period. These studies are inter-related with efficiency of deuterium burning or radiochemical fusion yield measurements. [redacted]

3. Project 1.3 - Cloud Sampling (MIKE - KING) (AEC)

This project was designed to collect appropriate samples of the atomic cloud, primarily in support of the radiochemical studies of Projects 1.1 and 1.2. The project was considerably complicated by the specifications for an "adequate sample", namely minimum acceptable physical size, absence of contamination during collection and shipment, sufficiency of nuclear activity and availability for relatively immediate recovery and delivery to the Laboratory for analysis.

b. Method

(1) Sixteen F-84G's, manned sampling aircraft, were maintained on Kwajalein in order that a minimum of twelve could be operational for each shot. A total of twelve filter samples were considered essential for the analysis required by Projects 1.1 and 1.2. Two papers from a given aircraft constituted a single sample. Since these carriers were required to have a flight capability of five hours, ten inflight refueling tankers were maintained (also on Kwajalein) for support purposes. One B-36 and one B-29 were used as primary and alternate operational air command posts, or traffic controllers for the project.

(2) Sampling devices and associated equipment installed on the F-84G aircraft consisted of the following:

(a) A filter was installed in the forward section of each wing tip tank - the filter paper area in each case being approximately one square foot. The filter mouth was supplied with a shutter which could be opened or closed by the pilot to preclude the possibility of rain washing the paper.

(b) A snap sampler (consisting of a poly-ethylene bag in a metal case, with a valve controlled inlet probe) was mounted in the nose of the aircraft.

(c) An ionization chamber was mounted in the right tip tank filtering unit - to act as the detector for a dose rate meter in the cockpit. This meter gave the pilot an indication of particulate sample strength collected.

(d) A second intensity rate meter, with its associated detector was mounted in the cockpit. This meter gave a direct reading of dose rate to which the pilot was subjected at a given time.

(e) A total-dose meter was also mounted in the cockpit to give the pilot a direct indication of how many roentgens of gamma he had received.

(3) At zero time, two of the spare F-84G's were in the shot area - ready to perform reconnaissance as required to establish:

(a) Base of the upper cloud.

(b) Lowest altitude of prominent features of the cloud created by wind shear.

(c) Lowest altitude at which a useful radiation intensity was present.

This information was relayed to the control aircraft, and was used to determine proper take off times and flight altitudes for the twelve carriers.

(4) A much larger component of "soft" gamma radiation was expected to be present in the cloud radiation flux from MIKE shot than one would expect from "normal" detonations. Fortunately, much of this soft component was about 70 kev in energy and could be "screened out" by a relatively thin layer of an absorbing material such as lead. The pilot was therefore shielded by a protective gown of lead impregnated glass fabric to reduce the soft component by a factor of about four.

(5) To protect the carrier pilot from ingestion of radioactive material, adequate precautions were taken to filter any air that entered the pressurized compartment.

c. Results

(1) MIKE Shot

(a) Twelve samples were obtained by the F-84G aircraft, including the two used for early reconnaissance. Aircraft operated in three flights of four aircraft each.

(b) Samples obtained by the first flight, as well as one sample from the second flight, were each approximately the size predicted and were satisfactory for yield determination. Two samples of the second flight and the four samples from the third flight were approximately one-third of 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 (Par. 3c (1) (g) below). The two reconnaissance aircraft gave very small samples which were useful for ratio checks.

(c) Sample quality is governed by the capability of penetrating the main body of the cloud. In general, all samples, except four which were taken at radically different altitudes or sections of the cloud, are considered to be as representative of the cloud as possible.

[redacted]

Excluding the exceptions, the samples were taken at altitudes between 42,000 to 44,000 feet which was in the region of the juncture between the upper toadstool and its stem.

(d) Only the first flight aircraft approached the planned operational radiation exposures to pilots. Failure to attain the planned exposure in the other flights is reflected in the lower sample sizes which they obtained. The first flight exposures were in the 3 to 4 r level, the second flight in the 0.5 to 1 r level, and the third flight in the 0.2 to 0.4 r level. Because the aircraft had been carefully hand-polished, the cockpit background was very much lower than expected. The total radiation exposures were 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 the first flight should be considered a testimony to the skill of its pilots. **BEST AVAILABLE COPY**

(e) Use of the shielded flight clothing by the first flight apparently gave about a four to five-fold reduction in radiation exposures. The effect did not appear to be significant for the second flight, although for the third flight there again appeared to be a significant protection. The protection afforded the first flight apparently corresponds to evidence that a considerable fraction of the radiation flux in the cloud during this flight's penetrations was due to the decay of U^{239} which gives a 73 kev gamma ray. This evidence was gained from an analysis of the decay rate of reported peak radiation intensities in the cloud.

(f) The MIKE burst formed an upper cloud about 100 miles in diameter with a stem in the center approximately thirty miles in diameter. A white vaporous undercloud, forming a collar around the stem, was present and 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 feet) but during the course of the day appeared to subside to about 40,000 feet. 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 feet, indicated. When such aircraft are available, it would be desirable for very high-yield devices

[redacted] [redacted]

[redacted]

in the future to have about 5,000 feet additional ceiling capability in order to sample well into the main body of the cloud.

(g) Successful sampling requires that the duration of the sampling mission be limited not by the capabilities of the aircraft but by the maximum allowable radiation exposure of the sampling crew. This condition was true only for the first 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 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; hence 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 the second and third flights did not meet the requirement capability of spending two hours in the sampling area.

(2) KING Shot **BEST AVAILABLE COPY**

(a) As in MIKE shot, cloud samples were obtained on KING using manned F-84G sampling aircraft. The cloud structure was initially good for large samples, but rapidly dispersed due to strong wind shear at several altitudes.

(b) Although somewhat smaller in absolute size than those collected during MIKE shot, the KING shot samples should prove to be entirely adequate for the necessary radiochemical analysis.

(c) The operational problems experienced during MIKE shot were not present for this shot, primarily because the weather at the refueling altitude was very favorable. The good samples obtained, in spite of the widely dissipated cloud, are a tribute to the skill of the pilots of these aircraft. The radiation exposures of the sampling pilots were all below the nominal limit.

[redacted]

APPENDIX B

PROGRAM 2: PROGRESS OF THE NUCLEAR REACTION

(NOTE: The results of the program presented herein are very preliminary. Errors have been listed sufficiently large to take into account the rough status of the analysis; however, the ultimate accuracy of the experiments should be considerably better than indicated. On the basis of preliminary analysis, it appears that all experimental equipment functioned properly.)

1. Project 2.1a - Alpha of the Fission Phase (MIKE) (AEC)

a. Object

(1) Regardless of whether the desired thermonuclear reaction took place, it was important that information be available as to how the fission phase operated. To obtain such information, it was natural to fall back on the classical diagnostic measurements for fission weapons, such as the measurement of alpha and yield. Since fission yield measurements would be overshadowed in the presence of a large scale thermonuclear reaction, it was necessary to rely upon the measurement of alpha as a primary indication of the proper functioning of the fission aspect of the reaction.

(2) Alpha may be defined as the logarithmic rate of rise of the fission reaction. Essentially it is a measure of the neutron multiplication rate in the array - that is, a measure of the rate at which the fission chain reaction compounds itself.

b. Method **BEST AVAILABLE COPY**

The classical method of measuring alpha is an indirect one, involving the measurement of gamma ray fluxes. This is feasible since the number of gamma rays given off is proportional to the neutron population, which is in turn proportional to the number of fissions. Two scintillation detectors were placed outside the MIKE case and the signals from these detectors were fed by coaxial cable to a recording station 3,000 yards distant on the island of Bogon. A permanent record was obtained by photographing the face of a recording oscilloscope.

c. Results - MIKE Shot

[redacted]

2. Project 2.1b - KING Alpha (KING) (AEC)

a. Object

[redacted] [redacted]

As was mentioned in describing Project 2.1a, the measurement of alpha is a classical diagnostic experiment for fission weapons. [redacted]

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b. Method

The method used herein is identical in principle to that outlined for Project 2.1a. An air drop, however, precludes the use of detectors placed near the bomb case. The bomb was fired at some 5,700 feet north of Station 250 on Runit Island, at an altitude of approximately 1,500 feet. The detectors were placed on the north end of Runit and their signals were piped through three-inch coaxial cable to recorders in Station 250. Hence, the nearest detectors were some 2,000 feet from the point of detonation. Additional detectors were placed near Station 250 in order that various portions of the intensity curve could be documented. The recorders for the latter were also in Station 250 and various recording sensitivities were used to prevent gaps in the curve.

c. Results - KING Shot

[redacted]

3. Project 2.2 - Timing in the Fission Phase [illegible]

a. Object

Consistent with the idea of obtaining as much diagnostic information about the thermonuclear reaction as possible, this experiment was designed to determine the timing of the fission phase [redacted]

[redacted]

b. Method

Appropriate gamma signals were transmitted through a helium column and recorded on the Island of Bogon, 9,000 feet distant.

c. Results - MIKE Shot

[redacted]

4. Project 2.3 - Rise of the Fusion Reaction (MIKE) (AEC)

a. Object

This experiment was a continuation of the diagnostic program for the MIKE device. It was designed to document the rise of the fusion reaction in order that the theory upon which predictions of such phenomena are based may be substantiated.

b. Method

The measurements for this project were made in a manner similar to Project 2.2 and recorded at the same station.

c. Results - MIKE Shot

[redacted]

5. Project 2.4 - Propagation of the Fusion Reaction (MIKE) (AEC)

a. Object

Consistent with the idea of obtaining a maximum amount of diagnostic information from MIKE shot, this experiment was designed to measure the propagation of the fusion reaction throughout the device.

b. Method

The measurements for this project were made in a manner similar to Project 2.2 and recorded at the same station.

c. Results - MIKE Shot

[redacted]

6. Project 2.5 - Measurement of Transit Time (KING) (AEC)

a. Object

The transit time of a fission weapon is defined as the elapsed time from the firing of the detonators to the initiation of the fission reaction. This time represents basic diagnostic information, in that it

[redacted] [redacted]

indicates the relative criticality of the assembled active components when the initiator is crushed. An abnormally long transit time may indicate post-detonation - that is, the implosion wave has been reflected from the center of the configuration and is now in the process of disintegrating the bomb. The relative criticality is therefore low and the total energy released will be low. Conversely, an abnormally short transit time indicates pre-detonation - that is, the implosion wave has not yet reached the center of the configuration and the density (and hence criticality) of the assembled components has not yet reached the desired maximum.

b. Method

(1) The measurement was made by observing, with the appropriate equipment, the duration of a modulated signal sent out by a transmitter on the bomb. The modulation was started by a voltage signal from the X-unit load ring, and was cut off by gamma from the nuclear reaction [redacted]

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(2) Two small radio transmitters were installed within the ballistic case of the weapon. The signals from these transmitters were monitored by four receivers, two of which were located in each of the two B-50 aircraft which accompanied the B-36 drop aircraft. The signals were keyed by the electrical impulse which fires the detonators, thus supplying the initial time to the receivers. The flood of gamma radiation, which accompanies the start of a nuclear reaction, ionizes the air around the bomb and makes the transmission of radio signals impossible. Thus a phenomenon (namely, the interruption of a signal) is observable at the receivers to indicate the end of the transit time period. Both of these signal perturbations (the pulse and the interruption) and a time index were supplied to the vertical deflection plates of an oscilloscope and the results recorded by photography of the oscilloscope face.

c. Results - KING Shot

[redacted]

7. Project 2.6 - Temperature Measurement by Neutron Energy Spectrum (NIME) (AEC)

a. Object

[redacted]

[redacted]

[redacted]

b. Method

[redacted]

c. Results - MIKE Shot

[redacted]

[redacted] [redacted]

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[redacted]

APPENDIX C

PROGRAM 3: SCIENTIFIC PHOTOGRAPHY

(NOTE: 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 responsible 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 before and after photographs of the reef where the device was detonated. LASL-J-15 Division was concerned with detailed photography of the very early stages for information about radiation flow down the channel, shock velocity in the steel case, etc.)

1. Project 3.1 - Ball-of-Fire Yield (MIKE - KING) (AEC)

a. Object

(1) The only available "absolute" method of determining yield is that which involves radiochemical analysis of atomic debris. By an absolute method it is meant one which gives, as its final result, the yield of the weapon directly, rather than a number proportional to the yield. The existence of hydrodynamical scaling laws, however, has made several "relative" methods of yield measurement available. One of these makes use of the ball-of-fire diameter at early times. By a relative method, it is meant one which gives as its result a number which is proportional to yield. In this case the magnitude of the proportionality factor must be deduced from comparisons of ball-of-fire photography results with results of radiochemical analysis methods. Such comparisons have been made on previous experimental programs, with the result that the above mentioned proportionality factor is well established for yields up to 100 KT. In addition, the GEORGE shot of GREENHOUSE supplied one piece of evidence as to its size [redacted]

(2) A distinct advantage accrues in having complete and reliable information as to the size of this factor over as wide a range of yields as possible. Operational use of atomic weapons will undoubtedly make immediate knowledge of weapon yield imperative, thus precluding the use of time-consuming laboratory techniques of radiochemical analysis; also, it may well be unfeasible to collect acceptable bomb debris samples in the face of enemy defenses. Ball-of-fire photography is a potentially feasible method for determining weapon yield quickly and under combat conditions.

[redacted] [redacted]

b. Method

(1) Eastman (200 frames/sec) and Mitchell (100 frames/sec) motion picture cameras were operated from appropriate positions to measure this phenomena.

(2) Rapatronic (single frame, with very fast exposure, at a definite delayed time after zero) cameras were operated from photo towers. It is hoped that sufficient reliability can be built into the Rapatronic technique and that sufficient confidence can be developed for the scaling of its result, so that the Eastmans may be eventually discarded in favor of the Rapatronic for this measurement. An obvious decrease in the cost and complexity of the experiment would result and evidence already exists to support the opinion that no accuracy would be sacrificed.

c. Results

(1) MIKE Shot

(a) Sixteen Eastman cameras were used with 79% operating properly, 7 % lacking velocity markers, and 14% failing to run due to faulty contactors. The records are of excellent quality; however, the extremely low surface brightness of the ball-of-fire at the time of minimum gave rather weak images in this portion of the record. Twelve Rapatronics were used, with 17% giving excellent pictures, 50% providing rather weak but usable records, 25% giving no images due to lack of light in the early stages of ball-of-fire growth, and 8% failing entirely because of mechanical shutter failure. One Mitchell camera operated 100%, giving good images during the interval of ball-of-fire growth. These cameras were located as follows - five on Engebi Island, two on the ESTES and the remainder on Parry.

(b) Preliminary measurements from one shipborne Eastman camera and eight Rapatronic plates gave the yield as 12 $\pm$ 1 MT. The ball-of-fire growth is regular and the outlines are smooth, so that film-measurement errors are believed to be small.

(c) The time to the light minumum was 300 to 330 milliseconds from Eastman cameras.

(2) KING Shot

(a) Seven Eastman cameras were used. All of them operated properly, all had timing markers, and all showed the intended images. Only five showed the initial burst and ball-of-fire growth. The remaining [illegible] were started late to cover the possibility of a long time of fall.

(b) Twelve Rapatronic cameras were used and all showed images. Five of these (in the interval 0.1 to 10 milliseconds) gave good measurable images. Four others were too weak to read and the remaining three showed clearly the ball-of-fire after shock separation and minimum time. These latter were interesting pictures and one proved useful for Project 3.8 (Burst Position), though they did not give information for Project 3.1.

(c) Preliminary measurements from five Rapatronics and one Eastman in the time interval 0.1 to 90 milliseconds, show the yield to have been 570 ± 30 KT. The ball-of-fire was perfectly spherical and resembled EASY shot of BUSTER in appearance.

2. Project 3.2 - Cloud Phenomena (MIKE - KING) (AEC)

a. Object

(1) To those interested in fall-out hazards, tactical bomb delivery planning, or the planning for aerial collection of bomb debris, reliable answers to the following dependent questions are of paramount importance.

(a) What will be the maximum altitude of the top of the cloud as a function of the yield of the weapon which produced it?

(b) What will be the size and shape of the cloud, as a function of altitude, time after zero, and yield of the weapon?

(c) What is the vertical velocity of the cloud top, as a function of altitude and weapon and weapon yield?

(2) The IVY cloud phenomena project was designed to extend this search for data, particularly in the high energy release range which is not available from ZI experiments. The Project involved photographic measurements of the cloud throughout the period of its rise to maximum altitude.

b. Method

Motion picture and still cameras were operated from appropriate land, sea and air sites.

c. Results

(1) MIKE Shot

Five Mitchell cameras (100 frames/sec) were used, of which

[redacted] [redacted]

80% performed properly. The reason for failure of the others has not yet been determined. These records document the early stages of ball-of-fire rise, but the later stages were obscured by natural cloud cover. Two Speed-Graphic cameras were used aboard ship, but also failed to document the rise because of cloud cover. Two Speed-Graphics and one A-6 movie camera were employed in two aircraft at approximately seventy to 100 miles. These cameras gave satisfactory photographs.

(2) KING Shot

Six Mitchell cameras were used, of which two failed to run because of a power failure at the control point. One Cine-Special camera was operated manually on Parry. One A-6 camera was operated successfully in a C-47 aircraft, and the same operator exposed an extensive series of stills with a Speed-Graphic camera for one hour. Another Speed-Graphic was used on Parry but for only twelve minutes, since the cloud grew much too large for the camera's limited field of view.

3. <u>Project 3.3 - Hot-Spot Observation (MIKE) (AEC)</u>

a. <u>Object</u>

One necessary item of diagnostic information for fusion weapon design is the temperature distribution inside the device prior to disintegration since the relative success of a fusion reaction is closely associated with temperature. This experiment was designed to supply some of that information in an indirect fashion, involving the theoretical interdependence of the speed of explosion wave in the metal case, strength of the explosion wave and temperature behind the wave.

b. <u>Method</u> **BEST AVAILABLE COPY**

An observation of the time at which the shock wave broke through portions of the steel surface of the bomb was made using six Bowen streak cameras in a shelter on Bogallua Island. Six spots on the device were observed [redacted] The light from these spots was piped to mirrors which were on a line approximately 45° to the line between Bogallua and Elugelab, and the Bowen streak cameras then observed the rise of the light signal on these mirrors. All cameras observed all mirrors. The time resolution of the system was of the order of 3 shakes.

c. Results - MIKE Shot

All equipment operated satisfactorily and, at this writing, data taken is being reduced and analyzed.

4. Project 3.4 - Bomb Case Motion (MIKE) (AEC)

a. Object

This experiment was designed to supplement and extend such "early time" documentation by observing the device case disintegration and initial ball-of-fire growth directly. A detailed knowledge of how the device case disintegrated is invaluable to those interested in internal temperatures, pressures, reaction rates, etc. [redacted]

b. Method

The case was observed directly with two groups of 3 cameras, the first group operating at a speed of 3,500,000 frames/sec and the second group operating at a speed of 90,000 frames/sec. The first group was designed to document the case disintegrations and the slower group was to document the initial ball-of-fire development. The six cameras used in this experiment were housed in a fall-out proofed shelter on Bogallua, the same shelter used by Project 3.3.

c. Results - MIKE Shot

All equipment operated satisfactorily and, at this writing, data taken is being reduced and analyzed.

5. Project 3.5 - Illumination as a Function of Time, With CR-Slit Cameras (MIKE - KING) (AEC)

a. Object

This project was included in the Scientific Photography Program to augment the collection of data on illumination as a function of time from exploding atomic weapons. One value of such data is discussed under Project 3.6. Another value is the establishment of a fund of information with which to design and adjust photographic equipment being used under the light conditions generated by atomic explosions. For example, the success of such projects as 6.2 and 6.4a was completely dependent upon good photographic records being obtained - which implied that such things as film sensitivity, shutter speed and auxiliary lenses (filters) must have been selected with great care. Knowledge of the light intensities to be experienced is essential in making these selections.

b. Method

For MIKE and KING shots, two GR-Slit cameras were operated on the Parry Island photo tower.

c. Results

(1) MIKE Shot

(a) The two Slit cameras were operated with 100% success. Data obtained is currently in the process of reduction and analysis.

(2) KING Shot

(a) The two Slit cameras operated properly and data reduction and analysis is currently in progress.

6. Project 3.6 - Bhangmeters (MIKE - KING) (AEC)

a. Object

(1) As was mentioned in the discussion of Project 3.1, there exists a definite requirement for a device capable of measuring weapon yield during tactical operations. Ideally, such a device will be:

(a) Small, light and self-contained.

(b) Sufficiently rugged to withstand normal operational use without impairment of its operation or accuracy.

(c) Capable of being operated by its user at a relatively great distance from the explosion.

(d) Capable of supplying its user with a yield number in a minimum of time.

(e) Simple to operate.

Bhangmeter studies represent an attempt to develop such an ideal device. In its present form the Bhangmeter is a steel box, eighteen inches long, twelve inches wide and five inches deep, weighing approximately thirty pounds.

b. Method

(1) The theory behind Bhangmeter operation can be described as follows. The light intensity emitted from an atomic bomb explosion [illegible]

to a minimum and rises again, somewhat less rapidly, to a second maximum, with the magnitude of the second maximum being very much less than that of the first. After passing through the second maximum, it falls off rather gradually (on a millisecond time scale) to background values. Past experience indicates a measurable relation between weapon yield and time to first minimum.

(2) The inclusion of this project in Operation IVY will augment calibration methods, and continue what might be called the Bhangmeter feasibility studies, especially in the relatively high yield range.

(3) For MIKE shot, four Bhangmeters were installed on the ESTES. For KING shot, five Bhangmeters were in operation at appropriate sites.

c. Results

(1) MIKE Shot

Of the four Bhangmeters installed on the ESTES, one triggered but gave an incorrect reading. All four instruments were wet from salt spray.

(2) KING Shot

Of the five Bhangmeters used, all operated. Four of the instruments gave readings of 68 milliseconds, and the fifth read 64 msec. The reason for the discrepancy is not known, but the 68 msec reading has been verified by examination of the Eastman films.

7. Project 3.7 - Preliminary Photographic Crater Survey (MIKE) (DOD/USAF)

a. Object

This project was designed to obtain a preliminary photographic survey of the crater caused by MIKE shot for use in the study of earth shock. It was also hoped that a correlation could be established between photographic evidence of surface perturbations and the fraction of the device's energy release that coupled with the ground. Experience on previous tests has shown that early ground surveys of craters were precluded by radiological hazards.

b. Method

A number of accurately surveyed ground points were established close to the shot island, with adequate marking of these points to assure contrast and definition when photographed. These positions were so selected as to be easily distinguishable after the shot as well as before. Precise location of ground zero in relation to these positions was essential, and sufficient aerial photography of the shot island and adjacent islands prior to the explosion was planned to confirm the ground control. Oblique, vertical and vertical stereoscopic photography was planned to provide the necessary coverage for analysis.

c. Results - MIKE Shot

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

8. Project 3.8 - Burst Position (KING) (AEC)

a. Object

Experimental air bursts, such as KING shot, impose the unique problem of determining their actual burst position in space. Prior to the shot, a ground zero is selected and the detonation mechanism of the bomb is set for a given height of burst. The combination of bombing inaccuracy and the inherent inaccuracies of the detonation mechanism, however, make it extremely unlikely that the burst will actually take place at the pre-selected point in space. On the other hand, the success of many experimental projects is dependent upon knowing the point of detonation with good accuracy. As a result, a rather precise photographic technique was used to locate the position (in space) of the light flash which characterized the exploding bomb.

b. Method

The proposed bomb zero point was 1500 feet above the ground and 5,700 feet due north of Station 250 on Runit Island. The region in space which includes this point was observed photographically by cameras on Coral Head and in the Parry Island photo tower. In addition to seeing the light flash from the exploding bomb, each camera was positioned to see two fixed points, the location of which (with respect to the camera) were known with great accuracy.

c. Results - KING Shot

(1) Four theodolites, set out on the first K-1 day (KING shot was twice postponed because of unfavorable weather) and subsequently

[redacted]

serviced twice, failed to operate. A fifth theodolite was set up on Parry the morning of K-Day and operated properly. The failures were due to water in the cameras, water on the film and lens, rusting of the shutters and soaking of the "Blue Box" batteries. It was extremely fortunate that Naval Research Laboratory (NRL) had installed a 16-mm GSAP camera on Coral Head, since this provided data leading to a reasonably good position of burst figure. It was also a fortunate circumstance that the array of rockets was used by Naval Ordnance Laboratory (NOL) (Project 6.13), since these provided the reference point from which position of burst was calculated.

(2) Position of burst

(a) The coordinates (IVY Grid) of the burst were:

N 108,450 ± 30 ft

E 123,650 ± 20 ft

(b) Relative to the target, the burst was:

N 300 ± 30 ft

W 480 ± 20 ft

(c) The circular error was thus: 570 ± 35 ft

(d) The height of burst was: 1480 ± 20 ft

[redacted]

APPENDIX D

PROGRAM 4: NEUTRON MEASUREMENTS

(NOTE: The flood of neutrons which emanate from an exploding atomic device is of great interest to workers in at least two independent fields - that of bomb design (and the associated diagnosis of bomb performance) and that of "effects on things" (materials and animals in particular). The Neutron Measurements Program of Operation IVY was designed to augment existing data on neutrons and to continue the development of field measurement techniques in order that the ultimate goal of complete documentation of neutron economy will be closer. In addition, especially for MIKE shot, the program was designed to supply diagnostic information as to the "modus operandi" of the device.

Although Program 4 measurements were designed both to satisfy the DOD requirement of knowing the neutron flux and to help the theoretician 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 device in the event of a fractional yield. However, enough samples were recovered to supply external neutron information.)

1. Project 4.1 - Slow Neutron Observations (MIKE - KING) (AEC)

a. Object

This project was part of a continuing program to determine the space distribution of low energy neutrons liberated by various sizes and types of atomic bombs.

b. Method

(1) Neutrons of energy in the range from thermal (on the order of .025 ev) to .25 ev are essentially all captured by the element cadmium. Also, cadmium is quite transparent to neutrons of energy greater than .25 ev. These facts permit the design of a "target" which, when bombarded with neutrons of many energies, is capable of measuring the number of those neutrons in the energy range from .025 to .25 ev.

(2) For MIKE shot, pairs of tantalum and gold samples (one of each being shielded with cadmium at each station) were placed on a line extending along the reef toward Bogallua. The first pair were 100 yards from ground zero, and a pair was placed every 100 yards from there to 2,500 yards. The sample recovery technique involved fastening the samples to a steel cable which could be hauled in after the shot. For MIKE shot these cables were arranged so that they were covered by water for thermal protection, using pressures developed in the detonation to [illegible]

[redacted]

of detectors into the lagoon.

(3) For KING shot, the same technique was used. The line of samples started on the reef (300 feet from proposed ground zero) and extended down the center of Runit Island to the region of the airstrip (7,200 feet from proposed ground zero).

c. Results

(1) MIKE Shot

Due to the large energy release, relatively few of the detectors were recovered. Analysis of these few is currently in progress.

(2) KING Shot

A larger percentage of detectors were recovered than for MIKE; however, analysis has not been completed.

2. Project 4.2 - High Energy Neutron Observations (MIKE - KING) (AEC)

a. Object

This project was designed to extend the measurements of Project 4.1 by documenting the flux of neutrons exhibiting energies considerably in excess of .25 ev, that is, up to 14 mev.

b. Method

Threshold detectors of sulphur, arsenic, gold and gold surrounded by indium were used in a manner similar to Project 4.1 and placed at the same positions.

c. Results

(1) MIKE Shot

(Same as Project 4.1)

(2) KING Shot

(Same as Project 4.1)

3. Project 4.3 - Neutron Spectrum-Nuclear Emulsions (MIKE) (AEC)

This project was designed to determine the total neutron energy spectrum versus distance; however, the project was deleted from the IVY programming because of the addition of Project 2.6.

4. Project 4.4 - Neutron Intensity as a Function of Time (MIKE - KING) (AEC)

a. Object

The neutron detection methods outlined in Projects 4.1 and 4.2 offered no information as to the time distribution of the original flood of neutrons. This project was designed to gain information as to the total

[redacted]

[redacted]

[redacted]

number of arriving slow neutrons versus time at given distances from ground zero.

b. Method

"Fission-Catcher Cameras" were used at close-in stations for both MIKE and KING.

c. Results

For both MIKE and KING, camera stations and equipment were destroyed by the detonations.

[redacted]

APPENDIX E

PROGRAM 5: GAMMA RAY MEASUREMENTS

(NOTE: 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 MIKE work was largely diagnostic, and proposed to determine the time between the two main reactions, and the fission yield. The more distant work was concerned largely with fall-out, and was conducted by DOD.

The gamma radiation from a weapon such as KING shot would be expected to be similar to that from any fission bomb when scaled to this yield except as modified by the effects of the shock wave. These effects would be expected to be large, the irreversible heating of the shocked air removing a large part of the attenuating medium during the time when fission fragment activity is dominant and movement of the ball-of-fire still has not yet removed this source. The shock wave should also have a rather large effect on the nitrogen capture gammas for close distances. An attempt was made on KING to obtain data to support these ideas.)

1. Project 5.1 - Total Dose (MIKE - KING) (AEC)

a. Object

This experimental project is part of a continuing program, the purpose of which is to obtain as much documentation as possible of the gamma radiation fields established by exploding atomic weapons. In particular it was designed to supply information as to the total gamma dose received by points located at various distances from ground zero.

b. Method

(1) For MIKE shot, two measurement lines of film badges were established out to 6,000 yards from Elugelab to the far end of Bogallua, and one from Elugelab to the far end of Engebi. The packet positions were on land only, and were spaced at 100-yard intervals insofar as possible. Three film badges were placed at each position, the first of which was designed to remain openly exposed to radiation until recovery. The second and third badges were designed to be openly exposed initially, but later to drop into prepared shielded positions, the second dropping 0.2 seconds after the explosion, and the third dropping sixty seconds later.

(2) For KING shot, a line of film badge stations were placed down the middle of Runit, spaced at approximately 100-yard intervals out to 4,000 yards. Each station consisted of a post to which one or more film badges were attached. All badges were openly exposed until recovery. [illegible]

[redacted] [redacted]

film used for those measurements covered the range from 0.1 to 30,000 r.

c. Results

(1) MIKE Shot

The bulk of these stations were totally destroyed, only those at the extreme ranges being recoverable. The stations from 4,500 to 6,000 yards should give meager data but, due perhaps to the low surface brightness of the ball-of-fire, the dropping arrangement failed on nearly all stations.

(2) KING Shot

The stations out to 1,200 yards were destroyed, apparently by a large block of concrete which rolled down the line destroying both the film badge and the neutron sample stations of Program 4. Film badges were recovered from all stations beyond 1,200 yards.

2. Project 5.2 - Gamma Intensity as a Function of Time (MIKE - KING) (AEC)

a. Object

(1) Consistent with the idea of eventually having complete documentation of the "field variables" associated with an atomic weapon detonation, this project was intended to measure the time dependence of gamma ray intensity (at certain fixed distances) from shortly after zero to plus thirty seconds.

(2) The time dependence of the prompt gammas was documented by the alpha experiment (Projects 2.1a and 2.1b) and was not considered here. This experiment was designed to start at 0.2 microsecond for MIKE shot (1 millisecond for KING shot) and extend for approximately 30 seconds, thus measuring the time dependence of the major portion of the delayed gammas.

b. Method

The detection method used here was essentially the same as that used in Project 2.1a.

c. Results

(1) MIKE Shot

(a) The gamma ray intensity versus time with a time resolution of 0.1 microsecond was recorded at a blockhouse on Ruchi, 2,[illegible] [illegible] ground zero. Satisfactory records were obtain[illegible] broke through the domes protecting the detectors. [redacted]

(b) Gamma intensity versus time measurements with better than millisecond resolution and running for several seconds, were attempted at stations on San Ildefonso (1,200 yards), Cochiti (1,800 yards), and Bogombogo (4,300 yards) to supplement the data of the Ruchi station 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 destroyed; the station on Cochiti lost the protective dome permitting the shock wave to destroy the recording unit, and the Bogombogo station gave data down to about 30 microseconds and lasting for some seconds showing the pronounced influence of the shock wave on the gamma radiation – the level rising after shock arrival to a factor of 50 above pre-shock arrival, in good agreement with calculated values.

(c) [redacted] Both numbers are very rough since they involve working back through a large amount of air subjected to a strong shock with unknown loading.

(d) An integration of the Bogombogo data, making an estimate as to the intensities after 11 sec, [redacted]

(2) KING Shot **BEST AVAILABLE COPY**

To study the effect of the shock wave upon the gamma radiation, three BUSTER type stations were used at distances of 1,200, [illegible] and [illegible] yards. The near station ran to shock arrival, at which time some debris broke through the protecting dome. The intermediate station ran through the shock and should yield very good data. The far station camera did not run due to a battery failure. Data from the two stations should be adequate to supply the information desired.

3. Project 5.3 - Fall-out Gamma Intensity [illegible]

a. Object

This project was designed to further the [illegible]

[redacted]

in conjunction with Nevada tests) of fall-out intensity versus time at various fixed points.

b. Method

The instantaneous dose rate at a given point was measured with an ionization chamber. A permanent record was obtained by using the current signal to drive a pen recorder.

c. Results

(1) MIKE Shot

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 away from Eniwetok Atoll 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. 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 has been recovered from Engebi, Runit, Biijiri, Aniyaanii, Parry, Eniwetok and Rigili. Some fall-out has been recorded on Kusaie and Ujelang. Plots of dose rate versus time for Engebi, Biijiri, Rigili and Runit, although preliminary in nature insofar as the absolute magnitude of the dose rate is concerned, are considered well within a factor of 2 in accuracy with the exception of Engebi where the ionization chamber sustained some damage. The decay rates as plotted and calculated are judged to be accurate within plus or minus 10% and 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, was recorded on Eniwetok or Parry. No data is reported for Aniyaanii as the motor of the recorder failed before shot time.

(2) KING Shot

Gamma ray intensity versus time recording monitors as used for MIKE shot were continued in operation for KING shot. New units were placed in operation on Bogallua and Engebi to replace units damaged during MIKE shot except for the stations destroyed on Bogon and Ruchi. The [illegible] were continued in operation for [illegible].

[redacted] [redacted]

No significant fall-out was recorded on any of the islands of Eniwetok Atoll except the shot island, where the range of the detector was 2,000 yards. On Runit the peak radiation was approximately 5,000 r/hr at K ≠ 5 sec, decaying very rapidly to approximately 0.5 r/hr at K ≠ 1 minute. No fall-out has been reported from any of the off-atoll stations.

4. Project 5.4a - Fall-out Distribution and Particle Size (MIKE) (DCD/USN)

a. Object

This project was designed to extend the measurement of fall-out distribution and magnitude following MIKE shot to distances greater than those being documented by Project 5.3.

b. Method

Five types of collection devices were employed on many of the Eniwetok Islands, rafts in the lagoon, ships in the fleet and at other islands in the Marshall group. In addition, the sea area out to approximately 150 miles was instrumented with collection devices mounted on dan buoys.

c. Results - MIKE Shot

(1) Of the eight land stations, Bogallua, Engebi, Yeiri, Piiraai, and Runit were within the fall-out area and, at all stations except Bogallua, some usable fall-out samples were obtained. On Yeiri, Runit, Aniyaanii and Eniwetok the "Blue Boxes" failed to trigger. The Bogallua station was demolished. A total of twenty rafts were placed at their anchored positions in the lagoon on M-15 and M-14 days. On M ≠ 2 and M ≠ 3 a total of fifteen rafts were recovered. The "Blue Boxes" on all rafts triggered. All of the rafts recovered were within the fall-out area. Nineteen dan buoy stations were set out by M-Day. Twelve of the nineteen buoys placed were recovered.

(2) 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. The radiation appears to be of low energy since in making radioautographs,

[redacted]

a double thickness of paper accidentally partially covered the film. This double section very effectively blocked out most of the radiation. The fall-out seems to have been more heavily concentrated on the western side of the lagoon and extended down to at least fifteen miles.

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

5. Project 5.4b - Close-in Particulate Cloud and Fall-out Studies (MIKE - KING) (DCD/USA)

a. Object

The object of this experiment was to obtain specific data from the clouds produced by Operation IVY atomic detonations for total activity in the particulate material; rate of fall-out and the fall-out pattern on land areas of Eniwetok Atoll; determination of the airborne concentration of the radioactive particulate matter near ground level over land areas of Eniwetok Atoll; determination of size distribution of gross and radioactive particulate matter; distribution of activity with particle size; determination of the presence of selected fission products in the particulate matter; and determination of the adequacy of aerial survey systems in assessing the ground contamination situation. This data will supplement the previous atomic explosion phenomena observations in the determination of hazard to personnel resulting from residual fall-out and airborne activity, contamination of areas and structures, and the development of decontamination measures.

b. Method

(1) The experiment consisted of two parts - fall-out collectors operated from H + 15 minutes until H + 6 hours on twenty-four islands (thirty-two stations), and cloud sampling at high altitudes in conjunction with Programs 1 and 7.

(2) Particulate samples from the two methods [illegible]

[redacted] [redacted]

[redacted]

will be analyzed for activity, particle size and radiochemical content. Relationship between activity and particle size will be determined. A number ratio of active to inert particles will be attempted.

c. Results

(1) MIKE Shot

(a) 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, Bogombogo, Ruchi and Bogon) were destroyed, and four others did not start due to "Blue Box" malfunction (those at Rujoru, Aaraanibiru and two at Runit). Fall-out samples were obtained at Engebi (2), Muzin, Kirinian, Bokonaarappu, Yeiri, Aitsu, Eberiru (2), Aomon, Biijiri, Piiraai, Rigili (2), Eniwetok and Parry.

(b) The fact that there was considerable liquid as well as solid fall-out is obvious. The solid fall-out contained many large particles, some of which were as large as 1/2 inch in diameter.

(2) KING Shot **BEST AVAILABLE COPY**

(a) At KING shot, the fall-out stations used for MIKE were again instrumented with some exceptions. Stations were not set up at Bogallua, Bogombogo, Ruchi and Bogon because of the high background. All stations were triggered by the battery operated "Blue Boxes"; however, certain stations did not operate (probably because of damage from heavy rains). They were Runit, Aniyaanii, Eniwetok, Igurin and Giriinien. The fall-out collected from KING shot was recovered on K ≠ 1 day and returned to laboratories at Army Chemical Center, Maryland. These samples will be studied in the same manner as the MIKE shot samples since all phases of the participation in KING shot are identical to that for MIKE.

(b) There was such a small amount of fall-out from KING shot that it is doubtful whether there is sufficient activity to complete all of the analytical procedures to be followed for MIKE shot. Few fall-out samples produced radiation in excess of 10 mr/hr.

[redacted]

[redacted]

[redacted]

APPENDIX F

PROGRAM 6: BLAST MEASUREMENTS

1. Project 6.1 - Pressure versus Time on the Ground (MIKE - KING) (AFC)

a. Object

This project was designed to augment the existing fund of experimental data on the studies of pressure fields near a reflecting surface, by measuring pressure as a function of time (on or near the earth's surface) at various fixed points around Eniwetok Atoll for MIKE and KING shots.

b. Method

(1) MIKE Shot

(a) The pressure ranges extended from 330 psi expected on Teiteiripucchi to 0.9 psi expected on Parry. The mounting arrangements were basically:

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

2. Baffles several feet above ground surface and facing parallel to the blast direction, measuring free air pressure.

3. Gauges on buildings to measure face-on pressures.

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

(2) KING Shot

(a) The main blast line consisted of eight air pressure gauges along the reef for the measurement of free air pressures. The expected pressures on this blast line ranged from 210 psi to 12 psi.

(b) For all pressure measurements, the Wiancko Twisted Bourdon tube gauge was incorporated. The important consideration in these measurements was the comparison of air pressure functions over water with those over land.

c. Results

(1) MIKE Shot (See Incl 1 to Appendix F)

Asymmetry was measured by twenty self-recording ind[illegible] gauges, ten placed on Engebi and ten placed on Bogallua at the [illegible]

[redacted] [redacted]

from ground zero. From the two clusters, and the fact that the impulse on the Engebi gauges is known from the Wiancko pickup near that cluster, calibration of these indentor gauges should determine if symmetry existed on these two azimuths.

(2) KING Shot

Air pressures over land were measured at four ground baffle stations spaced along Runit. A free air pressure measurement was made on Parry for a far distant point.

2. Project 6.2 - Air Mass Motion Studies (MIKE - KING) (AEC)

a. Object

This project was designed to provide free-air over-pressure versus distance.

b. Method

(1) The method of labeling the atmosphere for this project involved placing a puff of smoke in the atmosphere in some region of interest. A motion picture camera was previously aligned in such a way that the puff was well within its field of view. Subsequent photography of the puff, and film analysis procedures, could then supply the experimenter with a time history of the puff's motion and perturbation. Such a method was expected to supply the elapsed time from zero to the arrival of the shock at the puff and the variation in shock strength with time from its dependence on the perturbation or "mass motion" of the puff.

(2) For MIKE shot, low altitude (~400 feet) labeling of the air was accomplished with exploding mortar projectiles. The distances from ground zero were similar to those chosen for the Wiancko gauges of Project 6.1. The actual positions, however, were quite different. In addition, the air was labeled with smoke at ten altitudes (8,000, 9,000, 10,000, 11,000, 15,000, 16,000, 20,000, 21,000, 25,000, and 26,000 feet) by means of bursting shells from anti-aircraft guns.

(3) For KING shot, only the low altitudes (~400 feet) air labeling technique was used.

c. Results

(1) MIKE Shot

Camera operation was 100%; mortar firing was 83% (the mortars on Coral Head and Parry failed to receive the radio firing [illegible]

[redacted]

and gun firing was 100%. Total equipment operation was 90%. An analysis of the fifteen films recovered shows that the reef mortars may produce limited 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 were marginal due to prevailing light conditions. The mortar film from Parry contains no data.

(2) KING Shot

The six cameras on Rojoa ran. The Parry camera did not produce a record due to power failure shortly after zero time. From preliminary viewing of the films, one raft mortar apparently failed to fire; a second raft mortar shows the mortar firing but no puff visible; all other mortars fired. The quality of the records obtained is good; however, thermal dust was present between the cameras and the puffs at an early time. The functioning of equipment may be broken down as follows - cameras at 86% and mortars at 71%.

3. Project 6.3 - Shockwind, Afterwind and Sound Velocity (MIKE - KING) (AEC)

a. Object

The objectives of this project were twofold. First, the measurement of shockwinds and afterwinds at various distances from ground zero, and second, the measurement of sound and material velocities, both prior to and after shock arrival, at various distances from ground zero.

b. Method

(1) MIKE Shot

Afterwind and sound velocities were measured at four stations by means of interferometers. The four locations used were Engebi, Muzin, Bokonaarappu and Aomon. Dynamic pressures were measured by means of Wiancko pitot tubes and Sandia-designed "Q" gauges. The "Q" and pitot tube measurements were made on Engebi, Muzin, Aomon, Bokonaarappu and Parry. Temperatures of the air during the blast phenomena were measured by resistance thermometers at the same locations as the "Q" gauges. The element was shielded from the direct radiation by a metal cover.

(2) KING Shot

Afterwinds and sound velocities were measured at two Runit stations by means of interferometers. Dynamic pressures were [illegible] means of Wiancko pitot tubes at three locations along Runit Island and at one station on Parry. Dynamic pressures were also measured on Parry by means of the Sandia-designed "Q" gauge. An air temperature measurement with the element shielded from the direct radiation by a metal cover was made on Parry.

c. Results

(1) MIKE Shot

Some gauge failures were encountered. All temperature gauge elements were broken by the force of the blast. High humidity caused some opens to occur in the strain gauge elements of the "Q" gauges. Sonic interferometer failures were caused by poorly designed weather-proofing of the exposed equipment.

(2) KING Shot

In general, all equipment functioned properly on KING shot.

4. Project 6.4a - Water Wave Motion - Shallow Water - Photographic (MIKE) (AEC)

a. Object

The purpose of this experiment was to observe the motion of water waves in the lagoon near various islands.

b. Method

Cameras were installed 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 ten minutes. At each location a large raft was moored at 3,000 feet from the camera. An array of five barrels was moored about 1,000 feet from the camera and a pole was placed in shallow water near the beach about 300 feet from the camera. These objects served as markers around which wave motion was measured by filming.

c. Results - MIKE Shot

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, designed to direct the image downward into the lens, was blown off by the air shock, so that no water wave pictures were obtained. Preliminary analysis of the remaining three original negatives indicates displacements of a foot or so at Parry and two or three feet at Runit. [illegible] arrival at Rojoa has not been detected on the film; however, air shock [illegible] at Rojon was indicated. On Engebi, where the camera with no mirror was looking overhead, the passage of the cloud chamber effect was detected.

5. Project 6.4b - Sea Waves (MIKE) (DOD/USN)

a. Object

The object of this project was to measure the barometric and surface waves produced by MIKE shot.

b. Method

Commercial recording microbarographs were used to instrument the barometric waves, while the water waves were 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 (Seamount 26 and Seamount 72) 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.

c. Results - MIKE Shot

(1) The waves from MIKE shot proved to be much smaller than expected. Within the lagoon they were about one-tenth of those expected, and outside none were recorded. Microbarograph records were also far below those anticipated. **BEST AVAILABLE COPY**

(2) 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 M + 3 days provided a good check on some of the instrumentation. A particularly successful aspect of the program, [illegible] sive deep sea moorings which utilized the tops of undersea mountains which rise to within 5,000 feet of the surface. Records recovered were of good quality. The only station lost was a raft which was not recovered from Seamount 26.

(3) The Eniwetok Lagoon stations (Runit and Eniwetok Islands) clearly showed the shock wave (equivalent to about four feet of water at [illegible] and 2.5 [illegible] Eniwetok). At Eniwetok, the shock [illegible]

[illegible]

the first wave had a trough-to-crest height of about three feet, and the remainder of the waves appeared to be only troughs about 1.5 feet deep. At Runit, the shock wave was followed in fifteen minutes by an irregular disturbance, the largest single wave of which was not only 2.5 feet high. As previously stated, no wave records from MIKE shot were obtained at the Seamount stations or at Bikini Atoll; however, small barometric changes were recorded there.

6. Project 6.5 - Ground Motion - Seismic Measurements (MIKE) (AEC)

a. Object

This project was designed to supply information relative to the transport of explosion energy by the ground as evidenced by earth accelerations and resulting motions.

b. Method

Earth motions, or, more specifically, earth accelerations were measured at Bogon, Engebi, Muzin, Bokonaarappu, Aomon and Parry. For each installation the radial, vertical and tangential acceleration components were measured utilizing Wiancko accelerometers. The three gauges at each installation were placed in a metal case or "bull plug" mutually perpendicular to each other and placed at an average depth of seventeen feet. An effort was made to match the density of the case to the density of the coral. The accelerometer case on Bokonaarappu 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.

c. Results - MIKE Shot

(See Incl 2 of Appendix F) Data from the pre-shot seismic surveys and earth attenuation measurements of Program 11 will aid in the analysis and interpretation of results obtained herein.

7. Project 6.6 - Microbarographic Measurements ([illegible]) ([illegible])

a. Object

The primary purpose of this experiment was to determine perturbation pressures established in the upper atmosphere by the nuclear detonations. The project was deleted from the IVY program due to incorporation of its measurements in other projects.

8. Project 6.7a - Underwater Pressures as a Function of Time and [illegible] as a Function of Distance ([illegible])

[redacted]

a. Object

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.

b. Method

To accomplish this purpose, instrumentation was completed on three types of underwater pressure measuring devices - a Wiancko system consisting of a variable reluctance pressure pickup of the Twisted Bourdon tube type modified for underwater operation and oscillographic recording; an Horizons system consisting of barium titanate pressure pickups employing magnetic tape recording; and an NRL telemetering system using the output signals from the Wiancko gauges and transmitting them via aircraft relay to a remote recording station aboard a Task Force vessel. The instrumentation was engineered to fit in a shock-mounted cage inside a first class standard can buoy. Each buoy was 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 planned for stationing on the ocean side of shot island as follows:

(1) Buoy No. 1 - Wiancko self-recording system at 6,000 feet from ground zero.

(2) Buoy No. 2 - Horizons self-recording system at 9,000 feet from ground zero.

(3) Buoy No. 3 - Wiancko self-recording system and NRL telemetering system at 9,000 feet from ground zero.

(4) Buoy No. 4 - Wiancko self-recording system and NRL telemetering system at 12,000 feet from ground zero.

c. Results - MIKE Shot

(1) The project succeeded in getting three buoys on station before MIKE shot, moored in 200, 375 and 500 fathoms of water at the proper distances from ground zero under extremely adverse weather conditions. Some instrumentation failures occurred in the electronic systems.

(2) 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. Telemetered records were obtained; however, analysis is not available at this writing.

9. Project [illegible] - Underwater Pressures Along Reef (MIKE) [illegible]

[redacted]

a. Object

As a continuation of the underwater pressure field studies, this project was designed to measure the pressure as a function of time in the shallow water of the lagoon.

b. Method

The basic instrument used herein was a Wiancko gauge modified for underwater use.

c. Results

(1) MIKE Shot

Four underwater pressure-time measurements were made at depths of approximately 100 feet and at a distance of about one mile offshore on the lagoon side. These were located off the Islands of Teiteiripucchi, Engebi, Aomon and Parry. Wiancko Twisted Bourdon tube gauges were utilized, mounted on tripods ten feet in height to raise them off the lagoon floor.

(2) KING Shot

An underwater pressure-time measurement was made at a depth of approximately 100 feet off Parry. This measurement was not called for, but as the installation was completed for MIKE, the channel was again opened up.

10. Project 6.7c - Acoustic Pressure Waves in Water (MIKE - KING) (DOD/USN)

a. Object

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.

b. Method

Several Sound Fixing and Ranging (SOFAR) stations in the Pacific and Atlantic Ocean areas were alerted to detect and record the acoustic signals generated. Such 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.

c. Results

Successful records were definitely obtained from [illegible]

[illegible] in the Pacific area. Although the [illegible]

[redacted] [redacted]

been completely reduced, preliminary indications are that the maximum energy received was apparently concentrated at a lower frequency than was the case in Operation GREENHOUSE. (No data is available for KING shot at this writing.)

11. Project 6.8 - Pre-Shock Arrival Air Temperature (MIKE - KING) (AEC)

This project was deleted from the IVY Program on the basis of the experience gained during TUMBLER-SNAPPER.

12. Project 6.9 - Air Density Versus Time (MIKE) (AEC)

a. Object

This project was designed to document the air density at various fixed points in the blast field prior to, during and subsequent to the passage of the shock wave.

b. Method

(1) To accomplish its purpose, this project utilized a device known as the Beta-ray Densitometer. Briefly, the Densitometer consists of a fixed source of beta rays, a detector which responds to changes in beta ray intensity, and a recording instrument which converts the detector output into a picture record on a negative film strip. The attenuation of beta rays and, hence, the detector output is a function only of the material density between source and detector.

(2) For MIKE shot, four Beta-ray Densitometers were used, one on each of the following islands - Engebi, Kirinian, Bokonaarappu and Aomon. The distances from ground zero to these stations were 19,000, 23,000, 31,000 and 42,000 feet respectively. **BEST AVAILABLE COPY**

c. Results - MIKE Shot

(1) The Densitometer at Engebi failed since the camera did not operate. The Densitometer on Kirinian worked successfully and gave good results. Densitometers on Bokonaarappu and Aomon 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 relays operating in reverse sequence, i.e., the -5 second relay operating at -1 minute, and the -1 minute relay at -5 seconds.

(2) Arrival time of blast at Kirinian was 9.5 seconds after zero. [illegible] density measured was 9.8 gms/liter = 7.3 times normal density, [illegible] after blast arrival. In general, [illegible]

period from 0.5 second after blast arrival to 3.0 seconds after arrival, the density varied randomly from about 2.5 to 3.5 times normal. This indicates considerable loading of the air by dust, pebbles, coral and other debris.

13. Project 6.10 - Free Air Pressure as a Function of Time (Manned Aircraft) (MIKE - KING) (DOD/USAF)

a. Object

This project was designed to determine the free air pressure as a function of time using manned aircraft to position the measuring instruments in space at altitudes significant to delivery aircraft. In addition, data on the dynamic structural response of aircraft was planned. The latter will be used as a basis for establishing structural design criteria and for immediate use in planning delivery techniques for very high yield weapons.

b. Method

To accomplish the mission an instrumented B-36D and B-47B were positioned at predetermined points in space near the explosion to record the blast effect on the aircraft structure. The B-36D was instrumented with strain gauges, accelerometers and a Cook recorder with eighteen channels for blast data. The B-47B was similarly instrumented and recorded six channels of blast data. Strain gauges were employed to determine deflections of individual aircraft components. Since the yield of MIKE shot was not known except within broad limits, it was necessary to instrument the aircraft with two distinct sets of pressure gauges to cover a pressure range of 0 to 10 psi.

c. Results

(1) MIKE Shot

Useful data was obtained on 100% of the channels of the B-36D, with 90% of the recordings of good quality. There was no useful data recorded on the B-47B. The aircraft was apparently too far out from the predetermined position and the oscillograph ran out of paper before the shock arrival. Shock arrival had been computed as 135 to 159 seconds, depending on yield. The recorder ran out of paper 165 seconds after zero. Horizontal tail bending moment for the B-36D was approximately 62[illegible] of limit. Bending moments in the wing due to the gust were very low, as expected. At shock arrival this aircraft was approximately 22.7 nautical [illegible] [illegible] at an altitude of [illegible],000 feet. The B-47B, [illegible] was at a slant range of approximately 28.5 nautical miles and at an altitude of 35,000 feet.

(2) KING Shot

This project was executed in the same manner as for MIKE shot. The B-36D and the B-47B were at slant ranges of approximately 10.4 and 9.1 nautical miles and at 32,000 and 35,000 feet respectively at shock arrival. Eighteen channels (95%) of blast data were recorded. The quality of the data obtained appears to be good.

14. Project 6.11 - Free Air Pressure as a Function of Time, Utilizing Parachute Suspended Canisters (MIKE-KING) (DCD/USAF)

a. Object

This project was designed to measure the free air overpressure versus time, at a number of different known close-in altitudes and distances from an atomic explosion. It was an attempt to collect data on the attenuation of a shock wave in a non-homogeneous atmosphere to aid in the determination of safe (to flight crew personnel) procedures for aircraft delivery of high yield atomic weapons, and to verify (or deny) presently available theoretical approximation methods. In addition, free space thermal measurements were to be obtained, under the conditions of severe reflection or absorption (due to cloud coverage) which was expected to exist at shot times.

b. Method **BEST AVAILABLE COPY**

For this project, the general plan of operation was to obtain pressure and thermal measurements at twelve points along a radial line from the point of detonation, extending from the shortest range at which data can be obtained to approximately the operational range for manned aircraft. Twelve parachute suspended canisters were dropped on each shot, from two B-29 aircraft flying at approximately 32,000 feet. The altitude of the canisters at shock arrival time was to vary from approximately 10,000 feet for the nearest to 30,000 feet for the most distant. The twelve instruments were divided into two groups, one to give useful data in the event of a low yield and the other adjusted for documentation of a high yield. The two B-29's were scheduled to deploy six canisters in such a way that a maximum of useful data would be obtained should either of the planes fail. Each canister contained a pressure sensitive element, a thermal sensing device, and a tele-metering transmitter. They were approximately [illegible]

[redacted]

fourteen inches in diameter and weighed 275 pounds.

c. Results

(1) MIKE Shot

Of the twelve parachute-borne canisters deployed during MIKE shot, ten canisters functioned properly in all respects. The radio telemetry stations recorded all four subcarrier 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 successfully accomplished. Two canisters had a free-fall due to parachute failure and experienced impact prior to zero. However, each position in the canister array was duplicated by two canisters so that all six positions in the array were recorded. 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.

(2) KING Shot **BEST AVAILABLE COPY**

Of the twelve parachute-borne canisters deployed during KING shot, eight canisters functioned properly. The radio telemetry stations recorded all four subcarrier channels from each of the eight canisters. Measures of ambient pressure, differential pressure and thermal flux were successfully recorded. Data results indicate that the aircraft arrived at the target point twenty seconds early. One aircraft deployed six canisters successfully; however, the other aircraft experienced bomb release difficulties and all six canisters were released by salvo operation. Two canisters incurred a free-fall because of parachute malfunction resulting in impact prior to zero. Two other canisters incurred electronic failure. In reference to the information obtained for each array position, the recordings indicate that approximately 75% data was obtained. The quality of the recordings obtained was excellent for each of the eight canisters. Thermal measurements were obtained from the five canisters nearest ground zero. The thermal measurements from the three canisters most distant from ground zero indicated that thermal instrumentation was not adequately sensitive for the [illegible] existing at that distance.

[redacted] [redacted]

[redacted]

15. Project 6.12 - High Altitude Waves (MIKE) (AEC)

Project 6.12 was deleted from the IVY program due to lack of a feasible method of placing detectors at extremely high altitudes.

16. Project 6.13 - Measurement of Free Air Pressures by Smoke Rocket Photography (KING) (DOD/USN)

a. Object

The function of Project 6.13 was to obtain free air shock pressure by rocket trail photography. A secondary purpose involved photographic time of arrival measurements at ground level of any precursor blast waves which might be formed.

b. Method

In this technique, smoke rockets were fired to form a grid of smoke trails behind the burst. The shock wave growth was recorded by photographic means (Mitchell cameras at approximately 100 frames/sec) against this background. The change of the index of refraction in shock wave front causes gaps to appear in the smoke trails. As a result of this, the time of arrival curve is obtained. Analysis of data will be similar to Project 6.2.

c. Results - KING Shot

The smoke rockets were fired from Station 6140 in the form of a fan with trails every 10° from an elevation of 10° to 170°. There were two others fired at 85° and 95°. All the rockets fired. Of the three cameras (focal lengths 100mm, 50mm and 35mm), only the 50mm focal length failed to function. The record obtained by the camera with the telephoto lens (100mm) was excellent. The other record (35mm focal length) will be difficult to interpret because of the smallness of detail.

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PRELIMINARY MIKE SHOT AIR PRESSURE DATA

Location	Distance (kilofeet)	Travel Time (sec)	Peak Pressure (psi)	Positive Phase (sec)	*Acoustic Travel Time (sec)	Shock Travel Gain (sec)	Yield from Chronobhang Chart	Yield from Peak Pressure (MT)
ESTES	188.5	145	---	---	164.0	19.0	13.5	...
Parry	114.24	85.3	0.36	14.0	101.4	16.1	9.7	~1.0
Runit	74.88	51.2	1.33	12.0	66.6	15.4	11.0	~6.0
Aomon	47.57	28.8	2.75	9.3	42.4	13.6	---	7.0
Rujoru	36.71	19.3	3.90	---	32.7	13.4	---	6.5
Muzin	21.41	8.7	12.00	5.7	19.1	10.4	---	9.7
Engebi	15.90	5.3	23.60	4.7	14.1	8.8	---	10.5
Bogon	8.25	1.4	---	---	7.3	5.9	---	---

Note: * Computed from meterological data taken on USS ESTES

Incl 1 to Appendix F

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PRELIMINARY EARTH ACCELERATION DATA (MIKE)

Location	Distance (kilofeet)	Acceleration Direction	Travel Time (sec)	Peak to Peak Acceleration (g)	Prominent Periods (sec)
Bokonaarappu	30.454	Radial	3.8	0.23	0.6, 0.22
		Transverse	3.8	0.26	0.4, 0.33, 0.25
		Vertical	3.8	0.24	0.6, 0.28
Engebi	18.333	Radial	2.2	0.22	0.25
		Transverse	2.2	0.07	0.20
		Vertical	2.2	0.17	0.40

Incl 2 to Appendix F

[redacted]

APPENDIX G

PROGRAM 7: LONG RANGE DETECTION

(NOTE: 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 ball of-fire light. Further, the continuing evaluation of airborne bomb debris requires the analyses of close-in bomb debris from known U. S. nuclear detonations.)

1. Project 7.1 - Electromagnetic Effects From Nuclear Explosions (MIKE-KING) (DOD/USAF)

a. Object

(1) This project is part of a continuing series of experiments investigating alternative techniques for employment by the Atomic Energy Detection System (AEDS). The existence of an atomic explosion-induced electromagnetic impulse has been established at previous ZI tests with identification at distances up to 2,000 miles from the detonation point. These IVY experiments were designed to gain further knowledge of the precise nature and character of the pulse through:

(a) Separation of this pulse from other atmospheric disturbances.

(b) Changes in signal with distance and determination of most favorable detection frequencies with distance.

(c) Procedures for best triangulation and signal coincidence.

b. Method

(1) Existent receiving equipment for high frequency reception was used as much as possible from locations at widely separated points in the ZI and outside - Maui, T. H., Guam, Alaska, Colorado and Virginia.

(2) Beveridge, rhombic, vertical and loop antennas were utilized to obtain best signal for frequencies encountered in an expected range from a few cycles per second to possibly 100 megacycles.

(3) Necessary accurate timing was obtained by means of crystal controlled oscillators tied to world time.

c. Results

(1) MIKE Shot

[redacted] [redacted]

 [redacted]

Of nine stations operating, six reported signals and three reported questionable signals. Further analysis is being carried on to correlate all objectives of the project.

(2) KING Shot

No reports are available at this time for this project because of widely separated collection points and the sixty-day period needed for analysis.

2. Project 7.2 - Airborne Low Frequency Sound From Atomic Explosions (MIKE - KING) (DCD/USAF)

a. Object

This project is part of a continuing program, determining reliability of acoustic long range detection methods from detonations of known characteristics in application to unknown characteristics from routine operations of AEDS. The experiment was designed to record variations in atmospheric pressure through induced low frequency acoustic waves caused by atomic detonations and from this recorded data to document amplitude, frequency, duration, apparent velocity of wave as well as azimuth of origination.

b. Method

(1) Widely scattered in distance and azimuth, acoustic detection stations were set up in Japan, Oahu, T. H., Alaska, Washington State, Washington, D. C., Arizona and New Jersey.

(2) Instrumentation at these stations utilized microphones - Signal Corps Infrasonic System M-2 (Modified), Navy Electronic Laboratory modified Rieber Microbarograph System and a National Bureau of Standards Microphone System. Signals from the instruments were transmitted over wire lines to a recording center. One instrumentation system consisted of at least four microphones with one or more located at each vertex of a quadrilateral, sides of which were four to six miles in length. Recordings were accomplished with both magnetic tape and Esterline-Angus techniques.

c. Results

(1) MIKE Shot

All stations received positive signals. Detailed study now underway will give the required information on amplitude, frequency, duration, apparent velocity of the incoming wave together with azimuthal path.

[redacted] [redacted]

(2) KING Shot

No reports are available at this date because of the widely scattered sources of information.

3. <u>Project 7.3 - Calibration Analysis of Close-in A-Bomb Debris (MIKE - KING) (DOD/USAF)</u>

a. <u>Object</u>

(1) This project was designed to furnish calibration data concerning fission product ratios, residual fissionable materials and induced radioactivity in airborne U. S. atomic bomb debris, measured by radiochemical, analytical techniques.

(2) Ultimately, the data obtained will again be used in evaluation of analysis of debris from foreign atomic detonations collected by AEDS.

b. <u>Method</u>

(1) Solid, liquid and gaseous samples of atomic debris were collected utilizing specialized sampling techniques and equipment developed by AFOAT-1 and its contractors.

(2) Sampling at 40,000 feet Mean Sea Level (MSL) and higher was a [redacted] project as discussed under Project 1.3. In addition, WB-29's (from the Air Weather Service) collected filter samples on meteorological and cloud tracking missions. These aircraft utilized instruments which detected and recorded airborne radioactive debris instantaneously (filter box monitor). Also, gas sampling and water collection devices were installed. A counting room was established at Kwajalein to determine activities of filter papers from cloud tracking missions. AEDS collections were coordinated with close-in operations.

(3) Soil and lagoon water samples were taken near zero point before and after detonations.

c. <u>Results</u> **BEST AVAILABLE COPY**

(1) MIKE Shot

Airborne sampling missions were considered successful from sample quantity point-of-view. Quality of filter (solid) and snap (gaseous and particulate) samples is in process of being determined. Initial estimates indicate filter samples may contain large quantities of natural uranium which will probably be a source of interference with projected analysis of uranium isotopes but no interference with fission product analysis.

Snap samples were obtained from nine F-84G aircraft, three gas samples and three humidry samples from two B-29 aircraft.

(2) KING Shot

WB-29 sampling was not very successful because of the peculiar distribution of KING shot debris at B-29 aircraft operating altitudes. Filter samples will probably be adequate for fission product and induced activity laboratory work. The samples do not appear adequate for plutonium and uranium isotopic analysis and other specialized techniques. Nine snap sample gas samples were obtained with F-84G filter aircraft and four with B-31 sampling devices. Moisture which possibly carries residual T_2O was successfully recovered from five samples. Detailed summaries of quantity and quality of material collected will be available after further laboratory analysis.

4. <u>Project 7.4 - Propogation of Seismic Waves (MIKE - KING) (DOD/USAF)</u>

a. <u>Object</u>

(1) This experiment was concerned with characteristics of seismic signatures from nuclear detonations. It is a continuation of measurements from other tests to gain information on scaling laws. The effort is directed toward:

(a) Measurements of amplitude of horizontal and vertical earth motions.

(b) Determination of times of arrival of distinctive phases of seismics and other factors correlated with known test conditions and seismic equipment.

(c) Determination of coupling coefficient of energy transmission of atomic bursts to seismic energy.

(2) Data obtained from U. S. operations will be applied to evaluation of data from foreign nuclear detonations on operations of the AEDS seismic net.

b. <u>Method</u>

(1) Two special standby seismic stations were activated in Alabama and Oklahoma. These were coordinated with three regular ZI AEDS stations in Wyoming and one in Alaska. Foreign seismic stations 4,000 - 7,000 miles from zero were operated.

(2) Instrumentation consisted of [illegible]

with special engineering to insure sensitivity on the order of 1 CPS and magnification to 10^6 for IVY. The seismographs at each location were employed in a linear array (one to three miles length of deployment of four vertical and two horizontal components) to separate desired signals from microseisms and other forms of "noise".

c. Results

(1) MIKE Shot

Six stations received strong signals, one fair, one questionable and one station with no report. U. S. Coast and Geodetic Survey seismic stations reported positive signals. Details of signals are not yet available.

(2) KING Shot

No reports are available at this writing due to the world-wide spread in stations and time needed for collection and analysis of data.

5. Project 7.5 - Transportation of Airborne Debris (MIKE - KING) (DOD/USAF)

a. Object

This project was designed to contribute information on vertical mixing in the stratosphere by using the atomic cloud as a gigantic tracer. The unusual height and size of the cloud was expected to aid in determining the approximate time required for gaseous debris to diffuse downward to the surface, the rate of progression toward polar areas and assist AEDS in its routine operations. These factors, to be measured directly, had never been made for the stratosphere.

b. Method

(1) At five locations in the Northern and Southern Hemispheres, it was planned to collect one-gallon atmospheric samples weekly for tritium detection in rain water. This operation will cover a period from two months prior to and six months after detonations. All counting of tritium samples will be completed by TRACERLAB Inc.

(2) Daily humidity samples for two weeks after detonations were obtained at Honolulu and Guam.

(3) Shipboard radars of Task Force and airborne clinometers were used to determine cloud height and movement.

c. Results

(1) MIKE Shot

[redacted]

Conflicting initial data relative to cloud height and movement precludes a true picture at present. Additional data will clarify most probable height and movement.

(2) KING Shot

No reports are available at this time.

6. Project 7.6 - Detection of Fireball Light at Distances (MIKE - KING) (DOD/USAF)

a. Object

The first long range detection of ball-of-fire light was made at night on EASY shot of Operation GREENHOUSE. The detection apparatus was in an aircraft above the cloud cover 630 miles from ground zero. Daylight detection, presenting favorable signal-to-noise ratios, was accomplished 270 miles from ground zero for all BUSTER shots except ABLE. This project was part of a continuing program to develop a light detection system capable of determining bomb yield at distances commensurate with practical operations in AEDS.

b. Method

Measurements were made at ground stations on Kwajalein and Johnston Islands and one air (C-47) station at Kwajalein.

c. Results

(1) MIKE Shot

No results of this project are available at this time. Measurements from the C-47 flying over Kwajalein are expected to be negative due to the heavy cloud cover between ground zero and location of the aircraft. Ground measurements at Kwajalein are also questioned because of low and heavy cloud cover and smoke interference from the F-84G's during take-off of these aircraft.

(2) KING Shot

No confirmed results of this project are available at this time, but cloud cover between ground zero and the aircraft above Kwajalein implies negative results. Ground measurements at Kwajalein are also questioned because of cloud cover.

[redacted] [redacted]

[redacted]

(b) All but one of the thermopiles functioned properly.

(c) The total incident thermal energy measured by each equipment is listed in the following table, together with the location of the equipment and the distance to zero.

Station	Distance to Zero (km)	Incident Flux (joules/cm^2)	Station Average (joules/cm^2)	Thermal Kilotonnage
802 Biijiri	6.85	29.9 25.9 29.1	28.3	52
804 Aniyaanii	11.0	7.83 7.93 8.77	8.18	45
805 Parry	16.8	3.83 3.38 3.48	3.56	51
806 Coral Head	11.6	Failed 6.04 6.80	6.42	40

(d) The values for air transmission used have been corrected for scattering in the field-of-view. This is a preliminary correction and will be modified when cloud locations are better known.

(e) The Coral Head and Aniyaanii stations included cameras set to show cloud obscuration. None was apparent. Also, no clouds obscured the Biijiri station or that at Parry.

(f) The thermopiles were housed in sealed boxes having quartz windows, except at Parry where a wooden box without windows was used. At Coral Head the windows were found somewhat fouled by spray and sawdust after the shot. A driving rain had fallen after the shot and before inspection of the windows and may have partially cleaned them. The Coral Head data is not considered as valuable for this reason and should not be included in an average. Also, the bombing error has not been included in the above calculations.

2. <u>Project 8.2 - Thermal Intensity as a Function of Time ([illegible]) ([illegible])</u>

a. <u>Object</u>

This project was designed to document the time variation in thermal intensity at several fixed points.

[redacted]

b. Method

(1) In IVY, three methods of measuring total thermal radiation versus time were used:

(a) High speed bolometers, having approximately 25 micro-second time resolution, were used to cover the period of time from just before to several seconds after zero.

(b) Liquid flow meters, having a time resolution of approximately 1 millisecond, were used to cover the same period of time as the bolometer assemblies above.

(c) For very early time coverage (0.1 to 100 microseconds), photocells were used.

(2) For MIKE shot, stations on Engebi and on Biijiri each contained the following thermal radiation versus time measuring equipment:

(a) Two high speed bolometer assemblies.

(b) Two photocell recorders - one sensitive to the violet portion of the spectrum and the other sensitive to the red portion.

(c) One or two of the above mentioned non-electronic instruments.

(3) For KING shot, the station on Biijiri was reactivated to take the same measurements as mentioned above for MIKE. In addition, these measurements were duplicated from the twenty-five foot tower on Aniyaanii.

c. Results

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(1) MIKE Shot

(a) There appears to be no signal at Biijiri before 1 microsecond except a possible pulse from Teller light. The area under a thermal power versus time curve integrated on a linear plot gives as the incident energy at Biijiri 50.5 joules/cm^2. Correction for atmospheric transmission and inverse square laws sets a value for the thermal energy radiated between 0.72 MT (where scattering correction for 30° diameter field-of-view is used) and 0.92 MT (where no scattering correction is made).

(b) At Engebi, one of the three photocell systems gave a readable trace of Teller light from the fusion phase of the explosion. The second Teller light appears to have come at 9.2 $\pm$ 0.2 microseconds.

(2) KING Shot

(a) [illegible] [redacted]

[redacted]

time, one instrument at Aniyaanii became noisy and, while it recorded power as a function of time, the results were quite poor. The other three instruments functioned properly.

(b) Three photocell equipments were set up at Biijiri to measure Teller light as a function of time. Between the last instrument check on K-2 days and shot time the 24V battery which operated the camera shutters lost charge, making shutter operation impossible.

(c) Four GR Slit Cameras were operated at Parry Island as strip instruments. The proposed burst point was imaged on the slits of the cameras, but in no case did the errors of pointing match those of bombing. All records show Teller light and give good time histories of bomb light scattered into the instrument as a function time through the first few milliseconds.

3. <u>Project 8.3 - Spectroscopy (MIKE - KING) (AEC)</u>

a. <u>Object</u>

This project was part of a continuing series of experiments, the purpose of which is to obtain as much information as possible concerning the thermal radiation spectrum associated with various sizes and types of atomic bursts, detonated under a variety of conditions.

b. <u>Method</u> **BEST AVAILABLE COPY**

(1) For MIKE shot, moving film spectrographs were installed at stations on Engebi and on Biijiri. At each of these stations, measurements were taken with two film speeds - one to obtain a spectrum every 2 milliseconds and the other to obtain a spectrum every 2 microseconds.

(2) In addition, a high resolution of energies was obtained on an integral spectrum. The instrument for this measurement was installed in a small room directly below the photo tower cab on Parry Island.

(3) For KING shot, the above mentioned Biijiri and Parry installations were reactivated. The measurements taken from them were to be identical to those taken for MIKE shot.

c. <u>Results - MIKE and KING Shots</u>

All equipment operated satisfactorily and gave excellent records. Reduction and analysis of data are currently in progress.

4. <u>Project 8.4 - Air Attenuation (MIKE - KING) (AEC)</u>

a. <u>Object</u>

[redacted]

This project was designed to add to the already existent fund of knowledge relative to the effective range of electromagnetic radiation in the atmosphere as a function of energy and the atmosphere's ambient conditions. Its secondary purpose was to satisfy an operational requirement - that is, to actuate a "go-no-go" system in the firing circuit. This latter function was tied to minimum acceptable air transmission properties essential to the success of priority projects.

b. Method

(1) Transmissometer (source, detector and recorder) assemblies were operated over several light paths. For MIKE shot, the searchlights were mounted approximately 100 feet above sea level on the Parry photo tower and the associated receiver was on Elugelab. A similar system was used between Bogon and Bogallua, with a smaller eighteen inch searchlight source on Bogon. This pair of transmissometer assemblies monitored the air attenuation along their lines of sight at all times prior to the shot and were made a part of the "go-no-go" system in the firing circuit.

(2) For KING shot, an attempt was made to measure air attenuation between bomb zero and the thermal stations on Parry (photo tower), Aniyaanii and Biijiri until some few hours prior to the shot. A helicopter was used to hold the light source at the proper position.

c. Results

(1) MIKE Shot

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

(2) KING Shot

Satisfactory measurements were made in accordance with the needs of this project.

5. Project 8.5 - Thermal Radiation as a Function of Time in Free Air Utilizing Manned Aircraft (MIKE - KING) (DOD/USAF)

a. Object

This project was designed to determine, in free air at altitudes significant to delivery aircraft, the thermal radiation intensity as a function of time and the maximum associated radiation induced aircraft

[redacted]

temperature. Such information is essential to studies of safe aircraft delivery procedures.

b. Method

(1) The maximum skin temperature of the B-36D and B-47B aircraft of Project 6.10 was determined with skin patches located on the inside surface of the skin. Thermocouples, properly located for representative measurements, were also used. The temperature as a function of time was correlated directly with the thermal radiation intensity measurements made with a directed phototube.

(2) Attenuation measurements were made over a two week pre-shot period, using similar equipment in a B-29, to determine the air transmission properties under conditions as nearly similar to those existing at shot time as possible. A strong mercury arc light source was operated near ground zero three weeks prior to MIKE shot and attenuation measurements were made on a number of days at about the same hour of the day as proposed shot time. Such measurements were also made immediately prior to the shot. A similar light source was placed on Runit Island and as many pre-shot attenuation measurements as possible were made during the time interval between reentry into the atoll subsequent to MIKE shot and the detonation of KING.

c. Results

(1) MIKE Shot

(a) The B-36D recorded thirty-six channels of thermal response. Eighteen channels of thermal information were recorded by the B-47B. Useful data was obtained on 100% of the channels on both the B-36D and B-47B. Of the recordings, 90% are of good quality. It was apparent from the analysis of the thermal flux readings that the B-47B was not tail-to at zero time. At zero hour, the B-36D and the B-47B were located at slant ranges of approximately 15 and 12.4 nautical miles from ground zero and at altitudes of 40,000 and 35,000 feet respectively.

(b) Preliminary indications were: 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 B-47B aircraft was apparently not in position. No temperature-tape data was obtained since the [illegible] [illegible] fuse. The B-36D received a relatively high thermal radiation flux of 46.9 BTU/ft^2 (predicted value based upon 6 MT was 36 BTU/ft^2). It is noted that the MIKE drone on Operation GREENHOUSE received approximately 26 BTU/ft^2.

(2) KING Shot

The B-36D and B-47B were in position approximately 7.8 and 5.7 nautical miles slant range and at 32,000 and 35,000 feet respectively at zero hour. Sixty channels (89%) of thermal data were recorded. The quality of the data obtained appears to be good.

[redacted]

APPENDIX I

PROGRAM 9: ELECTROMAGNETIC PHENOMENA

(NOTE: Program 9 was concerned with the measurement of various electromagnetic phenomena associated with the nuclear event. Measurements of electromagnetic signals were made by LASL with specific interest devoted to evaluating the interval between signals received from the two MIKE fission events. Ionosphere effects were measured by the Signal Corps Engineering Laboratories, and electromagnetic radiation throughout the radio spectrum by 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.)

1. Project 9.1 - Electromagnetic Signals (MIKE - KING) (AEC)

a. Object

The purpose of this project on MIKE shot was to determine, by means of electromagnetic signals from the detonation, the time between the [redacted]eaction and the beginning of the thermonuclear reaction. An additional purpose on both shots was to continue the investigation of the shape and magnitude of the very early portion of the electromagnetic signal produced by a nuclear detonation. The first 10 microseconds of the signal were of particular interest.

b. Method

Recording equipment was operated at Parry Island and at Los Alamos, for both MIKE and KING shots.

c. Results

(1) MIKE Shot

A rough measurement of the time interval gav[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.

(2) KING Shot

All equipment operated properly, and all films show the appropriate signals. Interpretation of these traces is not presently available.

2. Project 9.2 - Effects on the Ionosphere With Respect to the Propagation of Radio Waves (MIKE - KING) (DOD/SCA)

a. Object

This project was designed to observe the effects of atomic explosions on oblique incidence radio signals reflected from the ionosphere and the attenuation caused by the ionosphere layers.

b. Method

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

(2) A P2V plane, flying in ellipses at an altitude of 1,100 feet, 200 miles west of Eniwetok, broadcast a continuous wave signal to be detected at Bikini. The signal 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.

(3) 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 minutes to H ≠ 4 hours and send a carbon copy of the transmitted and received messages to the project officer. In addition, this traffic was to be intercepted at Bikini, if possible.

(4) The same test were scheduled for KING shot as for MIKE shot, except that instead of intercepting the Guam-to-Kwajalein circuit, teletype messages from Eniwetok were recorded at Bikini.

c. Results - MIKE and KING Shots

In general, no results are available on this test at this writing. All experiments appear to have been completed in a satisfactory manner.

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3. Project 9.3 - Investigation of Electromagnetic Radiation Throughout the Radio Spectrum Caused by an Atomic Explosion (MIKE - KING) (DOD/USA)

a. Object

The objective of this experiment was to measure the pulse shape, polarization and energy distribution of electromagnetic radiation, over the radio spectrum, resulting from a nuclear detonation.

b. Method

A spectrum analysis of the radiated pulse was made on [illegible] Island. Observations were made at Hawaii and Bel[illegible], New Jersey, on 10 kilocycles, usi[illegible] sferics receivers. Observations were also made at such [illegible]

[redacted]

optimum propagation frequencies.

c. Results

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(1) MIKE Shot

(a) On-site Station, Parry Island

No data was obtained due to failure to receive a -15 second time signal.

(b) Off-site

Bikini - 100% of data obtained.

Okinawa - No report to date.

Oahu, T. H. - No report to date.

California - No report to date.

New Jersey - No report to date.

(c) 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 kilocycles (general propagation) and 4.215 megacycles (ionsopheric propagation).

(2) KING Shot

(a) On-site Station, Parry Island

Broad-band oscillographic recording equipment was employed to measure pulse shape and polarization, and a 14-channel magnetic tape recorder was used to measure energy distribution versus frequency. Ninety percent of data was obtained. The data indicates a very sharp negative pulse of over 100 volts (antenna voltage), then two positive pulses of approximately 70 volts amplitude having a duration of 12 microseconds and a separation of 12 microseconds. The polarization measurement indicates a predominantly vertical polarization.

(b) Off-site Stations

These stations were located at Bikini, Okinawa, Oahu, California and New Jersey, and operated on optimum traffic frequencies (OOT) to measure ionospheric and ground waves from the nuclear detonation. No data is available at this time.

4. Project 9.4 - Evaluation of Indirect Bomb Damage Assessment (IBDA) Techniques (MIKE - KING) (DOD/USAF)

a. Object

The purpose of the IBDA project was to determine the capability

[redacted]

of the Air Force in the detection of the detonation of a thermonuclear device by radar, with particular emphasis on the location of ground zero, and to evaluate the IBDA techniques using Bhangmeters and radar scope photography as tools. This project is a continuation of similar test projects conducted at GREENHOUSE, BUSTER-JANGLE and TUMBLER-SNAPPER. Radar scope data is also available from CROSSROADS, SANDSTONE and RANGER.

b. Method

(1) For MIKE, instrumentation consisted of using three aircraft, each equipped with the radar set AN/APS-23, namely, one B-36D, one B-47B, and one B-50D. The B-36D was located at 40,000 feet and at a slant range of approximately fifteen nautical miles from ground zero, while the B-47B at 35,000 feet and the B-50D at 25,000 feet were located at 12.4 and forty-five nautical miles respectively. All radar sets were looking toward ground zero at zero times.

(2) This project was executed for KING shot in the same manner as for MIKE shot, with altitudes of 32,000, 35,000, and 20,000 feet and slant ranges of 7.8, 5.7 and nine nautical miles respectively.

c. Results

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(1) MIKE Shot

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

(2) KING Shot

All radar scopes were looking at ground zero and all radar operators witnessed the detonation. A total of sixty feet of film was exposed.

[redacted]

APPENDIX J

PROGRAM 10: TIMING AND FIRING

(NOTE: Accuracy and dependability in timing and firing are among the most important of the facilities in atomic testing. This was the first series of atomic detonations in which this array of services became a program because of complexities involved with an unmanned timing and firing panel as well as an air drop of unusual yield.)

1. Project 10.1 - Timing and Firing (MIKE - KING) (AEC)

a. Object

This project was designed to supply all the timing and firing signals required in the IVY experimental programs. Arming and firing were needed between the control ship and Eniwetok Atoll with special signals to and from the ship for safety or emergency reasons. In addition, television equipment was needed between the MIKE site and the control ship to provide the necessary history of the timing equipment before the shot.

b. Method **BEST AVAILABLE COPY**

(1) For MIKE shot, the master timing equipment was located on the shot island near zero. 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:

-30 min	-5 min	-30 sec	-5 sec
-15 min	-1 min	-15 sec	-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 minute signal was due, and ran through its cycle automatically. Two independent television channels between the shot island and the ship were used for telemetering. The two cameras were focused on identical indicator panels which showed the information required by the Firing Party Commander to determine whether or not the detonation would take place in an acceptable fashion. An automatic "go-no-go" interlock system was connected in the MIKE firing circuit to stop the shot unless appropriate firing conditions existed.

(2) For KING shot, the following time signals were available:

[redacted]

-30 min	-5 min	-15 sec	-2.5 sec
-15 min	-30 sec	-5 sec	-1.5 sec

Zero time signals were furnished by individual "Blue Boxes", located near the equipment with which they were used. The first three signals were sent out manually and all later signals from an automatic timer. The latter was started by a radio signal from the drop aircraft when the bomb was dropped. Manual signals were based on the estimated bomb release time and automatic signals were based on the time of fall of the bomb. "Blue Boxes" were triggered by the sharp rise in light from the explosion.

c. Results

(1) MIKE Shot **BEST AVAILABLE COPY**

This shot was successfully monitored and fired at 0714:59 ± 0.2 sec, 1 November 1952 local time, on Elugelab Island of Eniwetok Atoll.

(2) KING Shot

Some "Blue Boxes" did not operate properly but all equipment received necessary signals.

2. Project 10.2 - Release Tone (KING) (AEC)

a. Object

For the air drop, the sequence timer was triggered by the interruption of a radio tone signal when the bomb was released. This project furnished the starting signal to the sequence timer in order that the timing signal system could be put into operation.

b. Method

Prior to release of the bomb, a radio tone signal was transmitted from the dropping aircraft. When the bomb left the shackle, the signal was interrupted. Interruption of tone allowed a relay activated switch to close, thus starting the sequence timer.

c. Results - KING Shot

The shot was scheduled for 1130, 16 November 1952 local time, off the north end of Runit Island of Eniwetok Atoll and was detonated within one minute before scheduled time. Time of fall was 55 ± 0.2 sec from 40,000 feet. Equipment operated properly and all hand and timer operated signals were sent out. No equipment failed to receive signals but some of the "Blue Boxes" did not operate properly.

[redacted] [redacted]

[redacted]

APPENDIX K

PROGRAM 11: PRELIMINARY GEOPHYSICAL AND MARINE SURVEY OF THE TEST AREA

(NOTE: In studying the supporting measurements necessary for this operation, AFSWP determined that the information on soundings in the ocean and on earth blast attenuation was insufficient for the operation at hand. Some soundings and some drilling with seismic measurements had been done in the area; however, the drilling had never reached base rock and the actual depth of the sediment was not known. The Actual composition of the island in question and the surrounding area had not been determined at a depth that would provide good attenuation measurements in the earth. Under these concepts, scaled ground shots would be needed to calibrate existing earth attenuation instrumentation on the atoll. In contrast to other scientific programs, all projects in this program (except 11.5) were desired prior to the actual test.)

1. Project 11.1 - Soundings of the Ocean Side of Eniwetok Reef (Pre-shot) (DOD/USN)

a. Object

(1) Because of the expected magnitude of MIKE shot, there was some possibility that the reef might be shattered and breached in the vicinity of the shot site. Although many water depth soundings have been made in the Eniwetok Lagoon and in the deep ocean water outside of the island ring, the configuration of the close-in oceanside profile of the reef was unknown.

(2) This project was designed to provide not only the reef configuration but information necessary for possible model studies of the atoll as an aid in interpretation of shot-time measurements.

b. Method

(1) The experiment employed by the Navy Hydrographic Office was a modified acoustic sounding system, whereby a vertical "fan" of acoustic pulses was directed against the ocean side of the reef, the echoes being recorded by photography of oscillographic traces.

(2) Sounding profiles to a depth of several hundred fathoms were taken at 500-yard intervals for a distance of five miles either way from shot island and at intervals of about one mile for the remainder of the reef perimeter.

c. Results

Preliminary report of results indicated successful operations completed prior to the MIKE event. Reef configuration was determined in detail.

[redacted]

2. <u>Project 11.2 - Scaled Ground Shock Tests (Pre-shot) (DOD)</u>

a. <u>Object</u>

This experiment was carried out to provide particular geological setting measurements <u>in situ</u>. These measurements were necessary to check predicted scaling laws and are being used as a measure of ground shock attenuation for the particular subsurface conditions at the atoll.

b. <u>Method</u>

(1) A series of scaled shots, i. e., 1, 5, 10, 15 and 20 equivalent tons of TNT were detonated at the saturated sand level near zero point for MIKE shot to provide ground shock measurements.

(2) Shots were arranged in a "Beehive" configuration with seismic recordings made at five stations around the atoll.

(3) Motion pictures of each shot were taken for preliminary study of wave action in conjunction with Project 6.4a

c. <u>Results</u>

(1) Preliminary reports from seismic records of U. S. Coast and Geodetic Survey indicated ground motions were irregular, resembling earthquake motions.

(2) Conclusions from data on size of shots versus relative energy are that energy reacting a station is roughly proportional to the square of the ratios of shot size.

(3) Further analysis continues at this time.

3. <u>Project 11.3 - Deep Drilling to Base Rock (Pre-shot) (DOD/USGS)</u>

a. <u>Object</u>

This project was devised to give checks on the validity of assumptions concerning the structure of coral atolls by drilling through the coral cap to basement structure underneath. Drill holes to great depths at selected locations on the atoll provided direct information on the geologic column which could not be obtained in any other way. Such information was necessary for interpretation of Project 11.4 (Seismic Refraction Surveys) and furnished data for determining vertical seismic profiles by velocity shooting.

b. <u>Method</u>

(1) Deep-well type, rotary oil well drill rig was used to drill two holes to the basalt layer at approximately 4,[illegible] feet. [illegible]

[redacted] [redacted]

[redacted]

were on Elugelab and Parry Islands.

(2) Continuous samples of the drill cuttings were taken at intervals and cores of the unaltered basalt, or basement rock, were cut for study.

c. Results

As of 31 July 1952, the project was completed. Plans for a third hole on Coral Head in the lagoon were dropped. Log of the drill holes indicated a notably small percentage of hard rock layers in the coral cap. The data will provide good control for studies still underway on Project 11.4.

4. Project 11.4 - Seismic Refraction Survey (Pre-shot) (DOD/USN)

a. Object

This experiment was designed to furnish seismic characteristics of the atoll substructure for the MIKE event.

b. Method

(1) The measurement of the characteristics was accomplished by a seismic survey which utilized high explosive charges fired at one point and the resulting refracted elastic wave detected by a recorder at another point. By varying the spacing between shots and recorder, results were interpreted in terms of the elastic constants and structure of underlying rock layers.

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(2) The technique was one used at Bikini for a similar survey. Two ships were used, one firing explosive charges and the other recording. Detection was by a trailed hydrophone. Water is considered one layer of a multilayer problem and the known seismic velocity for sea and water was used to measure distance between ships.

(3) Measurements were made along traverses criss-crossing the lagoon, and interpretation made in terms of configuration of subsurface layers under the atoll. The deep drill holes of Project 11.3 gave positive control in interpretation.

c. Results

(1) One of the two vessels needed for the seismic survey was delayed in arrival at the atoll. However, another vessel, although not equipped for listening, was made available and a major part of the work was [illegible] before the MIKE event. Additional work continued on-site for [illegible] with arrival of the regular survey vessel.

[redacted] [redacted]

(2) The use of the Elugelab drill hole for listening was an innovation which will result in irrefutable correlation of direct and indirect geological sequences. Expected high velocity strata were found, and preliminary velocity profiles were made.

5. <u>Project 11.5 - Marine Survey (MIKE) (AEC)</u>

a. <u>Object</u>

This project, relatively minor in effort, included a collection of specimens of marine life from the reef and lagoon before and after MIKE shot. The purpose was to study uptake by various marine flora and fauna of atomic explosion debris and induced radioactive elements in the marine environment.

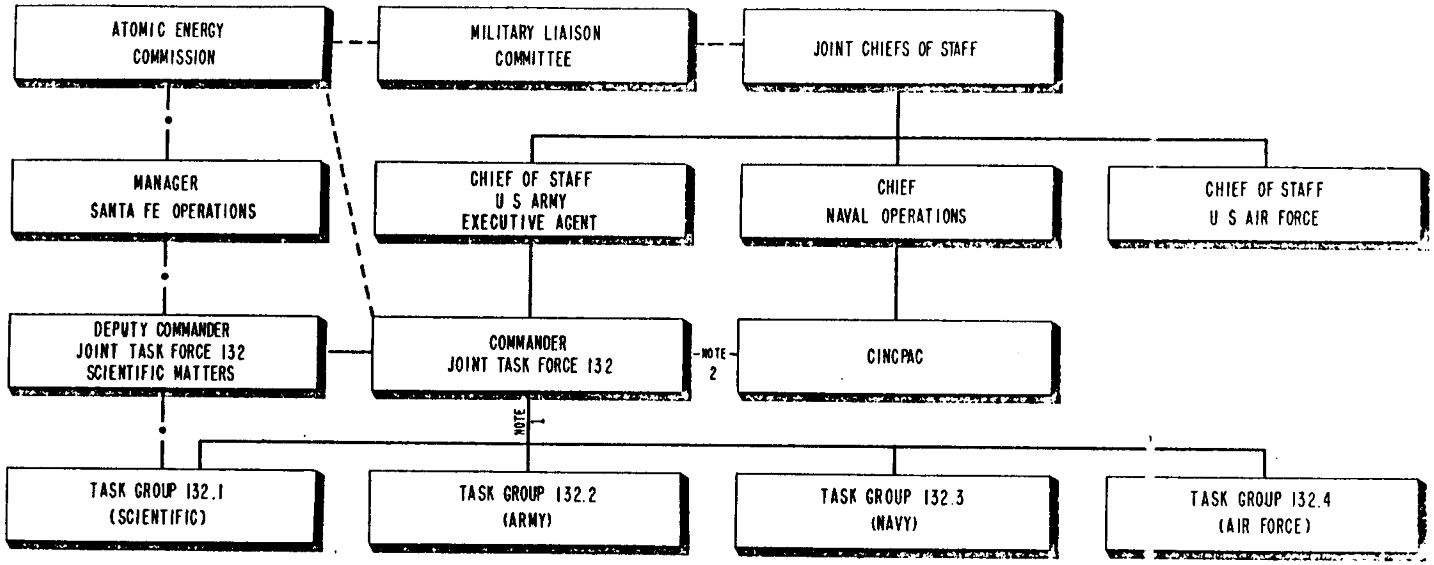
b. <u>Method</u>

Samples of flora and fauna were obtained from the reef and lagoon with some analysis on-site but with most of the study to be done upon return of samples to the ZI.

c. <u>Results</u>

Preliminary reports indicated complete success in obtaining the desired specimens. Laboratory analysis is underway.

ORGANIZATION FOR OPERATION IVY



NOTE:

1. CJTF 132 EXERCISED OPERATIONAL CONTROL OF ALL TASK GROUPS FOR PLANNING AND COORDINATION ONLY UNTIL THE ON-SITE PHASE AT WHICH TIME HE ASSUMED FULL OPERATIONAL CONTROL. THE OPERATIONAL (ON-SITE) PHASE EXTENDED FROM 0300 Z 17 SEPTEMBER 1952 TO 0001 Z 21 NOVEMBER 1952.

2. BY DECISION OF THE JOINT CHIEFS OF STAFF ON 13 APRIL 1951, THE COMMANDER, JOINT TASK FORCE, REPORTED TO CINCPAC FOR MOVEMENT CONTROL, LOGISTICAL SUPPORT, AND FOR PURPOSES OF GENERAL SECURITY WITH RESPECT TO THE TASK FORCE AND ENIWETOK ATOLL.

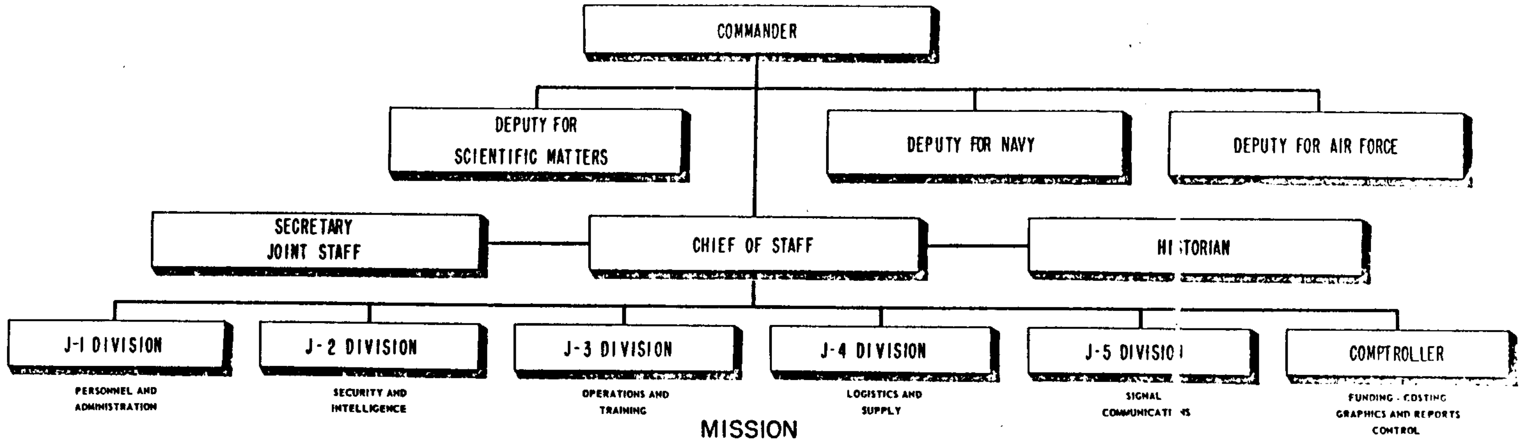
LEGEND:

_____ OPERATIONAL CONTROL

_ _ _ LIAISON

__.__ AEC POLICY

HEADQUARTERS, JOINT TASK FORCE 132
ORGANIZATION



MISSION

CONDUCT TESTS OF TWO EXPERIMENTAL DEVICES.

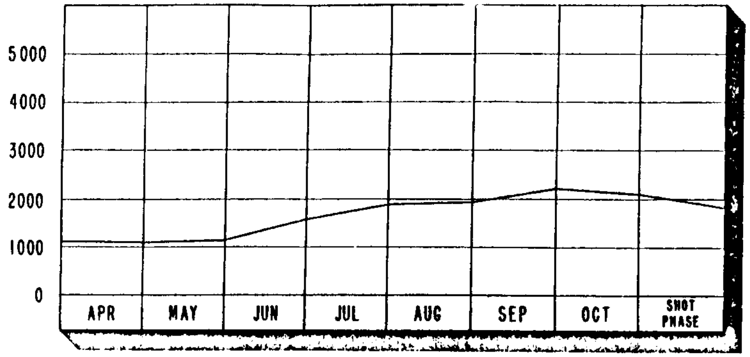
CONDUCT THE EXPERIMENTAL MEASUREMENTS PROPOSED BY THE AEC, AND SUCH OTHER TESTS PROPOSED BY THE ARMY, NAVY, AND AIR FORCE AS APPROVED BY THE JCS.

KEY PERSONNEL

MAJOR GENERAL P. W. CLARKSON, USA, Commander
DOCTOR A. C. GRAVES, AEC, Deputy for Scientific Matters
BRIGADIER GENERAL W. W. WISE, Jr., USAF, Deputy for Air Force
CAPTAIN J. R. PAHL, USN, Deputy for Navy
BRIGADIER GENERAL A. R. WALK, USA, Chief of Staff
COLONEL E. W. COFIELD, USAF, Assistant Chief of Staff J-1
LT. COLONEL R. M. GLESZER, USA, Assistant Chief of Staff J-2
COLONEL F. J. SACKTON, USA, Assistant Chief of Staff J-3
CAPTAIN W. L. KNICKERBOCKER, USN, Assistant Chief of Staff J-4
COLONEL L. H. STANFORD, USA, Assistant Chief of Staff J-5
COLONEL J. M. RUDDY, USA, Assistant Chief of Staff Comptroller

OVERSEAS PHASING of PERSONNEL BY TASK GROUP

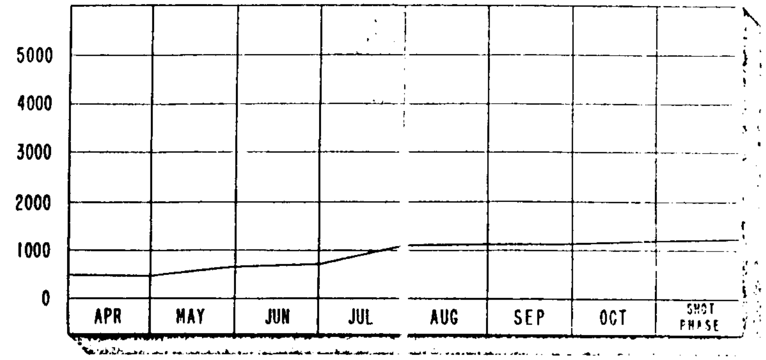
TG 132.1 (SCIENTIFIC)



1952

APR	MAY	JUN	JUL	AUG	SEP	OCT	SHOT PHASE
1095	1259	1585	1906	1962	2251	2124	1819

TG 132.2 (ARMY)



1952

APR	MAY	JUN	JUL	AUG	SEP	OCT	SHOT PHASE
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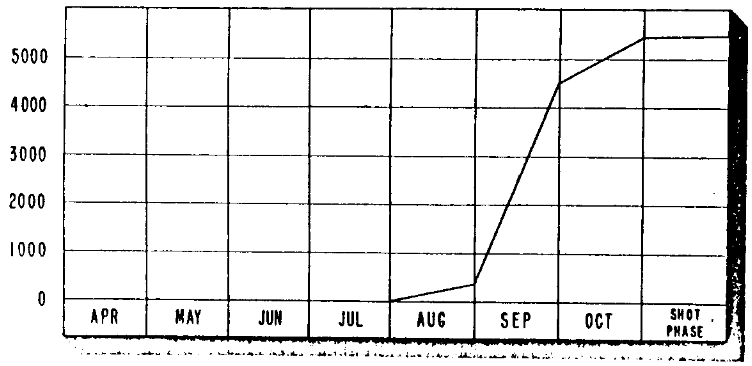
TG 132.3 (NAVY)



1952

APR	MAY	JUN	JUL	AUG	SEP	OCT	SHOT PHASE
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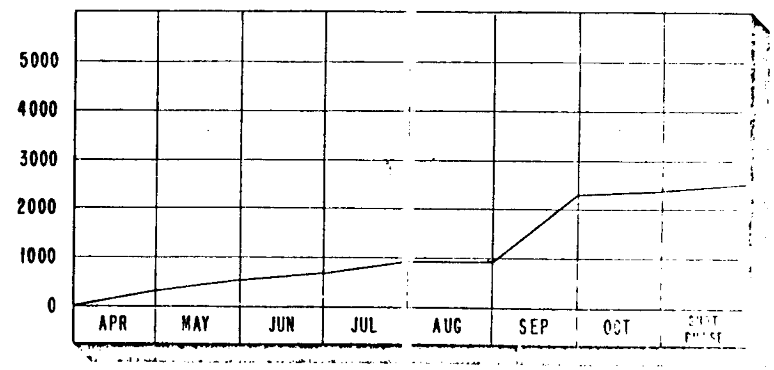
TG 132.4 (AIR FORCE)



1952

APR	MAY	JUN	JUL	AUG	SEP	OCT	SHOT PHASE
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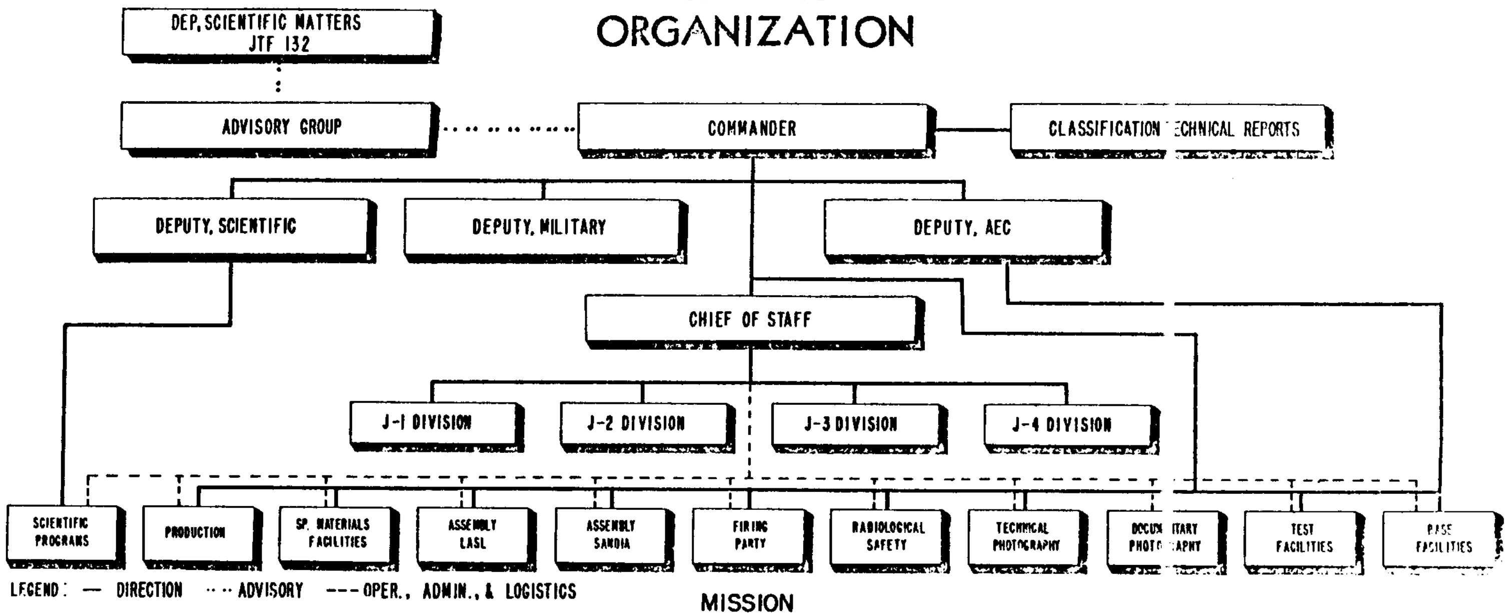
TASK GROUP 132.1 SCIENTIFIC ORGANIZATION



MISSION

TO CONDUCT THE EXPERIMENTAL DEVICES TESTS; PROCURE, ASSEMBLE AND PLACE THE DEVICES TESTED; ARM AND DETONATE THE DEVICES TO BE TE TED.
CONDUCT OF TECHNICAL AND MEASUREMENT PROGRAMS AS FINALLY APPROVED.
CONDUCT OF DOCUMENTARY FILM OPERATIONS.
OPERATE AND MAINTAIN CERTAIN SPECIFIED UTILITIES AND FACILITIES ON ENIWETOK ISLAND.
PLAN, CONSTRUCT AND OPERATE ALL REQUIRED INSTALLATIONS AND FACILITIES (INCLUDING AEC CONTRACTOR BOAT POOL) ON ALL OTHER ISLANDS OF ENIWETOK ATOLL.
CONDUCT THE RADIOLOGICAL SAFETY PROGRAM.
ESTABLISH THE TECHNICAL MISSION FOR JOINT TASK FORCE 132 TEST AIRCRAFT.

KEY PERSONNEL

MR. S. W. BURRISS, Commander
DR. W. E. OGLE, Deputy for Scientific
LT. COLONEL R. T. LUNGER, USA, Deputy for Military
MR. P. W. SPAIN, Deputy for AEC
MR. D. CURRY, Jr., Chief of Staff
MR. A. W. KELLY, J-1
MR. W. R. ADAIR, J-2

COLONEL P. L. HOOPER, USA, J-3
MR. H. S. ALLEN, J-4
LT. COMMANDER J. D. JOHNSON, USN, Communications
CAPTAIN R. D. SHROYER, USA, Budget & Fiscal
DR. R. C. SMITH, Classification
DR. W. E. OGLE, Task Unit 1
DR. H. L. JOHNSTON, Task Unit 2
MR. W. H. STEITLER, Task Unit 3

MR. R. D. KROHN, Task Unit 4
MR. H. NORTH, Task Unit 5
MR. S. W. BURRISS, Task Unit 6
COMMANDER R. H. MAYNARD, USN, Task Unit 7
MR. L. N. GARDNER, Task Unit 8
LT. COLONEL J. L. GAYLORD, USAF, Task Unit 9
MR. R. H. CAMPBELL, Task Unit 10
MR. P. W. SPAIN, Task Unit 11

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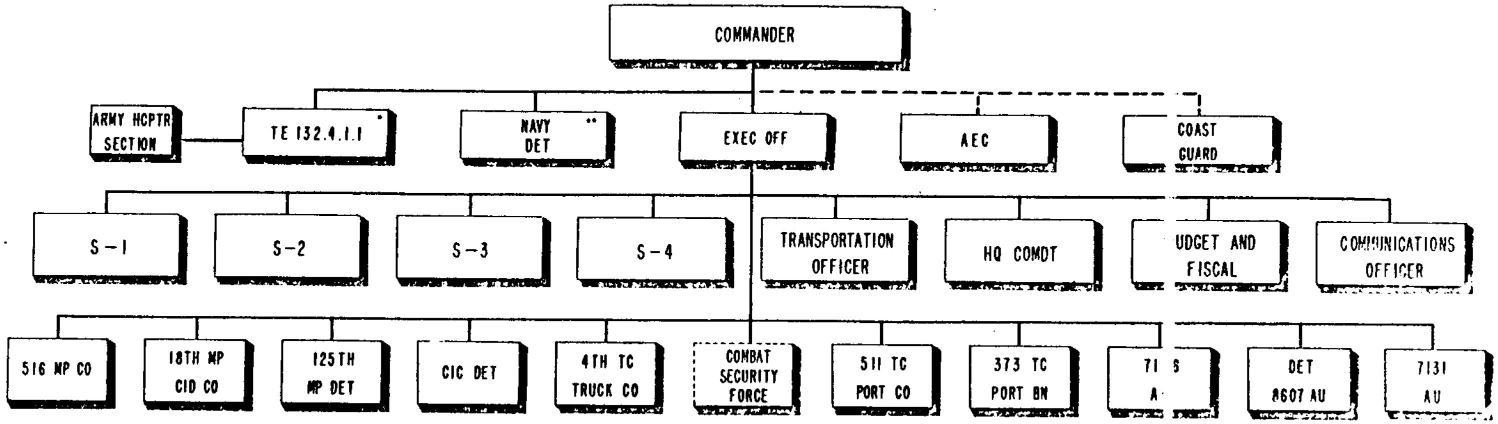
TASK GROUP 132.2
ARMY
ORGANIZATION



LEGEND: ---- LOG SUPPORT & LN

* CTG 132.4 HAS OP CONTROL DURING OP PHASE

** CTG 132.3 HAS OP CONTROL DURING OP PHASE

MISSION

RENDER NECESSARY SUPPORT TO TASK GROUP 132.1.
PROVIDE LOGISTIC SUPPORT FOR THOSE ELEMENTS OF THE JOINT TASK FORCE BASED ON ENIWETOK ISLAND.
PROVIDE GROUND SECURITY FOR ENIWETOK ATOLL.
OPERATE PORT FACILITIES, BASE FACILITIES, AND SIGNAL COMMUNICATIONS.

KEY PERSONNEL

COLONEL G. E. BURRITT, USA, Commander
COLONEL R. H. CUSHING, USA, Executive Officer
MAJOR E. B. FINNEGAN, USA, S-1
MAJOR K. C. OSWALD, USA, S-2
MAJOR C. V. CHAPMAN, USA, S-3
LT. COLONEL F. S. WARING, USA, S-4
CAPTAIN G. M. LIPPENCOTT, USA, Communications

CAPTAIN C. T. SOKOLOSKI, USA, Comptroller
CAPTAIN R. W. SPEARS, USA, 7126th A U
2D LT. F. J. DEVANEY, USA, 7131st A U
CAPTAIN W. E. SHELLEY, USA, 511th T Port Co
MAJOR F. S. PEMBERTON, USA, 4th T Truck Co.
LT. COLONEL H. R. FLEMING, USA, 373rd Trans Port Bn.
MAJOR P. E. LYONS, USA, CIC Det.

TASK GROUP 132.3
NAVY
ORGANIZATION

COMMANDER

TASK ELEMENT 132.30	TASK ELEMENT 132.31	TASK ELEMENT 132.32	TASK ELEMENT 132.33	TASK ELEMENT 132.34	TASK UNI 132.3.(	TASK UNIT 132.3.1
WEAPONS ELEMENT *	*TRANSPORT ELEMENT*	*SERVICE & HARBOR CONTROL ELEMENT*	*DESTROYER ELEMENT* **	*CONVOY AND ESCORT ELEMENT* *	*CARRIER U T*	
1 AV 2 DDE	1 AGC 1 LST 2 TAP 1 AKA	1 LSD BOAT POOL 1 AN 5 LCU 1 AOG 3 AVR 1 YOG 21 LCM 1 YON 4 LCP(L) 3 ATF UNDERWATER DETECTION UNIT SEISMOGRAPHIC UNITS (EX-ATA BAIRD & HORIZON)	4 DDE	1 AV 2 DDE	1 CVE 6 Fighters (F4U-) 4 Utility A/C (T N 3R) 5 HRS Helicopter	9 P2V4 Patrol A/C 3 P2V5 2 PBM (5A) A/C

NOTE: * These separate functional elements have the same ships. (i.e. the same 2 destroyers and AV, but with different missions)

** Total Number of destroyers in Task Group 132.3.

MISSION

PROVIDE SHIPBOARD COMMAND FACILITIES FOR CJTF 132 AND ADMINISTRATIVE SPACE AND COMMUNICATIONS CIRCUITS FOR HEADQUARTERS, TASK GROUPS 132.1 AND 132.2.

PROVIDE AMPHIBIOUS AIRLIFT FOR VARIOUS ELEMENTS OF THE JOINT TASK FORCE DURING SHOT PERIODS.

PROVIDE SUITABLE WATER TRANSPORTATION WHILE THE JOINT TASK FORCE IS LAND BASED, AND SHIPBOARD FACILITIES TO SUPPORT THE JOINT TASK FORCE WHILE AFLO T.

RENDER NECESSARY SUPPORT TO TASK GROUP 132.1.

CONTROL HARBOR FACILITIES AT ENIWETOK ATOLL IN COORDINATION WITH CTG 132.2 AND CTG 132.1.

BE PREPARED TO AUGMENT FACILITIES FOR INTRA-ATOLL TRANSPORTATION AND TO ASSIST IN CARGO HANDLING OPERATIONS AT ENIWETOK ATOLL.

PROVIDE LIMITED SHIPBOARD FACILITIES FOR RADIO CHEMISTRY TECHNIQUES, FALL-OUT STUDIES, AND PHOTO-DOSIMETRY FACILITIES.

DISCHARGE, WITHIN THE CAPABILITY OF FORCES AVAILABLE, THE OFF-SHORE AND AIR SECURITY RESPONSIBILITIES FOR ENIWETOK ATOLL.

COLLECTION OF SCIENTIFIC DATA AND WATER SAMPLES.

KEY PERSONNEL

REAR ADMIRAL C. W. WILKINS, USN, Commander

CAPTAIN E. TATOM, USN, Chief of Staff

LT. COMMANDER D. K. DEJARNATT, USN, Administration and Personnel

LT. COMMANDER R. A. KLARE, USN, Security and Intelligence

COMMANDER F. R. BIARD, USN, Plans and Operations

COMMANDER D. BONTECOU, USN, Logistics

LT. COMMANDER H. C. TONINI, USN, Communications

CAPTAIN J. HULME, USN, Weapons Element

CAPTAIN J. S. HOLTWICK JR, USN, Transport Element

COMMANDER E. J. YOUNGJOHNS, USN, Service and He bor Control Eler ent

CAPTAIN N. DUPSKI, USN, Destroyer Element

CAPTAIN W. L. KABLER, USN, Carrier Unit

COMMANDER M. J. BERG, USN, Patrol Plane Unit

TASK GROUP 132.4
AIR FORCE
ORGANIZATION

COMMANDER

TASK UNIT 132.4.1	TASK UNIT 132.4.2	TASK UNI' 132.4.3
TEST SUPPORT UNIT	*TEST AIRCRAFT UNIT*	*TEST SEK 'CES UNIT*
15 L-13	16 F-84G	1 R -50
4 C-47	1 B-36D	10 ' 29
1 B-17	2 B-36H	2 S 29
1 B-25	2 B-50D	3 (4
3 H-13	10 KB-29P	2 S 16
3 H-19	4 B-29	
	1 B-47	

MISSION

PROVIDE, OPERATE AND MAINTAIN AIRCRAFT FOR TECHNICAL MISSIONS IN THE CONDUCT OF OPERATION IVY.

PROVIDE AIRWAYS AND AIR COMMUNICATIONS SERVICE (AACS) AND AIR RESCUE SERVICE (ARS) TO SUPPORT THE JOINT TASK FORCE.

PROVIDE SUPERVISORY PERSONNEL FOR AN AIR OPERATIONS CENTER AFLOAT.

PROVIDE A WEATHER CENTRAL ON ENIWETOK, AND PERSONNEL FOR WEATHER CENTRAL AFLOAT. ESTABLISH WEATHER REPORTING STATIONS ON PONAPE, KUSAIE, AND BIKINI.

PROVIDE CLOUD TRACKING AIRCRAFT FOR POST-SHOT RADIOLOGICAL SAFETY "SITUATION DATA" TO ASSIST CJTF 132 IN DETERMINING ADVISABLE TIME FOR REENTRY FOLLOWING DETONATIONS.

OPERATE AIRBASES AND SUPPORT SERVICES AND FACILITIES AT ENIWETOK.

PROVIDE INTRA-ATOLL AIRLIFT AT ENIWETOK ATOLL.

PROVIDE ADMINISTRATIVE AIRCRAFT AS REQUIRED BY CJTF 132.

KEY PERSONNEL

BRIGADIER GENERAL F. E. GLANTZBERG, USAF, Commander
COLONEL J. W. THOMSON, USAF, Deputy Commander
LT. COLONEL K. D. KIENTH, USAF, Chief of Staff
MAJOR B. R. WILLIAMS, USAF, Personnel

LT. COLONEL C. A. OUSLEY, USAF, Operations
LT. COLONEL N. A. CICCONE, USAF, Materiel
LT. COLONEL R. S. NUGENT, USAF, Communications
LT. COLONEL A. C. FLEMING, USAF, Comptroller
LT. COLONEL W. R. HANNA, USAF, Inspector General

COLONEL A. E. TOKAZ, USAF, Task Unit 1
LT. COLONEL T. T. OMAHUNDRO, USAF, Task Unit 1.1
COLONEL W. E. BERTRAM, USAF, Task Unit 2
COLONEL R. W. NELSON, USAF, Task Unit 3

[redacted]

APPENDIX S

RADIOLOGICAL SAFETY

1. General

a. The basic RadSafe organization for operation IVY provided trained personnel and suitable radiac equipment for each task group. As a result, individual task groups solved problems peculiar to their respective Service needs. All task group missions were integrated, however, into the fulfillment of task force missions. The RadSafe Unit, Task Unit 7 (TU 7), of the Scientific Task Group acted as the major technical servicing agency to the Task Force for such matters as calibration, repair, photodosimetry, radiochemical laboratory, equipment and special monitor missions, as well as for general radiological advisory assistance. This unit was composed mainly of RadSafe engineers from the Army, Navy, Marine Corps and Air Force, and technical personnel from Oak Ridge National Laboratory, LASL, Army Radiation and Chemical Laboratory and Evans Signal Laboratory.

b. The main objectives of RadSafe plans for IVY were:

(1) Protection of personnel in the conduct of operations.

(2) Training of personnel in routine atomic test radiological operations, utilizing methods and equipment evolved from other atomic tests. In spite of unusual and some unknown pre-shot factors concerning the detonations, all objectives were met successfully.

c. During the operation, the Task Force supported the Commander in Chief, Pacific Fleet (CINCPACFLT), in off-site security by giving assistance in off-site RadSafe operations. The World Wide Fall-Out Program of the New York Operations Office (NYOO) and AEC encompassed IVY operations with respect to the unusual aspects of the MIKE event. Personnel and equipment from NYOO were airborne by Task Force elements in off-site, general area surveys under the cognizance of CINCPACFLT. These post-shot surveys covered the Marshall Islands in detail, using Kwajalein as a base; the Caroline Islands, using Guam as a base; and the Hawaiian Islands, using Pearl Harbor as a base.

d. To minimize unusual potentialities of RadSafe factors, upper wind patterns were given careful study prior to shot times. Surveys such as the world wide fall-out coverage off-site and the intensive [illegible]

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b. Communications between the JOC, in the ESTES, and the RadSafe Center, in the RENDOVA, was by means of a direct channel (AN/TRC) backed up by radio teletype. This system was augmented by a direct radio contact between helicopter aircraft and the RadSafe Center with intercept facilities in the JOC. Direct communications also were utilized between the RadSafe Center and individual boats, DUKWS and ultimately, through this means, monitors on foot or in jeeps.

c. As a result of a conference with cognizant personnel of CINCPAC relative to the safety and security of Eniwetok Atoll, conclusions were formalized in a letter to CINCPAC on 14 July 1952. This letter outlined considerations and provided steps to be taken in the case of significant radiological fall-out outside the immediate area of Task Force operations. One of the considerations in this letter indicated the possibility of a health hazard at Ujelang Atoll, with a remote possibility of the same at Bikini, all as a result of MIKE shot.

d. An LST, under control of CINCPACFLT (COMHAWSEAFRON), took station at Ujelang and embarked all the native population at 1700 hours local on M-4 days. This LST had earlier been directed to take station at 8° North 161° East. In the evening of M-3 days, a message, indicating a predicted cloud path with respect to significant fall-out, was sent to CTG 132.3 to cover the special P2V security sweep commencing at the earliest daylight of M-2 days. This message directed a sweep up to 800 miles from ground zero on a bearing of 270° true. At M-2 days, 2130 local, a detailed command conference and execute order for MIKE shot was confirmed. The confirmation was based on the following conclusions: **BEST AVAILABLE COPY**

(1) The general weather picture gave a favorable outlook.

(2) The weather trend for the predicted fall-out pattern, as determined by a resultant winds forecast, presented an extremely favorable picture. The four hour fall-out pattern was forecast to lie entirely in the northwest quadrant which, in accordance with the criteria established for MIKE shot, was most favorable.

(3) The surface Radiological Exclusion Area (RADEX) gave a pattern for the "hottest" cloud as being from the surface to 3[illegible],[illegible]0 feet in an arc 2[illegible]0° true to 35[illegible]° true from ground zero out to a 10[illegible] [illegible]

[redacted] [redacted]

[redacted]

verified the correctness of the pre-shot assumptions of the detailed criteria established for relative degrees of favorable conditions for shot times.

e. Future training for military personnel should constantly stress the differences between peacetime atomic tests and wartime field applications relative to RadSafe operations. In this respect, maximum permissible exposures and their significance in both classifications are the factors which still seem to be doubtful to the average military individual.

2. Preliminary Operations

During pre-shot phases of the operation, vigorous training was employed in all phases of RadSafe activities - especially in the types of post-shot operations required and levels of radiation in fall-out expected from the IVY detonations. The Army Task Group was more completely trained and provided with instruments than at any other overseas test. Similarly, the Air Task Group solved difficult control problems in the technical phases of manned sampling while the Navy Task Group, for the first time at any overseas atomic tests of the scope of IVY, had the capability of complete salt water spray decontamination with resultant protection from fall-out on all weather surfaces of the units which got underway with the embarked Task Force. The Scientific Task Group had the capability and provided a photo-dosimetry program which gave ultimate dosage records on every individual in a manner superior to that of any previous tests. All these preliminary special steps in the task groups were initiated to provide the Task Force Commander with flexibility and effective control in critical shot time firing conditions, a factor of great importance considering the great yields of devices and weapons now being attained at the Pacific Proving Ground.

3. MIKE Shot **BEST AVAILABLE COPY**

a. The MIKE event commenced in [illegible] the establishment of the RadSafe Center on the RENDOVA one day prior to [illegible] Day. At the same time the RadSafe Section of the Joint Operations Center (JOC) in the ESTES was organized in three groups with one group working with surface situation data; one working with air situation data; and the third with the general overall situation, air and surface, both in the area of Task Force responsibility and in other areas of the Pacific Ocean under the cognizance of CINCPAC. Liaison was also maintained with [illegible] coordination with the World Wide Fall-out Program of the [illegible]

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(4) The air RADEX significant to sampling operations was concentrated in an east-west band which was twenty miles west, thirty miles north and sixty miles east of ground zero.

(5) Twenty-four, forty-eight and seventy-hour trajectories at significant altitudes were presented. These indicated a column of air three miles in height from 40,000 to 55,000 feet moving generally east under the tropopause. Below this altitude, the cloud column was forecast to move generally west, northwest; whereas, above the tropopause, cloud parcels were forecast generally to move west.

e. During the evening of M-2 days, a message was sent to CTG 132.3 prescribing a sector to be searched out to about 800 miles by a P2V sweep on a bearing 235° true, with instructions to divert any shipping therein so as to clear the Eniwetok area by at least 200 miles radial distance from ground zero. This message covered the sweep on M-1 day commencing at earliest daylight. At 1423 local, on M-1 day, a surface RADEX forecast from H Hour to H/4 hours was sent to all task group commanders. This forecast covered an area bearing 260° true clockwise to 320° true, radial distance 100 miles, all from ground zero.

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f. At 2130, M-1 day, a command conference was held in the ESTES. The general weather picture gave a less favorable forecast than had been indicated in the M-2 days briefing. The weather trend for fall-out pattern, as determined from the resultant winds forecast, presented a favorable picture although cloud trajectories would pass slightly into the southeast quadrant from ground zero. The outlook with respect to specific considerations was:

(1) Ujelang would be well south of the significant cloud pattern with the evacuation LST in an even more favorable position.

(2) The [illegible]RIZON, because of its location with respect to the surface RADEX, i.e., in the northeast quadrant, was ordered to be moved, after collection of data, in a general northeast direction for four hours commencing no later than H/1 hour.

(3) Bikini appeared clear of the fall-out pattern, with no evacuation needs considered necessary.

(4) Pearl Harbor to [illegible] and Wake to Guam air routes were considered clear, [illegible]

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twenty-four hour closure beginning with H Hour.

(5) With respect to surface routes, information from the special P2V searches on M-2 days indicated one British ship on course 120° true at such a position that if course were continued it would be well within the 200 miles radius of Eniwetok at shot time. This ship was directed on M-1 day to change course, which it did, clearing the Eniwetok area by the requisite 200 mile radial distance.

(6) Early reentry into Eniwetok for crash parties and maintenance crews appeared favorable. The early aerial survey schedule by helicopter also appeared feasible without additional delay factors. The overall conclusion from the radiological standpoint was for a favorable pattern. Firing MIKE on schedule, with a movement of Naval vessels from points south of ground zero to a more easterly position, was recommended. Since the upper wind pattern presented a less favorable outlook than had been indicated at the M-2 days conference, the Task Force Commander decided to review the situation again at 0300 local, M Day.

g. At midnight, the observed wind pattern which was considered only favorable for the fall-out pattern, changed to a most favorable criteria pattern which would place all fall-out north of ground zero. On the basis of the later command conference at 0300 local, the situation from a RadSafe standpoint was recommended as most favorable and the shot schedule was firmly laid on. No recommendations for movement of Naval vessels in the south sector was necessary under this fall-out pattern. At H-9 hours, a message was dispatched to CINCPACFLT giving the seventy hour forecast trajectories of the cloud and information on conditions relating to RadSafe of air and surface routes. This message recommended closing the Kwajalein to Guam air route from H hour to H+24 hours, whereas the Wake to Guam route could remain open up to 10,000 feet. No health hazard problem was considered to exist on the surface routes except inside the 300 mile radius, northwest quadrant of the Eniwetok area. A final air RADEX was dispatched, giving an exclusion area bearing clockwise 230° true to 090° true, maximum distance fifty miles for H Hour to H+3 hours.

h. The MIKE device was detonated at 0715 hours local, 1 November 1952, and by H+10 [illegible] the Eniwetok [illegible] RadSafe survey [illegible]

[redacted]

helicopter from the RENDOVA. This survey covered Eniwetok and Parry Islands. Upon receipt of the information covering these two islands, two helicopter flights were sent in with emergency parties - one for the Eniwetok landing strip; and the other, a contractor engineer group for surveying damage and checking reefers, powerhouses and the water plant. The next flight of helicopters for Parry was dispatched at H/45 minutes. Results were successful and the parties returned to the RENDOVA within the first three hours. Meanwhile, another helicopter transferred scientific personnel from the ESTES to the RENDOVA from which point they proceeded to make an early damage survey. At approximately this time, the early RadSafe survey team, operating via helicopter, was as far north as Runit Island where excessive, active fall-out was encountered. This helicopter returned to the RENDOVA at H/70 minutes. By this time, the cloud had reached greater than 120,000 feet in altitude and in its rapid climb was forced to billow out at the tropopause level though continuing to rise to a still greater height. This billowing out effect reached to a distance of thirty miles in diameter in approximately forty minutes and resulted in heavy, mud fall-out which occurred as late as H/40 minutes when it was encountered by the initial RadSafe survey team. Heavy rain showers were in progress within two hours after the detonation and were concentrated mainly within and around the lower cloud stem. All utilities on Parry and Eniwetok were reported in operating condition and the crash crew was ready to receive aircraft at the Eniwetok air strip by H/2 hours.

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i. At about 1028 local, helicopters were dispatched to rescue a downed pilot in the lagoon. Although the rescue efforts failed to locate the downed pilot, one of the rescue aircraft was heavily contaminated and landed at Eniwetok Island. Radiation level on the external surface of the aircraft was about 5 r/hr, while readings inside the cockpit were roughly 150 mr/hr. Meanwhile, winds were being received from Bikini which indicated that the very favorable pattern of air flow aloft was being maintained, i.e., cloud was moving all to the northwest of ground zero up to about 70,000 feet. By H/5 hours, the early survey of the entire atoll - accomplished at altitudes of 800 to 1,500 feet where necessary to avoid excessive ground radiation - had been completed by scientific and monitor personnel. An attempt [illegible]

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[redacted]

Operation IVY.

j. Early reports from the Navy Task Group, which was responsible for the RadSafe of the Task Force while afloat, indicated that no ships had encountered fall-out as of 1600 local, M Day; however, the HORIZON - which had been seventy-two miles north, northeast of ground zero and had steamed at shot time in a northeast direction for four hours - reported that she was just out of the fall-out area and that radiation levels on board were 14 mr/hr average, 50 mr/hr maximum. The topside water spray system proved successful in reducing this contamination.

k. At H/7 hours, a lagoon water survey commenced in accordance with a plan initiated by CTG 132.3. This involved a pass across the lagoon on a control line between Runit and Rigili Islands, taking samples of water at the surface and at thirty-five foot depths with an additional sampling line north of Coral Head in the center of the lagoon. Other water samples were taken at the Deep Entrance, the anchorage AREA and the Wide Passage. These early samples indicated no contamination at the southern half of the lagoon. At this time, a message was sent to CTG 132.4 prescribing tracks for the first WB-29 cloud tracking mission, WILLIAM 5, take-off time H/12 hours. Early cloud tracking showed the cloud to be moving in three general segments: one segment from above 80,000 feet moving westerly; one segment between 40,000 and 80,000 feet moving northwesterly; and another segment between the surface and 40,000 feet moving northeasterly, all at about sixteen knots. On M Day, at 1700, a message was sent to Kwajalein prescribing the tracks for the second WB-29 cloud tracking mission, WILLIAM 6, scheduled to take off at H/24 hours.

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l. As of 0715 local on M/1 day, all ships had reported negative fall-out and early morning water samplings of the lagoon indicated no contamination of its southern half. On the basis of this water sampling and other evaluation, the time for reentry (R Hour) was announced and the Navy Task Group entered the lagoon at 0900 local with assurances that Eniwetok and Parry were RadSafe cleared and significant fall-out was no longer expected. The RadSafe control point for all traffic north of Japtan Island was in Building 57 on Parry Island. All lagoon traffic south of Japtan was unrestricted and swimming was permitted only at the authorized beaches.

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[redacted]

m. At M+1 day, a careful survey of the atoll - both ground and air - was made. Also, P2V flight CHARLIE from Kwajalein in connection with the World Wide Fall-Out survey of the Marshall Islands made a sweep of the south-western Marshalls, including Ujelang, reporting ~~negative~~ Negative results. This was the signal for the disembarkation of natives from the LST. The disembarkation was completed on the afternoon of M+1 day.

n. At 1400 hours local, a message was sent to Kwajalein directing the final WB-29, WILLIAM 7, to proceed to a point 14° North, 165° East and, from this point, to search an area clockwise from 315° true to 010° true out to an approximate distance of 450 miles at any altitude between 10,000 and 15,000 feet. On this flight, which was well out in the northwest quadrant, readings were higher than on the flight of the previous day. All flights up to this time had indicated negligible fall-out in the northwest and none in the southeast and southwest quadrants. Radiation levels at flight altitudes were, in general, 5 to 10 mr/hr outside of the aircraft with an allowance for a factor of 10 higher for rain showers concentrating fall-out particles at lower altitudes. This was considered insignificant as a health hazard. At 2000 local on M+1 day a third RadSafe advisory message was sent to CINCPACFLT stating that no health hazard problems existed on air or surface routes as a result of the MIKE detonation.

o. Early recoveries continued on M+1 day and it appeared that early reentry to Runit on M+2 days was feasible. This would include reestablishing a labor camp with a control monitor on Runit so that KING instrumentation could be initiated. **BEST AVAILABLE COPY**

p. At earliest daylight on M+2 days, World Wide Fall-Out flights ABLE and BAKER from Kwajalein were initiated, covering the remainder of the Marshall group. No significant activity was reported. As of M+2 days, no TG 132.3 vessels had encountered fall-out other than minute amounts, during evening showers, of approximately 5 mr/hr on topside decks which reduced to background by morning.

q. On the night of M+2 days, the fourth and final RadSafe advisory was sent to CINCPACFLT indicating that no health hazard to surface or air routes existed anywhere in the Pacific Ocean Area as a result of MIKE shot. Outlying weather stations at Ponape, Kusaie, Majuro and Bikini indicated no

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delayed fall-out as of 1600 local, M/2 days. With this message to CINCPAC and CINCPACFLT, the MIKE event was officially secured as a possible hazard to areas outside of JTF 132 responsibility. Messages from Guam indicated, subsequently, that airborne contamination reached a maximum of approximately 5 mr/hr with no fall-out on the ground on M/4 days.

r. On M/2 days, complete recovery was made from the Bogallua bunker. Recovery programs were reviewed each evening between TG 132.1 scientific personnel and the RadSafe control group. On this basis, sites, allowable periods of work and boat and aircraft schedules - along with the necessary work for KING shot instrumentation - were established for the following day.

s. One photo documentary plane flying near the shot island encountered fall-out which resulted in exposures of about 10 r to passengers and crew. Subsequent investigation indicated laxity in scheduling the operation of the plane as well as general poor monitor understanding of the situation during and after the exposure. All critical, manned sampling operations were conducted with less than the total allowed 3.9 r for operation IVY, although a separate exigent exposure of 20 r had been permitted for this phase of the operation. It is interesting to note that lead impregnated suits worn on one of the sampling missions reduced the dose received by a factor of approximately four.

t. The MIKE device was detonated under almost ideal conditions and most certainly under the favorable conditions prescribed in pre-shot criteria for fall-out. The ultimate final fall-out pattern and nonexistence of health hazards to distant areas is considered the answer to hazards of detonations occurring under these conditions.

4. KING Shot **BEST AVAILABLE COPY**

a. KING critical activities commenced with M/1 day and as recovery from MIKE projects progressed, instrumentation for KING progressed. By K-3 days it was apparent that the weather trend was becoming more unfavorable. The cloud cover condition for this shot was critical since the requirement called for less than .3 cloud below 2,000 feet, preferably none below 3,000 feet and conditions amenable to a visual drop from 45,000 feet. These conditions do not too frequently exist in this region. An effort was made at Task Force level to move K Day, then designated as Thursday, 13 November,

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1130 local, up one day to Wednesday, 12 November, but the Scientific Task Group was unable to meet this schedule. The weather picture for K Day on 13 November was deteriorating and by scheduled shot time it went "sour". This necessitated a forty-eight hour delay stand-down for the aircraft concerned, with a new series of command conferences, which were held on Friday night (2130 local, 14 November) and on Saturday night (2130 local, 15 November). The general weather picture presented a favorable outlook at the conference on the night of 14 November. The four hour fall-out pattern was forecast to lie in a narrow cone of thirty-five degrees, from 240° true to 275° true, all within a radius of eighty miles. Since the wind directions were so invariant because of the deep trade pattern aloft, surface RADEX from the ground to the top of the sounding, 70,000 feet, was in a cone of 90° measured from 200° true to 290° true. Twenty-four, forty-eight and seventy hour trajectories were presented and showed all cloud levels to all heights moving west. Overall conclusions from the radiological safety standpoint were, again, for a most favorable pattern and a recommendation was made to detonate KING on schedule. However, because of cloud conditions and general bad weather affecting aircraft in the Kwajalein terminal area, the decision to postpone KING for another twenty-four hours (to Sunday, 16 November) was made at a last minute command conference. This meeting then became the equivalent of the K-2 days command conference. **BEST AVAILABLE COPY**

b. At the K-1 day command conference, the fall-out pattern continued very favorable with good strong easterly winds in the lower levels, i.e., below 35,000 feet where the "hot" dirt cloud was expected to extend after shot time. Although upper level winds just below the tropopause (trapping cut-off for fall-out consideration) were toward the southeast quadrant after shot time, the dirt cloud was not expected to reach these levels and the fall-out pattern was considered very favorable. Surface RADEX was from 210° true to 290° true from H Hour to H+3 hours, radial distance ninety miles. Air RADEX was concentrated in the west, southwest sector. The outlook for specific items was as follows:

(1) No health hazard was considered to exist for air and surface routes, Ujelang, the OAK HILL (which was located in the northeast quadrant and seventeen miles from zero) and the Navy Task Group.

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(2) Early aerial survey appeared feasible after shot time, both north and south of Runit.

(3) Overall conclusions from the RadSafe standpoint were again for a most favorable pattern and a recommendation was made for the shot on schedule.

c. This led to confirmation of the shot schedule for Sunday, 1130 local, 16 November and KING was detonated on schedule. What began as an almost cloudless day with few low, fair weather cumulus clouds became an overcast one at midday with a high thin overcast as the KING cloud spread out radially and eventually in long streaks to the west, southeast and southwest near the tropopause and above. Also, small convective showers - probably caused by temporary slight distortion of the general area circulation - were evident for a period of about two hours until once again the trade conditions were reestablished. An emergency evacuation capability for the Task Force was maintained even though the Navy Task Group was outside the lagoon at shot time. **BEST AVAILABLE COPY**

d. Early reentry was commenced at H/10 minutes except for the helicopters which were on the RENDOVA at H Hour (8 miles at sea to avoid blast). They departed the RENDOVA and landed on Parry at H/18 minutes. The initial aerial survey helicopter then again loaded the monitor group from Parry and the group relayed information back from the site at H/50 minutes. This survey found little contamination on Runit. Since the shot time wind pattern with resultant low dirt cloud (about 19,000 feet) had made possible certain pre-shot estimates of the possibility of early reentry, the remaining K Day recovery parties shoved off on schedule for Runit and adjacent islands.

e. At H/75 minutes, a fairly comprehensive report of the damage and contamination on Runit Island was received. Although a water reading in the vicinity of the target read zero, a reading of 300 mr at 500 feet above the target was registered and the ground reading at the Runit powerhouse was 3 mr. Two telephone poles remained standing; tent frames were demolished and charred; mud had been thrown almost to the airstrip; there was evidence of a wash-over of the northern end of the island; the radar target had been dished out; NRL revetments were eroded; the blockhouse was left but the sand was gone; discolored yellow water was observed 2,000 yards off the beach, downwind from ground zero; and the reef was unchanged. This preliminary survey was of assistance to TG 132.3 as an indication of the extent of water contamination to be anticipated from the dirt cloud.

f. By H+3 hours another helicopter had completed a lagoon water survey and by H+5 hours the Navy Task Group had returned to the lagoon. This action had been anticipatory and predicated on advice from the Task Force Headquarters relative to assurances on fall-out. These advices, in turn, were based on early cloud tracking flights which occurred immediately after shot time.

g. By K+1 day, the KING recovery program had essentially been completed and the operational phase of IVY was rapidly drawing to a close. The RadSafe advisories to CINCPACFLT were simple and concise with no added emphasis on health hazards from fall-out in areas outside the Pacific Proving Ground area. This lack of emphasis on health hazards was based on documentation of previous atomic tests involving air bursts as well as actual cloud tracking of the KING cloud. All cloud tracking ceased with flight WILLIAM 6, thus cancelling WILLIAM 7, the last regularly scheduled "tracker". However, it should be noted that because of the ball-of-fire size, the lower dirt cloud - with induced activity from soil and water - was estimated to be a consideration from the standpoint of maximum permissible exposures. This was true since an additional total dosage, even as small as 900 mr, for some personnel of the Scientific Task Group and AEC would have resulted in cases of total dosages in excess of the allowed 3.9r for IVY.

h. The K+1 day sweep under off-site cognizance of CINCPACFLT, utilizing sensitive airborne special survey equipment of NYOO, was made over Ujelang, Kusaie and Ponape by Task Force P2Vs operating from Kwajalein. This sweep showed no appreciable activity on the ground at these sites. Thus, with the KING delayed fall-out considered finished business, return of the portable, field-type photodosimetry and radiochemical laboratories to the ZI aboard the RENDOVA got underway. Final turnover of RadSafe responsibilities by the RadSafe Unit of the Scientific Task Group to the AEC RadSafe representative was accomplished at 2400 hours on 22 November at Parry Island with the following recommendations made:

(1) Discourage activity in the area of Bogallua through

[redacted]

Ebiriru until 1 January 1953.

(2) Initiate a planned program for removal of radioactive scraps from the upper islands.

i. All film badge developing ceased in the forward area as of K+4 days.

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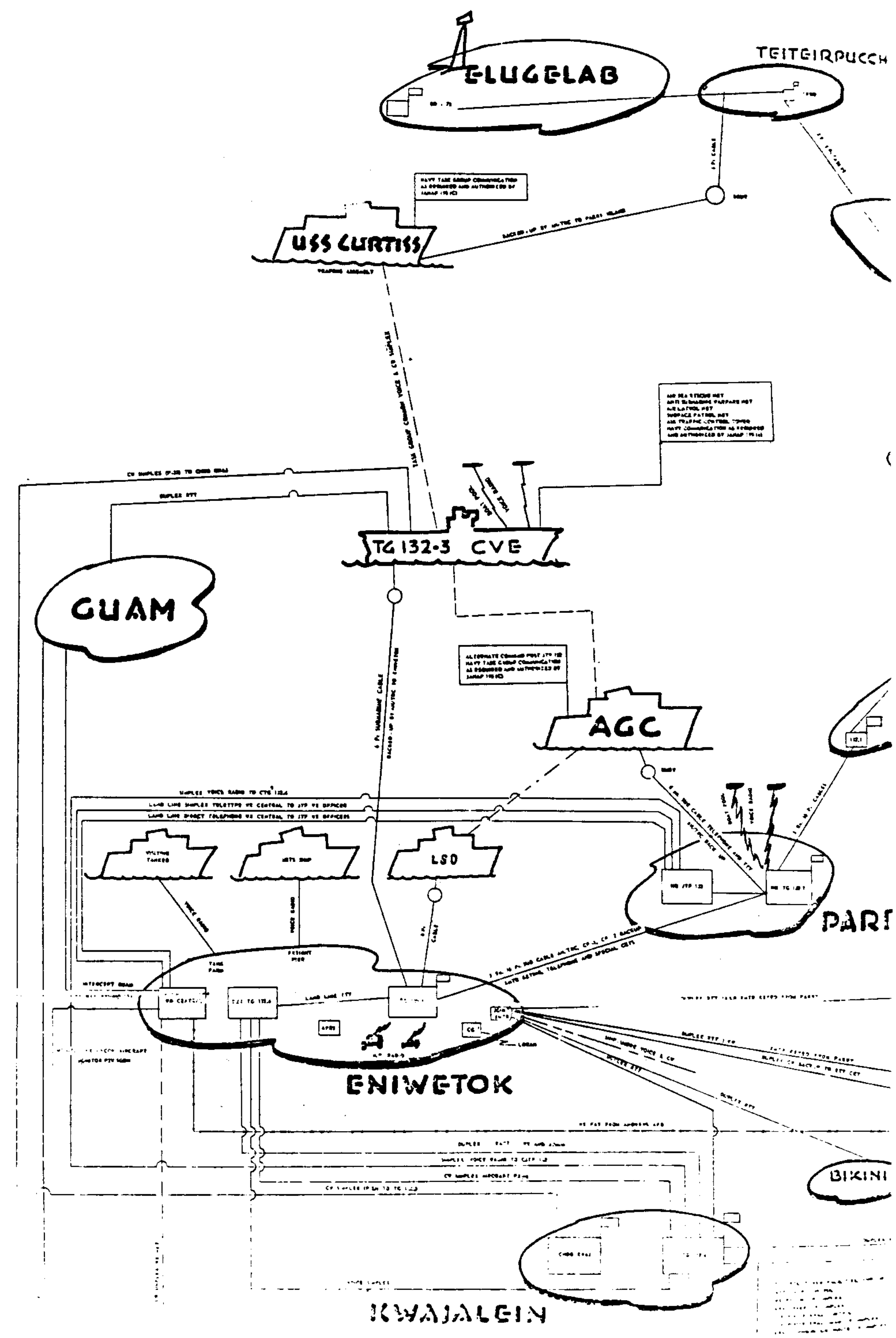
PRINCIPAL COMMUNICATIONS CKTS CJT



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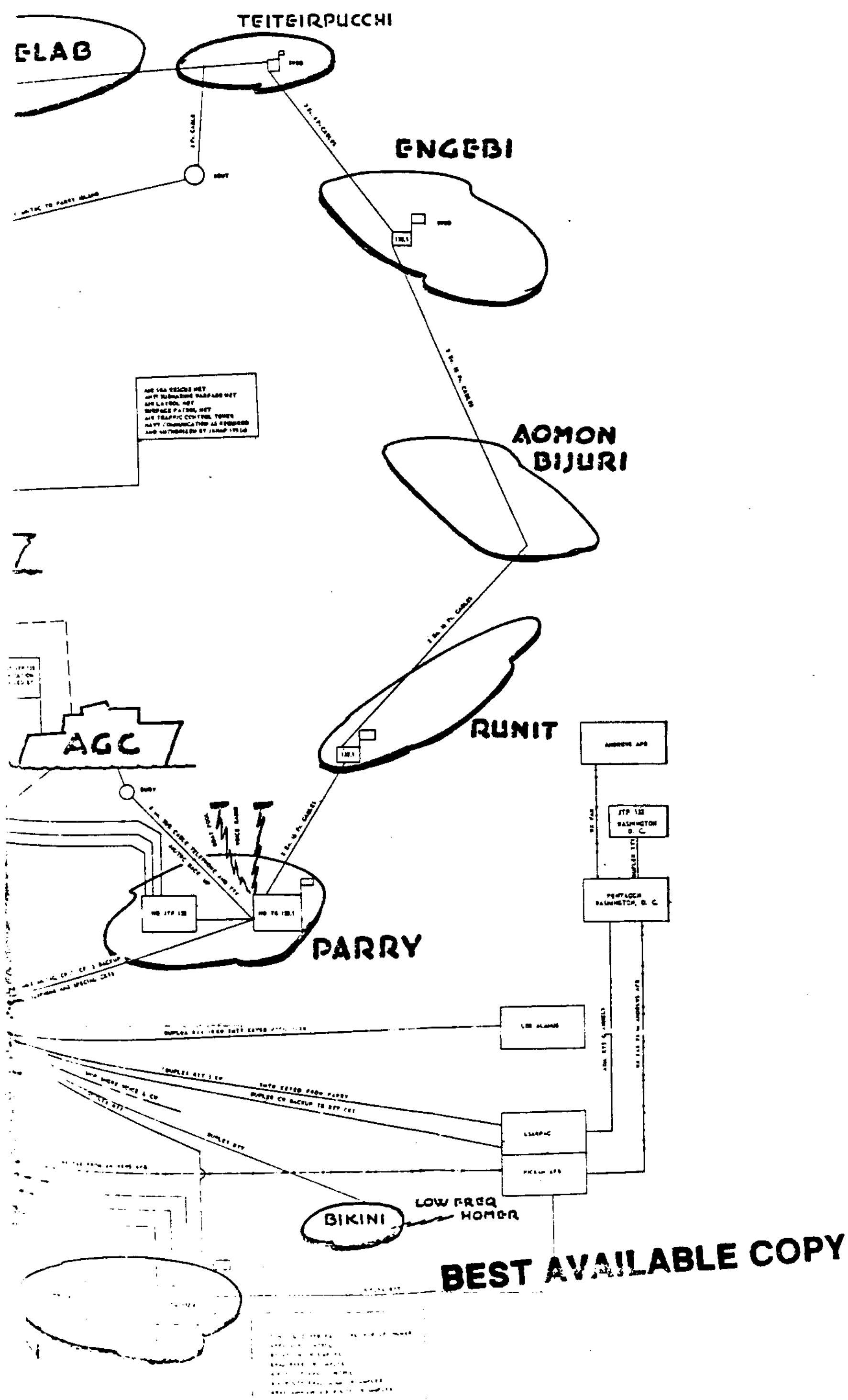
TIONS CKTS CJTF132 ASHORE



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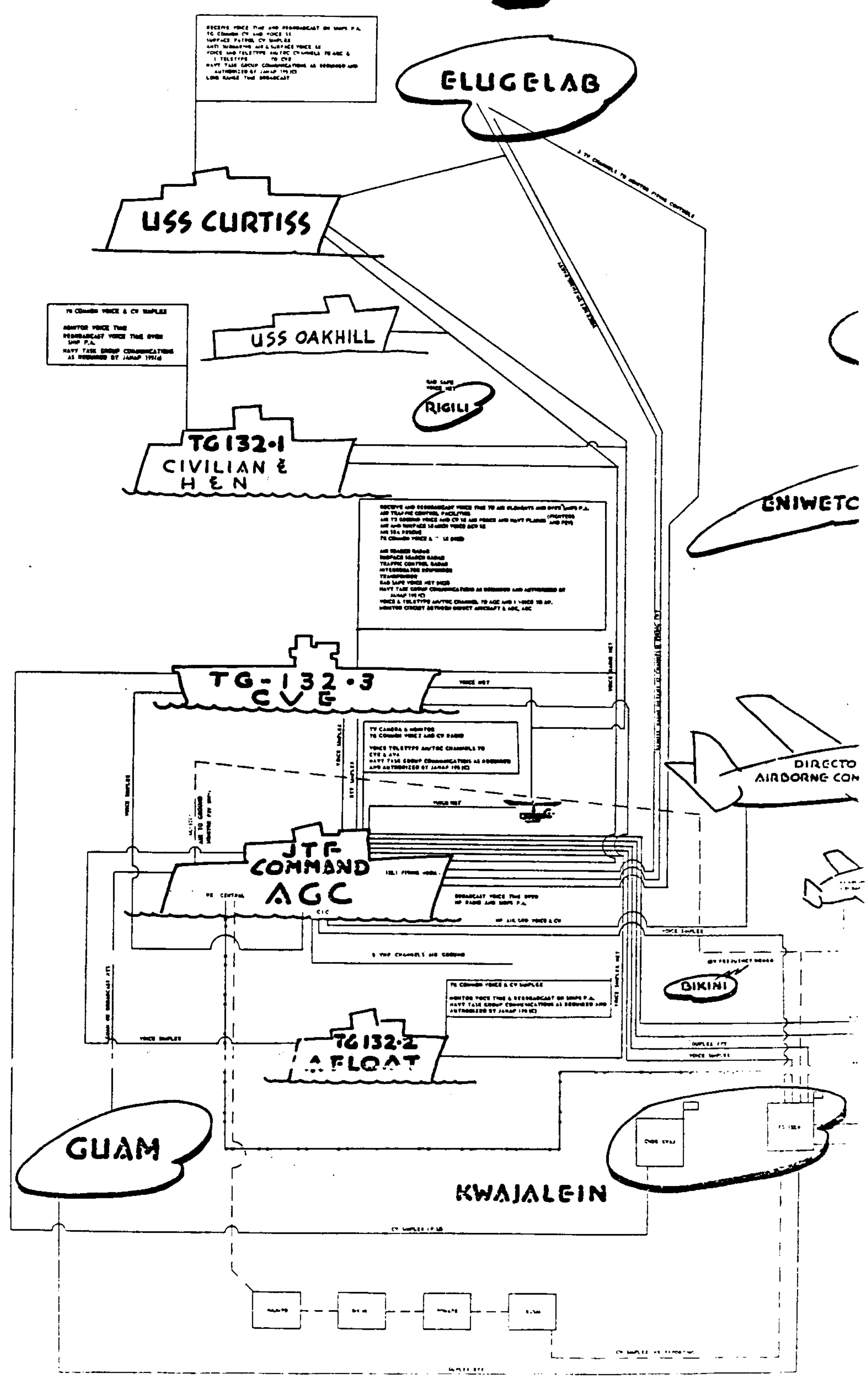

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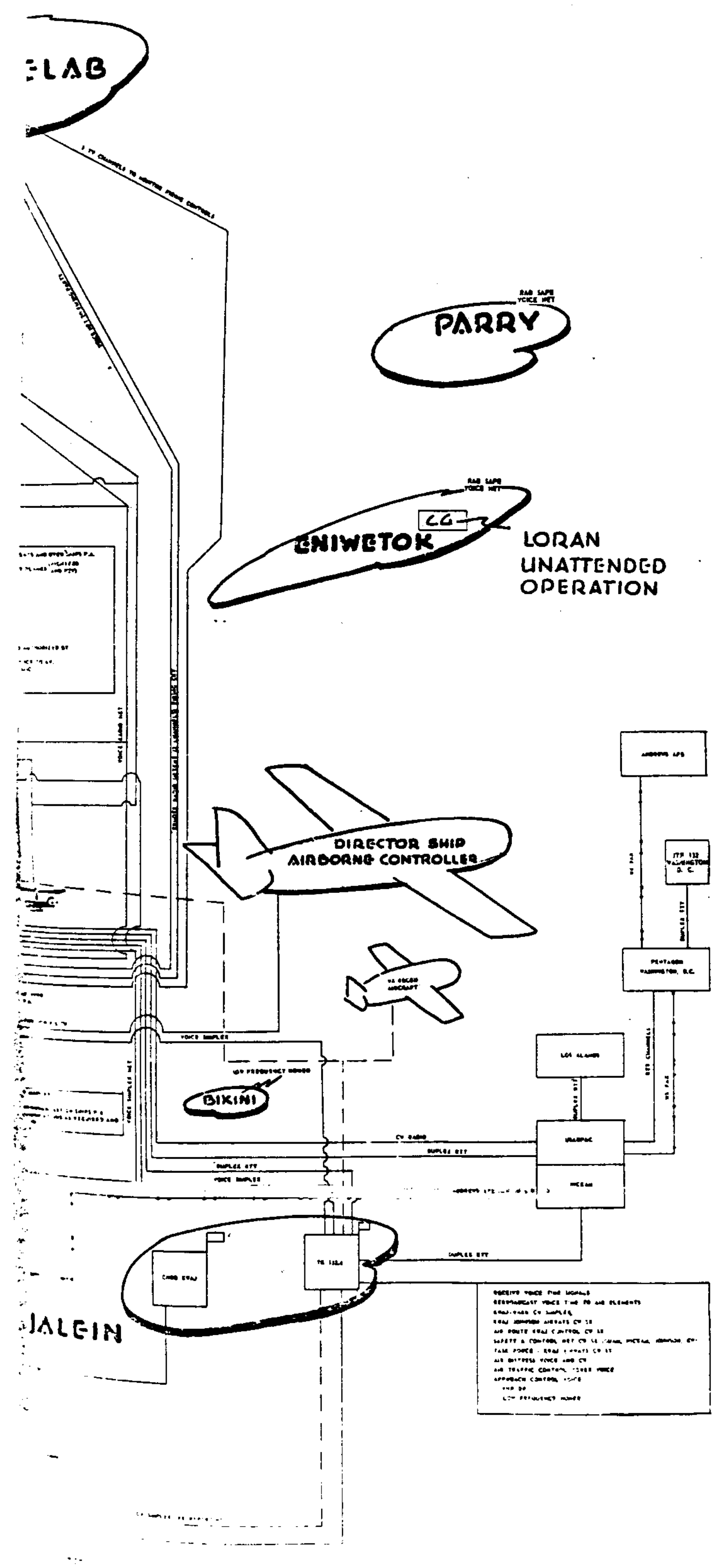
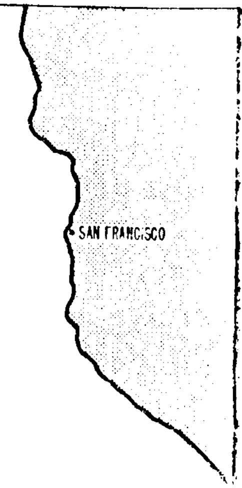
...TIONS CKTS CJTF 132 AFLOAT



AIR AND WATER LOGISTICAL SUPPORT



TOTAL WESTBOUND
1,571.3 CARGO S/TONS
6,721 PASSENGERS

TOTAL EASTBOUND
683.8 CARGO S/TONS
5.514 PASSENGERS

TOTAL WESTBOUND
111,747.3 CARGO M/TONS
1,652 PASSENGERS

TOTAL EASTBOUND
31,699.8 M/TONS
1,010 PASSENGERS

HAWAII

ENIWETOK

KWAJALEIN

ACTUAL

ESTIMATED

		1951	1952									OCTOBER		NOVEMBER	
		JUL — DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	CARGO	ERS	CARGO	PERS
WATER M/TONS	EAST	5,728.9	440.1	1,048.8	43.0	—	3,351.9	371.7	5,206.0	1991.0	3,107.0	1,509.5	3.0	8,901.9	1,005.0
	WEST	3,745.1	2,771.4	4,103.3	6,196.3	5,700.1	10,149.2	6,832.5	7,119.0	18,611.0	16,059.3	26,403.1	10.0	4,057.0	0.0
	TOTAL	9,474.0	3,211.5	5,152.1	6,239.3	5,700.1	13,501.1	7,204.2	12,325.0	20,602.0	19,166.3	27,912.6	13.0	12,958.9	1,005.0
AIR S/TONS	EAST	299.3	23.4	39.0	23.2	17.9	26.0	31.0	31.0	36.0	35.0	52.0	505.0	70.0	1,639.0
	WEST	317.4	85.7	53.3	40.3	50.4	61.7	55.5	124.0	163.0	235.0	299.0	661.0	96.0	220.0
	TOTAL	616.7	109.1	92.3	63.5	68.3	87.7	86.5	155.0	199.0	270.0	351.0	1,166.0	166.0	1,868.0

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APPENDIX W

INTRA-ATOLL TRANSPORTATION - PERFORMANCE DATA

Number of Liaison Aircraft and Helicopters Operated:

TYPE	NO. OPERATED
L-13	15
H-19	3
H-13	3
HRS	5

Liaison Aircraft and Helicopter Performance:

MONTH	HOURS OF OPERATION	NO. OF LANDINGS	NO. PAX AIRLIFTED	POUNDS OF FREIGHT AIRLIFTED
July	244	1506	1270	7543
August	406	1927	2147	16633
September	749	3564	3485	27221
October	1194	5551	5402	47343
November	281	1472	1355	6115
TOTALS	2874	14020	13659	104855

Number of Small Craft Operated:

TYPE	NO. OPERATED
LCM	41
LSU	10
YTL	2
LCPL	4
AVR	3
LCV(P)	2
Water Taxi	3
Motor Whale Boat	1
Sea Mule	1
AFDL	1
Barges (500 Tons)	6
DUKW	26

Small Craft Performance:

MONTH	BEACH LANDINGS	PIERHEAD LANDINGS	PASSENGERS TRANSPORTED	M/TONS CARGO TRANSPORTED
July	2665	333	12039	65744
August	7018	582	29577	66152
September	7526	628	34844	87461
October	8300	1292	55959	105957
November	2074	384	26816	46939
TOTALS	27649	3219	159235	372303

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APPENDIX X

OBLIGATIONS AGAINST DOD EXTRA MILITARY FUNDS AS OF 31 DECEMBER 1952

	FY 1952	FY 1953	TOTAL
Travel	$ 140,615	$ 494,768	$ 635,383
Transportation of Things	2,896	52,675	55,571
Communications	7,812	14,360	22,172
Task Force Overhead Expense *	35,416	26,755	62,171
Cargo Handling - Navy	30,000		30,000
Station Maintenance - Kwajalein		25,000	25,000
Activation, Modification and Inactivation of Aircraft	523,477		523,477
Activation, Modification and Inactivation of Ships	256,500	111,046	367,546
Construction of Real Facilities	505,535	39,273	544,808
Documentary Photography	145,259	18,100	163,359
Radiological Safety	5,940	45,158	51,098
Weather Service		3,000	3,000
Ship Rental		407,550	407,550
Operational & Logistical Support **	40,000		40,000
TOTAL	$1,693,450	$1,237,685	$2,931,135

* Includes expenses such as local procurement of equipment, supplies and services not obtainable from the military Services and not otherwise classified.

** Covers reimbursable expenses incurred by the AEC for DOD scientific programs not otherwise provided for.

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APPENDIX Y

OBLIGATIONS AGAINST DOD RESEARCH AND DEVELOPMENT FUNDS AS OF 31 DECEMBER 1952

	PROGRAM	FY 1952	FY 1953	TOTAL
3.	Scientific Photography	$ 185,000	$	$ 185,000
4.	Neutron Measurements	50,000		50,000
5.	Gamma Ray Measurements	550,000		550,000
6.	Blast Measurements	2,190,000	87,500	2,277,500
7.	Long Range Detection	212,217	404,485	616,702
8.	Thermal Radiation Measurements	450,000		450,000
9.	Electromagnetic Phenomena	385,000		385,000
11.	Preliminary Geophysical Survey of the Test Area	527,120		527,120
	TOTALS	$4,549,337	$ 491,985	$5,041,322

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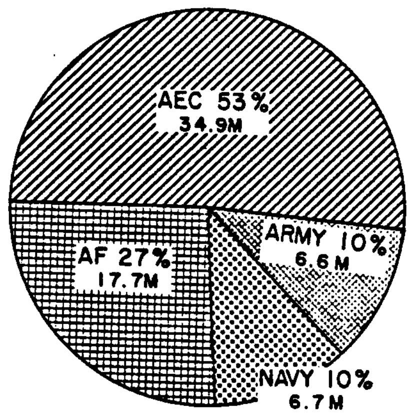
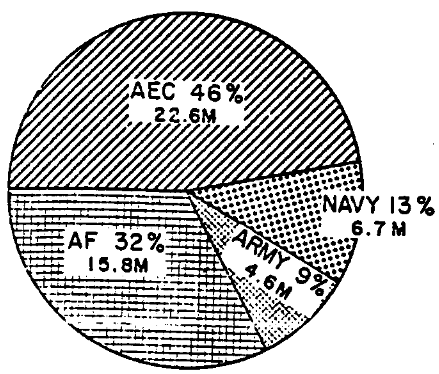
TOTAL
OPERATION IVY COSTS
through 31 December 1952



TOTAL 65.9M 100%

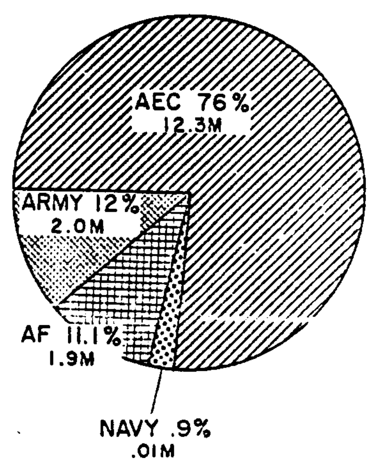
OPERATING COST 75%

TOTAL 49.7M 100%



CAPITAL COST 25%

TOTAL 16.2M 100%



NOTE: THESE FIGURES ARE A COMPILATION AS OF 31 DECEMBER 1952 AND DO NOT CONSTITUTE THE FINAL COSTS FOR OPERATION IVY. MANY ITEMS THAT NOW APPEAR IN THE CAPITAL COSTS WILL BY ULTIMATELY RETURNED TO STOCK AND THEREFORE CREDITED OUT OF THE TOTAL IVY FIGURE.

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