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OPERATION IVY

REPORT OF COMMANDER, TASK GROUP 132.1

Pacific Proving Grounds

Joint Task Force 132

November 1952

NOTICE

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Extract version prepared for:

Director

DEFENSE NUCLEAR AGENCY

Washington, D. C. 20305

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Operation IVY

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The mission of the Task Group included the responsibilities to conduct experimental measurement programs on Shots Mike and King and to conduct the radiological safety program. Programs were established to make radiochemical analysis of bomb debris; to follow the progress of the nuclear reaction; to make neutron, gamma ray, blast, thermal radiation, and electromagnetic measurements; and to make a preliminary geophysical and marine survey of the test area. The organizational structure and command relations to accomplish the mission are outlined.

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FOREWORD

This report has had classified material removed in order to make the information available on an unclassified, open publication basis, to any interested parties. This effort to declassify this report has been accomplished specifically to support the Department of Defense Nuclear Test Personnel Review (NTPR) Program. The objective is to facilitate studies of the low levels of radiation received by some individuals during the atmospheric nuclear test program by making as much information as possible available to all interested parties.

The material which has been deleted is all currently classified as Restricted Data or Formerly Restricted Data under the provision of the Atomic Energy Act of 1954, (as amended) or is National Security Information.

This report has been reproduced directly from available copies of the original material. The locations from which material has been deleted is generally obvious by the spacings and "holes" in the text. Thus the context of the material deleted is identified to assist the reader in the determination of whether the deleted information is germane to his study.

It is the belief of the individuals who have participated in preparing this report by deleting the classified material and of the Defense Nuclear Agency that the report accurately portrays the contents of the original and that the deleted material is of little or no significance to studies into the amounts or types of radiation received by any individuals during the atmospheric nuclear test program.

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CHAPTER 1

DEVICES TESTED

1.1 MIKE DEVICE

1.1.1 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 test could be used to design, test, and produce stockpile thermonuclear weapons.

1.1.4 Yield

In order to be assured that a thermonuclear reaction progressed to a desired magnitude, the Mike device was essentially overdesigned. The yield of this device is considered to be within the range of 6 to 12 Mt. A better yield figure is not available at the date of writing, pending a more complete analysis of test data.*†

*Application of the LASL analytic solution method to the EG&G photographic data has resulted in the following as the fireball yield figure as of May 15, 1953: Mike, 11 ± 1 Mt; King, 550 ± 20 kt.

†See note on p. 14.

1.1.5 Remarks

It is desirable to point out that the thermonuclear device tested was not a weapon. All 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 over-all size and weight can be reduced and that the cryogenics system can be simplified to make a usable weapon. It is hoped that a new design will be ready for overseas tests in the spring of 1954.

1.2 KING WEAPON

1.2.1 Objective of Detonation

The objective of King Shot was to

Data on the field variables leading to consideration of weapon effects in this yield range were also desired.

1.2.5 Yield

The preliminary estimates of yield are given by radiochemistry as 550 ± 50 kt, whereas the photographic analysis indicates the yield to be 570 ± 30 kt. It therefore seems probable at this time that the yield for King Shot lies in the range of 530 to 600 kt.

1.2.6 Remarks

Within the limitations of the basic design of the present pit, this test demonstrated the immediate high-yield capabilities of King Shot provided valuable information on thermal, blast, and radiation effects from high-yield fission weapons.

CHAPTER 2

SUMMARY OF EXPERIMENTAL PROGRAMS

2.1 PROGRAM 1, RADIOCHEMISTRY

The objective of this program was the collection and radiochemical analysis of bomb debris samples, the primary purpose of the analysis being the determination of yield. Also, for Mike Shot, an attempt was made to obtain pertinent diagnostic information (whether or not, and to what extent, the desired thermonuclear reaction took place and propagated, etc.) by means of further analysis designed to detect activity in selected tracer materials, quantities of which were built into, or placed in the vicinity of, the device.

The quantity of gaseous and particulate bomb 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 in-flight refueling to accomplish their mission. Shielded flight clothing was worn by the pilots of these aircraft to reduce radiation exposure. The clothing seems to have been effective in some cases, indicating that low-energy gamma radiation was present in the cloud during some penetrations. The radiation exposures received by these pilots were in all cases well within the prescribed limits.

Laboratory analysis was not complete at the time of writing and is being done at the Los Alamos Scientific Laboratory (LASL). Preliminary results are: Mike Shot, 5 to 7 Mt; King Shot, 550 ± 50 kt. The discrepancy between this yield result for Mike Shot and that given by ball-of-fire photography (see Sec. 2.3) has not yet been resolved. At present, however, it appears that the ball-of-fire result is more reliable. (See note on p. 14.)

2.2 PROGRAM 2, PROGRESS OF THE NUCLEAR REACTION

This program was designed to document the performance of the devices tested, utilizing various diagnostic measurements. New and untested experimental techniques were used on Mike Shot; hence the large amount of data obtained is very gratifying. For Mike Shot, measurements were made of the alpha (logarithmic rate of rise of the nuclear reaction) of the reaction to the beginning of the thermonuclear reaction, the rate of propagation of the thermonuclear reaction, and the energy spectrum of the neutron flux. The data for these measurements were recorded in a concrete bunker which was 9000 ft from the device and was connected to the cab by a helium-filled tunnel, through which gamma-ray and neutron signals could pass with little attenuation. For King Shot, alpha and transit time (the time from the firing signal to the first nuclear reaction) were measured, the latter by a remote-measurement technique capable of tactical utilization.

2.3 PROGRAM 3, SCIENTIFIC PHOTOGRAPHY

This program had many objectives, each of which involved photographic documentation of some aspect of the detonations. Fireball growth, cloud development, and illumination vs time were measured for both shots. For Mike Shot and the crater structure were documented, and

For King Shot the precise position of the burst was measured. In addition, bhangmeters (detection of fireball light) were utilized for both shots. These instruments were designed to obtain a remote and quick yield result from light-signal observation.

Generally speaking, three camera types were used to accomplish the photographic objectives, 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 zero. Depending on the phenomenon being photographed, film speeds from 16 frames/sec to 3½ million frames/sec were utilized.

Many data were obtained in spite of isolated equipment failures. Most of the film records have yet to be completely analyzed, but preliminary analysis of the fireball-growth films indicates the following yield values: Mike Shot, 12 ± 2 Mt; King Shot, 570 ± 30 kt. (See footnote on p. 7.)

The King Shot burst position was determined to be: Calculated error in position, 570 ± 35 ft; height of burst, 1480 ± 20 ft.

2.4 PROGRAM 4, NEUTRON MEASUREMENTS

Program 4 was primarily devoted to the measurement of total numbers of neutrons, in various known energy 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, and zirconium. For each shot many detector stations were established in radial lines extending outward from bomb 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 the "fission-catcher camera." The basic difference between these two measurements should be noted. The first allows only a counting of neutrons and gives 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. However, 35 samples were recovered, 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 the fission-catcher cameras were destroyed by the blast.

Incidentally, 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 the bomb, and the value of such close-in data is well worth the risk of losing an inexpensive station. Also, one of the great potential values of these neutron measurements is to explain why a device fizzled or detonated with a yield much lower than predicted.

2.5 PROGRAM 5, GAMMA-RAY MEASUREMENTS

This program was another of those devoted to studying the phenomenology of the device tested. 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 function of distance. The close-in instrumentation was also designed for diagnostic studies and a study of shock-wave effects on 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 stations being established on radial lines extending from bomb zero. Close-in intensity vs time (one ten-millionth of a second time resolution) was measured with phosphor-photocell–oscilloscope-camera combinations for the first few seconds. More distant intensity vs time measurements (a few seconds time resolution) were made with ionization-chamber–recorder combinations. Fall-out samples were collected over both land and water at selected points ranging from a few to several hundred miles from bomb zero.

On Mike Shot nearly all the film-badge stations were destroyed. Meager data will be extracted from those more than 4500 yd from zero, however. High time-resolution intensity records were obtained in sufficient quantity to indicate the pronounced effect of the shock wave and to measure the time between the two fission phases of the device. Lower time-resolution intensity records were obtained on seven islands of Eniwetok Atoll. Thus far no such data have been recovered from the off-atoll stations, although fall-out has been recorded on Kusaie and Ujelang Atolls. Usable fall-out samples (some of them as a function of time) were collected on the islands of Eniwetok Atoll, on rafts within the lagoon, on buoy-type sea stations, and at other atolls. It is expected that an analysis of these samples and the ionization-chamber–recorder data will definitely augment the understanding of the over-all fall-out hazard problem, particularly because of the time dependence of portions of the data.

On King Shot the film-badge stations out to 1200 yd 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 vs time data were obtained with both slow and fast time resolution. It is interesting to note that the peak radiation level on Runit (2000 yd from zero) was 5000 r/hr 5 sec after zero and had dropped to $\frac{1}{2}$ r/hr approximately 1 min later. No significant fall-out was recorded on any other island of the atoll, and none had been reported at any off-atoll station at the time of writing. Samples were obtained from 24 fall-out collector stations on islands of the atoll. These samples exhibited extremely low activity, however, indicating very slight to no fall-out.

2.6 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 on those media. In particular, data were sought to document the following:

1. Pressure vs time as a function of distance from zero at the surface.
2. Material velocity behind the shock front at known positions in space.
3. Shock wind, afterwind, and sound velocity before, during, and after blast-wave passage.
4. Water-surface motions in both deep and shallow water.
5. Subsurface earth accelerations.
6. Subsurface pressures in both deep and shallow water, including acoustic pressure waves at great distances.
7. Air density vs time before, during, and after shock-wave passage.
8. Free-air pressure vs time at known positions in space.

The tremendous energy release associated with Mike Shot and the quasi-operational nature of the King Shot airdrop assured that great interest would be shown in this program by both the AEC and the DOD.

The experimental techniques utilized to obtain the above-mentioned data were too many and too 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 aircraft.

Many usable data were 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 as follows:

1. 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 fireball and extending to pressures less than 1 psi.

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

3. Blast hydrodynamics offers considerable immediate promise as a diagnostic tool on tests of atomic weapons.

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

1. Water-surface displacement was 2 to 4 ft at Runit Island and 1 to 3 ft at Parry Island for Mike Shot. The waves produced by this shot were in general much smaller than predicted, being approximately one-tenth of those expected within the lagoon and nonexistent in the open sea.

2. A newly devised light and inexpensive deep-sea mooring, which utilizes the top of undersea mountains rising to some 5000 ft under the surface, was proved highly successful. This ability to establish semirigid reference points in mid-ocean may well offer a valuable contribution to ocean studies in general.

3. The B-36D horizontal tail bending moment was approximately 62 per cent of design limit, although in the wing the bending moments due to gust were very low. At shock arrival this aircraft was approximately 24 nautical miles from bomb zero at an altitude of 40,000 ft. The preliminary conclusion implied is that the B-36D will not be capable of delivering a megaton bomb without an aid (drone or drogue) of one type or another.

4. Identical peak pressures of 0.36 psi were measured on Parry Island for Mike and King Shots. This anomaly appears to be due to a refraction effect.

2.7 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 (and 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, air-borne low-frequency sound, seismic-wave propagation, and the detection of fireball light, as well as the tracking, collection, and analysis of air-borne bomb debris samples.

The quantity and general characteristics of the data and samples collected in this program are indicative of a successful operation, but practically no data have been reduced and analyzed in detail at the time of writing. Existing cloud-cover and smoke observations make the bhangmeter results appear questionable; however, final conclusions must await film analysis. Communication difficulties lessened the effectiveness of the King Shot air-sampling operations, but the samples obtained are adequate for at least partial analysis. The Mike Shot air sampling was more successful. Most of the remote stations report reception of excellent signals in conjunction with Mike Shot. For King Shot no reports have yet been received from these stations, but no difficulty is anticipated.

2.8 PROGRAM 8, THERMAL-RADIATION MEASUREMENTS

The thermal radiation emitted by an atomic detonation represents still another subject for investigation. The projects of Program 8 were each designed to document a particular aspect of this phenomenon. Near the surface of the earth attempts were made to measure the total thermal energy received as a function of distance from bomb zero, the time variation of the thermal intensity received, and the energy spectrum exhibited by this radiation. In conjunction

with these measurements the atmospheric attenuation (transmission property) along light paths of interest was studied in order to aid in the interpretation of results. Instrumented bomber-type aircraft were also employed to study, in free air and at altitudes significant to delivery aircraft, the thermal intensity vs time and the associated radiation-induced aircraft-skin temperatures. The latter information is clearly essential to studies of safe aircraft delivery techniques. The instrumentation utilized to accomplish the thermal-radiation measurements included thermocouples, bolometers, photocell-recorder combinations, high-speed spectrographs, and skin patches.

Results were, in general, most gratifying, the only serious loss of data occurring in the thermal-radiation project for King Shot. Many data, the quality of which appears to be excellent, were obtained on both shots. A cursory analysis points out the following facts of more or less general interest:

1. 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.

2. 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 in., and the aircraft was approximately 15 nautical miles from zero at an altitude of 40,000 ft. This aircraft received a relatively high thermal flux of 46.9 Btu/sq ft. The predicted value based on a 6-Mt yield was 36 Btu/sq ft.

3. The apparent thermal energy of King Shot was at least 48 kt.

2.9 PROGRAM 9, ELECTROMAGNETIC PHENOMENA

This program was concerned with the detection and measurement of various electromagnetic phenomena associated with nuclear detonations. The purpose of one project was a study of the correlation between nuclear-explosion-induced ionospheric disturbances and the interruption of radio communications. Another project was a feasibility study of radar-scope photography as an indirect bomb damage assessment (IBDA) technique. In addition, two projects were concerned with documentation of the broad-band electromagnetic signal given off by the exploding devices. Selected standard radio-frequency (20-kc and 4.215-Mc) bands were of particular interest in one of these projects; the other project was designed to test the feasibility of this technique for making remote diagnostic measurements, and hence the particular interest here was in the early (first few millionths of a second) signal characteristics.

The techniques used to obtain data for the detection and measurement of electromagnetic phenomena included air-borne 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 these efforts were excellent. All projects obtained usable data on both shots, the detailed reduction of which is being carried out at present. On 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 flying 200 miles west of Eniwetok and transmitting a continuous-wave signal to Bikini was able to contact Bikini shortly after M+2 hr, indicating no long-time disruption of the ionosphere. Also, for this shot, the radar-scope photographs show both fireball growth and shock progress.

2.10 PROGRAM 10, TIMING AND FIRING

The timing and firing program was primarily one of support rather than experimentation. As its name implies, this program consisted in furnishing the various experimental projects with the required timing signals (for starting equipment, etc.) on both shots and 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.

For Mike Shot the master timing equipment was located on the shot island near zero. Radio controls were used to give 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 by wires to the various experimenters: −30, −15, −5, and −1 min; −30, −15, −5, and −1 sec. The earliest signal was sent manually, and all later signals were sent by cam-operated switches on a sequence timer. This timer was manually started at the proper time before the −15 min signal was due and ran through its cycle automatically. 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 in determining whether or not the detonation would take place in an acceptable fashion.

For King Shot, time signals were available at −30, −15, and −5 min and at −30, −15, −5, −2.5, and −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 manually, and all later signals were sent from an automatic timer. This timer was started by a radio signal from the drop plane 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.

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

2.11 PROGRAM 11, PRELIMINARY GEOPHYSICAL AND MARINE SURVEY OF THE TEST AREA

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) on that structure might be more readily and reliably interpreted. In addition, it included a study of the biological contamination effects resulting from atomic bursts 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 conjunction with HE 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 were recovered and are being reduced.

Note: Later work has shown that the radiochemical yield results for Mike Shot quoted in Sec. 2.1 are too low. The reason for this is that it has been found that the uranium content in coral varies markedly with coral depth. Since a considerable part of the uranium in post-shot debris came from associated coral, the resulting error was large. Although it has not been possible to make a good correction for the coral uranium contribution, a rough correction indicates that the radiochemical results are not inconsistent with the ball-of-fire yield, and the latter can be considered to be correct.

CHAPTER 3

GENERAL ACTIVITIES OF TASK GROUP 132.1

3.1 MISSION

The mission of Task Group (TG) 132.1 included the following responsibilities:

1. To prepare for shipment, assemble, and place the devices to be tested.
2. To arm and detonate the devices to be tested.
3. To conduct the experimental measurement programs.
4. To conduct the radiological-safety program.
5. To provide technical and documentary photographic coverage.
6. To assume responsibility for the successful completion of tasks outlined in Annex E, Commander, Joint Task Force (CJTF) Operations Plan No. 2-52.
7. To maintain detailed records of TG 132.1 activities during all phases of Operation Ivy and keep Joint Task Force (JTF) 132 informed as to the TG 132.1 status of operations, providing specific information regarding unforeseen obstacles to the succesaful completion of this mission.
8. To be responsible for the packaging, loading, transfer, unloading, and supervision (to include radiological-safety monitoring) of test samples at all points and in transit as required.

3.2 ORGANIZATION AND COMMAND RELATIONS

J-Division of the Los Alamos Scientific Laboratory (LASL) is a permanent test unit within the Laboratory and was established to supervise experimental tests for AEC and to assure continuity of plans for atomic testing programs. In preparation for Operation Ivy, J-Division became the nucleus of an organization which was expanded by the addition of civilian personnel from AEC and AEC contractors and military personnel of JTF 132. In addition, two military support units, Radiological Safety and Documentary Photography, were appended to the test group, which was formally activated as TG 132.1 of JTF 132 on 2 January 1952.

The organization and command relations of TG 132.1 are depicted in Figs. 3.1 and 3.2.

The relations between TG 132.1 and JTF 132 were as would normally be expected between a subordinate and a higher command. TG 132.1, having the immediate responsibility for conducting the experimental programs which were the heart of Operation Ivy, received much support from the Headquarters, JTF 132 and the other Task Groups comprising the Task Force. In general the requirements submitted during the planning phase were approved by JTF 132, and during the operations phase TG 132.1 received excellent cooperation and support from the Army, Navy, and Air Force Task Groups in providing these requirements.

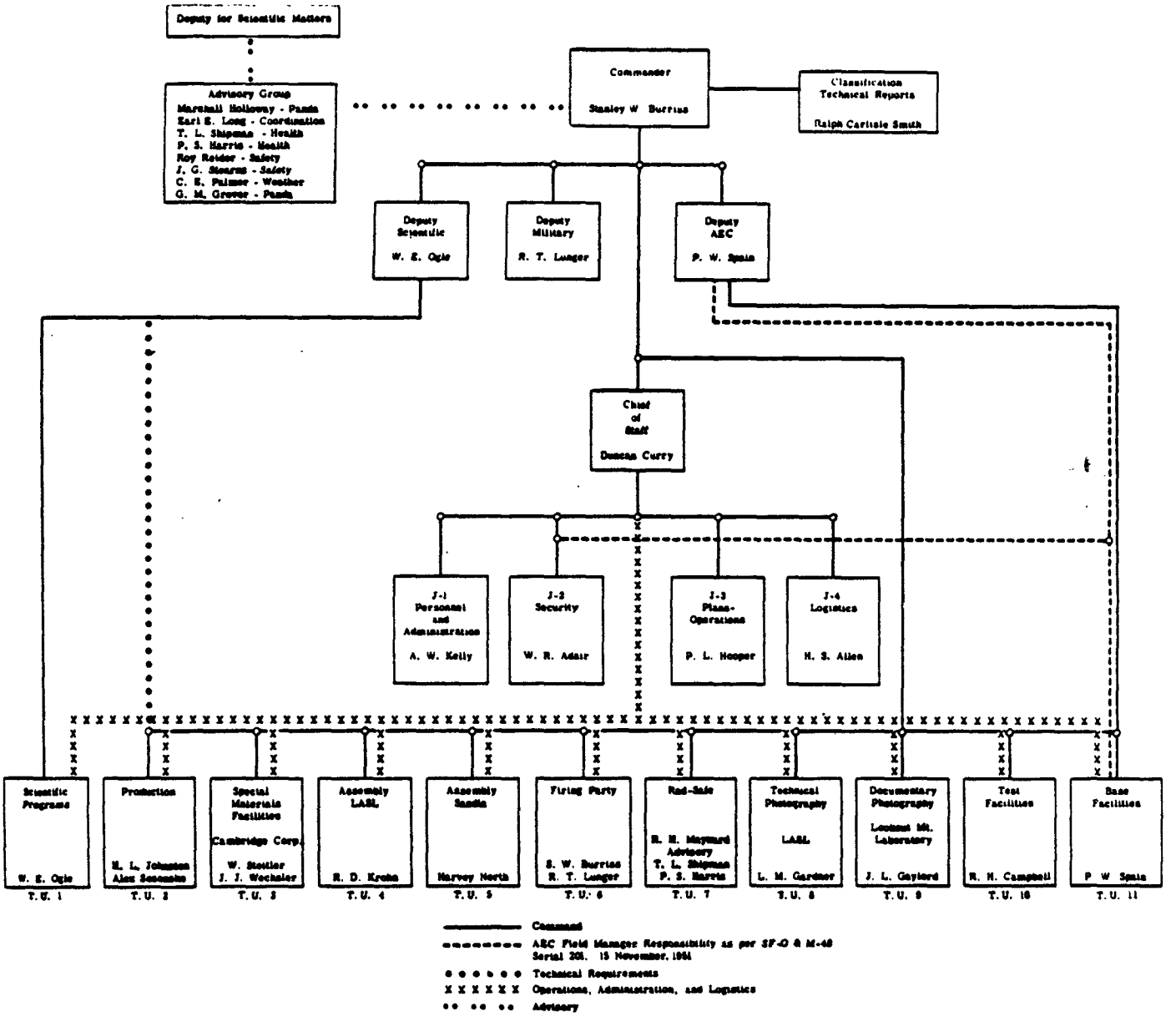

Fig. 3.1—Organization chart of Task Group 132.1.

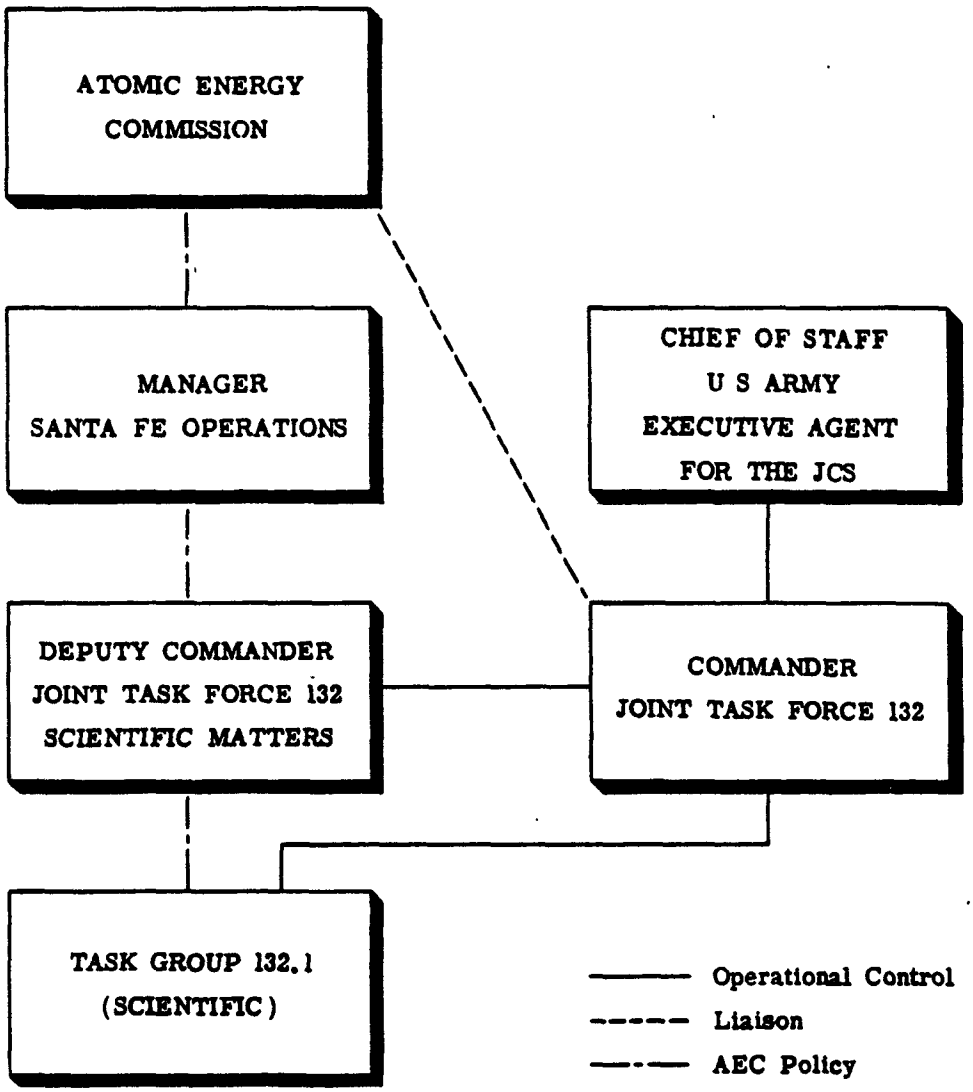

Fig. 3.2—Relation of Task Group 132.1 to higher headquarters.

3.3 THE ADVISORY GROUP

This group was composed of a number of consultants in specialized fields. Its function was to advise the Commander, Task Group (CTG) 132.1 and the JTF 132 Deputy for Scientific Matters on the numerous and complex technical problems involved in this operation.

Representatives for health, safety, and weather were included in the group. The principal efforts of this group were directed toward the problems peculiar to the Mike device. The group acted as an inspection agency and represented LASL and AEC in certifying that, prior to its detonation, the Mike device was assembled and operating in the manner intended in its design. It was the function of this group to make decisions and authorizations for any changes in the Mike device necessitated by field conditions. Fortunately the need for such changes did not occur.

The advisory group took an active part in the Mike assembly. Their advice and assistance was a major factor in the timely completion of the assembly.

3.4 PLANNING AND TRAINING

3.4.1 Device Planning

One of the major purposes of Operation Greenhouse was to answer key questions relating to the possibility of developing thermonuclear explosions. The Greenhouse George and Item Shots were important steps in the investigation of basic problems in the development of a thermonuclear device.

By August 1951 the Chairman of AEC had stated in a letter that a thermonuclear device would probably not be ready for testing prior to the winter of 1952-53. However, in late October 1951 he reported that progress in research and development activities had been such that a more realistic date for planning purposes appeared to be the fall of 1952, possibly 1 October. In addition to the thermonuclear device to be tested on Operation Ivy, the Director of LASL instructed J-Division to plan for an airdrop of a high-yield (500 kt) fission weapon as a second Ivy event.

In view of the October 1952 target date, the Panda staff, comprised of key personnel of LASL and certain contractors, was organized in October 1951 to consider the operational, design, fabrication, and planning problems related to the thermonuclear device to be tested during Operation Ivy. Initially,

would be tested on Operation Ivy. Consideration was given to the possibility of testing this device in the "dry" form, but the lack of critical materials at this point indicated a need for the use of liquid deuterium. Variations in the design of the Mike device continued up to the time of final assembly.

The King Shot weapon was particularly desirable to test in order to extend the knowledge of the effects of high-yield weapons and knowledge of certain factors involved in the design of high-efficiency weapons.

The choice of a specific island for the detonation of a device with the predicted yield of Mike Shot (the thermonuclear device) presented many problems, both from construction and from experimental points of view. But by November, after consideration and discussion, the island group of Eniwetok Atoll from Elugelab clockwise to Bogon was decided on as the shot-island group, with Elugelab to be the shot island, thus permitting the use of the islands both east and west of the shot island for instrumentation.

The sequence for the two detonations was initially decided to be King Shot, the high-yield fission weapon, followed by Mike Shot. However, further study in late February 1952 proved that it would be best to fire Mike Shot first. This would permit the greatest flexibility of oper-

ations and would afford no risk of damage to Mike Shot installations, nor would it interfere with vital Mike Shot preparations. King Shot had relatively little instrumentation, and Mike Shot was not expected to cause a great amount of damage to these installations. Therefore it was recommended to CJTF 132 that the shot sequence for Operation Ivy be changed to Mike Shot followed by King Shot. This shot sequence was approved by CJTF 132.

At this time it was recommended that the planned date for the detonation of Mike Shot be changed from 1 October 1952 to 1 November 1952, and it was decided that King Day would be no later than M+3 weeks.

A tentative cab working schedule was drawn up in April 1952 in order that scientific personnel could properly schedule their work in the cab area (zero point for the Mike device, so called by analogy to the cab on the top of a tower). This schedule was followed as planned with only slight deviations. Initial Mike assembly schedules were laid out and were revised to agree with changes in concept which occurred throughout the preoperational stages.

Ground zero for the King weapon was selected in April 1952 as the junction 6000 ft from Station 6a and 2000 ft from the furthest point north on Runit Island. Runit was selected because of its distance away from Mike Shot, thus lessening the possibility of damage to installations. Runit was also far enough from Parry Island to avoid the risk of major damage on Parry.

This Task Group's concept of operations was then disseminated for further operational planning by other participating agencies in late May 1952, and in June an evacuation conference was held at Los Alamos, during which time the effects of Mike Shot were predicted. It was concluded that the structural damage on Parry and Eniwetok should be minor, that the thermal effects at that distance should be negligible, that there was no danger from sea waves, and that boats could be anchored safely in water of 50-ft depth.

The advanced echelon of this Headquarters was established on Parry in early August 1952, and by the end of August the Mike device had been completed. It was then under the operational control of TG 132.1 and was loaded aboard the USS Curtiss for transport overseas. The Cambridge Corporation (Camco) had completed eight Dewars (specialized equipment for the transportation of liquid hydrogen), had shipped them overseas, and was beginning initial filling operations on the Dewars in the Forward Area. All major construction was essentially complete, except for the construction of scientific stations. This Task Group's Operations Plan 1-52 was then issued.[1]

3.4.2 Basic Requirements

In early October 1951 the basic requirements for testing the thermonuclear device became apparent; namely, a large cryogenics plant, Dewar transport facilities, a specialized cab in which to build the device, and the use of the USS Curtiss as an assembly ship.

Upon the activation of TG 132.1 on 2 January 1952, staff studies were made which were based on Greenhouse experience and on the best available estimates of the requirements peculiar to an accelerated thermonuclear program. In consideration of the Mike event many new problems were introduced which had no precedents as criteria for establishing operational requirements.

By January 1952 the support requirements from the DOD were established and presented to the Joint Chiefs of Staff (JCS). The requirements dictated the use of certain types of ships, numbers of small boats, various aircraft, and much other military support.

In February 1952 the cryogenics plant design was finalized, and construction began in March. The shot-island camp was started and was completed in late April.

By April 1952 the project aircraft requirements became firm, and TG 132.4 was in the process of obtaining modifications for most of these aircraft. The requirements for modifications to TG 132.3 ships became firm, and the operational dates for ships to be in the Forward Area were determined.

The various modifications required for aircraft were coordinated with CTG 132.4, and

certain ship modifications were coordinated with CTG 132.3. These changes were requested and were in the process of modification by June. Except for the last-minute revisions, the operational requirements for both aircraft and ships were firm by June 1952.

3.4.3 Experimental Programs

By mid-January 1952, both the AEC and the DOD had drawn up tentative proposals of test programs that they wished to carry out on Operation Ivy. As result of a conference at Los Alamos with representatives of AFSWP, JTF 132, the Division of Military Application (DMA) of AEC, and LASL, in mid-February 1952, the planned programs of the AEC and the DOD were consolidated into an over-all proposal for approval of CJTF 132 and the Research and Development Board. These programs were approved by CJTF 132 in the last week of February and by the Research and Development Board in March 1952. The conference at Los Alamos examined the plans at that time to ensure that the program covered was possible and feasible under the limitations imposed by the operational problems, time scale, logistics, and performance predictions. The test programs are outlined in the Turquoise Book,[2] and, except for major revisions of techniques to be used in Program 2, only a few minor changes occurred after this date.

3.4.4 Determination and Support of Project Requirements

It was necessary during early planning to assess the numbers of ships, boats, vehicles, and aircraft. These numbers were reviewed and modified where necessary to meet the needs of the operation as they became more clearly defined by progress in planning. In March 1952, CTG 132.1 established a system of monthly status reports to be submitted by project officers, task unit commanders, and staff sections of this organization. These status reports were for the purposes of establishing support requirements and keeping the Commander informed of the over-all progress in planning for Operation Ivy. In addition to status reports, requirements were submitted by letter as they occurred, at frequent conferences, and by interviews with responsible project representatives.

The J-3 Section extracted and compiled the operational requirements submitted and integrated these requirements into the available operational means of accomplishment. This consisted in submitting requirements to JTF 132 for approval and necessary support by subordinate Task Groups. The J-3 Section monitored these requirements by direct contact with these organizations.

3.4.5 Training

Operation Tumbler-Snapper at the Nevada Proving Grounds, in the spring of 1952, provided invaluable training for many of the personnel concerned with Operation Ivy. Many of the ideas, techniques, methods, and much of the equipment tried at Tumbler-Snapper determined the experiments or techniques to be used on Operation Ivy. Five F-84G sampling aircraft participated in Operation Tumbler-Snapper, and the crews gained valuable experience and training for their sampling mission in Operation Ivy by their actual penetration of heavy radiation fields in the atomic clouds to collect samples of bomb debris.

The Camco transport Dewars, which were produced in Somerville, Mass., and trucked to Boulder, Colo., were first filled with liquid hydrogen, and the units were studied for characteristics under operational conditions in late April 1952. Additional information was gained in the trucking of these Dewar trailers from Boulder to Los Alamos when the cryogenics system was tested in June.

Assembly training for the Mike device was first carried out at Los Alamos on an assembly of the [redacted] The cryogenics system was also

assembled and connected for filling operations. The entire cryogenics system was filled with liquid hydrogen in June 1952 with the use of Camco transport Dewars operating from Boulder. The results of this test indicated that certain modifications were necessary to the cryogenics system. These modifications were completed in July, and a second filling was made. This filling proved that the system, as now designed, was adequate and could be duplicated overseas.

At the Buffalo plant of American Car and Foundry, the Mike device was completely assembled, less the cryogenics system and

during the week of 14-19 July. This gave added experience in the assembly of the which is the most difficult part of the operation and, for the first time, all the components of the device except the cryogenics system were assembled.

This Task Group assumed operational control of the Mike device on 25 July 1952.

The Forward Area training conducted during the months of September and October by the Scientific Task Group included activities such as Dewar filling, trial movements of the transport Dewars from Parry to the shot island aboard an LCU, radiological-safety monitor training, and electronics checks of the television equipment aboard the USS Estes, which was used as a firing control ship in addition to being the command ship. It is somewhat difficult to distinguish training activities from field tests, check-outs, and trial runs using the apparatus or equipment to be used in the actual test. These last-minute checks were the culmination of months of research, study, and training. They were not training activities in the sense that repetition was necessary to successful accomplishment, but they were proof tests of basic ideas, circuitry, and final calibrations.

All training of TG 132.1 was culminated in the comprehensive rehearsals held in the Forward Area to determine the state of readiness of all elements. The Mike Shot rehearsal, referred to as the "MX rehearsal," was held on 28 October and covered all phases of the test with the exception of those items which would cause undue interference with preparations for the actual shot. This rehearsal was successfully carried out, and no serious deficiencies were noted in TG 132.1 preparations.

3.5 MOVEMENT TO THE FORWARD AREA AND ASSEMBLY OF SUBORDINATE UNITS

3.5.1 Personnel

Information regarding the expected number of personnel to move to the Forward Area during Operation Ivy was obtained from the monthly status reports as submitted by the various staff sections, task units, programs, and projects. This information was graphically plotted and used by the interested staff sections and by Holmes and Narver (H&N) in planning for transportation, housing, messing, and administration in the Forward Area. Because of the many variables affecting the length of stay of the majority of personnel in the Forward Area, this expected-population graph was not entirely accurate but was useful for over-all planning purposes.

The processing of individuals prior to movement overseas was accomplished by the Adjutant General at Los Alamos. This processing included:

1. Preparation of travel orders for each individual.
2. Preparation of identification cards for those persons not already possessing them.
3. Notifying each individual of the immunization requirements and the procedure for obtaining them.
4. Ensuring that each person, prior to movement to the Forward Area, had a valid radiological-safety physical examination.
5. Working in close liaison with the J-2 Section to determine the clearance status of the individual. (No orders were issued to those not considered good security risks.)
6. Issuance of necessary government travel requests to military personnel for commer-

cial transportation to Travis Air Force Base, Calif., or to the port of embarkation.

7. Notification to CINCPAC that each individual traveling to the Forward Area was considered a good security risk and of the type of clearance he possessed. Security statements were signed by personnel and filed in the J-2 Section office.

8. Notification by teletype to the AEC Resident Engineer at Eniwetok [information to Santa Fe Operations Office (SFOO)] as to the expected arrivals.

The actual move to the Forward Area was as individuals rather than as units. Liaison officers were stationed at Travis Air Force Base; Hickam Air Force Base, T. H.; and Kwajalein to aid personnel and to expedite travel. Most nongovernment employees proceeded to Hickam Air Force Base via commercial transportation. Most government employees and all military personnel traveled from Travis Air Force Base to Hickam Air Force Base via Military Air Transport Service (MATS). The majority of the personnel were airlifted by MATS from Hickam Air Force Base, and the remainder were transported by MSTS or Navy ships to the Forward Area.

Although the majority of the personnel of TG 132.1 were located at Eniwetok Atoll, several of the units were based on Kwajalein and other Pacific atolls because of operational necessity. Most of these small elements were a part of the scientific-measurement programs of Task Unit (TU) 1. Other Task Units having a fairly large off-island responsibility were TU 5 and TU 9. TU 5, the assembly unit for the King device, operated at Kwajalein since this was the base of operations for the Air Task Group which dropped this device. TU 9, the Documentary Photography Unit, had approximately half of its personnel strength at Kwajalein in order to obtain documentary photography required of the air operations and, of course, the air-borne photography at the time of detonation. Other units included in the approximately 100 personnel of TG 132.1 on Kwajalein were Projects 1.3, 2.5, 3.2, 3.7, 5.3, 5.4a, 5.4b, 6.4b, 6.10, 6.11, 7.3, 7.6, 8.5, 9.4, and 10.2 Although Eniwetok and Kwajalein were the main operational bases for Ivy experiments, a few of the projects had stations at Bikini, Majuro, Kusaie, Ponape, Maui, Ujelang, and Johnston Islands. Program 7 and some other projects monitored stations at several remote places throughout the world as a part of the long-range detection program and other studies.

The Headquarters Commandant, TG 132.1, met all new arrivals of the Task Group at Eniwetok Atoll and effected processing, billeting, and arranged individual transportation to Parry Island or to the up-island sites as required. An accurate daily count of the population of TG 132.1 personnel was kept. The population curve by weekly increments is presented in Fig. 3.3. The peak population was reached on 24 October 1952 when 556 staff and scientific personnel and 1129 H&N personnel, making a total of 1685 in TG 132.1, were present at Eniwetok Atoll.

3.5.2 Equipment

Owing to the nature of Operation Ivy (the testing of a thermonuclear device), the logistic problems involved in accumulating, shipping, and assembly of equipment were of large magnitude.

The Department of Supply and Property, LASL, worked very closely with four major contractors in connection with the procurement of the necessary equipment for Operation Ivy. There were, of course, hundreds of other contractors who provided scientific and technical equipment. Much of the equipment required months of specialized engineering before the preliminary designs could be firmed up enough to order material. This required the use, in some cases, of directives to obtain raw materials in time to fabricate, test, and ship them overseas without delaying the program.

A critical problem of the Department of Supply and Property was that of arranging the shipping schedules so that there would be space available to transport overseas, during the few

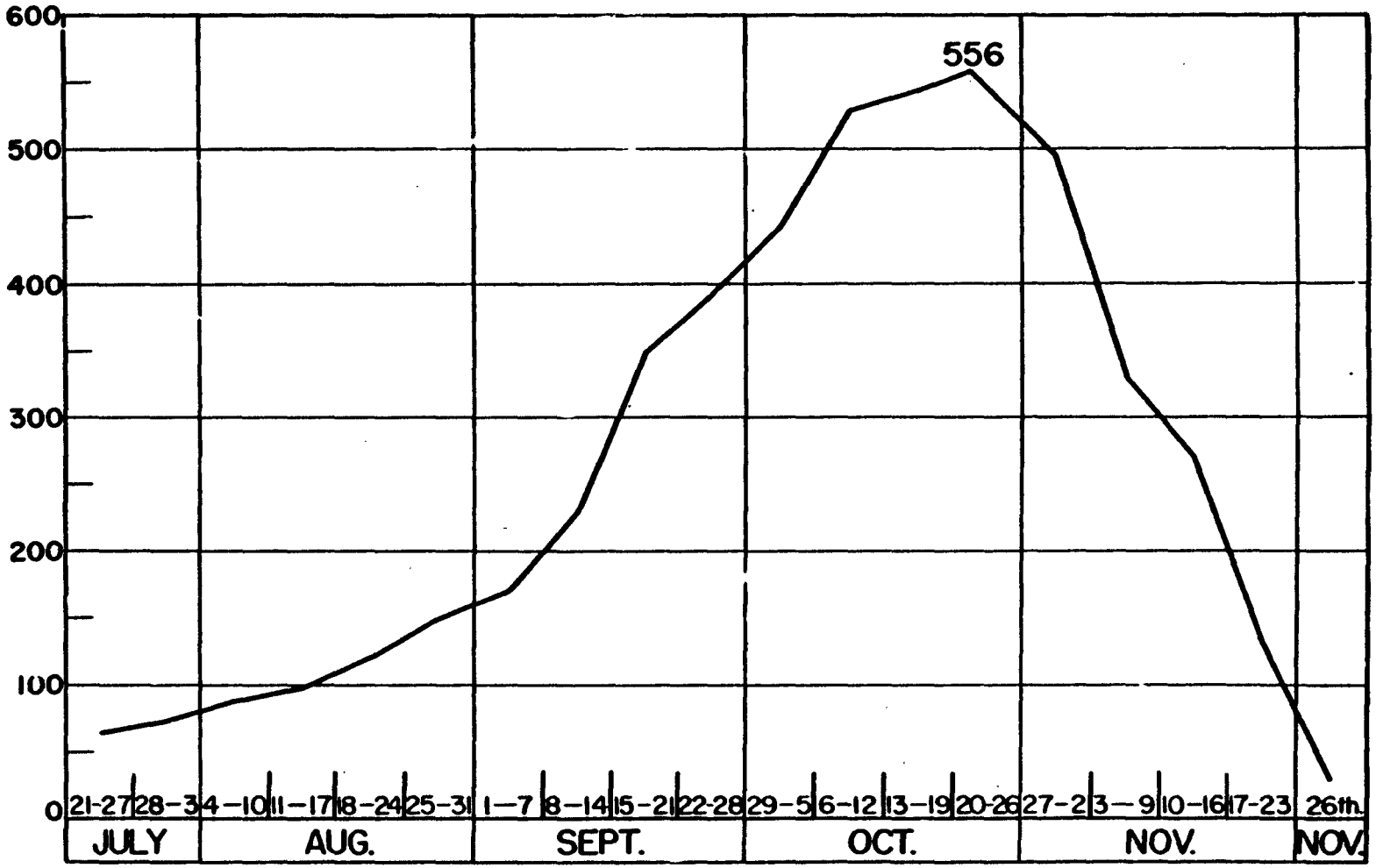

Fig 3.3—Weekly average of Task Group personnel in Forward Area.

months prior to the test, the many tons of critical units for Operation Ivy. The determination of shipping requirements and of the dates on which the equipment from the various organizations and agencies throughout the United States would be ready was essential to a successful movement plan. TG 132.1 informed JTF 132 of some of the major shipping problems as early as January 1952. The Scientific Task Group, however, was unable to furnish realistic schedules or even approximate dates, in some cases, for the bulk of the material which had to be transported overseas in early 1952. This was due to the fact that the speed-up of the operation resulted in research and development being done side by side with production work. This procedure necessitated many changes during the course of production, and the completion schedules were inevitably sometimes unreliable. As plans for the shipment of equipment to the Forward Area became firm, the Task Force was informed of schedules and requirements. The Task Force then arranged for the necessary air or water transportation as required.

Since much of the equipment which was to be shipped by surface transportation departed from the San Francisco area, special handling procedures were arranged with the Naval Supply Center at Oakland, Calif. Complete instructions concerning shipping, labeling, etc., were issued to all participating groups.

During a conference in Washington, D. C., in late February, the problems associated with shipment and evacuation of the bulky and delicate hydrogen transport Dewars were discussed. Representatives of JTF 132, TG 132.1, and Camco determined that it would be possible to carry the packaged Dewars in the holds of any Liberty ship. It was proposed at this conference that the Dewars be shipped in two shipments of four Dewars each, one shipment on 2 August and the other on approximately 21 August. This scheduled movement was carried out as planned.

During March 1952, arrangements were made for special warehousing space at Oakland for TG 132.1, and a liaison officer was assigned at Oakland to coordinate and expedite the movement of cargo through the water port of embarkation. At the same time liaison officers were also assigned to Travis Air Force Base and Hickam Air Force Base for movement of both cargo and personnel through these aerial ports.

General air and water transportation requirements for movement of equipment overseas were made known to the J-4 Section of TG 132.1 through the status reports submitted by the various project officers. These requirements were consolidated and forwarded to JTF 132, and the Transportation Officer arranged for the necessary transportation. Air and water transportation requirements were submitted to the Task Force each month in accordance with established procedures. In general, the bulk of the cargo and equipment was shipped by surface craft during July and August 1952. The movement of personnel and cargo by air gradually increased and reached a peak during September and October 1952.

Due to several special air shipments required during September and October, serious backlogs sometimes developed at Travis and Hickam. Backlogs as high as 30,000 lb at Travis and 50,000 lb at Hickam were experienced. The Wake Island evacuation, because of the hurricane, accounted for some backlog in late September. The special air shipments which had priority over normal air movement included shipments such as the aluminum sheet and the balloons for the helium tunnel of Program 2. Replacement parts for the cryogenics plant compressors required special airlift to the Forward Area. Several special series of flights were arranged to ship last-minute critical equipment to the coast.

Representatives of the J-4 Section of TG 132.1 were placed at critical points during October to expedite the shipment of urgently needed or misplaced items. The normal errors in incorrect marking or obliterated addresses were experienced. Items which were reported as delivered and could not be located were traced by the J-4 Section representatives.

Considering the likelihood of backlogs developing, it was found that water transportation of equipment was somewhat more reliable as far as date of delivery was concerned. This no doubt was due to the fact that a little extra cargo does not particularly create a backlog when

the volume capability of a ship is considered. Also, the people who sent their equipment by ship did not particularly expect quick service. Whenever extra cargo did arrive at the port of embarkation, special types of ships, such as troop transports or reefers destined for this area but not scheduled to transport TG 132.1 cargo, were able to load this material aboard and thus assure earlier delivery.

3.6 MOVEMENT OF DEVICES AND COMPONENTS

Based on experience gained from previous operations, it was recommended that accountability for all source and fissionable materials involved in Operation Ivy remain with the AEC (SFOO) at all times. This recommendation was approved, and this procedure was followed for both Mike and King components, which were moved in accordance with the following plans:

1. Mike. In the early planning for Operation Ivy the decision was made to transport all the assembly parts of the Mike device on the USS Curtiss. The movement was accomplished as planned.

2. King. It was originally planned that the King weapon, all spare parts, and the necessary handling equipment would be transported on the USS Curtiss. However, by April 1952 it became apparent that the LASL time schedule did not permit completion of the design, procurement of special materials, tooling, machining, and production of the King nuclear assembly prior to the sailing date of the USS Curtiss. It was therefore recommended that the King weapon be transported by air in order to allow the Laboratory more latitude in the time schedule. This recommendation was concurred in by SFOO and approved by CJTF 132, and CTG 132.4 was assigned the responsibility for providing the necessary air transportation.

3.7 ON-SITE OPERATIONS AND REHEARSALS

3.7.1 General

In preparation for full-scale activities, a forward echelon of CTG 132.1 Headquarters was established at Eniwetok early in August 1952 with an acting commander and task unit and staff section representatives.

On-site operations included the construction of base facilities and scientific stations, the scheduling of operational events, the assignment of transportation, the coordination of off-atoll support, evacuations, the coordination of recovery operations in contaminated areas with the Radiological Safety Unit, the scheduling of sample return by aircraft, and Task Group communications.

3.7.2 Construction

TU 11 of TG 132.1 was composed of AEC and contractor civilian personnel who were responsible for engineering, construction, operation, and management of the Pacific Proving Grounds base and test facilities. TU 11 was under the direction of P. W. Spain, who was also the Deputy Commander for AEC of TG 132.1 and AEC Field Manager, Eniwetok Field Office, SFOO. Supervision of jobsite activities of the civilian contractor, Holmes and Narver, was the responsibility of the AEC Resident Engineer, who is a member of the Field Manager's staff.

The design of scientific structures was the responsibility of H&N, who received criteria from TU 10 through the Field Manager, Eniwetok Field Office. Active design of supporting facilities, such as the causeway and the cryogenics area, began in late October 1951, and the design of scientific structures began in late November 1951. In order to meet established firing dates, the Field Manager notified all concerned on 20 March 1952 that a deadline of 1 May 1952

must be met for major scientific construction requirements and that a deadline of 1 June 1952 must be met for less complex structures. Approximately 800 sheets of drawings were prepared for this operation, and by 1 September 1952 all home-office designs had been completed.

The first portion of construction for Operation Ivy was the cryogenics-area facility which was started in late 1951. By 20 October 1952 all construction had been completed in time for the previously established firing date. Because of the large amount of instruments and equipment to be installed in major scientific stations, it was necessary to work considerable overtime in order to complete construction by deadline dates.

More than ten million dollars was required for construction on this operation. Of this amount, approximately seven million dollars was for scientific-test or test-supporting construction, and the remainder was for Parry Island base facilities. Scientific-test construction consisted of scientific stations to house instruments, recorders, cameras, etc. Test-supporting construction consisted of a causeway, marine pier and ramp, an airstrip, and two tent camps. Base facilities on Parry Island consisted of a 3000-kw power plant, machine shop, and various buildings for a cryogenics plant and appurtenances. Over 500 scientific stations were constructed on 30 separate islands in addition to reef locations on Eniwetok Atoll. These stations ranged from the simple, such as those on small rafts, to the complex, such as Station 1, which was the zero structure. Approximately 8600 cu yd of concrete had been poured in construction of all facilities as of 30 September 1952. Two temporary tent camps of 250- and 500-man capacity, with roads and utilities, were constructed for housing scientific and construction personnel.

Some difficulties were experienced in construction because of slow delivery of critical materials and because adverse field conditions were encountered during the construction period. Critical materials which required special action were submarine cable and aluminum sheeting. Late in the construction period an existing submarine signal and communications cable failed, and it was necessary to obtain a replacement before the test date. By full cooperation of all parties concerned, the cable was manufactured, transported by ship to the jobsite in September, and put in operation by the required date. Aluminum sheets necessary for the protection of a scientific station were transported by air and placed during October 1952. The large weight over a comparatively small area caused a scientific station to sink 3 in. a few days before the test date. Since there was not time to replace this facility and because the line of sight was an important factor in experimentation, there was considerable alarm. However, after a few days the structure reached a point of stability, and the experiment was successful. The steel strike during the summer caused some trouble, but most orders were delivered on time. High tides washed out a portion of the causeway, but, by fast work during low tide, the gap was filled.

The contractor furnished support services to the scientific groups for the installation of their instruments and equipment. Major items of support services were the installation of cryogenics equipment and the transportation, loading, etc., of deep-well drilling equipment. Other instrumentation and labor support was furnished to the scientific groups as required.

Housing, messing, laundry, and other ordinary municipal facilities were furnished to a peak population of approximately 900 personnel of the Task Force, exclusive of 1300 contractor personnel, on islands other than Eniwetok. The military garrison on Eniwetok reached a peak total of approximately 1600. The military garrison is self-sustaining except for maintenance of structures, which is furnished by the contractor. Marine transportation for intra-atoll travel is a contractor responsibility, but assistance is provided by the Navy during operational periods.

3.7.3 Intra-atoll Airlift Service

The J-3 Section, Operations Section of TG 132.1, was assigned the responsibility for controlling the scheduling of all aircraft used in the intra-atoll air transportation service in a

manner that would most effectively fulfill the airlift requirements and at the same time effect the best possible utilization of available aircraft.

Based on experience gained during Operation Greenhouse and the anticipated requirements for Operation Ivy, a requirement for type L-13 aircraft and helicopters was established with JTF 132 in January 1952. The following aircraft were made available to operate the intra-atoll airlift service, including the evacuation, re-entry, and recovery phases of the operation:

Number	Type	Maximum passenger capacity
15	L-13 aircraft	3
3	H-19 helicopter	8
3	H-13 helicopter	2
5	HRS-2 helicopter	8

Of these aircraft the five Navy HRS-2 helicopters, which were based on the USS Rendova (CVE-114), were not available until 4 October 1952. At this time one of the Air Force H-19 helicopters was transferred to Kwajalein for air-sea rescue purposes. The primary mission of the HRS-2 helicopters was for use in the evacuation, re-entry, and recovery phases of the operation. During the initial stages of the operation their use in the normal intra-atoll airlift service was somewhat limited.

The L-13 aircraft were available in sufficient numbers, but they were unable to operate on several occasions because of unfavorable weather conditions. This posed a very serious problem during the 5-day period preceding Mike Shot. The L-13's were grounded for the first 3 days of this period, and it was necessary to use helicopters for all flights.

The H-13 helicopter was excellent for observation purposes but was not suitable for many of the other requirements because of the relatively small load it could carry.

The H-19 and HRS-2 helicopters were entirely adequate in every respect except in numbers available. During the 5-day period preceding Mike Shot and during re-entry and recovery operations, there was a definite need for more helicopters of this type. Owing to the carrying capacity of the HRS-2 helicopter, it was fortunate that the decision was made to use this type of aircraft rather than HUP-1's as originally planned.

With the exception of the period when the Task Force was afloat and all helicopter operations were controlled from the USS Rendova, Task Element (TE) 132.4.1.1 had operational control of all aircraft used in the intra-atoll airlift service. An officer in TG 132.1, J-3 Section, was designated as the scheduling authority for all passengers. Headquarters, JTF 132 and each Task Group designated one or more representatives to be responsible for preliminary screening of all requests for air transportation from their units. It was asked that requests for flights between 0730 and 1200 hours be established by 1600 hours on the previous afternoon and that requests for flights between 1300 and 1700 hours be established by 1100 hours on the day of the flight. These requests were then given to the TG 132.1 scheduling authority. On the basis of these requests, an operational schedule for the following day was established, and a requirement was placed on TE 132.4.1.1 to furnish the necessary air transportation. There was sufficient flexibility in this system to accommodate most of the requests which were made after the schedule was established.

The majority of the air travel was between Parry Island and the northern islands. The flights between Parry and Eniwetok Islands were usually made on an "as-available" basis and in the slack operating periods of the day. TG 132.1 personnel, including H&N personnel, comprised approximately 80 per cent of all passengers carried. H&N furnished dispatchers for the Parry and Teiteiripucchi airstrips. After Mike Shot the dispatcher from Teiteiripucchi was

located on Runit prior to King Shot.

Very close controls were placed on the use of aircraft from M−5 days to M−1 day and K−3 days to K−1 day. Schedules for all flights during these periods were established in advance and were followed very closely. This ensured the availability of aircraft for all necessary missions and reduced the over-all traffic during this period. These controls during the period prior to Mike Shot permitted TE 132.4.1.1 to make an orderly withdrawal of the L-13 aircraft and H-13 helicopters from service and take the action necessary to place them in temporary storage.

The HRS-2 helicopters proved very valuable during the period preceding Mike Shot. Without them it would have been impossible to accomplish many of the scientific-project requirements in the available time. On M−1 day the two H-19's and four of the HRS-2 helicopters were in use all day. Upon completion of their mission they were evacuated to the USS Rendova.

3.7.4 Motor Vehicle Transportation

Another on-site operations activity assigned to the J-3 Section was to provide motor vehicle transportation in support of TG 132.1 activities on Eniwetok Atoll and to assist CTG 132.4 in support of scientific projects on Kwajalein by assigning vehicles to the TG 132.4 motor pool for maintenance and dispatching to TG 132.1 personnel.

Based on experience gained during Operation Greenhouse and the anticipated requirements for Operation Ivy, vehicle needs were made known to JTF 132. These vehicles were procured by the Task Force from military sources and shipped to the Forward Area.

The TG 132.1 motor pool was established at Parry Island on 14 August 1952, and a smaller motor pool for TG 132.1 vehicles was established on the shot-island group. Task units and project personnel requested vehicles from the motor pool either on a daily basis or for longer periods as required. H&N personnel accomplished the maintenance and repair of TG 132.1 vehicles.

During the peak operational period just prior to Mike Shot, the total numbers of general-purpose vehicles assigned to TG 132.1 at Eniwetok were as follows: 48 ¼-ton 4 × 4 jeeps, seven ¾-ton 4 × 4 carryalls, 19 ¾-ton 4 × 4 weapons carriers, 30 1½-ton 6 × 6 personnel and cargo carriers, nine 2½-ton 6 × 6 cargo carriers, and two 2½-ton 6 × 4 cargo carriers.

In addition the following special-purpose vehicles were assigned: two 2½-ton 6 × 6 machine shop trucks, one 2½-ton 6 × 6 welding truck, four 7½-ton F-1 truck tractors, two 1-ton two-wheel trailers, three ¼-ton two-wheel trailers, two 2½-ton 6 × 6 COE cargo carriers, and one ¾-ton 4 × 4 ambulance.

The total number of vehicles for Operation Ivy was considered adequate. The vehicles were properly utilized, and close control of the dispatch of vehicles ensured that all needs were met.

For Mike Shot evacuation, all vehicles were stored on Parry Island in readiness for the re-entry of Task Group personnel.

3.7.5 Intra-atoll Boat Service

The movement of heavy equipment and much of the movement of personnel in support of on-site operations were accomplished by the TG 132.1 boat pool. This unit, with support from the TG 132.3 boat pool as required, supported the many activities of TG 132.1 personnel.

The TG 132.1 (H&N) boat pool was composed of one AFDL, 19 LCM's, five LCU's, three water taxis, six YC's, two YTL's, and six DUKW's.

The TG 132.3 (Navy) boat pool was composed of one LSD, three AVR's, 19 LCM's, four LCPL's, five LCU's, and one DUKW.

The TG 132.2 (Army) boat pool was composed of two LCM's and 18 DUKW's.

The TG 132.1 requests for boats were submitted to the boat officer the day before re-

quired whenever possible. During the critical operating periods of M−5 days to M−1 day and K−3 days to K−1 day, a detailed operating schedule was prepared and followed. When requirements exceeded the capability of the TG 132.1 boat pool, boats were requested from the TG 132.3 boat pool.

H&N operated five LCU's, one of which was at Bikini, to support the H&N camp development. These boats were used primarily for the movement of heavy equipment between Parry and the northern islands. Two of these boats were assigned to make Dewar runs, and the crews were trained for this special task by making several rehearsal movements of the Camco Dewar units under conditions of both daylight and darkness. The Navy operated five LCU's, two of which made scheduled runs between Parry and the northern islands shuttling rolling stock. An average of one LCU was requested each day for direct support of project personnel of TG 132.1. The other two LCU's were used for loading and unloading and for general movement of supplies.

An average of 13 of the 19 LCM's available to H&N were operationally manned. All LCM's were not used because of the inability of H&N to recruit operators to replace those whose contracts expired during the operation. The Navy had 19 operational LCM's. An average of seven were requested each day for direct support of TG 132.1 project personnel. Those boats not directly assigned to a project for its use were used for loading and unloading ships, ship-to-shore movement of personnel, and recreation parties.

H&N had three Seacraft water taxis, two of which were on scheduled runs to various islands of the atoll.

An average of three H&N DUKW's were required for work at locations inaccessible to other boats. The other three H&N DUKW's were used at Parry for carrying crews to moored boats. An average of seven Army DUKW's were requested for exclusive use at the northern islands.

TG 132.3 provided adequate boat support in supplementing the needs of the TG 132.1 boat pool. The TG 132.3 boat officer trained his boat operators efficiently in the type of operations required at Eniwetok and furnished the numbers and types of boats required.

3.7.6 Off-atoll Activities

In addition to the operational activities at Eniwetok, there were many other selected locations on surrounding islands where experimental tests in connection with Operation Ivy were conducted. The J-3 Section of TG 132.1 monitored the support requirements of these outlying units.

Requirements were first submitted by project personnel at a conference on 14 May 1952. These requirements were tabulated and forwarded to JTF 132, TG 132.3, and TG 132.4 for planning and support. In planning requirements, on-site surveys by several project personnel were conducted to determine the feasibility of using the sites. After review by the J-3 Section as to the capability of furnishing support at the locations selected, approval for the use of the sites was obtained from JTF 132.

The locations selected by TG 132.1, and approved by JTF 132, for experimental tests other than at Eniwetok were Kwajalein, Bikini, Majuro, Ponape, Kusaie, Ujelang, Wake, Guam, Midway, and Johnston. Approval for the use of Kwajalein, Ujelang, and the weather islands of Bikini, Majuro, Ponape, and Kusaie was obtained from CJTF 132. Approval for the use of Guam, Midway, and Johnston was obtained from CINCPAC, and CINCPAC cleared the use of Wake with the CAA, Honolulu. Truk and other atolls originally requested by projects as desirable sites were not approved by CJTF 132 because the use of these locations was considered inadvisable owing to security risks and the support involved.

The locations of projects and task units were as follows:

Kwajalein: Projects 1.3, 2.5, 3.7, 5.3, 5.4a, 5.4b, 6.10, 6.11, 7.3, 7.6, 8.5, 9.4, and 10.2;

and TU 5 and 7.

Bikini: Projects 5.3, 5.4a, 5.4b, 9.2, and 9.3; and TU 7.

Wake, Guam, Midway, and Hawaii: Project 6.4b.

Midway and Johnston: Project 7.6.

At Kwajalein the support of project personnel was provided by TG 132.4. It consisted of the construction of prefabs and the installation of power, communications, air-conditioning, work benches, etc., as required by the projects. TG 132.4 also arranged for housing and subsistence of scientific personnel with the cooperation of the Naval Station. JTF 132 furnished TG 132.1 with a motor pool consisting of seven jeeps and six weapons carriers which were attached to the TG 132.4 motor pool for maintenance and dispatching. TG 132.4 also furnished fork lifts, trailers, and other items of equipment as required. Support by the Air Task Group at Kwajalein was very satisfactory.

Arrangements were made with TG 132.4 to airlift Project 5.3 personnel by C-47 to Roi on a scheduled basis for installation and collection of data for Mike and King Shots. Kwajalein was also the base of operations for airlift support by PBM and C-47 for projects with installations at other atolls as explained below.

The initial Bikini development by H&N in preparation for Operation Castle coincided with the movement and support by LST of Projects 9.2 and 9.3 and the installation of the Weather Station. The projects required water transshipment of equipment consisting of trailers, generators, gasoline, and housekeeping support from Eniwetok.

LST 836 was made available to support the Bikini development, the scientific projects, and the Weather Station. The first shipment of material left Eniwetok on 15 September, and subsequent trips were made on 1 October, 15 October, and 6 November. In addition, LSD 7 was used on 1 October to carry one LCU and two LCM's loaded with H&N heavy equipment for their base development. Weekly PBM flights carrying H&N, AEC, and project personnel and mail and special cargo were made between Eniwetok and Bikini. An additional flight each week was added if required.

Projects 9.2 and 9.3 established two camp sites on Bikini, with tents and field equipment furnished by TG 132.2. The project personnel subsisted with the Weather Station and furnished housekeeping support to the Weather Station. The weapons carrier and DUKW assigned to the Weather Station were used part time by project personnel. Late shipments of project equipment were moved to Bikini Island from the LST off-loading point on Eninman Island by means of H&N LCM.

Project 6.4b had installations on Eninman Island and Chireete Island. Their personnel and equipment were transported by the Scripps vessel Horizon for installation prior to, and roll-up after, Mike Shot. Part-time use was made of the H&N LCM to lay cables, install sea-mount equipment, and to support the personnel on Chireete Island. The project personnel lived and subsisted on Eninman Island at the H&N camp.

The LST 836 was standing by at Bikini for evacuation capability of personnel on Eninman Island, and the LCU was at Bikini Island for the same purpose. Personnel went afloat in the lagoon during Mike Shot. Projects 9.2 and 9.3 were rolled up after King Shot and returned to Eniwetok by LST.

Weekly PBM flights were made from Kwajalein to Bikini, Ponape, and Ujelang, and weekly C-47 flights to Majuro and Roi were made as scheduled for the project users. The PBM flights, under the operational control of CTG 132.3, were originally scheduled to support the Weather Station under CTG 132.4. TG 132.1 submitted project requirements to JTF 132 coinciding with the established schedule and requested flights to Ujelang. Similar requirements were submitted on the C-47 flights to Majuro, and an additional schedule was made for flights to Roi. The following conditions affected the reliability and convenience of these flights:

1. Flights were canceled and rescheduled because of poor weather.
2. Flight take-off times were changed frequently without consulting this Task Group.

3. TG 132.1 was not notified well in advance of changes in schedules or take-off times.

Owing to the frequent flights required by Project 5.3, this project was inconvenienced considerably by these conditions.

After obtaining permission from CJTF 132 and CINCPAC to use Midway, Guam, Wake, and Hawaii, project personnel were authorized to make direct arrangements for housing and subsistence with the authorities on the islands and to arrange for MATS or commercial air transportation from Hickam.

3.8 SHOT PHASE EVACUATION

3.8.1 Mike Shot

Preparation for Mike Shot was made more difficult by the necessity of evacuating all personnel from Eniwetok Atoll, the latter course of action being dictated, in the interests of safety, by the expected large energy release of the Mike device. Although early planning for the evacuation of Eniwetok Atoll dates back prior to the evacuation conferences held at Los Alamos on 10 June 1952, there were many details which, of necessity, were not completed until just a few days prior to the shot.

On 20 September a preliminary meeting on evacuation was held by Headquarters, JTF 132 with representatives of all Task Groups present. The purpose of this meeting was to establish a working committee to study and prepare evacuation plans for the orderly evacuation of personnel and material from Eniwetok Atoll prior to Mike Shot. At this meeting some of the problems involved in the evacuation of personnel and material were discussed. This group recommended that an Evacuation Committee be established with membership composed of one or more members from each Task Group and Task Force Headquarters. Lt Col R. D. Denchfield of JTF 132 was named Chairman of the Evacuation Planning Committee.

The first meeting of this committee was held at 0900 on 25 September. Representatives of J-1, J-3, and J-4 Sections of TG 132.1 attended this meeting. A TG 132.1 Troop Quartermaster was nominated at this meeting. Such problems as mail while afloat, hold baggage, preparation of plans, and loading schedules for passengers and cargo were discussed by the committee.

Additional meetings of the Evacuation Planning Committee were held on 30 September and 1 and 3 October to discuss further evacuation plans. Allocation of personnel by Task Groups to the evacuation vessels was completed, subject to late changes. At the Commanders Staff Conference on 8 October, CTG 132.3 reported that the Navy Task Group was concerned about the apparent difficulty experienced in establishing evacuation schedules for both material and personnel. TG 132.3 had prepared an evacuation boat schedule which was presented to the Evacuation Planning Committee for consideration. Captain Knickerbocker explained that, in the meetings held during the previous two weeks by the Evacuation Committee, difficulty was experienced in firming up evacuation plans owing to the inability of some committee members to obtain detailed data from their respective Task Groups.

The assignment of personnel to the various ships was dependent on the operational requirements of the individual. The operational functions of the principal evacuation ships of TG 132.3 were as follows:

USS Estes	Command and Firing Group
USS Curtiss	Weapon Assembly and Cryogenics
USS Rendova	Radiological Safety and Recovery Parties
USNS Shanks USNS Collins	Majority of personnel not assigned to other vessels

In addition to these ships, representing the major evacuation of the Task Group, some personnel were aboard ships of the Scripps Institute expedition, the USS Leo, the USS Oakhill, and other ships of the evacuation fleet.

In so far as was feasible, every man was evacuated to assigned space on an appropriate ship as soon as his contribution to the Mike Shot preparation was completed. Naturally, however, the bulk of the evacuation had to be accomplished during the last few days. A detailed chronological check list, which scheduled all intra-atoll transportation of personnel and equipment, was prepared to cover the 5-day period prior to shot time.[3] Each task unit and experimental project was consulted prior to the issuance of the list to ensure that it contained appropriate entries to allow (1) the completion of all experimental readiness work, (2) the evacuation of equipment and supplies from the northern islands, and (3) the availability of a boat or helicopter for evacuation of personnel to the appropriate ship. It was also adjusted to the framework of the Task Force check list in order to conform with ship movements and general policies established by CJTF 132.

The project personnel of TU 1 posed the greatest problems, in both evacuation and intra-atoll transportation, primarily because of the requirement that each piece of experimental equipment was to be left unattended the shortest feasible time before it was utilized on a shot. As a result, a member of the J-3 Section, TG 132.1, was given the mission of assuring that the evacuation of each project individual was adequately provided for, by name, after that individual's work was done. Personal liaison with the appropriate project officer was utilized to accomplish this mission, rather than the issuance of directives and lists, because of the changeable nature of experimental duties prior to a detonation.

Since space aboard the USS Estes, Curtiss, and Rendova was critical, these ships presented the greatest problem in working out assignments and passenger lists. Up until M−3 days, major changes in the assignments to these ships were taking place owing to changes in the operational requirements of the technical groups. For this reason it was impractical to work up final passenger lists of TG 132.1 personnel prior to M−3 days. Those lists which were prepared on M−15 days required many corrections, and the final and accurate lists on each ship were made as the ship got under way.

In so far as possible, ship and quarters assignments were worked out by the J-1 Section in close liaison with the Chief of Staff and the J-3 Section. Cards stating ship and quarters assignments were issued to all personnel. Last-minute assignments to quarters were handled by the J-1 Section representative aboard each ship.

In order to assure that all personnel were actually evacuated from the atoll, a muster was conducted of all TG 132.1 personnel. The Task Group was divided into 15 muster groups, each with an appointed muster officer and sub muster officers. Four days prior to the shot a list of each muster group was distributed to the respective muster officers. Additions and corrections were sent to the Headquarters Commandant by M−2 days. On M−1 day each muster officer turned in a signed copy of the muster list, indicating those personnel who were accounted for.

Muster for M−1 day was conducted at 1230 hours. Each muster officer reported to the J-1 Section representative at his location, whether ashore or afloat, who in turn reported via radio to the Headquarters Commandant aboard the USNS Shanks. Upon completion of the muster the Headquarters Commandant reported to the J-1 Section aboard the USS Estes. Persons who were reported ashore on the 1230 muster were checked by a J-1 Section representative as they arrived aboard their evacuation vessel. The J-1 Section representative reported periodically to the Task Group muster officer until all personnel were shown on board. The Firing Party and a few technical personnel were mustered aboard the USS Estes just prior to the departure of that ship from the lagoon, at which time all personnel were accounted for.

3.8.2 King Shot

All islands of the atoll, other than Eniwetok and Parry, were evacuated for King Shot. Compared to the Mike Shot evacuation this posed a simple problem, but the method of solution was somewhat similar. Again a chronological check list was prepared to schedule all intra-atoll transportation of personnel and equipment, this time for the 3½-day period prior to the shot. The list was not issued, however, but was used as a work sheet for the construction of Operational Directive K-3 which was issued in its stead—a combined airlift and boat schedule.

Evacuation of all northern islands other than Runit was completed the afternoon of M−1 day, and a partial safety sweep was made by helicopter. Runit was evacuated the evening of K−1 day except for two H&N powerhouse personnel who remained on duty all night. A muster was conducted the evening of K−1 day. On the morning of King Day the powerhouse was "buttoned up," a final check of selected instrumentation was made, and the final safety sweep was conducted. Evacuation was completed by 0830, at which time the drop aircraft entered the area.

Although the atoll was not completely evacuated for King Shot, the potential for such an evacuation was maintained as insurance against the eventuality of hazardous postshot fall-out on Parry and Eniwetok Islands. No such fall-out occurred; hence the potential was not utilized. The postponement of King Day did not alter the above procedures.

3.9 OPERATIONS AFLOAT

Headquarters, TG 132.1 established a Command Post afloat on the USS Estes at 1700 M−1 day. Firing control equipment (for detonation of the Mike device by remote control) and communication facilities (for adequate control of other elements of the Task Group aboard other vessels) were installed on board this ship.

By 2230 M−1 day the evacuation of Eniwetok Atoll was completed except for the Firing Party on the shot island and a small detail on Parry. The Firing Party, after completing their instrumentation and Firing Party check-out lists, departed the shot island at 0100 via AVR and returned to the USS Estes, which was moored off Parry Island. The USS Estes then proceeded to sea and maneuvered so as to be at a position 30 miles, bearing 135° true, from the shot island at zero hour. The firing control room on board the USS Estes consisted of two television monitor scopes for observing the positions of timing signals, Go-No-Go indicators and the monitor dials of various important systems of the device itself, and a control panel located between the two monitor scopes to permit the use of three radio links for control of the timing signals, sequence timer, and the emergency stop. In the appropriate sequence the controls were activated to detonate the Mike device at 0715, 1 November 1952.

The Gunnery and Landing Force Office was used as the Command Post by CTG 132.1 afloat. This space was equipped with the necessary communication and monitoring facilities to provide for the control of other elements of the Task Group.

The Command Post returned to Parry Island at 0800 M+2 days.

3.10 SAMPLE RETURN

The return of radioactive samples to various laboratories within the Zone of the Interior (ZI) was accomplished with specifically assigned MATS aircraft. These aircraft were designated by the word "Easy" preceded by the flight number. Numbers one through four were for Mike Shot, and numbers five through eight were for King Shot. For each pair of such flights an extra plane was assigned for emergency backup purposes. Although no emergencies arose, two of the backup planes were utilized for additional sample return—one for Mike Shot which bore the designation Four Easy Extra and one for King Shot which bore the designation Eight Easy

Extra. More complete details of the planning for this phase of the operation are included in JTF 132 SOP No. 76-4, dated 4 September 1952, as amended by SOP No. 76-4A, dated 18 October 1952, and need not be repeated here. The following outline indicates, in part, the results of that planning, including modifications made necessary by unforeseen conditions in the field.

Flight Number	Comments
1E	As planned.
2E	As planned.
3E	Program 4 samples not on board because of unavoidable delay in sample recovery; otherwise as planned.
4E	Departed Eniwetok, with first available Program 4 samples, at approximately H+68 hr. Program 5 samples not aboard because insufficient recovery time was allowed. AFOAT-1 samples on-loaded at Kwajalein as planned, but off-loaded at Travis and held for 4EE. Flight terminated, and Program 4 samples off-loaded at Kirtland.
4EE	Departed Eniwetok, with bulk of Program 5 samples, at approximately H+115 hr. Carried tritium containers from Kwajalein to Kirtland. Picked up AFOAT-1 samples at Travis as indicated above. Served effectively to clean up the bulk of Mike Shot sample-return requirements.
...	Remainder of Mike Shot samples returned to ZI via regular MATS flights as required.
5E	As planned.
6E	As planned.
7E	Departed Eniwetok at approximately H+32 hr with first available samples for Program 4 and AFOAT-1. Picked up additional AFOAT-1 samples at Kwajalein. Program 4 samples off-loaded at Kirtland. AFOAT-1 samples off-loaded, and flight terminated at Logan.
8E	Departed Eniwetok at approximately H+48 hr with samples for Programs 4 and 5. Picked up AFOAT-1 samples at Kwajalein. Program 4 samples off-loaded at Kirtland, and Program 5 samples off-loaded at Friendship. AFOAT-1 samples off-loaded, and flight terminated at Logan.
8EE	Departed Eniwetok at approximately H+56 hr with final group of Program 4 samples. This flight was also utilized to return Program 1 instruments, the high priority of such a return being dictated by ZI test planning. Flight terminated, and load transferred to CARCO, for transport to Los Alamos, at Travis.

Thus we see that the sample-return mission was accomplished. The chain of events first indicated by the lack of Program 4 samples on Flight 3E directed attention to several weaknesses in the plan outlined in the above-mentioned SOP's that, it is hoped, can be avoided in future operations. A suggested solution to these weaknesses is discussed in Sec. 3.19.

3.11 RECOVERY OPERATIONS

The recovery of experimental data, samples, and equipment after Mike and King Shots of Operation Ivy involved extensive coordination between experimenters, the intra-atoll transportation system, and the radiological-safety organization (TU 7). Each recovery team was accompanied by a TU 7 representative responsible for monitoring the radiation levels en-

countered and advising the senior member of the party as to potential hazard. Each recovery-team member was supplied with a pocket-size integrating dosimeter, a film badge, and appropriate protective clothing by TU 7. Recovery-party size was dictated by both the type of work to be done and the principle of keeping each party as small as possible, in order that personnel would not be subjected to radiation exposures without necessity.

The type of transportation utilized by a particular recovery party was dictated by the location of the material to be recovered, the radiological-safety situation at that location, and the priority of the experiment. The major portion of the required airlift was accomplished with TG 132.3 helicopters operating from the USS Rendova flight deck on Mike, M+1, and M+2 days and from the Parry airstrip thereafter.

The order in which recovery operations were accomplished was fixed by a combination of radiological-safety conditions and experiment priorities, the latter being designated by the Scientific Deputy of TG 132.1.

For Mike Shot recovery the responsibility for scheduling of required intra-atoll transportation was delegated to TU 7. Such an arrangement was seen to be faulty after the reestablishment of this Headquarters on Parry Island, however, since continuing recovery requirements and the necessity for King Shot preparation implied two separate offices (TU 7 and J-3 Section, this Headquarters) scheduling intra-atoll airlift for a single dispatcher. This situation was rectified for King Shot, and Operational Directive K-4 was used as a guide by the air and boat dispatchers.

The detailed recovery plans of the two shots were prepared by TU 7 in coordination with W. E. Ogle's office and the J-3 Section, including the appropriate priority classification of experimental projects.[4]

Generally speaking, the recovery operations were successful and were conducted as planned. The extensive contamination and destruction resulting from Mike Shot caused delays; these, however, were unavoidable, and the problem of dual scheduling was not posed by recovery itself.

3.12 POSTSHOT RE-ENTRY

3.12.1 Mike Shot

Shortly after the detonation of the Mike device the Task Force vessels moved to an area south of Eniwetok Atoll and awaited the results of the radiological surveys on which the re-entry plan was to be based. The radiological-safety surveys were accomplished by personnel of TU 7 with the support of the Navy helicopters from the USS Rendova.

At approximately H+10 min an aerial-survey helicopter took off from the USS Rendova to go directly to Parry Island. This helicopter then flew over the center of each island in the chain in the direction of the shot island at an altitude of 25 ft and at a ground speed of about 10 mph. While flying over each island, readings were taken with a T1B survey meter. It was planned to make a survey of the entire atoll, but this helicopter became contaminated while going through a rain squall, and the survey had to be completed later.

At H+40 min the TG 132.4 emergency re-entry party and radiological-safety monitors went ashore to reopen the airstrip facilities on Eniwetok Island. At H+45 min the H&N utilities crew and a radiological monitor were taken to Parry Island.

Commencing at approximately H+2 hr the TG 132.1 Scientific Deputy and a radiological-safety monitor accomplished a damage and radiological survey of the entire atoll by means of helicopter. At H+4 hr water samples were taken at the anchorage off Parry and Eniwetok Islands. Extensive ground surveys of Parry and Eniwetok Islands were accomplished early on M+1 day.

Based on the results of the radiological-safety surveys, R-hour was established at 0900 on 2 November, and unrestricted radiological-safety clearance was declared for Parry and Eniwetok Islands and all lagoon water traffic south of Japtan Island. TU 7 set up their headquarters in Building 57 on Parry Island by 1200 hours on this date.

Re-entry of the Task Force vessels into the lagoon was accomplished by approximately 0945 on 2 November, and the first personnel were ashore by approximately 1045.

The re-entry of H&N personnel was accomplished in the following order:

1. Division heads, including the doctor.
2. Personnel to float and operate the M boats.
3. Personnel necessary to restore and operate the power, water, and telephone systems.
4. Complete mess hall complement.
5. Maintenance crews as necessary.

The priority of re-entry of TG 132.1 personnel was based on the need for scientific and staff personnel to complete recovery operations and to begin the necessary preparations for King Shot. Certain TG 132.1 personnel remained afloat for a few days until adequate H&N support facilities were available. All personnel of TG 132.1 were ashore by M+4 days.

All personnel who went ashore on the morning of M+1 day were provided with lunches for the noon meal. The H&N mess hall was open for the evening meal.

On 3 November unrestricted re-entry was declared for the islands of Aniyaanii and Japtan, including lagoon traffic to these islands. Small boats were further authorized to travel in the northern half of the lagoon if they were accompanied by a monitor from TU 7. As radiological-safety conditions permitted, re-entry into other islands was permitted. Work on Runit was authorized on M+2 days.

3.12.2 King Shot

Since a complete personnel evacuation was not required for King Shot, the re-entry problem applied only to the islands north of Parry. Again, the re-entry to these islands was based on radiological-safety surveys which were accomplished in much the same manner as those following Mike Shot.

3.13 DOCUMENTARY PHOTOGRAPHY

Operation Ivy was documented on film, both still and motion picture, ground and remote, as a basis for a photographic record for historical purposes and as a motion-picture report to the JCS and AEC depicting the scope and conduct of Operation Ivy. The JCS, at the request of JTF 132, established a military requirement for the USAF Lookout Mountain Laboratory to support Operation Ivy, and Headquarters USAF approved its employment to organize and support a documentary photographic unit (TU 9) as part of TG 132.1.

Complete documentary motion pictures and still coverage of Operation Ivy were required and obtained. A scientific historical documentary motion picture which summarizes the record of the operation will be produced. This film will not be limited by security classification. The film will not be required to contain material classified Top Secret Restricted Data; however, this material may be included if it is deemed necessary to portray the history of the operation. In the event the film is Top Secret, only three prints will be made. In the event the film being processed is given a final security classification of Top Secret, this print will be reedited to produce a film with a lower security classification so that it may be shown to larger audiences. To produce this version, various Top Secret sequences will be removed which will make the classification no higher than Secret. Seven copies of the reedited version will be made.

Complete still coverage was also obtained, including photographs that can be used for historical purposes by the various Task Units and Task Groups. All film exposed on Operation Ivy, both still and motion picture, will be catalogued and indexed. The cataloguing of the motion-picture film will be accomplished utilizing the microfilm process, with one copy of the final catalogue distributed to AEC, Los Alamos, and one copy to AFSWP Headquarters, Washington. AFSWP is to be the coordinating authority for additional prints required by DOD agencies of anv stock footage shown in the catalogue.

No restrictions have been imposed on the length of the documentary film; however, approximately 45 min running time is desirable. The film is to document Operation Ivy, the problems encountered, and the solutions to these problems.

One of the first steps in the production of such a motion picture was to prepare a first-draft motion-picture script. This was accomplished by TU 9, and this draft script was submitted for approval to CJTF 132. In the Forward Area, TU 9 completed the photographic program in accordance with these approved plans.

Owing to the nature of Operation Ivy, it was necessary that each ground photographic crew be completely mobile and all necessary camera and allied equipment be made a part of that crew. A total of four ground crews, which included one synchronous sound crew, were utilized at Eniwetok Atoll and Kwajalein Atoll for Operation Ivy.

Three C-54 aircraft were obtained on loan from MATS. The modifications for these aircraft were fabricated at Wright-Patterson Air Force Base and Lookout Mountain Laboratory, and most of the modification work was performed at Hickam Air Force Base. All three C-54 aircraft participated in three practice missions prior to Mike Day, and all three aircraft were flown on the actual mission. Two practice missions were flown prior to King Day, and all three aircraft were flown on King Day.

Remote camera installations utilized on Operation Ivy were designed and constructed by Lookout Mountain Laboratory and were located at the following stations during the operational phase:

1. Station 390.01 (Engebi): One 16-mm camera was pointed at the north and west sides of the multistory building on Engebi. This camera was triggered by photocell and was loaded with a special panchromatic film, emulsion type 918. The camera operated successfully on both Mike and King Shots.

2. Station 390.02 (Engebi): One 16-mm camera was pointed at the south and west sides of the multistory building on Engebi. This camera was triggered by photocell and was loaded with a special panchromatic film, emulsion type 918. The camera operated successfully on Mike Shot, but on King Shot it was turned to cover the blast and did not operate.

3. Station 390.03 (Runit): One 16-mm camera was pointed at the dock on Runit and also covered the burst. This camera was triggered by photocell and was loaded with a special panchromatic film, emulsion type 918. The camera operated successfully on Mike Shot, but this camera station was removed for King Shot.

4. Station 390.04 (Japtan): One 16-mm camera pointed at the burst, shooting through the trees on Japtan. This camera was triggered by photocell and was loaded with Eastman color negative. The camera failed to operate on both Mike and King Shots.

5. Station 390.05 (Eniwetok): One type K-25 aircraft camera was pointed at the burst from the north tip of Eniwetok. This camera was triggered by photocell and was loaded with Ektachrome film. The camera failed to operate on Mike Shot, and this installation was removed for King Shot.

6. Station 390.06 (Eniwetok): One 16-mm camera was pointed at the beach club and at the burst. It was triggered by photocell and was loaded with Eastman color negative. This camera did not operate on Mike Shot and was removed for King Shot.

As of 25 November 1952, the following amounts of film, both still and motion picture, had been exposed during Operation Ivy:

Type	Amount
16-mm KCO	61,600 ft
35-mm B/W motion picture	18,000 ft
35-mm EK motion picture	1,000 ft
4 × 5 B/W still	2,244 each
35-mm Bolsey	36 each
K20–K24 5½ × 5½	1,500 each
K20–K24 EK 5½ × 5½	400 each
4 × 5 EK still	130 each
K-17 9½ × 9½ EK	360 each
K-17 9½ × 9½ B/W	500 each

3.14 RADIOLOGICAL SAFETY

3.14.1 Early History

In order to provide for the radiological safety of the Task Force, a radiological-safety unit was activated as TU 7 of TG 132.1 on 22 January 1952. CDR Russell H. Maynard, USN, in addition to his duties as Chief of the Technical Operations Branch, J-3 Section, JTF 132, was designated as the commander of this unit. During the early growth of this unit Maj John D. Servis, USA, was designated as Deputy Commander and Operations Officer of TU 7. Since Commander Maynard remained at Washington, D. C., with the Task Force Headquarters during the period prior to the overseas movement, Major Servis served as his representative at LASL. Owing to the large number of LASL employees operating with TG 132.1, the services of the necessary medical technical consultants to TU 7 were obtained from LASL. These consultants were Dr. Thomas L. Shipman, Director of H-Division, LASL, and Maj Payne Harris, MC, USA, also of H-Division.

During the growth of the organization, contacts had to be made to secure the necessary personnel for carrying out the mission of this unit. For a short-period operation such as this, personnel support was requested from the Armed Forces and specific civilian installations. Of the five civilian personnel operating with TU 7, three were obtained from the staff of LASL, one from the Evans Signal Laboratory (ESL), and one from ORNL. The following personnel were requested of the various branches of the Armed Forces for their operational support:

Radiological monitors (officers)	20
Radiological monitors (enlisted)	4
Laboratory director (officer)	1
Laboratory technicians (enlisted)	4
Photographic assistants, photodosimetry	4
Electronics officer	1
Radiological instrument repairmen	3
Clerks	6

The Armed Forces furnished all the requested personnel with the exception of the instrument repairmen. When the names of individuals selected were known with certainty, those who were to hold key positions in TU 7 met with Commander Maynard in Washington for a preliminary briefing before departing for the Forward Area.

3.14.2 Orientation and Training of Task Unit 7 Personnel

An indoctrination course was conducted by key personnel of the Task Group and TU 7 in the Forward Area from 17 to 22 October 1952 in order to present a comprehensive picture of the operation to members of this unit. The material discussed during these seminars included the following subjects:

1. Concept of Operation Ivy.
2. Radiological-safety operations and responsibilities.
3. Radiological instrumentation.
4. Photodosimetry, dosimetry, and records.
5. Weather relations.
6. Scientific programs.
7. Weapons effects.
8. Mike and King descriptive material.

Since TU 7 was responsible for the radiological safety of the Task Force during Operation Ivy and since there existed the possibility that the regularly assigned monitors might receive their prescribed dosage limit before the completion of the operation, the availability of the services of a pool of reserve monitors was evidently necessary. The personnel for this pool were made available from JTF 132 and its various Task Groups. Those reserve monitors who did not possess credit for the Armed Forces six-weeks course on radiological safety attended a series of conferences and practical exercises conducted from 7 to 11 October 1952. The course consisted of the following subject matter: introduction to atomic weapons, instrumentation, calibration procedures, monitoring procedures, protective clothing and practical decontamination, and monitoring responsibilities and special instructions applicable to Operation Ivy.

3.14.3 Organization and Activities of Task Unit 7

TU 7 was organized into the following groups:

1. Control Group (including special missions such as Ujelang evacuation, Kwajalein liaison and control, and Horizon radiological safety).
2. Laboratory Group (Radiochemical Laboratory, Electronics, Photodosimetry, and Dosimetry Sections).
3. Decontamination Group.
4. Information Center.
5. Administration and Supply Group.
6. Special Projects Group.

The activities of these groups and their various sections are discussed below.

3.14.3.1 Control Group

Upon organization of this group and designation of the various duties of its personnel, immediate contact was made with the interested agencies of the various projects to determine the necessary radiological-safety support required for the various recovery activities. Complete plans were drawn up for the post-Mike re-entry and the post-Mike and post-King recovery programs. Several drills were held to test the adequacy of communications, time elements, transportation facilities, etc. The group operated from the USS Rendova in the post-Mike period until re-entry was accomplished. After re-entry and during the post-King operational phase, they operated from the Radiological Safety Center on Parry Island. Before any survey, recovery, or work-party trip was initiated, checks were constantly maintained to assure adequate radiological safety. Personnel operating in contaminated areas were advised of their accumulated gamma dosage and were further advised as to operating times which would permit them to accomplish their mission and still not exceed the permissible dosage limit. Other protective measures included the issuance of protective clothing, various dosimeters, etc. Communication facilities consisted of SCR 508 radio nets, SCR 300 radio nets, AM/TRC radio nets,

and telephonic nets when available. During each recovery or work phase, the monitor constantly kept track of the accumulating dosage with pocket dosimeters and through calculations, using the readings obtained on the AN/PDR-T1B. Some of the results of aerial and ground surveys are shown in Table 3.1. The ground values given in the table are indicated by daggers, and, unless otherwise stated, the aerial values are from an altitude of 25 ft.

Table 3.1—RADIATION LEVELS, FROM AERIAL AND GROUND SURVEYS, IN MILLIROENTGENS PER HOUR

	Runit	Biijiri	Engebi	Teiteir	Ruchi	Bogallua
M-day	5–5,000 at 1,200 ft (Max)†	None recorded; 8,000 over Piiraai	50,000 at 500 ft	None recorded; 10,000 at 500 ft over Bogon	None recorded	7,000 at 1,500 ft
M+3	40–120†	2,000†	3,300 8,000†	18,000 10,000 on lagoon reef	9,000 26,000 on lagoon reef off Cochiti	10,000
M+8	12–16	400†	1,400 2,500†	3,400 8,000†	1,300 2,500†	1,300 2,800†
M+14	0–40†	130 270†	600 1,400†	1,900	800	850
K-day	0–3,800 (3,800 over north end; 3–5 south of airstrip)†	120 200†	480	2,400	400	750
K+1	1.0 1.0† South 10 Center 100	70 150†	430 900†	1,600	420	440

(a) Ujelang Evacuation. This evacuation was accomplished utilizing the LST 827, commencing on 27 October 1952, and re-entry was accomplished on 2 November 1952. TU 7 loaned personnel to CINCPAC to ensure that all necessary radiological-safety precautions were taken. The evacuation was carried out in a successful manner, and no radiological hazards were encountered.

(b) Horizon Radiological Safety. Radex had shown the possibility of the Horizon being subjected to some fall-out. The data which this vessel was to collect were essential, and the vessel had to be "on station." The radiological-safety-responsible agency was TG 132.3. The interest of TU 7 in the operation lay in the furnishing of radiological-safety personnel and equipment to accomplish the radiological-safety activities. This craft, which had been 72 miles north northeast of zero, reported contact with the fall-out area. Within 20 min after the

fall-out commenced, average readings indicated 15 mr/hr with localized maximums of 35 mr/hr. Washdown procedures and other necessary radiological-safety measures reduced the hazard to the point where it was no longer a health hazard aboard the craft. The Horizon was considered as "marking" the edge of the fall-out pattern in its direction.

(c) Kwajalein Liaison and Control. The officer performing this function acted as the radiological-safety officer of TU 7 for TG 132.1 personnel at Kwajalein Atoll. In addition, monitoring was accomplished for Project 1.3. Further monitoring activities included checking of snap sample removal from F-84 aircraft for Project 5.4b and monitoring of sample removals for Project 7.3. This mission also supervised and controlled the use of dosimetry devices for the F-84 pilots. Instructions were passed to the monitors accompanying samples on courier planes to the ZI. Assistance was rendered to the AEC (New York Operations) in conducting its World-wide Fall-out Program. Water samples were obtained from Bikini, Ponape, Kusaie, Majuro, and Kwajalein.

3.14.3.2 Laboratory Group

(a) Electronics Section. Maintenance was satisfactorily executed, and at no time did the demand for instrumentation exceed the available supply. Component spare parts were obtained by cannibalization of excess instruments. Sufficient quantities of instruments were available, and the decision to cannibalize was made in order to facilitate repair and maintenance without excess-storage problems of the delicate component parts.

(b) Radiochemical Section. This section remained afloat aboard the USS Rendova during the entire operation. A Signal Corps Radiochemical Laboratory trailer was the base of operations and was located on the port side of the hangar deck. They received, prepared, and assayed all samples delivered. Desired data were reported to all interested personnel. Data obtained included discriminated activities and some beta and gamma energy determinations. The majority of the samples assayed were the water samples from various locations in the lagoon. In general, the primary assays desired were the decay rates and specific activities per measure of sample submitted. Standard methods and procedures were used in the subsequent analysis of samples furnished.

(c) Photodosimetry and Records Section. This section operated until M+2 days aboard the USS Rendova, using a photodosimetry laboratory trailer located adjacent to the Field Laboratory. Upon re-entry the section moved ashore and resumed its operations at the Radiological Safety Center, Parry Island. Films were stored, handled, and issued in such a manner as to minimize any undesirable effects, such as humidity, loss of control, etc. Films and the self-reading pocket dosimeters were calibrated, using standard radium-source procedures. Calibration curves were obtained for the film, and the pocket dosimeters were marked with an appropriate correction factor. Film readings were the standard of record, whereas dosimeters were used primarily to indicate a "running" exposure record by the monitor or user. Records were maintained to effect as complete a history as possible of the various exposures. Upon completion of the operation, a master list of all exposures was prepared. The final repository for film records will be the AEC Division of Biology and Medicine. The final repository for all films will be AFSWP. Reports of exposures will be forwarded to the home station of each civilian who was film-badged. Exposure records of military personnel will be forwarded to the proper Surgeon General.

3.14.3.3 Decontamination Group

During the operational phases afloat, it was the responsibility of the Commanding Officer of the USS Rendova to decontaminate any contaminated aircraft and/or personnel boarding his ship. The USS Rendova was a part of TG 132.3, and, during the operational phases afloat, all flights made prior to re-entry originated and terminated at the USS Rendova, making decontamination procedures a TG 132.3 responsibility. Upon re-entry, TU 7 commenced operations at the Radiological Safety Center on Parry Island. Check control points were maintained at the

airstrip and at the personnel pier on Parry Island. Aircraft decontamination was accomplished by the preventative measure of lining interior surfaces with paper that was subsequently removed and by the use of commercial-type vacuum cleaners. Decontamination of vehicular and other equipment was accomplished in a designated area north of the personnel pier. Methods included lining with paper that was subsequently removed, high-pressure fresh-water hosing and scrubbing with soap on local "hot spots," and subsequent removal to the storage area north of the Radiological Safety Building if results showed that contamination was still above the permissible limits. Working personnel were equipped with the necessary protective clothing. The source of high-pressure water jets was truck-mounted M3A2 300-gal power-driven decontaminating apparatus with a standby electrically operated centrifugal suction-discharge pump. Personnel decontamination was accomplished using the change-room facilities in the south end of the Radiological Safety Building. Personnel who were not completely decontaminated returned to the showers. Localized hot spots which were found were removed by using hand brushes and soap. Various chemical and complexing-agent solutions were available to facilitate personnel decontamination, but their use was not necessary. Contaminated clothing was allowed to lose its activity by decay and was then cleansed by laundry or brushing procedures as applicable. Before each mission, personnel in the party were briefed in the procedures they were expected to follow. No personnel of TG 132.1 were found to be seriously contaminated.

3.14.3.4 Administration and Supply Group

This group operated both afloat and ashore upon re-entry. Its functions were standard with the exception of the handling of devices peculiar to radiological-safety operations, i.e., instrument issue, etc. The supply group supervised the issuance of protective clothing and equipment, instruments, etc. The administrative portion of this group handled all the correspondence and necessary administrative details resulting from the operational activities of TU 7.

3.14.3.5 Information Center

This group operated both afloat and ashore and correlated, as required, all information obtained by the other groups into an over-all picture of the radiological security of the operation. Daily situation maps were maintained, showing various radiation levels at all available sites. Records of sample assays were kept and utilized as required.

3.14.3.6 Special Projects

One man was available on call for special monitoring in connection with the special radioactivity problems of the Mike device.

3.14.4 General Comments

Throughout the operational activities, assignments were rotated as much as possible in order to provide experience for personnel in all phases of the operation. Over-all efficiency seemed to be excellent. Supplies, equipment, and personnel were adequate to accomplish the assigned mission.

3.15 CLASSIFICATION ACTIVITIES

The mission of the Classification Officer of TG 132.1 included the making of classification decisions as required during construction, test planning, test operations, roll-up, and test reporting. The Classification Officer advised the Commander, TG 132.1, on problems involving security of information. This office advised the J-2 Section on classification of areas and activities so that appropriate safeguards could be provided. Apparent security breaches were reviewed by the Classification Section in an advisory capacity to the JTF 132 J-2 Section, AEC

Security, and the FBI. The Classification Officer served with representatives of other Task Groups as a classification board on those classification matters not solely within the purview of TG 132.1.

The Classification Officer, using the experience gained in Operation Greenhouse and other continental and overseas tests, early in the program prepared an interim Classification Guide for approval by the AEC and issuance by the Task Force. As the nature of the tests became more specific, it was possible to make a more detailed Classification Guide. This was done and submitted to the Task Force for approval by the AEC and other authorities. Any guide is, of course, reliable as of the time of issuance but is subject to change with the occurrence of events. Furthermore, in making a guide it is impossible to anticipate every situation which may arise. Consequently, the Classification Officer and staff maintained contact with the operating technical organizations, the AEC Washington headquarters, and the J-2 Section of the Joint Task Force so that decisions could be made to meet the situations as they developed prior to the overseas phase of the operation. The Classification Office moved to the Forward Area with the Task Force but left a rear-echelon group at Los Alamos. The Classification Office has a continuing load of photographic review and technical-report review for assignment of classification grading.

Only one anomalous situation occurred during the over-all operation. It is generally agreed that the size, weight, and shape of a nuclear device are Restricted Data, but, in the case of the Mike device, it was not feasible to produce and transport the case on a Restricted Data basis within the time limit set, if ever. Furthermore, the Mike case was determined by the scientific authorities not to reveal information on the nature and operation of the Mike device. Consequently, it was arranged that the components of the Mike case, when not identified as nuclear-device components, could be treated as Confidential Security Information, and the Classification Guide reflected this ruling that the size, weight, and shape of the Mike device would be Confidential Security Information. However, whenever the Mike device was illustrated or photographed as a nuclear device, it was graded as Restricted Data. Later, on a directive from Washington, the Mike device was graded Restricted, not Security Information, in order to avoid the ridiculous situation which results from possible interpretation of the wording of the Atomic Energy Act of 1946, in defining Restricted Data. The Classification Office at no time relied on this grading authority but considered all photographs of the assembly to be at least Confidential Restricted Data. After the completion of the operation, at the direction of the AEC, Washington, the grading of the size, weight, and shape of the Mike device was raised to Confidential Restricted Data, which conforms to the actual gradings applied to photographs of the assembly. However, component parts of the case, when not identified as nuclear-device components, are merely treated as accountable property and are given such protection. The component parts are, of course, kept in containers or otherwise separated so that the shape of a complete case is not apparent.

The Classification Office maintained a uniform policy that no information relating to the operation would be considered totally unclassified unless it was approved for release by the AEC and DOD authorities. Sometimes this rigid rule worked some unpleasant delays in routine administration, but no alternative seemed apparent in view of the extreme concern expressed by the Washington authorities about any public statement relative to the operation. The Classification Officer can only comment parenthetically that some of the items treated as classified could not reasonably be considered classified when viewed from the field of operations. Furthermore, it was necessary to use open radio circuits giving information which was considered highly classified in the Washington headquarters. In addition, the unique procedures employed for the Mike Shot clearly revealed yields of extraordinary magnitude to thousands of personnel cleared for only low-order military information. These are matters of security, not of classification, but they are pertinent to the application of security gradings in an unrealistic manner because of the necessity to enforce directives by individuals not personally acquainted with the situation as it actually occurs.

3.16 SECURITY

When JTF 132 was activated in August 1951, the Security Section of the Scientific Task Group continued in the same capacity as in Operation Greenhouse as the AEC-NME Test Security Branch, SFOO. In November 1951 the Eniwetok Field Office was established by SFOO and was assigned the responsibility for AEC security at the Pacific Proving Grounds. In January 1952 the AEC-NME Test Security Branch, SFOO was converted into the Security Branch, Eniwetok Field Office. The branch was established when the Chief and one security assistant of the AEC-NME Test Security Branch were transferred to the Eniwetok Field Office Security Branch. In February 1952 two other assistants were assigned to the Eniwetok Field Office, and a military deputy, J-2 Section, was assigned to TG 132.1, Los Alamos.

The security program associated with the construction phase of Operation Ivy at the Pacific Proving Grounds was under the direction of the Security Branch, Eniwetok Field Office. In this connection it was necessary from December 1951 to November 1952 to secure 1482 Q clearances for employees of H&N. The Los Angeles AEC Security Branch was responsible for the actual processing and granting of the Q clearances for H&N personnel. It was also necessary for the Manager, SFOO, to grant five Q clearances to personnel of H&N in critical job categories.

For the information of JTF 132 and for the operations of TG 132.1, it was necessary to maintain a clearance roster of all personnel of the Scientific Task Group (approximately 2500, including H&N) who participated in Operation Ivy.

It was necessary in June 1952 to establish visitor security controls as required by AEC security regulations for visits to the Pacific Proving Grounds. This procedure enabled the Resident Engineer to become cognizant of anticipated visits and any requirements of the visitors for contractor services.

A security indoctrination letter was prepared and issued by the Commander, TG 132.1 to all personnel of the Task Group in August 1952 to comply with JTF Security Letter No. 6. This letter outlined the security responsibilities of all TG 132.1 personnel assigned to Operation Ivy. Security lectures were given to all TG 132.1 personnel by members of the J-2 Section upon their arrival at the Pacific Proving Grounds. The lecture included a brief description of the Ivy Identification System; the reporting of any suspicion of sabotage, espionage, and seditious and subversive activities; censorship; and a brief security indoctrination on local security regulations. In accordance with a JTF 132 directive, all personnel leaving the Pacific Proving Grounds after 12 November 1952 were required to sign a certificate stating that they would not disclose information to unauthorized persons.

The Security Section established AEC facilities for the transmission of Top Secret messages between the Pacific Proving Grounds, the Los Alamos Field Office, and Washington. This was accomplished through the cooperation of SFOO communications. It was necessary to establish document channels for the dissemination of Restricted Data to DOD and DOD contractor participants through cleared DOD channels to the various facilities concerned. Nine military cryptographic clearances were obtained for personnel of the Los Alamos Field Office and SFOO to facilitate the handling of JTF 132 teletype traffic at Los Alamos and Eniwetok for AEC and AEC contractor purposes.

To expedite the mail channels to the Pacific Proving Grounds from Albuquerque, a mail-pouch system from Honolulu to Eniwetok was established for transmittal of material up to and including Secret Non-Restricted Data with the approval of AEC, Washington. This service was extended to TG 132.1 in August 1952.

It was necessary to notify the State Department of the departure and arrival of U. S. citizens from and to the ZI because DOD AGO cards were utilized by JTF 132 in lieu of passports.

The designations of classified areas, the identification system, and guarding requirements were established through coordination of the Security Section, J-2 Section, JTF 132, and the scientific operating personnel of TG 132.1 during the period from August 1951 to July 1952.

The procurement of the necessary laboratory equipment, supplies, and personnel to activate the identification system was accomplished by 1 September 1952.

By delegation of authority from CJTF 132, access to the classified areas at Eniwetok Atoll (except on Eniwetok Island) during Operation Ivy was controlled by the J-2 Section, TG 132.1. Liaison was established with TG 132.2; Provost Marshal, TG 132.3; Marine Guard Detachment; and TG 132.4 Air Police Commander in order to carry out this authority. During Operation Ivy over 7000 badges were issued, including exclusion-area exchange badges and necessary badge replacements due to changes in the access requirements of personnel and to lost and damaged badges. Over 10,000 permits were issued, which included temporary Parry Island permits, temporary badge permits, and temporary exclusion-area permits.

Two additional security assistants were detailed to the J-2 Section from the Los Alamos Field Office, AEC, and were utilized to provide security coverage to critical areas, both afloat and ashore at Eniwetok Atoll. As part of Operation Ivy it was necessary to provide protection to weapon components being transported from SFOO facilities to the point of embarkation from the ZI and on the return trip. Because the Security Section was designated as a Source and Fissionable Materials accountability station, accountable for all such materials used in Operation Ivy, it was necessary to prepare the required inventories, expenditure reports, and shipping documents for the materials utilized.

3.17 COMMUNICATIONS

3.17.1 Mission

The missions of the TG 132.1 Communications Section included the following:

1. Preparation of communications and electronic plans for TG 132.1 and coordination of the communications requirements of the scientific programs with Headquarters, JTF 132 and the AEC.
2. Installation, operation, and maintenance of the telephone system on all islands other than Eniwetok.
3. Provide and maintain point-to-point wire circuits in the intra-island and buoy submarine cable system to meet timing and telemetering requirements of the scientific programs and provide loaded and nonloaded circuits in these cables as required by Headquarters, JTF 132 to meet operational and administrative communications requirements, including telephone-trunking, teletype, and transmitter-keying lines.
4. Operation and maintenance of the ZI terminal of the Eniwetok–Los Alamos Ratt circuit.
5. Installation, operation, and maintenance, with the assistance of TG 132.2, of tactical radio equipment required for use by scientific contractors.
6. Instructions of TG 132.1 personnel in the proper use of communications facilities available.

3.17.2 Organization

The TG 132.1 Communications Officer, attached to the Plans and Operations Section of the Task Group, was assigned responsibility for the above-mentioned missions. Items 2, 3, and 4 are, in the main, covered by the Manager, Eniwetok Field Office, SFOO, as part of the normal Proving Grounds operation and maintenance. Additional facilities required to be furnished by the AEC, through H&N, were coordinated by a communications officer attached to the AEC, SFOO, and to TU 11 of TG 132.1. H&N provided a radio-repair section consisting of a supervisor and three radio technicians and a telephone-operator section consisting of a supervisor and seven men. One cryptographic security officer and one enlisted assistant, attached to TG 132.1, were employed at the AEC Communications Facility, Los Alamos, to handle messages encrypted in military cryptographic channels. The AEC Communications Facility, Los Ala-

mos, was assigned the mission of operating the Los Alamos terminal of the Eniwetok–Los Alamos Ratt circuit and providing communication support to TG 132.1 Headquarters, Los Alamos.

3.17.3 Preliminary Planning

Initial operational planning was hampered by the absence of a TG 132.1 Communications Officer, who reported for duty on 2 June 1952. Lieutenant Colonel King, J-5 Section, Headquarters, JTF 132, assisted in preparation of the Communications Status Report, 8 May 1952. Requirements were received through monthly status reports, communications letters, and by personal contact. In many instances prospective users had to be contacted to amplify or clarify requirements, since many were unfamiliar with facilities available and communications in general. Each requirement was usually handled separately and submitted to the appropriate agency for implementation as soon as the necessary information became available. This resulted in earlier implementation and a more even workload on the personnel concerned.

Communications requirements were consolidated into status reports dated 8 May, 16 July, and 18 August. The last report was in the form of a tentative TG 132.1 Communications Plan. This report was revised and issued as Annex G to TG 132.1 Operations Plan 1-52. Operation Ivy communications requirements were submitted to either CJTF 132 or AEC, SFOO, for implementation and to CJTF 132 for approval. In all instances CJTF 132 furnished the required support through directives and requests to subordinate Task Groups and other agencies. Liaison prior to establishment of the overseas Headquarters was maintained by several visits of J-5 Section, Headquarters, JTF 132, personnel to Los Alamos and by one visit of the TG 132.1 Communications Officer to Headquarters, JTF 132.

The planning stage was essentially complete on 21 August 1952, at which time the TG 132.1 Communications Officer proceeded to Eniwetok.

3.17.4 On-site Operations and Rehearsals

Prior to arrival of TG 132.1 Headquarters at Parry Island, about 15 September, a TG 132.1 telephone directory was published; office and laboratory telephone and intercom systems were installed; the boat-pool, airstrip, and other immediately required radios were installed; and a schedule of installation, based on probable usage dates, was furnished H&N.

The installation and issue of equipment required to furnish facilities shown in the TG 132.1 Communications Plan proceeded on schedule and met the users' requirements. The H&N property clerk signed for all communications equipment drawn from TG 132.2 stock and reissued it to the appropriate H&N shop supervisor, who in turn issued it on subcustody to users. During the overseas operational period, weekly communications conferences with JTF 132 communications officers were held from about 20 September until 10 October, after which several communications rehearsals prior to Mike Shot were conducted. The success of TG 132.1 communications was totally dependent on support and liaison with other agencies. The Section J-5 JTF 132 staff rendered every assistance practicable to this Headquarters in the performance of its communications mission.

3.17.5 Control Station Communications

3.17.5.1 Mike Shot

The Control Station for Mike Shot was located in the Firing Room and the Gunnery and Landing Force Office, USS Estes. Edgerton, Germeshausen & Grier, Inc., (EG&G) provided two television receivers, operating in the frequency band 1990 to 2110 Mc, and several presentations which showed the timing-signal and Go-No-Go indicators and the monitor dials for important systems of the device. A control panel was located between the two presentation channels in the Firing Room. This panel controlled, by the use of three 250-watt Motorola

radio links, the timing signals, the start of the sequence timer, and the emergency stop. Voice time was broadcast from the Firing Room on 126.18 Mc from the clock located on the control panel. One 30-watt Motorola set provided communications with the cab on the shot island during rehearsals and alignment.

The Gunnery and Landing Force Office was the Command Post for CTG 132.1 afloat. Other elements of the Task Group were in voice contact with this Post via an SCR 508 radio net. This space was also equipped with monitoring facilities, and one receiver located therein was used by EG&G to monitor WWVH. One 10-watt Motorola set was installed and used to maintain contact with the Firing Party during the check-out period ashore. During this period the Firing Room was locked.

3.17.5.2 King Shot

The Control Station for King Shot was located in Building 311, Parry Island. The Control Station was subdivided into four small rooms: Timing Room, Control Room, Workshop, and Dehumidification Room.

The Timing Room contained the EG&G installed timer which was activated by the absence of tone release signals occurring when the device was released from the drop aircraft. This timer furnished times in relation to the detonation to the ground scientific stations from −30 sec to the time of detonation.

The following communications facilities were in the Timing Room:

1. A 10-watt Motorola radio on a net with the Combat Information Center (CIC) aboard the USS Estes and the Control Room at Parry Island.
2. A VHF remote control and backup on a net with the drop aircraft and CIC on the Estes.
3. Two headset phone circuits to the Control Room.

The Control Room was operated as the Command Post for CJTF 132, assisted by the Scientific Deputy. The following communications facilities were provided:

1. A VHF remote control and backup on a net with the drop aircraft and CIC on the Estes.
2. A 10-watt Motorola radio on a net with CIC on the Estes and the Timing Station.
3. Two headset phone circuits to the Timing Station.
4. A control for the Parry Island siren on which warning signals were sounded at −30 min, −5 min, and −1 min.
5. A voice intercom system with the TG 132.1 Scientific Director and CJTF 132 Headquarters.
6. Hot-line telephone circuits to CIC on the Estes and CJTF 132 Headquarters.

The Workshop contained a VHF remote unit on a net with the WB weather plane. The JTF 132 Weather Officer used this circuit to obtain weather information in the operating area in order to advise CJTF 132 on weather conditions.

The Dehumidification Room contained two BC 522A VHF radio transceivers to furnish VHF service on Baker and Charlie channels to remote units located in Building 311.

3.18 DISPOSITION OF FORCES (ROLL-UP)

3.18.1 General

The Forward Area roll-up or redeployment of TG 132.1 proceeded as a normal phasing-out function, with units and individuals being reassigned and equipment disposed of as tasks were completed. The redeployment of TG 132.1 began prior to Mike Shot with the permanent evacuation of certain material no longer required in the Forward Area. This included items such as the special Camco transport Dewars and their specialized equipment. Certain personnel whose work in the Forward Area was completed before Mike Day were redeployed either to Hawaii on a standby basis or to their respective stations in the ZI.

3.18.2 Phase-out of Personnel

Phase-out planning for units as well as individuals was dependent on several variables, such as recovery programs, roll-up requirements, and the availability of transportation. Actual planning of the disposition of the Task Group forces was a week-by-week and day-by-day process. As individuals became available for departure, arrangements were made for their transportation to the ZI.

All processing of departing personnel was handled by the Headquarters Commandant, TG 132.1. This included (1) endorsing of the individual's orders, (2) obtaining an air priority from the Transportation Section of TG 132.2, (3) completion of the MATS information card, and (4) obtaining MATS reservations for the departee to Hickam Air Force Base.

The majority of the personnel of the Task Group were transported via MATS to Hickam Air Force Base. The remainder of the individuals traveled by MSTS or Navy ship. Most non-government employees and a small number of government employees traveled via commercial air transportation from Honolulu to the ZI. The majority of the government employees and all military personnel traveled from Hickam Air Force Base to Travis Air Force Base via MATS, and thence to their home station via MATS or commercial air transportation.

The decrease in population is shown graphically in Fig. 3.3. As of 24 November 1952 all but approximately 50 of our personnel had been returned to the ZI.

3.18.3 Property Roll-up

The roll-up of equipment began prior to Mike Shot. When equipment was no longer needed, it was prepared for shipment and loaded aboard cargo ships and planes bound for the ZI.

All personnel were requested early in September by the J-4 Section to retain all crates, packages, and boxes in which items were shipped to the Forward Area in order that they might be utilized for shipments being returned to the United States. In order to assist project personnel in carrying out this plan, a "users' reusable-container yard" was set up on Parry. Care was taken in the storing of containers so that maximum protection was afforded to the salvageable packing materials for use in the roll-up operation.

Early in September the attention of all Task Group property representatives was called to the necessity of a continuing review of their property requirements in the overseas area. Property in excess of anticipated requirements was to be shipped to the United States without delay, thus cutting down the future workload at the time of roll-up operations.

In establishing a guide as to the amount of supplies to be retained in the Forward Area, the J-4 Section determined that all material which would likely be used within an 18- to 24-month period and which could be stored easily without deterioration would be retained. This policy is reasonable when the cost of packing and returning supplies to the ZI is considered. As an example of such long-term storage, the large-diameter coaxial cable may be cited. This cable can be utilized in future test programs, and there is no need to return this item to the ZI. As this cable became excess to the needs of Operation Ivy, it was prepared for storage by shielding it from the direct sunlight by means of canvas and tarpaulins.

The roll-up of highly critical items such as the Camco Dewar units required that they be returned to the United States. Several of these Dewars were evacuated permanently to the ZI just prior to the Mike Shot detonation aboard the USNS Pendleton. The remaining Dewars were shipped aboard the USNS Leo after King Shot. These units were returned to Camco in Boulder, where they are being prepared for storage in a manner that will protect government equipment and will allow later use of the units with only reasonable effort. It is presently planned that these units will be modified somewhat and will be stored at Boulder until required for future use.

Another important phase of the roll-up was the disposal of the extensive Naval Research Laboratory—Krause (NRLK) equipment in the Forward Area. Since most of the work performed by Ernst Krause will be accomplished in future tests by a group at Los Alamos, under the direction of Bob Watt, most of this equipment was turned over to the J-4 Section while in

the Forward Area and thence to the ultimate user. This section was responsible for the proper receipt and shipment of this equipment to the ZI. The equipment, consisting of approximately 20 large trailers, cable laying and test equipment, traveling-wave scopes, 1056 scopes, 5XP scopes and amplifiers, scope cameras, and scope test equipment, was returned in part to Los Alamos and the remainder to the Nevada Proving Grounds. That equipment required by Krause for the reduction of data was returned to the NRL, Washington. Upon completion of this work the equipment will be sent to LASL.

The roll-up of the Herrick L. Johnston production facilities was dependent on the amount of damage sustained as a result of the shots. After postshot inspection of these facilities it was determined that H&N would install dehumidification equipment in these buildings preparatory to preparing them for long-range protection in their present positions. Installation of this equipment was completed after King Shot. Further details of protection for this equipment were to be determined after an inspection by Herrick L. Johnston.

Immediately after King Shot certain specialized camera equipment was prepared for air shipment to the ZI since its use in Upshot-Knothole in Nevada was urgent. As soon as high-priority personnel were transported from the Forward Area, this movement of critical cargo by air began. The same problem of priority return of large trailers by surface transportation existed. This equipment consisted mainly of priority deck cargo. CTG 132.1 specifically requested priority shipment of this equipment in order to avoid a delay in the commencement of Operation Upshot-Knothole, as well as of rear-area work in connection with Operation Castle.

The water transportation of large trailers and equipment was primarily accomplished on four ships. These included the Pendleton, which left the Eniwetok Area prior to Mike Shot, the Leo, the Crain, and the Merrill. The Leo left Eniwetok on 8 November to pick up cargo at Kwajalein. It then returned to Eniwetok on 16 November and departed with a full load of TG 132.1 cargo on 22 November. The Crain and the Merrill were to leave the atoll in early December. It was expected that the roll-up of TG 132.1 equipment would be essentially completed by 7 December 1952.

3.18.4 Headquarters Roll-up

3.18.4.1 Joint Task Force 132

On 20 November CJTF 132 relinquished authority as the AEC representative in the Eniwetok Area by reason of his departure. The Army Task Group Commander, CTG 132.2 (AtCom Eniwetok) assumed military command of the atoll for security purposes under CINCPAC Command residual responsibilities of CJTF 132 in the Forward Area.

3.18.4.2 Headquarters Roll-up

Effective at 0800 on 20 November 1952, the Forward Echelon Headquarters of TG 132.1 closed. After this date all incoming messages were processed and delivered by the Office of the AEC Resident Engineer. Outgoing messages and correspondence were processed by the TG 132.1 Adjutant until 24 November, when this function also became the responsibility of the AEC Resident Engineer.

3.19 CONCLUSIONS AND RECOMMENDATIONS

3.19.1 J-1 Section, Personnel and Administration

1. Military personnel having no Q clearance who arrived at Los Alamos for duty with TG 132.1 imposed several problems on both LASL and the individuals concerned. At one time there were 23 military personnel at Los Alamos who could not be fully utilized owing to the lack of Q clearances. It is recommended that military personnel to be assigned to a future task group organization be nominated sufficiently in advance so that Q clearances can be obtained prior to the date of reporting for duty at Los Alamos or elsewhere.

2. For future operations it is recommended that the airlift for phasing personnel out of the Forward Area be committed by MATS at the earliest possible date so that roll-up can be efficiently planned and executed.

3. In an operation requiring widespread camp areas for large numbers of personnel of the Scientific Task Group, it is recommended that administrative sections be established at these locations to assist our personnel in obtaining housing, messing, and transportation. For example, it would have been advantageous to have had an officer and an enlisted man of the J-1 Section at Kwajalein to keep necessary population figures and other administrative records. At Eniwetok a J-1 Section representative should be stationed at the upper island camp to perform these functions. When a camp is established at Bikini, a J-1 representative should be assigned there.

3.19.2 J-2 Section, Security

1. It is felt that the identification system (relative to badge inserts) utilized for Operation Ivy was cumbersome owing to the variety of color combinations used. It is recommended that a simplified color system indicating general operating areas be utilized in forthcoming operations. A letter or numeral system could be used to indicate clearance status and for access to areas where entry requires a close scrutiny of the badge. Such areas where the letter or numeral system is used would be small enough not to require the guard to be able to distinguish a badge color at a distance. A letter or numeral could also be used to designate a photographer, etc. Such a system would be less confusing to guards and operating personnel. It is further recommended that the identification system be established as early as possible during the planning stage of each future operation to enable early procurement of necessary supplies and to enable the J-2 Section, TG 132.1, to indoctrinate the security sections of Headquarters, JTF 132; other Task Groups; and the guard force in its utilization and implementation. Some confusion existed among the various Task Groups owing to the inability to indoctrinate properly the various security sections and guard forces in the use of the Ivy identification system.

2. One of the more serious difficulties encountered during the operation was that of procuring information relative to the status of pending clearances for participating personnel, particularly military personnel. It now appears that the system, whereby the parent organization of an individual processed the necessary paper work up through the channels of the organization to eventually reach the Washington staff responsible for processing clearance matters for that particular organization, resulted in too frequent delays and inability to determine the status of a particular clearance prior to its being received by the AEC, Washington, for transmittal to the FBI. In future operations it is recommended that forms being processed for clearance be forwarded through the Scientific Task Group Security Officer, who would in turn forward them to AEC, Washington.

3. It is recommended that a representative of the Security Section contact all Program Directors to coordinate and indoctrinate these various units in the security requirements of forthcoming operations.

4. It is recommended that a security assistant be assigned to all Forward Area operational locations. This need was made apparent during Operation Ivy by the difficulties encountered at Kwajalein in administering the TG 132.1 security program there.

5. For future operations the departure of personnel from the Forward Area immediately following a shot should be coordinated by the J-1 Section with the J-2 Section so that necessary security agreements can be secured from such personnel prior to their departure.

3.19.3 J-3 Section, Plans and Operations

1. Recommendations concerning the sample-return flights for a future operation are based on the assumptions that

a. Headquarters, TG 132.1 will be located at Parry Island.

b. Test material requiring expeditious return to ZI installations will be recovered at

Bikini, Eniwetok, and Kwajalein Atolls.

c. Special MATS flights will be utilized for all sample-return missions, and the arrangements for these flights will be made well in advance of the operational phase.

d. Devices having yields which cannot be accurately predicted will be detonated.

Considering these assumptions, it is recommended that

a. This Headquarters, under the direction of CJTF 132, be given the responsibility for submitting the requirements for sample-return flights and, in addition, the mission of establishing times of departure, points of departure, loads to be carried, radiological-safety measures in flight, etc.

b. The above-mentioned planning be predicted on assumption d. This implies that maximal aircraft utilization may be necessarily sacrificed, since postshot radiological-safety conditions can dictate radical departures from planned recovery programs.

c. This Headquarters be given the mission of supervising the loading and dispatching of all sample-return aircraft, to include dictating itineraries (within the structure of MATS regulations) and assignment of couriers and monitors and/or high-priority (i.e., experimental program) passengers.

d. All messages designed to alert personnel as to itinerary, cargo and/or passengers carried, or special facilities required at points of landing be originated by this Headquarters. Furthermore, all such messages should contain specific information as to what is being transported where for whom.

2. The number of intra-atoll aircraft as augmented by the Navy helicopters was adequate for the operation. It is the present opinion of this Headquarters that the L-13 aircraft could be replaced by H-19 helicopters, thereby increasing operational flexibility and reducing over-all dual maintenance and spare-parts problems. It is recommended that there be sufficient type H-19 helicopters to provide a minimum of eight in an operational condition at all times.

3. TG 132.3 furnished helicopters to augment the intra-atoll aircraft. However, because this support was considered secondary to their primary mission, interpreted to be re-entry and recovery, some difficulty was encountered in obtaining the use of these aircraft throughout the preshot periods. In future operations it is recommended that, when some of the supporting aircraft belong to another Task Group, the primary mission of these aircraft should be so defined as to include support, as required, throughout the entire operational phase.

4. The number and types of boats in the TG 132.1 and the TG 132.3 boat pools are considered adequate. The Navy LCU's were not equipped with the SCR 508 radios which were used in boat dispatching. It is recommended that the same number and types of boats be used for an operation of the size of Ivy and that all boats be equipped with SCR 508 radios to ensure maximum control and utilization.

5. The boat pools were used to their maximum capability during the Mike evacuation period because of the additional requirements of unloading a reefer and loading cargo vessels for return to the ZI. It is recommended that reefer and cargo vessels not be scheduled for loading or unloading less than 5 days prior to a total evacuation.

6. The total number of vehicles was considered adequate. It is recommended that the numbers of vehicles remain the same for an operation similar to Ivy.

7. The use of two PBM's to support weather stations and projects on other atolls, as well as to provide air-sea rescue service is considered inadequate to maintain reliable schedules. It is recommended that two PBM's be available for JTF operational requirements to off-atolls and that an additional PBM be assigned for other missions.

8. Submarine and overhead cables required for the Ivy telephone system were difficult to obtain from commercial sources owing to critical shortages. These cables arrived just in time to prevent a serious obstruction to operations. It is recommended that a stockpile sufficient to meet the maximum anticipated needs for the next operation be established by the AEC at Eniwetok at the earliest possible date.

9. The type SCR 508, SCR 300, and TCS-12 radios proved most satisfactory when they were used to meet operational requirements which were within their respective design capa-

bilities. For example, the 508's functioned most satisfactorily on the boat net. These sets, however, did not prove to be satisfactory in meeting the peculiar communications requirements presented by this Task Group. The commercial frequency-modulated type did give satisfactory service between instrument stations, on board ship, and at Headquarters, TG 132.1. Since for other purposes standard power is available throughout the test area, it is recommended that commercial frequency-modulated types of radios be procured and that one of the AEC contractors (EG&G or H&N) be assigned the responsibility for installation and servicing as required.

3.19.4 J-4 Section, Logistics

The system of requisitioning, procuring, shipping, and putting into service in the Forward Area vehicles for the Scientific Task Group has caused problems during the last two overseas operations. Considerable difficulty has been experienced in obtaining the vehicles necessary by the dates that have been requested for delivery in the Forward Area.

It should be noted that in Operation Ivy the method of shipping the vehicles to the Forward Area, by consignment to TG 132.2, resulted in TG 132.1 not receiving vehicles directly and not getting, at least at the beginning of the operation, the vehicles actually shipped for its use.

The vehicle requirements forwarded by the Task Group to the Task Force should be agreed on early, and it is recommended that the Task Force place its orders through standard DOD channels. In addition, it is recommended that all vehicles be inspected, before being shipped overseas, by a representative of the J-4 Section, TG 132.1, and that they then be shipped directly to this Task Group.

3.19.5 Documentary Photography

Operation Ivy was the first in the history of tests in the Forward Area in which the Documentary Photography Unit (TU 9) was assigned directly under the Scientific Task Group. It is the conclusion of all concerned that the documentary photographic mission for Operation Ivy was accomplished with a minimum of the operational handicaps which have slowed production on previous tests. It was conclusively shown that this production efficiency was directly attributable to the organizational arrangement mentioned above. Specifically, the following advantages resulted from this organizational system:

1. Unnecessary channels of communication were eliminated since the Documentary Photography Unit was already a part of the Task Group with whose activities it was mainly concerned.
2. Information as to schedules of events and any last-minute changes was readily available inasmuch as TU 9 was present along with the other Task Units at regular staff meetings.
3. Important personal contacts were easily and quickly made.
4. Technical advice as to important script changes was readily available.

It is strongly recommended that in all future tests the Documentary Photographic Unit be a part of the Scientific Task Group as in Operation Ivy.

3.19.6 Shot Island and Off-atoll Organization

Experience has shown the need for closer coordination of all shot-island activities, especially in matters of operations and support functions. On future operations it is proposed that a billet be established for an island coordinator. This individual would report to the Chief of Staff and would have available to him representatives of appropriate staff sections and task units.

At test sites remote from Eniwetok a site commander will represent CTG 132.1 and be responsible for all activities of the Scientific Task Group at that site.

At other off-atoll sites, such as Kwajalein, a CTG 132.1 representative will be in residence and will coordinate all Task Group activities at that point.

It is proposed that these organizational changes be accomplished in so far as possible within the existing authorized structure of TG 132.1. At the same time it is recognized that the scope of the mission of this Task Group may, on future operations, become so complex that its personnel structure will require augmentation.

REFERENCES

1. Task Group Operations Plan 1-52, J-14183, 15 August 1952.
2. The Turquoise Book, J-12366, 15 May 1952.
3. Operational Directives M-12, M-12A, and Change No. 1 to M-12A, 26 October, 29 October, and 30 October 1952, respectively.
4. Appendix II to Annex H, Operation Order 1-52, TG 132.1, "Mike Recovery Program," 30 October 1952; and Appendix III to Annex H, Operation Order 1-52, "King Recovery Program," 12 November 1952.

CHAPTER 4

SUMMARY OF TASK UNIT ACTIVITIES

4.1 TASK UNIT 1, SCIENTIFIC PROGRAMS

TU 1 was organized to design and carry out the experiments required for weapons development and for the measurement of field variables. This included the responsibility for program preparation and conduct in coordination with agencies or contractors of the AEC and DOD.

Chapter 2 of this report presents a summary of the experimental programs. The Turquoise Book gives an account of the purpose and method of each project planned for Operation Ivy. The Mike and King Shot cursory reports on the experimental programs give preliminary data on the results of many of the projects.

4.2 TASK UNIT 2, PRODUCTION

TU 2 had as its primary mission the production and supply of liquified gases in the amounts and at the times required by the various users. The Mike Shot experiment required large amounts of liquid hydrogen, liquid deuterium, and liquid nitrogen. From time to time smaller amounts of compressed pure hydrogen and dry nitrogen were required for various purposes. In order to have the capability for providing these large amounts and varieties of liquified gases, it was necessary to greatly expand the Greenhouse cryogenics facility. The Greenhouse plant was therefore completely rebuilt and expanded so that it could be used for the liquefaction of deuterium on a continuous basis at the rate of ___ This compares with an average continuous-production capability of about ___ for Greenhouse. The old nitrogen-liquefaction plant was overhauled and used as a standby in case of inoperation of the new plant. The capability of this plant was approximately ___ The newly built hydrogen and nitrogen plants had capabilities of continuous operation at the rates of ___ respectively. In order to operate the above-mentioned plants a new 3000-kw power plant was installed in the cryogenics area.

The fabrication and repair of units for the Greenhouse liquefaction plant began in November 1951 in Columbus, Ohio. A training program for operators started at the Ohio State University Cryogenics Laboratory, followed by visits to Air Products, Inc., and then to the cryogenics installation at the NBS Laboratory in Boulder, Colo., for observation of installations and tests of equipment similar to that planned for the Forward Area installation.

The first group of TU 2 personnel departed from Columbus, Ohio, on 17 January 1952 for the Forward Area to begin the repair and installation of equipment for the old liquefaction plants in Building 330. A second group arrived in the Forward Area about 1 May 1952 to complete the installation for Building 330 and to begin the assembly and erection of the new liquefaction plants in Building 344. The remainder of the personnel arrived prior to 15 July 1952, by which time the installations were completed and ready for test and training purposes.

TU 2 activities were coordinated closely with H&N construction. The completion of buildings and facilities was scheduled for 15 July, the scheduled date for the first test runs of the liquefaction plants being assembled. Test runs to assure smooth operation of the plants and to train operators were performed as rehearsals for the production schedule beginning 24 August and were completed 28 October. During this period

were delivered to Camco transport Dewars. In addition, purified gas and liquids were provided for TU 4 as needed. Rehearsals for emergency operation in case of delay of the shot schedule were performed for each of the four liquefaction plants.

Re-entry to the cryogenics area on Parry Island was possible on M+1 day. Test productions for each plant indicated no damage to the liquefaction units. After King Shot, dehumidification units were installed in the cryogenics buildings, and the interiors of the buildings were sealed. Periodic operation of the compressors and other equipment is planned in order to resist corrosive activity. It has been recommended that gas be circulated through the plants every 2 months to maintain oil films on moving parts of the compressors and vacuum pumps and that the plant be checked for leaks and general operational condition.

4.3 TASK UNIT 3, SPECIAL MATERIALS FACILITIES (Cambridge Corp.)

The primary mission of TU 3 was to operate and maintain eight Dewar-refrigerator combinations at the Forward Area for Operation Ivy. This included the moving of the Dewars and refrigerators throughout the Forward Area as required by the operation schedule. This unit collaborated with TU 2 in Dewar filling and delivered filled Dewars to the cab in conformance with the requirements of TU 4.

The Cambridge Corporation of Somerville, Mass., during early 1952, designed the special hydrogen transport Dewars. These containers of necessity had to be capable of operation, fully loaded, over the highway system of the United States under long-haul conditions and, at the same time, capable of overseas operation and during loading on and off landing craft. As finally constructed, these huge Dewars, or vacuum bottles, each of 2000 liters capacity, were trailer mounted, weighed 49,000 lb, and were 35 ft long by 8 ft wide by 12 ft high. Each unit possessed its own helium refrigerator and power supply. The high vacuums necessary were maintained by vacuum pumping equipment which is a part of the Dewar-refrigerator combination. These Dewars were operated at Boulder, Colo., as a training for the Forward Area operation and at Los Alamos as a necessary part of the check-out of the Mike device Dewar and reflux system. Eight refrigerated Dewars were shipped to the Forward Area,

The successful design, construction, and operation of Dewars of this size, within the short time available, were major contributions to the ultimate success of the Mike test.

A shop building, approximately 100 ft long by 25 ft wide and equipped with a traveling overhead 20-ton crane, was provided in the cryogenics area to perform the necessary maintenance on the Dewar units. In addition there were seven lean-to buildings, approximately 20 ft by 40 ft, for storage of Dewars between fill and transport.

Fixed facilities on Parry were substantially completed by 1 August 1952. Four of the Dewars left Oakland on the USNS Pendelton on 2 August. The remaining four Dewars were shipped via the USNS Merrill on 21 August 1952. These vessels arrived at Eniwetok approximately 12 days after sailing. The Camco shop in the cryogenics area was fully equipped and operating with the personnel on hand as of 15 August 1952.

Operation in the Forward Area consisted of many filling and transfer operations in coordination with TU 2 and 4. Movements of the filled Dewars on land and by boat were rehearsed carefully many times prior to the actual operational period. Operations of TU 3 were carried out very efficiently.

In addition to the safety efforts usually employed in atomic test operations, considerable forethought and planning were required in the handling of liquified hydrogen. The Ivy operation overseas and its preparation in the ZI involved the handling of liquified hydrogen in quantities not previously encountered. The safety aspects of engineering design and operating procedures were continuously reviewed by LASL personnel who retained as safety consultants recognized leaders in the commercial field.

In the development of experience with this product a conservative approach was adopted. Standard safety techniques for combustible gases were used and modified as experience and circumstances indicated. Although liquified hydrogen is recognized as the most energetic chemical fuel, it has desirable properties that facilitate simple safety techniques. For example, although the mixtures of hydrogen gas and air do have a wide explosive range, they require a relatively high concentration of hydrogen as a lower explosive limit, which means that, compared to most other combustible gases, a larger quantity of hydrogen must be free for a risk to be present. In addition, although liquid hydrogen has a low heat of vaporization, it also has a high rate of diffusion and thus is easily dissipated. Both these characteristics, a high lower explosive limit and a rapid upward diffusion rate, make the problems of safe handling not too difficult. Adequate ventilation was readily incorporated in the designs and operating procedures so that the prevailing conditions were continuously safe, with minimum risk even in the case of untoward incidents. These safety features were incorporated for all operations of TU 2, 3, and 4.

The primary roll-up of equipment for TU 3 was completed prior to Mike Shot. Virtually all equipment, except three Dewars and several "transportainers," was ready for evacuation by M−3 days. This left only a very small amount of equipment and materials to be handled after Mike Shot.

The over-all storage efficiency of the TU 3 Dewars, from the time of receiving liquid hydrogen until it was emptied from the Dewars, and including all losses of every kind (from normal heat leaks, from accidents, from Dewar-to-Dewar transfers, from some experiments, and from malfunction of the equipment) was 95 per cent over a period of approximately 2½ months. Since the one completely critical commodity, for which TU 3 was responsible, was deuterium, it is interesting to note that, of stored by TU 3 over a period of 36 days, the total loss was 0 liters.

4.4 TASK UNIT 4, MIKE ASSEMBLY

TU 4 was organized to prepare for shipment and to assemble the complete Mike device. CTU 4 coordinated the Mike assembly at all points for all groups and contractors. These groups consisted of personnel of American Car and Foundry (ACF) and CMR, GMX, and W Divisions, LASL. Each of these groups was responsible for various specific assembly operations. For example, ACF was responsible for the mechanical assembly of the device; CMR was responsible for the cryogenics system,

and W-1 was responsible for all nuclear components.

Prior to the assumpdon by CTG 132.1 of operational control of the device, TU 4 maintained efficient liaison with all the diversified groups of the Laboratory concerned with the development of the Mike device.

The Mike device was shipped to Eniwetok aboard the USS Curtiss, and after the arrival of TU 4 personnel in the Forward Area in mid-September the Mike assembly program began with the components being unloaded as necessary from the USS Curtiss to the cab on Elugelab Island. Prior to departure for the Forward Area, a schedule of operations for assembly of the device, and for other installation within the cab after commencement of the device assembly, was decided upon. This schedule took into account not only the predicted assembly time of the

device but also phased in the practice hydrogen and deuterium fillings as well as the necessary instrument installation. This entire task required continuous coordination to ensure non-interference with either the experimental programs or the assembly program. This schedule was adhered to with only minor variations created by difficulties in obtaining tight vacuum systems either in the device itself or in the cryogenics system. The ACF personnel first ran into considerable difficulty in obtaining a After this was remedied, the only problems encountered were those concerned with obtaining adequate vacuums in the cryogenics system.

After the vacuum-system assembly was complete, the system was filled with hydrogen and eventually with deuterium. After each of these practice fills, the system was drained. The final filling operation was started the evening of M−6 days and proceeded according to schedule, except for difficulty in removing a solid air block in one of the deuterium lines. After the solid air block was removed, filling proceeded normally, and the system operated within designed limits. The device was detonated at 0715 on Mike Day.

4.5 TASK UNIT 5, KING ASSEMBLY

TU 5 was assigned the task of preparing and delivering to the strike aircraft the King weapon and also the unit used for King

The components for these units were procured through the Sandia Corporation Production Department. The King unit was shipped on the USS Curtiss, in its storage condition, to be assembled on the Curtiss in the Forward Area. The King unit was delayed until 20 October, which was the completion date on the parts for this unit. At this time it was assembled in a ready condition, which means that it had detonators, fuses, and all components, ready for firing. The King unit was stored in Albuquerque until M+3 days, when it was flown to Kwajalein on a C-124. These planes arrived at Kwajalein on 7 November.

The personnel of TU 5 departed from Albuquerque on 31 October and arrived at Kwajalein on 3 November. After their arrival, the USS Curtiss, which served as the TU 5 workshop, was brought alongside the dock, and the King unit was loaded aboard for storage. On 8 November the King unit was loaded into the strike aircraft, and all final electrical checks were made. This unit was expended on 9 November as scheduled.

The King unit and all components were then checked in preparation for loading on 12 November. This weapon was flown to the test area on 13 November, but, because of a solid overcast, the test could not be completed. After a 24-hr delay, it appeared that further delays would be encountered, and the King unit was unloaded from the aircraft and taken aboard the USS Curtiss again for check-out on 15 November. At 1400 on this same day, the unit was reloaded into the strike aircraft with all final checks being made. This unit was expended at 1130 on 16 November.

4.6 TASK UNIT 6, FIRING PARTY

The arming and firing of the Mike device were the responsibilities of the Firing Party, TU 6. This Task Unit was divided into an arming team and a firing team, which were functionally separate organizations with different missions. The arming team had the mission of arming the Mike device, which included making all final connections, tests, adjustments, and calibrations necessary to ensure a successful detonation. The mission of the firing team was to operate the firing control room aboard ship and to detonate the device at H-hour. The Firing Party set up specific operations as contained in the Firing Party Order and the Firing Party Check List and, in addition, determined those procedures to be instituted in case of

emergencies such as misfire, low-order nuclear detonation, delays, or postponements.

After completion of the Firing Party Check List, the arming team returned from the shot island to the USS Estes, on which the firing control room was located. By means of television monitoring equipment and radio control circuits, the firing team began the preparations for detonating the device. By use of the television equipment the firing team was able to monitor the various systems or critical equipment within the Mike device and to note the position of various timing signals and the position of the Go-No-Go interlocks. By using three radio links the firing team, at the proper time and in the proper sequence, activated the timing signals and the sequence timer so that the Mike device was detonated on schedule. Provisions existed such that the Firing Party Commander could stop the shot at any time by means of remote control.

A similar firing team was used for King Shot but had only the responsibilities for the activation of the timing signals and a voice time broadcast.

4.7 TASK UNIT 7, RADIOLOGICAL SAFETY

Activities of this Task Unit are fully covered in Sec. 3.14.

4.8 TASK UNIT 8, TECHNICAL PHOTOGRAPHY

The tasks of the Technical Photography Unit included the following:

1. To make such technical photographs as were required to illustrate reports and to photograph each event.
2. To furnish darkroom facilities to experimenters and to process records upon request.
3. To furnish storage and accountability for photosensitive material.

TU 8 personnel consisted of six photographers, one control clerk, and one supervisor. Since this unit has had experience in a number of previous operations, no specific training for Operation Ivy was required.

Forward Area operations consisted of taking photographs of scientific equipment as requested, processing of film, printing, photostating, etc. Operations at shot times were concerned mainly with shot coverage. Some military photographers assisted this Task Unit at shot times. Scientific processing of an urgent nature was accomplished in the USS Estes darkroom.

4.9 TASK UNIT 9, DOCUMENTARY PHOTOGRAPHY

Activities of this Task Unit are covered in Sec. 3.13.

4.10 TASK UNIT 10, TEST FACILITIES

Activities of this Task Unit are discussed in Sec. 3.7.2.

4.11 TASK UNIT 11, BASE FACILITIES

Activities of this Task Unit are discussed in Sec. 3.7.2.