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Operation CASTLE

PACIFIC PROVING GROUNDS

March – May 1954

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REPORT OF COMMANDER, TASK GROUP 7.1

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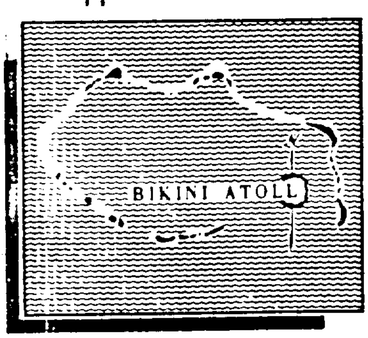

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JOINT TASK FORCE SEVEN

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CHAPTER 1

DEVICES AND TECHNICAL CONCLUSIONS

1.1 GENERAL OBJECTIVES

The objectives of Operation Castle were threefold: first, to fire some seven experimental devices, six of which were to be in the megaton range and several of which were to be proof tests of weapons; second, to obtain that diagnostic information on these devices which is necessary to evaluate properly their performance in case of either success or failure; and third, to obtain effects information for megaton-region devices.

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REPORT OF COMMANDER, TASK GROUP 7.1

Los Alamos Scientific Laboratory
Los Alamos, New Mexico
June 1954

[redacted]

[redacted]

AFWL/HO

ACKNOWLEDGMENTS

In connection with the Scientific Task Group's planning for and participation in Operation Castle, I wish to acknowledge the over-all direction and invaluable advice of Alvin C. Graves, J-Division Leader, Los Alamos Scientific Laboratory, and Deputy for Scientific Matters, Joint Task Force SEVEN.

It would not be possible in the limited time available to determine all of the contributors to this report. It is based largely on data provided by Programs, Projects, Task Units, and Staff Sections and was assembled by the Task Group staff.

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CHAPTER 2 SUMMARY OF EXPERIMENTAL PROGRAMS

CHAPTER 3 GENERAL ACTIVITIES OF TASK GROUP 7.1

CHAPTER 4 SUMMARY OF TASK UNIT ACTIVITIES

[redacted]

CHAPTER 1

DEVICES AND TECHNICAL CONCLUSIONS

1.1 GENERAL OBJECTIVES

The objectives of Operation Castle were threefold: first, to fire some seven experimental devices, six of which were to be in the megaton range and several of which were to be proof tests of weapons; second, to obtain that diagnostic information on these devices which is necessary to evaluate properly their performance in case of either success or failure; and third, to obtain effects information for megaton-region devices.

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CHAPTER 2

SUMMARY OF EXPERIMENTAL PROGRAMS

2.1 TASK UNIT 1 PROGRAMS (LARGELY LASL)

2.1.1 Introduction

The function of Task Unit 1 (TU-1) was to carry out experiments which would provide information desired by LASL to help in the design of thermonuclear devices. For further information on the purpose of measurements and analysis of results, reference should be made to the reports of the individual projects. Most results presented here are tentative. Their analysis is not complete, and the numerical values given are subject to change in the final reports.

2.1.2 Yield Analysis

The J-10 Group of LASL analyzed the fireball data obtained by Project 13.1, using the "analytic solution" method described in WT-9001 by Francis Porzel. They also provided an early value of the yield based on the difference in time between arrival of the air shock wave and the arrival of a hypothetical sound wave starting at the same time. This method is dependent on knowledge of wind direction and velocity at zero time at the firing site.

The results of these and various other hydrodynamic methods of determining yield are given in Table 2.1.

2.1.3 Program 11, Radiochemistry

(a) Objectives

1. To determine the fission yield of the devices.
2. To ascertain, where possible, what nuclear reactions take place in the devices.
3. To study specific aspects of the reactions by radiochemical tracers placed within the devices.
4. To look for new heavy elements in the bomb debris.

(b) Techniques

1. Samples of the radioactive material from the cloud were obtained by manned aircraft. The samples were flown to Los Alamos for analysis. The fraction of the bomb in the sample was determined by measuring the amount of [redacted] in the sample. Each of these measurements gives a separate value for the bomb fraction in the sample.

Measurement of various fission fragment activities gives the number of fissions represented by the sample. Dividing this by the bomb fraction gives the total number of fissions and therefore the fission yield.

No satisfactory method has been devised to measure the fusion yield by radiochemistry.

[redacted]

2. Np^{239} is produced by capture of a neutron in U^{238} and subsequent decay, U^{240} is produced by neutron capture in U^{239}, and U^{237} is produced by fast (6 Mev) neutrons on U^{238} by an (n,2n) process. Measurements of the ratio of these isotopes to the total number of fissions give information about the neutron economy and neutron fluxes. Sufficient U^{237} is produced in the devices to permit measurement of its fission cross section on separated samples.

Table 2.1 — YIELDS BY HYDRODYNAMIC METHODS (MEGATONS)

Method
Time difference*
Time of arrival
Pressure-distance
Time of minimum (Bhangmeter)
Fireball ϕ^5 scaling
Analytic solution
Weighted average yie Mt

DELETED

*Spread of data covering Sandia's close stations to shipboard data.
†Field value of May 1.

Table 2.2 — RADIOCHEMICAL RESULTS

DELETED

3. Various radiochemical tracers were placed inside the devices. Most of these were intended as tests of the tracers, but those in the [redacted] DELETED

4. Portions of the samples were separated and counted in the Forward Area in an effort to find new, possibly short-lived, heavy elements found by multiple neutron capture. Additional analysis for such elements was conducted on the samples received at Los Alamos.

(c) Results

1. The results of measurement of fission yields by various methods are given in Table 2.2.

[redacted]

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2. Ratios of Np^{238}, U[illegible] nd U^{237} to fissions for the various devi[illegible] are also given in Table 2.2. The U^{237} fission cross section is apparently very similar to Np^{237} except for a lower threshold.

3. No new heavy elements were found in the shot debris. Fall-out after the first shot raised the background at Eniwetok to the point where it largely offset the advantage of obtaining samples early. A new plutonium beta emitter with a 13-hr half life, Pu^{245}, with a 2-hr alpha daughter emitter, Am^{245}, was foun[redacted]

2.1.4 Program 12, Reaction History

(a) Objectives

1. To measure alpha* of the primary bomb [redacted]
2. To measure the time interval between the primary and secondary bombs [redacted]
3. To measure the velocity of propagation of the burn[redacted]
4. To measure the temperature of the thermonuclear reaction by means of the neutron spectrum [redacted]
5. To study the rise of the thermonuclear reaction by observing gamma rays.

(b) Techniques

1. The [redacted]evice was fired on land in order to permit detailed study of the reactions. This study was accomplished by collimation of radiation from various parts of the device and propagation of the radiation to a detector station down a manifold of 12 vacuum pipes.
2. The [redacted] device was fired on a barge; therefore collimation upon separate spots was difficult. However, a large shield on the barge suppressed radiation except from limited regions about the primary and secondary reactions. Further collimation at the detector station on shore at a distance of 2300 yd from the barge kept scattered radiation, which might have spread the signal out in time, from reaching the detectors.

(c) Results

1. See Table 2.4 for alpha measurements.
2. ~~See Table 2.6 for time-interval measurements.~~

[redacted]

4. A good neutron spectrum was obtained [redacted] The position of the peak may indicate a disassembly velocity of [redacted] Analysis for temperature is proceeding. Loss of most of the scattered neutron-spectrum data on other channels may make it impossible to separate wall acceleration from temperature broadening of the spectrum.

[redacted]

2.1.5 Program 13, Diagnostic Photography

(a) Objectives

1. To measure fireball radius vs time.
2. To measure cloud rise and to photograph cloud development.
3. To measure the time to the light minimum for purposes of yield scaling.
4. To photograph the bomb case for approximately the first 10 μsec.
5. To test a system for measuring temperature and opacity at temperatures such as 1 kev.
6. To measure the shock velocity in the bomb case as the region inside is heated.
7. To measure the time interval between primary and secondary reactions.

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*In a supercritical assembly the number of fissions increases in time as $e^{\alpha t}$.

[redacted]

16

(b) Techniques

1. Cameras were placed on towers at distances of 10 to 20 miles to photograph the early growth of the fireball and to measure cloud rise.

2. Bhangmeters were placed on the Enyu tower for the Bikini shots and on Parry for the Eniwetok shot. These devices record light intensity as a function of time.

3. Nominal three million frames/sec framing cameras were used to observe the bomb case from recording shelters near the bomb, where possible. [redacted] observed from a distance of 10 miles since the close shelter was destroyed on the first shot.

4. For the temperature-opacity measurement [redacted] a system of pipes, collimators, and turning-mirror towers was set up to observe the travel time of radiation through various materials [redacted] In addition, shock arrival through the case and through pads on the case at the same distance from the primary was observed. Records were made on Bowen streak cameras.

5. Bowen streak cameras looking at the case and surrounding air were used to measure the time interval between reactions.

(c) Results

1. Fireball radius vs time pictures were obtained on all Los Alamos shots.
2. The early cloud-rise velocity was approximately 510 ft/sec [redacted].
3. Bhangmeter results are given in Table 2.1.
4. The recording shelter at 7500 ft from zero failed under the blast pressure [redacted] Case pictures were obtained [redacted] There was no evidence of case rupture.
5. Photomultiplier records were recovered from the damaged station [redacted] They indicated that the rate of rise of the light signal in two typical channels had been too slow for the desired temperature-opacity measurement. The streak pictures were fogged by gamma radiation.
6. The time interval between primary and secondary reactions, as measured by various methods and observers, is shown in Table 2.6 together with the predicted values.

2.1.6 Program 14, Threshold Detectors

(a) Objective

To determine the total number of neutrons above various threshold energies leaving the devices.

(b) Techniques

1. Samples were placed at various distances from the devices for activation by neutrons arriving at the samples. Activation was compared with that produced by known fluxes of neutrons in the laboratory, and the measured flux was extrapolated back to the source. In some cases differences in spectrum between calibration neutrons and bomb neutrons could introduce appreciable error into the results, as could errors in the extrapolation. Table 2.3 gives detectors used and their thresholds.

2. Information about the number of neutrons leaving the devices may be obtained from measurement of the gamma rays arising from neutron capture in nitrogen. This analysis is obscured at early times by inelastic-scatter gammas from the bomb materials and in late stages by lack of knowledge of neutron diffusion and hydrodynamics.

Survey experiments were made [redacted] with two forms of gamma detectors having thresholds to eliminate low-energy gammas from inelastic scatter and fission, leaving mostly the desired capture gammas. One detector used pulse-height discrimination and the other used Cerenkov radiation to provide thresholds.

(c) Results

1. Table 2.5 gives integrated neutrons at the devices as measured by the various detectors, together with the measurements of total neutrons made by Program 16.

[redacted]

2. Gamma-ray measurements made as a function of time with threshold gamma detectors were made [redacted] The pulse-height discrimination system [redacted] with a threshold of approximately [redacted] recorded a gamma signal [redacted]

DELETED

2.1.7 Program 15, Alpha Measurement

(a) Objective

To determine, by measuring alpha,* whether or not the primary bombs in the various devices operated properly.

(b) Techniques

1. A large fluorescent plastic, capable of rapid time response, was erected near each of the Castle devices and viewed from a distance of 3 to 10 miles by a 2-ft-diameter telescope. When excited by gamma rays it fluoresced. Light from the telescope was collimated at the image point and passed on to photomultiplier tubes. The output signal was amplified and displayed on oscilloscopes.

2. This system had not previously been checked out in an actual bomb test, although similar systems were tried at Upshot-Knothole. It was therefore used as a backup on the first shot, where an orthodox photocell detector was in operation. On the remaining LASL devices it was the primary method of alpha measurement.

3. An attempt was made to measure alpha by observing the electromagnetic signal generated by the nuclear reaction. This signal also contains information on the time interval between primary and secondary reactions.

(c) Results

1. The results of the various alpha measurements are given in Table 2.4. In addition to the estimated probable error indicated, there remains an unexplained scatter in results on some shots. Further study of photomultiplier-tube operation will be made in an effort to reduce this. The table indicates that the [redacted] device may have been as much as 10 per cent low in yield. DELETED

2. Fall-out from the first test made it necessary to move the electromagnetic detector equipment from Bikini to Eniwetok. A fair test of the system for measuring alpha was only

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*In a supercritical assembly the number of fissions increases as $e^{\alpha t}$. Since the device disassembles rapidly when the nuclear energy becomes appreciable, a larger alpha allows more fissions before disassembly and, therefore, more yield. Additional measurements were made [redacted] by Program 12.

[redacted]

possible on the last shot, where the measured value was a factor of 3 low. The time interval between reactions was measured on all LASL devices after the first test and is shown in Table 2.6.

Table 2.4 — ALPHA MEASUREMENTS

Method of alpha measurement	[redacted]
Gamma-to-light conversion at photocell detector	
Gamma-to-light conversion at photomultiplier detector	DELETED
Gamma-to-light conversion at remote fluor-photomultiplier detector	
Electromagnetic signal	

*Errors shown are estimated probable error. Traces on the [redacted] shot were poor.
†Exploratory measurement, not a significant value.

DELETED

2.1.8 Program 16, Gamma Intensities at Late Times

(a) Objectives

1. To determine the number of neutrons escaping the case for the Castle devices.
2. To determine the number of fission gammas coming from the fireball a few tenths of a second after the detonation, and from this to determine the fission yield.

(b) Technique

To measure gamma rays as a function of time at various distances from zero. Interpretation of the early records is complicated and involves difficult hydrodynamic and neutron-diffusion calculations. After shock arrival most of the air between the source and the detector has been removed. This allows a relatively simple estimate of fission yield by measuring fission gammas.

(c) Results

Results of measurements of neutrons and fission yield are given in Table 2.5, together with neutron measurements by threshold detectors.

2.1.9 Program 17, Microbarographic Measurements

(a) Objective

To use the large detonations of the Castle series to study the upper atmosphere.

(b) Technique

Microbarograph recorders were placed on the USS Curtiss, Eniwetok, Kwajalein, Ponape, and in New Mexico.

(c) Result

Records were obtained on all shots and are presently being studied.

Table 2.5– EXTERNAL NEUTRON AND FISSION MEASUREMENTS

Measurement	[redacted]
Fission yield from γ rays	[redacted] DELETED
Neutrons leaving case from γ rays	
Zr (>12.2 Mev)	
As (>10.5 Mev)	DELETED
I (>9.35 Mev)	
S (>3 Mev)	
Pb (>8.5 Mev)	

2.1.10 Program 18, Thermal Radiation

(a) Objectives

1. To measure the time interval between primary and secondary reactions.
2. To measure thermal radiation from the fireball as a function of time.
3. To study the excited air in and about the fireball by spectroscopy.
4. To measure the transmission of the atmosphere for visible light over several paths.

(b) Techniques

1. The time interval between reactions was measured by Bowen streak cameras and by photocell detectors with oscilloscope indicators.

2. Thermal radiation was measured as a function of time by a chopped bolometer bridge with magnetic-tape recorder.

3. Spectrographs were taken of the fireball light as a function of time and space with various resolving powers.

4. Transmission was measured by calibrated tungsten-filament bulbs in searchlights at zero and transmissometers at various receiving locations. The transmissometers were calibrated to indicate the fraction of light received, compared to the amount which would be received if there were no absorption in the atmosphere. For the barge shots the transmitting searchlights were stabilized by gyro-stabilizer units.

5. Total thermal radiation from the devices was measured by integrating thermocouple detectors and recorders at several locations.

(c) Results

1. Results of all time-interval measurements are shown in Table 2.6.

2. Thermal power vs time curves are reproduced in the summary reports of the various shots. Time of first minimum and second maximum are shown in Table 2.7.

3. Spectographic records suffered from the dimness characteristic of all large fireballs. In general no spectra were taken below 4500 A because of lack of light. Analysis of spectra must be deferred until after detailed study.

4. Transmission measurements were used to ensure successful fireball pictures and to correct thermal measurements. They were successful on all LASL shots, but because of unusual conditions the simple transmission measurement was not a sufficiently good criterion for successful photography [redacted] Further study of the resolution problem is being made.

5. Results of total thermal measurements are given in Table 2.7. The definition of total thermal power is somewhat arbitrary, depending on when the thermal radiation ceases to be measured. The quantity measured could perhaps better be called prompt thermal radiation.

[redacted]

Table 2.6—TIME INTERVAL BETWEEN REACTIONS (MICROSECONDS)

DELETED

Table 2.7—RESULTS OF THERMAL MEASUREMENTS

[redacted]	
Time to first minimum, sec	DELETED
Time to second maximum, sec	
Total thermal radiation, Mt	

*Before cloud obscuration correction.

2.1.11 Program 19, Marine Survey

(a) Objectives

1. To study the effects of radiation from the Castle tests on various forms of life at Eniwetok Atoll.
2. To study the amount and distribution of radioactive materials in living plants and animals at Bikini Atoll.
3. A request was added during the test series for a radiological survey of Lapardi and Kabelle Islands, Rongelap Atoll.

(b) Techniques

Biological specimens are collected for dissection at Parry Island. There they are weighed and oven-dried before shipment to the United States for analysis. In a few cases rough analysis for radioactivity is done in the field. Representative locations are studied before and after the tests, and the effects of radiation on the life there are noted.

(c) Results

1. Specimens were collected at Aaraanbiru and Aitsu Islands in Eniwetok Atoll.
2. As a result of shot-schedule changes, emphasis was shifted to Teiteiripucchi and Bogombogo.
3. Observations and collections were made on Rongelap Atoll. Marked radioactive contamination was found in many tissues.
4. This study of the effects of radiation will be continued for 1 year. Most of the results are not available at present.

2.2 TASK UNIT 12 PROGRAMS (UCRL)

2.2.1 Program 21, Radiochemistry

DELETED

[redacted]

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ball as it swept by the field of view. The Model 6 shows a faint glowing (Teller light?) [redacted] and then a somewhat brighter glow growing in size [redacted]

2.2.4 Program 24, External Neutron Measurements

The object of Program 24 was to measure the energy spectrum of neutrons emanating [redacted] An energy resolution of about 2 per cent should be obtained for the (d,t) peak.

Neutrons from the device coming down the Tenex pipe strike two CH_2 radiators. Recoil protons from (n,p) collisions in the radiators are detected in nuclear emulsions. Measurements of proton ranges in emulsion yield proton energies, from which the neutron energies may be determined.

The signal-to-noise ratio in the exposed plates is good. The single-grain background is small, indicating a negligible exposure to gammas and electrons. Under a magnification of 1000×, there is about 1 recoil proton from fission events per field of view and about 1 recoil proton from the (d,t) reaction per 20 fields of view. When corrections are made for angles of observation, solid angle, radiator thickness, and the (n,p) cross section, the resulting neutron energy spectrum shows a peak at 14 Mev, superimposed on a fission spectrum. [redacted] There is a noticeable tail of the peak toward the low-energy side which would indicate a contribution of scattered 14-Mev neutrons down the pipe. The yield in the 14-Mev peak is about 3 per cent of that expected from the initial calculations where a yield of 1 Mt was taken as the basis for calculation.

2.3 TASK UNIT 13 PROGRAMS (DOD)

2.3.1 Program 1, Blast and Shock Measurements

The broad objective of Program 1 was to measure and study the blast forces transmitted through the various media of the earth. In the main, measurements were obtained in air by means of Wiancko and mechanical self-recording pickups. Those obtained within the water were taken by means of tourmaline, Wiancko, strain gauge, and ball-crusher pickups. A few earth measurements were made, using Wiancko accelerometers. Successful measurements contributing to the fulfillment of the objectives were made by 10 out of 12 projects. Of the two unsuccessful projects, one failure was brought about [redacted] The other project failure was brought about by the scheduled time of firing which imposed unfavorable light conditions for photography.

Many interesting and valuable records were obtained during the shot series. These records were interpreted in the field and will be reexamined subsequently at the home laboratories of the various project agencies. The following tentative conclusions are based on preliminary data and, therefore, are subject to change upon a more careful study of the records.

1. The air shock pressure-time traces obtained at close-in ground ranges were distorted.

2. Although distorted air shock wave forms were noted, no serious peak pressure discrepancies (as compared to the 2W Operation Tumbler-Snapper composite free air pressures) were noted.

3. Dynamic air pressures were obtained that were higher than those predicted by the Rankine-Hugoniot relations applied to air. The pressure discrepancies were probably a result of sand and/or water loading of the shock wave.

4. Within the ranges instrumented (7500 to 20,000 ft), underwater shock pressures were not appreciably larger than the air pressure at the corresponding distance. Approximately equal peak-pressure-inducing signals were transmitted through the earth and air, and these induced peak pressures were approximately equal to those of the air shock wave at corresponding distances.

5. The heights of the water waves induced within the Bikini lagoon can be approximated by the empirical relation

$$H_tR = \frac{2.25W^{1/2}\ (\phi/180)^{1/2}}{\rho}$$

where H_t = shallow water crest height in feet

R = range in feet

W = equivalent charge weight in megatons

ϕ = angular breach width in degrees in a semicircle into the lagoon

ρ = relative density of media beneath fireball

2.3.2 Program 2, Nuclear Radiation Effects

The general objective of this program was the determination of the militarily significant nuclear radiation effects of high-yield surface detonations. Of primary interest was the determination of the nature, intensity, and distribution of radioactive fall-out resulting from surface-land and surface-water detonations of high-yield devices. In addition, the effects of initial gamma radiation and the flux and spectrum quality of neutrons were investigated.

Gamma film- and chemical-dosimetry techniques and gamma scintillation-counter equipments were employed to evaluate initial and residual gamma-radiation exposure and to provide information on arrival time and early field decay characteristics of gamma radiation from fall-out.

Neutron-detection techniques, including the use of a variety of fission and threshold detectors, were employed to document the neutron flux [redacted]

The fall-out instrumentation included a variety of types of collectors, including samplers for total liquid and dry fall-out collection, intermittent collectors, and liquid aerosol collectors. The lagoon and island areas local to the shot zero points were heavily instrumented for all Operation Castle detonations [redacted]

Documentation of fall-out over extensive downwind ocean areas encountered serious experimental and operational difficulties. The problem was attacked initially by the employment of an array of free-floating buoys equipped with sample collectors. [redacted]n area survey was mounted which involved surface and subsurface activity measurements, water sampling, and hydrographic measurements. This survey covered a broad downwind zone to a distance of 200 miles and met with a large measure of success.

Neutron-flux measurements [redacted] and initial gamma data [redacted] established the nature and magnitude of these effects for these types of high-yield surface detonations. Initial gamma radiation and neutrons are of minor significance in relation to other effects of such bursts.

Considerable information was obtained on the distribution and characteristics of fall-out from high-yield land and water surface detonations. Extensive close-in data DELETED were augmented by a postshot survey of numerous downwind islands within the path of the fall-out to a range of 300 miles. The oceanographic and radiological survey [redacted] provided good coverage of the principal zone of downwind fall-out to a range of 200 miles. The results of the latter, plus limited good buoy samples taken 35 to 50 miles downwind [redacted] should allow evaluation of the nature and distribution of fall-out for high-yield surface-water bursts.

These results indicate that surface bursts of megaton yields distribute casualty-producing fall-out over areas upwards of 1000 square miles.

The oceanographic survey [redacted] indicates that the techniques employed, coupled with a rapid synoptic monitor survey of the water surface by fast surface vessels or aircraft or both, provide a feasible method for documentation of fall-out over water areas.

2.3.3 Program 3, Structures

The objective of Program 3 was to study the effects of blast in various areas of military interest. The nature and results of this study are briefed in the following paragraphs.

In Project 3.1 a rigid 6- by 12- by 6-ft cubicle at 9500 f[redacted] was instrumented to record pressure vs time on the cubicle faces. Records were obtained, but the pressure field was on the order of 3.5 psi instead of the order of 15 psi which had been expected on the basis of predicted yield. The data are yet to be analyzed and interpreted.

[redacted]

In Project 3.2 the apparent craters formed by the [redacted] DELETED detonations were measured by fathometer soundings as originally planned. The results are given in Table 2.8.

In Project 3.3 a study was made of tree damage on Eniirikku, Rukoji, and Chieerete Islands [redacted] Graded damage was observed, but data obtained are yet to be analyzed and interpreted. DELETED

Project 3.4 determined the effects [redacted] upon naval mines of various types planted at distances of 2000 to 15,000 ft from the detonation site. Graded damage was obtained from 0 per cent at 15,000 ft to 100 per cent [redacted]

Project 3.5 was activated [redacted] to document the unexpected damage to the camp on Eninman and certain instrumentation shelters near Ground Zero. This was done primarily by photography.

Table 2.8—CRATER DATA

Crater [redacted]	Diameter, ft	Depth of apparent crater, ft
[redacted]	6500	120
[redacted]	700	24
[redacted]	1500–2500	20*

*Below original bottom which was 160 ft below water surface.

2.3.4 Program 4, Biomedical Studies

These studies represented the first observations by Americans on human beings exposed to excessive doses of radiation from fall-out. The groups of exposed individuals are sufficiently large to allow good statistics. Although no preexposure clinical studies or blood counts were available, it was possible to obtain Marshallese and American control groups that matched the exposed population closely with regard to age, sex, and background. Thus the conclusions which may eventually be drawn from group comparisons should be reliable.

The type of radiation received, and the manner in which the radiation dose was delivered, differed in several important respects from that seen in the Hiroshima and Nagasaki casualties, the Argonne or Los Alamos accidents, or in the bulk of animal laboratory radiation exposures. In addition to a wide spectrum of gamma-ray energies in the fission-product field, there was a beta component. Some clinical, and especially laboratory, findings in this study are consistent with a hard penetrating component. The clinical and pathological findings in the skin lesions, as well as the correlation of distribution of the lesions with exposed skin areas, are consistent with a sizable component of extremely soft radiation. The absence of evidence of skin damage deeper than the superficial lesions in the initial biopsies described would argue against a considerable component of radiation of intermediate energy. In addition to external radiation, some internal contamination did occur. The extent and long-term significance of this interval component remains to be evaluated.

Therefore it is probable that the exposed individuals were subjected to essentially three types of radiation: penetrating total-body exposure, beta or soft gamma exposures of the skin, and irradiation of internal organs from radioactive materials in the body. It remains to be evaluated if the various findings observed can each be attributed to one of the different radiation components separately, or if combined effects of these radiations must be invoked to explain some of the findings. There is no good reason to date to suspect possible combined effects from the over-all clinical or dermatological picture observed.

As stated, the meager preliminary information on the skin biopsies taken in the present studies indicates that skin damage was limited to the superficial layers. To date, none of the vascular lesions reported by Lushbaugh et al. as being characteristic of experimental beta

[redacted]

burns have been seen in the biopsy sections. However, the energy of the beta rays in the fall-out may have been very low, thus limiting the injury to the superficial epidermis and sparing the vascularized dermis. Accordingly, the absence of specific vascular lesions in the biopsies would not necessarily eliminate radiation as a causative factor.

The dose rate from fall-out varied continuously, and the total dose was received over a period of many hours or days. This is in contrast to previous experience mentioned, in which the dose can be considered to be either essentially instantaneous or received at a constant dose rate over a period of minutes. From previous animal experimentation it might be expected that the dose received by exposed individuals in the present study, extending over two or three days, would produce less of an effect than would the same total dose given over a few minutes. It is not possible without further experimentation to attempt quantification of the degree to which observed effects in the population studies may have been altered by this particular combination of dose rate and time during which the total dose was delivered.

Hematological findings were somewhat similar to those seen following single doses of penetrating radiation in animals. However, the time course of changes in both the leucocyte and platelet counts in the Rongelap group was markedly different from that seen in animals. Maximum depression of these elements occurred much later in these individuals than is seen in animals, and the trend toward normal was considerably delayed. The marked delay in return to normal leucocyte values in the present study appears to exceed that observed in the Hiroshima and Nagasaki casualties. Further evidence that the return to normal may be later in human beings than in animals can be seen in the response of the few cases of the Argonne and Los Alamos accidents. Although the doses, types, and conditions of irradiations were sufficiently different in the several series of exposed human beings to preclude strict comparisons among them, the added evidence from the present studies would seem to validate the general conclusion that the time pattern of hematological changes following irradiation in man is significantly different from that observed in the large species of animals studied to date.

2.3.5 Program 6, Service Equipment and Techniques

Program 6 included six projects concerned with the developing, testing, and analyzing of various aspects of weapons effects on service equipment and operational techniques.

Project 6.1 was successful in obtaining excellent radarscope photos of the detonation and blast phenomena for utilization in establishing Indirect Bomb Damage Assessment (IBDA) procedures for high-yield weapons.

The high-yield weapons detonated in regions such as Bikini, where sharp land and water contrasts are obtainable, gave excellent results for radar-return studies and air-crew training for the 20 Strategic Air Command (SAC) air crews who participated.

Projects 6.2a and 6.2b were successful in obtaining significant data concerning blast, thermal, and gust effects on B-36 and B-47 aircraft in flight. Minor blast damage was sustained by the B-36 on several shots; however, predictions on temperature rise as a function of incident thermal energy for both the B-36 and B-47 were shown to be conservative. Some concern arose over the response of the B-36 horizontal stabilizer to gust-loading at a critical station. Additional studies will be required, including instrument calibration, before any revisions of current concepts of delivery capabilities can be expected.

Project 6.4 was successful in evaluating the effectiveness of washdown systems for naval vessels. Also much valuable experience was gained in ship-decontamination procedures and techniques. In addition, one vessel (YAG-39) assisted in the collecting of fall-out data for Project 2.5a. Project 6.4 has demonstrated that a typical naval vessel, when adequately equipped with washdown apparatus, can operate safely in regions of heavy fall-out and still maintain operational capability without excessive exposure of the ship's company to residual radiation from fall-out.

Project 6.5, operating in conjunction with Project 6.4, evaluated current decontamination procedures on representative walls, roofing, and paving surfaces which were subjected to the wet contaminant of barge and land shots. The contaminant, particularly from the barge shots,

[redacted]

was found to be much more tenacious than that experienced in similar tests at the Buster-Jangle underground shot, and the accepted decontamination procedures were less effective.

Project 6.6, recordings of effects on ionospheric layers, particularly the F_2 layer, was successful in most instances. Because of radiation levels, the Rongerik station could not be operated continuously for complete ionosphere history, but the station was activated for all shots. The significance of recorded results will require detailed study prior to the writing of a final report.

2.3.6 Program 7, Long-range Detection

The general objectives of Program 7 experiments in this test series were the improvement of present techniques, development of new techniques, and collection of calibration data in furtherance of the AFOAT-1 mission. Participation in the test was really twofold, consisting of some experiments specifically designed for Operation Castle and some operational tests of routine procedures.

The three projects of Program 7 were instrumented to investigate electromagnetic signals, acoustic signals, and particulate and gaseous debris associated with nuclear explosions. Portions of the experiments were conducted at the Pacific Proving Grounds (PPG), but most of the project sites were located at great distances from the detonation points.

In all projects the operational phase of the experiment was successful in that, quantatively, the desired records and debris were obtained. The analytical phase of the experiments was not complete at the time of this report, and qualitative results are not yet available.

2.3.7 Program 9, Cloud Photography

The only technical project in Program 9 was Project 9.1, Cloud Photography. A summary of this project follows.

The purpose of this program was the photogrammetric determination of the various parameters of nuclear clouds as a function of time and the attempt to establish approximate scaling (yield) relations. The most important of these parameters is the rate of rise of the cloud and the area of the cone swept out by the rising material. Of secondary importance are the dimensions and drift of the cloud as functions of time after it has reached maximum altitude.

The operational plan for this project involved the participation of four aircraft equipped with gyro-stabilized mounts holding a K-17 aerial camera and an Eclair 35-mm motion-picture camera. Three of these aircraft were C-54's, with a flight plan which called for altitudes of 10,000, 12,000, and 14,000 ft orbiting around the cloud for the purpose of conducting photography from H-hour until H plus the time required for the cloud to lose its identity. One aircraft, an RB-36, operated at 35,000 ft and conducted photography for a period of 10 min.

The aerial photography and processing of the negatives were the responsibilities of TU-9. The backup terrestrial photography was done by Edgerton, Germeshausen & Grier, Inc. (EG&G), in conjunction with Project 13.2. Analysis of the photography and evaluation of the data are solely the responsibility of EG&G. Program 9 participated in all shots.

As of this date pre-preliminary results [redacted] have been submitted by EG&G. It has been reported, however, that analysis is [redacted]ceeding satisfactorily, and it is believed by EG&G personnel conducting the photogrammetric analysis that preliminary and final data results will exceed in accuracy the preoperational expectations.

[redacted]

CHAPTER 3

GENERAL ACTIVITIES OF TASK GROUP 7.1

3.1 MISSION

The mission of Task Group 7.1 (TG 7.1) included the following tasks:

1. Position, arm, and detonate the weapons and devices.
2. Conduct technical and measurement programs.
3. Keep Commander, Joint Task Force SEVEN (CJTF SEVEN) informed on test and technical developments affecting the operational plan and military support requirements therefor.
4. Schedule the interatoll and intra-atoll movement of weapons and devices and provide required technical assistance to other task groups in connection with their responsibilities for such movements.
5. Complete the installation and calibration of the weapons and devices and all instruments and test apparatus.
6. Be responsible for the removal of all TG 7.1 personnel and necessary equipment from the shot-site danger area.
7. When directed by CJTF SEVEN, evacuate TG 7.1 personnel from Bikini Atoll.
8. Be prepared, upon directive from CJTF SEVEN, to conduct emergency postshot evacuation of TG 7.1 personnel from Eniwetok Atoll.
9. Provide CJTF SEVEN with a statement of preliminary test results.
10. Provide nontechnical film coverage.
11. Recommend to CJTF SEVEN safe positioning for aircraft participating in the scientific programs.
12. Conduct the radiological-safety (Rad-Safe) program.
13. Initiate voice time broadcasts for all elements of the Task Force.
14. Prepare appropriate technical reports at the conclusion of each shot and the whole operation.

3.2 ORGANIZATION AND COMMAND RELATIONS

With the completion of Operation Ivy in November 1952, the Headquarters of TG 132.1 returned to J-Division in the LASL to begin planning for Operation Castle. The final organization is shown in Fig. 3.1. It includes task units for the UCRL programs, for UCRL device assembly, and for the Department of Defense (DOD) programs. These are changes from the Ivy organization. In order to free himself for other urgent commitments, the Task Group Commander did not personally take charge of the Firing Party Task Unit. This proved to be a worth-while change from the previous practice.

At midnight Washington time, Jan. 31, 1953, JTF 132 became JTF SEVEN and TG 132.1 became TG 7.1. On Mar. 4, 1953, TG 7.5, AEC Base Facilities, was established.

[redacted]

25

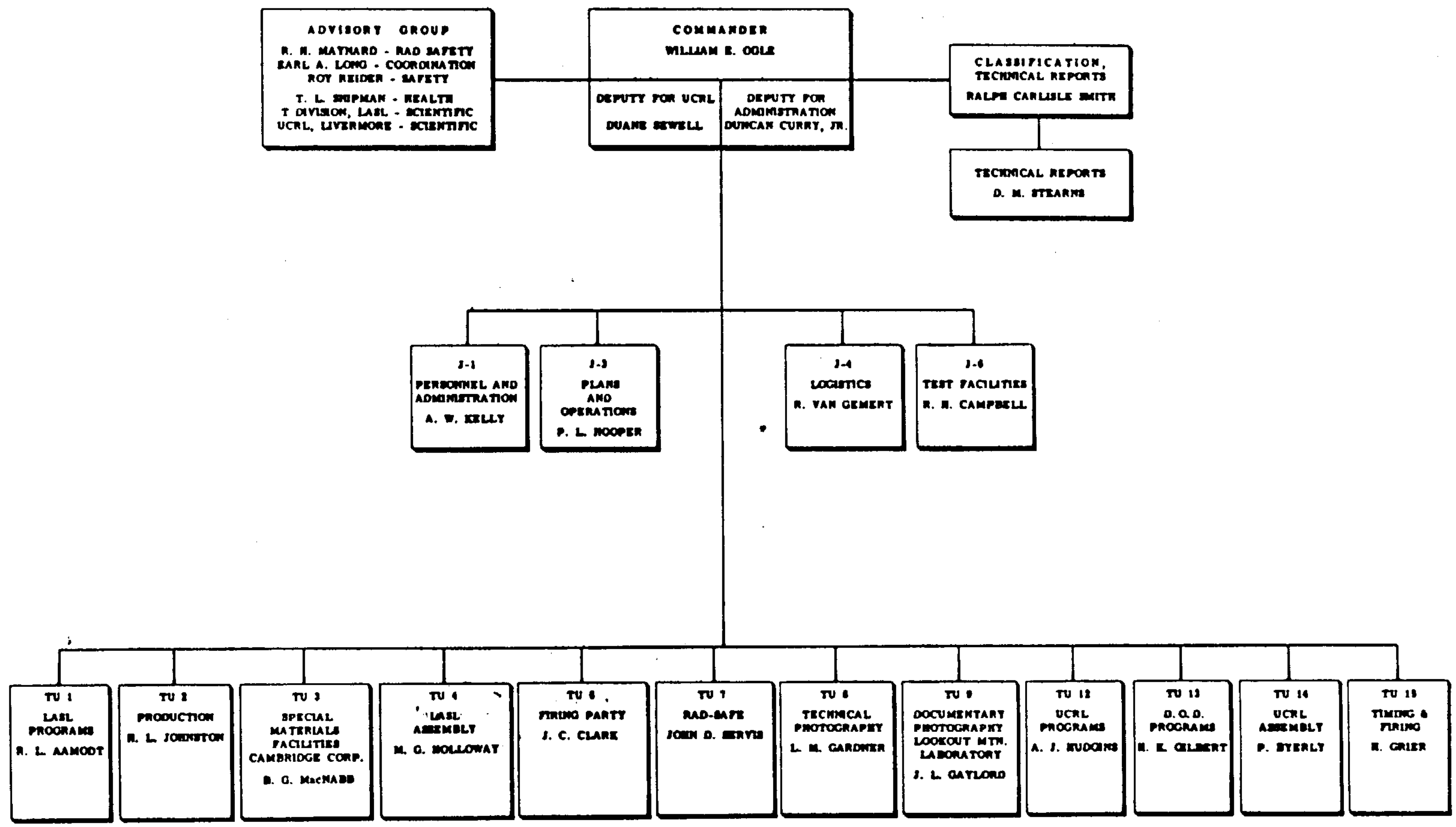


Fig. 3.1—Organization chart, Task Group 7.1.

[redacted]

29

During 1953, UCRL organized, staffed, and established L-Division at Livermore, Calif. Relations between the L-Division Group and Headquarters, TG 7.1, were very close during this period. For most of the time UCRL had a liaison representative in residence at Los Alamos, and visits were constantly exchanged between members of the two organizations. In order to support UCRL overseas and to train personnel for future overseas tests, L-Division integrated personnel into the TG 7.1 J-1, J-3, and J-6 Staff Sections and filled billets in those sections overseas.

Since the principal function of the Task Force and most of the Task Groups was to support the scientific effort, most of the over-all planning depended on the plans of TG 7.1. Therefore command relations differed somewhat from the normal military pattern. Figure 3.2 shows the JTF SEVEN organization and some of the major command relations involved, and Table 3.1 shows the key personnel of TG 7.1. CJTF SEVEN coordinated the activities of TG 7.1 and 7.5 through his Scientific Director, in accordance with existing AEC-CJTF policy agreements. Relations with the Task Force and with the other Task Groups were cordial, and the cooperation and support received from them were excellent.

3.3 ADVISORY GROUP

As shown in the organization chart, the Advisory Group consisted of experts in various fields who advised the Task Group Commander and members of the Task Group on technical problems. LASL T-Division representatives were particularly active at the test site and at Los Alamos [redacted] LASL Health Division representatives, in addition to their advisory functions, actually served in the Rad-Safe Task Unit and performed special functions in connection with accidental fall-out on inhabited islands and conducted studies to improve fall-out predictions. T. N. White of H-Division took part in several surveys of contaminated islands and was in charge of one of the surveys.

3.4 PLANNING AND TRAINING

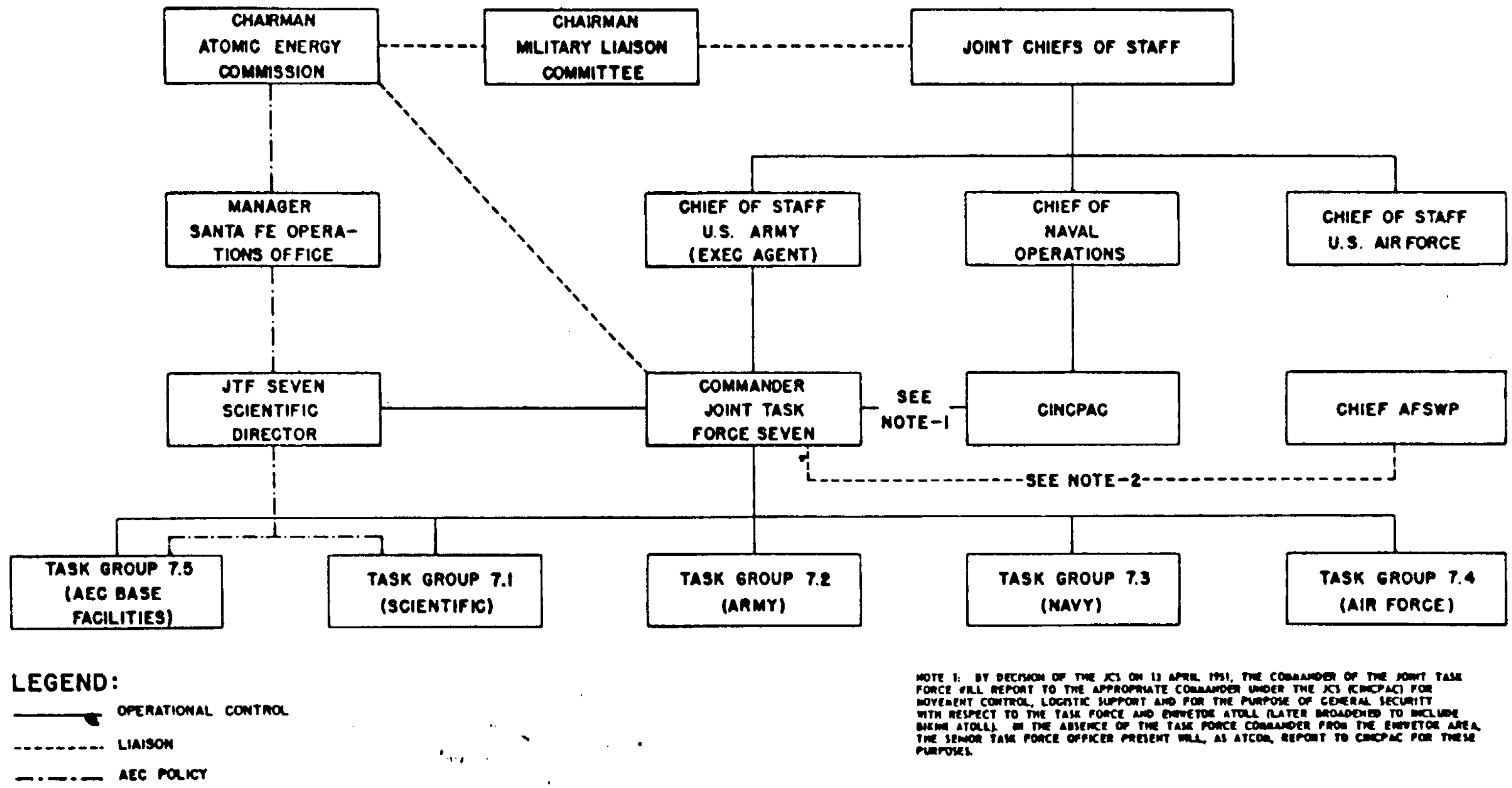
3.4.1 Programs, Concepts, and Schedules

The first general statement of concept for Operation Castle was issued by CTG 132.1 in June 1952. It envisaged the testing of as many as three fission experimental weapons of the order of 50 kt in addition to one high-yield thermonuclear experimental device (dry). At that time, Castle was tentatively scheduled for September–October 1953. Bikini was being considered for the thermonuclear shot and Eniwetok for the fission shots.

Holmes and Narver (H&N) made a cursory reconnaissance of Bikini in September 1952 and started an extensive survey the following month. In November 1952, late in the Ivy operation, construction at Bikini started. At about the same time a considerable amount of preliminary Castle planning, including a rough outline of support requirements, went on between TG 132.1, JTF 132, and representatives of the AEC. At this time the AEC decided to establish an AEC Base Facilities Task Group for Castle.

By February 1953 it had been decided that Feb. 15, 1954, was the earliest possible date for the first Castle detonation. A tentative schedule shown in Table 3.2 was given limited distribution at that time. It included four Los Alamos weapons and devices and two UCRL devices. Of these, four were to be detonated at Bikini and two at Eniwetok; three were to be ground shots, two barge shots, and one barge or ground. Except for [redacted] UCRL) all shots were predicted to be in the megaton range. The idea of barges as shot sites was conceived in order to reduce contamination, to make better use of the limited amount of real estate available, and to speed up the tests by scheduling assembly operations at a proposed barge slip at Eniwetok and moving each barge into position about five days before detonation. This made it possible to plan on using the same concrete bunkers for several shots and the same zero point, if necessary or desirable, regardless of the high radiation levels to be expected on the islands in the vicinity of the preceding shot.

[redacted]



NOTE 1: BY DECISION OF THE JCS ON 13 APRIL 1951, THE COMMANDER OF THE JOINT TASK FORCE WILL REPORT TO THE APPROPRIATE COMMANDER UNDER THE JCS (CINCPAC) FOR MOVEMENT CONTROL, LOGISTIC SUPPORT AND FOR THE PURPOSE OF GENERAL SECURITY WITH RESPECT TO THE TASK FORCE AND ENIWETOK ATOLL (LATER BROADENED TO INCLUDE BIKINI ATOLL). IN THE ABSENCE OF THE TASK FORCE COMMANDER FROM THE ENIWETOK AREA, THE SENIOR TASK FORCE OFFICER PRESENT WILL, AS ATCOM, REPORT TO CINCPAC FOR THESE PURPOSES.

NOTE 2: BY DECISION OF THE JCS ON 21 APRIL 1953, THE CHIEF OF THE ARMED FORCES SPECIAL WEAPONS PROJECT (AFSWP) WILL EXERCISE, WITHIN ANY TASK FORCE ORGANIZATION, TECHNICAL DIRECTION OF THE WEAPONS EFFECTS TESTS OF PRIMARY CONCERN TO THE ARMED FORCES AT ATOMIC TESTS CONDUCTED OUTSIDE THE CONTINENTAL UNITED STATES. PRIOR TO THE ON-SITE PHASE OF AN OVERSEAS TEST OPERATION, THE TASK FORCE COMMANDER WILL CONSULT THE CHIEF OF AFSWP ON MODIFICATIONS OR DELETIONS TO THE DEPARTMENT OF DEFENSE WEAPONS EFFECTS TEST PROGRAMS.

Fig. 3.2—Organization chart, Joint Task Force SEVEN.

[redacted]

Table 3.1 — KEY PERSONNEL, TASK GROUP 7.1

Unit or Section	Name
Commander	W. E. Ogle
Deputy for UCRL	Duane C. Sewell
	Walter D. Gibbins
Deputy for Administration	Duncan Curry, Jr.
Advisory Group	
T-Division, LASL	J. Carson Mark
UCRL Scientific	Edward Teller
Radiological Safety	Russell H. Maynard, CAPT, USN
Coordination	Earl A. Long
Safety	Roy Reider
Health	Thomas L. Shipman
	Thomas N. White
Classification and Technical Reports	Ralph Carlisle Smith
	Joseph F. Mullaney
J-1, Personnel and Administration	Armand W. Kelly
	Larry W. Burns
	Robert B. Cruise, Lt Col, USA
J-3, Plans and Operations	Philip L. Hooper, Col, USA
	Walter T. Kerwin, Col, USA
	David V. Miller, Col, USAF
J-4, Logistics	Harry S. Allen
	Robert J. Van Gemert
	John W. Lipp, Lt Col, USA
J-6, Test Facilities	Robert H. Campbell
	Robert W. Newman
TU-1, LASL Programs	Rodney L. Aamodt
Program 11, Radiochemistry	Roderick W. Spence
	Harold F. Plank
	Charles I. Browne, Maj, USAF
Programs 12 and 16, Reaction History and Gamma Intensities at Late Times	Bob E. Watt
	Stirling A. Colgate
	George L. Ragan
Program 13, Diagnostic Photography	Gaelen L. Felt
	Herbert E. Grier
Program 14, Threshold Detectors	Leon J. Brown
	Wendell A. Biggers
Program 15, Alpha Measurement	Newell H. Smith
	Leland K. Neher
	John Malik
	Robert D. England
Program 17, Microbarographic Measurements	John M. Harding
Program 18, Thermal Radiation	Herman Hoerlin
	Harold S. Stewart
Program 19, Marine Survey	Lauren R. Donaldson
	Edward E. Held
TU-2, Production	Herrick L. Johnston
	Nathaniel C. Hallett

[redacted]

Table 3.1 — (Continued)

Unit or Section	Name
TU-3, Special Materials Facilities	Stanley H. Ellison
	Byron G. MacNabb
	Dewey J. Sandell
TU-4, LASL Assembly	Marshall G. Holloway
	Jacob J. Wechsler
TU-6, Firing Party	John C. Clark
TU-7, Rad-Safe	John D. Servis, Maj, USA
	Ragnwald Muller, LCDR, USN
	William R. Kennedy
	Pasquale R. Schiavone
TU-8, Technical Photography	Loris M. Gardner
	John D. Elliott
	Robert C. Crook
TU-9, Documentary Photography	James L. Gaylord, Lt Col, USAF
	James P. Warndorf, Lt Col, USAF
	Buford A. Mangum, Maj, USAF
TU-12, UCRL Programs	Arthur J. Hudgins
Program 21, Radiochemistry	Kenneth Street
	Peter Stevenson
	William Crane
	Floyd F. Momyer
Program 22, History of Reaction	Stirling A. Colgate
Program 23, Scientific Photography	William P. Ball
Program 24, External Neutron Measurements	Stephen R. White
TU-13, DOD Programs	Huntington K. Gilbert, Col, USAF
	Neil E. Kingsley, CAPT, USN
Program 1, Blast and Shock Measurements	Walton L. Carlson, CDR, USN
1.1	Casper J. Aronson
1.2a, 1.3, and 1.7	John M. Harding
1.2b	Julius J. Meszaros
1.4	William J. Thaler, J. P. Walsh
1.5	J. W. Smith
1.6	R. R. Revelle, John D. Isaacs
1.8	Edward J. Bryant
Program 2, Nuclear Radiation Effects	Edward A. Martell, Lt Col, USA
2.1	Robert H. Dempsey, Maj, USA
2.2	Peter Brown
2.3	Thomas D. Hanscome
2.5a and 2.6a	E. R. Tompkins
2.5b	Edward F. Wilsey
2.6b	R.C. Tompkins
2.7	T. Folsom
Program 3, Structures	Neil E. Kingsley, CAPT, USN
3.1	Laurence M. Swift
3.2	Robert B. Vaile, Jr.
3.3	Wallace L. Fons
3.4	James Murphy, LCDR, USN
3.5	Wayne J. Christensen, LCDR, USN
Program 4, Biomedical Studies	Edward P. Cronkite, CDR, USN

[redacted]

Table 3.1 — (Continued)

Unit or Section	Name
Program 6, Service Equipment and Techniques	Donald I. Prickett, Lt Col, USAF
6.1	Rockly Triantafellu, Lt Col, USAF
6.2a	G. Miller
6.2b	C. L. Luchsinger
6.4	George G. Molumphy, CAPT, USN
6.5	Joseph C. Maloney
6.6	Albert Giroux, Capt, USA
Program 7, Long-range Detection	Paul R. Wignall, Col, USAF
7.1	J. A. Crocker
7.2	G. B. Olmstead
7.4	Walter Singlevich
Program 9, Cloud Photography	Jack G. James, Lt Col, USAF
TU-14, UCRL Assembly	Paul Byerly
TU-15, Timing and Firing	Herbert E. Grier Bernard J. O'Keefe

Table 3.2 — CASTLE FIRING SCHEDULES

Order		Date	Location	Code name
		Actual		
1		3/1/54	Bikini, reef, 2500 yd southwest of Namu	Bravo
2		3/27/54	Bikini, barge, [redacted]	Romeo
3	DELETED	4/7/54	Bikini, Eninman	Koon
4		4/26/54	Bikini, barge, 2300 yd south of Yurochi	Union
5		5/5/54	Bikini, barge, [redacted]	Yankee
6		5/14/54	Eniwetok, barge, Elugelab crater	Nectar
		Canceled	Eniwetok, Eberiru	Echo
		Feb. 4, 1953		
1		2/15/54	Elugelab, ground†	
2		2/22/54	Eninman, ground	
3		3/1/54	Bikini, barge or ground	
4	DELETED	3/11/54	Bikini, barge	
5		3/21/54	Bikini, barge	
6		3/28/54	Eberiru, ground	
		Apr. 7, 1953		
1		2/15/54	Bikini, barge, $1\frac{3}{4}$ miles south of Bokororyuru	
2		2/25/54	Bikini, reef, southwest of Namu	
3	DELETED	3/8/54	Bikini, barge, 2300 yd south of Yurochi	
4		3/17/54	Bikini, barge, [redacted]	
5		3/24/54	Bikini, Eninman	
6		4/3/54	Eniwetok, Eberiru	

[redacted]

Table 3.2—(Continued)

Order	Device	Date	Location	Code name
		Aug. 24, 1953		
1		2/15/54	Bikini, reef, southwest of Namu	
2		2/25/54	Bikini, barge, 2300 yd south of Yurochi	
3	DELETED	3/8/54	Bikini, barge [redacted]	
4		3/17/54	Bikini, Eninman	
5		3/24/54	Eniwetok, Eberiru	
6		4/3/54	Eniwetok, barge, Elugelab crater	
		Oct. 20, 1953		
1		3/1/54	Bikini, reef, southwest of Namu	
2		3/11/54	Bikini, barge, 2300 yd south of Yurochi	
3		3/22/54	Bikini, barge, [redacted]	
4	DELETED	3/29/54	Eniwetok, Eberiru	
5		4/5/54	Bikini, barge, [redacted]	
6		4/15/54	Bikini, barge, [redacted]	
7		4/22/54	Bikini, Eninman	
		Mar. 6, 1954		
2		3/13/54	Bikini, barge, [redacted]	
3		3/22/54	Bikini, Eninman	
4		3/29/54	Bikini, barge, 2300 yd south of Yurochi	
5		4/8/54	Bikini, barge, [redacted]	
6		4/17/54	Bikini, barge, [redacted]	
7	DELETED	4/24/54	Eniwetok, Eberiru	
		Apr. 13, 1954		
4		4/16/54	Bikini, barge, 2300 yd south of Yurochi	
5		4/20/54	Eniwetok, barge, Elugelab crater	
6		4/27/54	Bikini, barge, [redacted]	

* Substituted for [redacted]

† Being surveyed to determine whether radioactively safe for work.

This and all subsequent schedules were based on having acceptable firing weather on the day each shot was scheduled. No such luck was anticipated, however, and in all operational planning weather was a problem of great concern. Completion dates anywhere from two weeks to two months later than scheduled seemed reasonable to expect. The sixth (last) shot was actually fired 29 days after its scheduled date.

By February 1953 the general outline of the LASL, UCRL, and DOD programs had been established. It included the programs covered in this report, with the exception of the following which were added later: Program 4, Biomedical Studies; Program 17, Microbarography; Program 19, Marine Survey; and Program 24, External Neutron Measurements.

During February a UCRL group visited Los Alamos to discuss transport Dewar and construction requirements and scientific programs. At this time it was decided that no additional transport Dewars were required for Castle.

At the same time, through the Task Force, the Chief of the Armed Forces Special Weapons Project (AFSWP) was urged to nominate as soon as possible a commander for TU-13, DOD

[redacted]

Programs, in order that planning for DOD projects could start and construction and other support requirements might be determined. Early in March a meeting was held at Los Alamos with representatives of the Santa Fe Operations Office (SFOO) and AFSWP, including the prospective Commander of TU-13, to discuss the DOD programs and support requirements. At this meeting AFSWP representatives presented a requirement for a barge shot in deep water. As a result of this meeting and the need for further studies by DOD in connection with the proposed deep-water shot, another meeting was scheduled at Los Alamos early in April. Meanwhile, studies of the lagoon-contamination problem and water-wave problem were started.

After the April meeting CTG 7.1 issued a general statement of concept for Operation Castle, including a shot schedule which is included in Table 3.2 under the date of Apr. 7, 1953. This schedule provided for three barge shots and two ground shots at Bikini and one ground shot at Eniwetok. [redacted] of greatest interest to Los Alamos at this time, was scheduled as a ground shot on the reef southwest of Namu at Bikini in order to permit maximum instrumentation. [redacted] (the smaller two of the Los Alamos shots) was scheduled for a location south of Bokororyuru on a deep-water barge secured to that island and the adjoining one by mooring cables. [redacted] the last shot at Bikini with acceptance of some risk of damage to instrumentation on the Eninman complex in order to retain the use of the airstrip on that complex until the last shot was fired. The problem of possible damage to [redacted] installations from Bikini lagoon barge shots continued to cause concern and was studied from time to time thereafter as additional information became available. [redacted]

Late in June a meeting of Project Officers was held in Los Alamos to discuss project plans, problems, and support requirements. Immediately after this meeting the evacuation concept was discussed with CJTF SEVEN. It was decided that at Bikini, for the first shot, and quite possibly for subsequent shots, it would be necessary to evacuate everybody aboard ships, except for a very small Firing Party which would remain in the reinforced-concrete control station on Enyu. At Eniwetok only the capability of emergency evacuation in case of fall-out was required. The possibility that any Bikini shot might make living ashore at Bikini radiologically unsafe was emphasized. The need for adequate shipboard facilities to finish the Bikini operation from afloat was presented at this time and was reaffirmed later when more definite housing, office, laboratory, shop, and work-space requirements became available. [redacted] the Los Alamos shot of least interest at that time, and the predicted yield [redacted] had become too large to be acceptable to the DOD for a deep-water shot. Therefore this barge shot was moved into the lagoon. The [redacted] barge was moved from the Bikini lagoon to the Mike crater in order to reduce the work load at Bikini and to fire both cryogenics devices at Eniwetok close to the plants which supported them. The schedule at this time is as shown in Table 3.2, Aug. 24, 1953.

By the middle of September, as a result of several readiness meetings, including one held by the Director of the LASL and attended by representatives of interested agencies, it was decided that readiness for the first shot by Feb. 15, 1954 was most improbable, depending as it did on very tight schedules for a number of the elements involved and that Mar. 1, 1954 was a reasonably realistic date for scheduling the first shot. [redacted] on October 20 a seven shot schedule was promulgated (see Table 3.2 [redacted] it only one shot was scheduled at Eniwetok [redacted] Eberiru as the fourth shot. [redacted] moved back to Bikini because of concern about fall-out on and damage to Eniwetok installations. The four barge shots at Bikini [redacted] scheduled for one location, 2300 yd south of Yurochi. This schedule held until [redacted] it was radically changed because of fall-out and unexpectedly high yield.

The large yield and the heavy contamination that ensued brought about radical changes in the operational concept and in the shot schedule. The Firing Party was evacuated aboard ship shortly after the shot. Thereafter all personnel at Bikini lived aboard ship, traveled to and from their stations by helicopter or boat, and firing was accomplished by means of a radio link

[redacted]

from the USS Estes to the control station on Enyu. Other effects of this change in the operating plan are discussed elsewhere in this report.

The revised firing schedule issued on Mar. 6, 1954 is shown in Table 3.2. [redacted]

DELETED

3.4.2 Determination of Requirements

Most of the basic requirements for the support of Castle were determined early in 1953. They included the following: construction of an assembly area and barge slip on Parry; extensive modification and improvement of the Parry cryogenic plant; procurement of shot barges, including a deep-water barge and an array of anchors, buoys, chains, and cable to moor it; the design and construction of structures on the barges to support and house the devices and accompanying personnel; construction of shot cabs on three islands to house the devices and adjacent equipment; and construction of a massive control station on Enyu and of numerous instrument stations throughout both atolls. Construction of an airstrip and various camps on Bikini had already started. Other requirements were a Task Group voice and teletype radio link between atolls; three or four large voice radio nets at each atoll; sample planes with a capability of obtaining samples at altitudes up to 55,000 ft; an improved weather service capable of forecasting winds at high altitudes and of making wind runs in the vicinity of zero point, up to shot time, and at altitudes up to about 100,000 ft; and a large number of four-wheel-drive vehicles.

Required from the Navy were a large carrier-based helicopter group and a helicopter landing barge; the use of a ship to transport devices and major components to the Forward Area and to furnish close support to the shot barges; the use of an LSD to transport shot barges between atolls; frequent interatoll surface lift; sea planes for interatoll airlift when the Eninman strip was not available; and ships with a capability of supporting prolonged operations, including actual firing from afloat.

The need for many additional landing craft and DUKW's was immediately evident. There remained to be settled the questions of how many, where, and manned and maintained by whom.

Development of the DOD projects entailed additional support and participation by the Navy, including two drone Liberty ships, five tugs, two salvage vessels, one destroyer mine sweeper, two patrol planes, and the modification of several landing craft.

In addition to sample planes and control planes for the samplers, the following support was required from the Air Force: planes for weather reconnaissance, for DOD effects projects, and for documentary photography; L-13 and helicopter airlift at Eniwetok and helicopter lift at Bikini until arrival of the carrier-based group; and several C-47 round trips daily between Eniwetok and Bikini. Many special flights were required from the Military Air Transport Service (MATS) for the transportation to the Forward Area of devices and components not ready in time for surface shipment and for the return of samples after each shot.

MATS was also required to provide regularly scheduled airlift between Travis and Hickam Air Force Bases and Eniwetok for passengers and urgent freight; and the Military Sea Trans-

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port Service (MSTS) was required to provide surface lift between the West Coast and PPG for ordinary freight including trailers, boats, and vehicles.

Although the over-all basic requirements were fairly well known early in 1953, it was late in the year before the details of most of them were ironed out. For example, February planning for sampling contemplated the use of B-57's, F-84G's, B-36's, and a B-52 if one were included in the DOD effects program. By October it was apparent that there was little chance of any B-57's being ready for Castle, and a need had arisen for some fairly low-level sampling on each shot by a B-29. No B-52 was assigned to effects tests.

In April a monthly status report system was established which was used to determine support requirements other than technical and construction requirements of the various projects. Construction requirements were handled directly between the projects and Section J-6. Detailed housing, weather, and vehicle requirements were ready in July, and requirements for landing craft, trailer movements, transportation of nuclear components, and sample return were ready in October.

An aircraft positioning meeting was held at Los Alamos in October 1953 to establish an organization and program to enable CTG 7.1 to carry out his responsibilities in connection with recommending safe positions for aircraft at shot time while meeting, in so far as practicable, requirements for acquiring data and operational requirements. This was the first of many meetings for this purpose, most of which were held between shots in the Forward Area.

Required phasing of major elements of military support was concluded in December.

Determination of all these requirements represented months of negotiation and accumulation of information; most requirements changed in at least a minor degree as the concept and schedules changed and better planning information became available.

3.4.3 Training and Rehearsals

Details of training are covered as appropriate in the reports of the various programs, projects, and Task Units. Extensive training of personnel and testing of equipment went on before movement overseas and continued at PPG. TG 7.1 was represented in the full-scale Air Task Group rehearsal, Operation Tigercat, off San Diego in October 1953. A Task Force rehearsal preceded the first shot. Projectwise and frequencywise the participation was complete. Evacuation was not rehearsed. For a number of days before each shot, dry runs of the timing and firing system were held once or twice a day.

Operations for which timing was important, such as recovery operations and key operations scheduled for D−1 day, were rehearsed as often as necessary to determine the actual time required and to decrease that time as practicable.

3.5 MOVEMENT TO THE FORWARD AREA AND ASSEMBLY OF SUBORDINATE UNITS

3.5.1 Personnel

Information regarding the expected number of personnel to be present in the Forward Area during Operation Castle was obtained from the monthly status reports submitted prior to forward movement by the various units of the Task Group. These population figures were subdivided by location into the following general categories: sites at Bikini Atoll, sites at Eniwetok Atoll, and shipboard space. Detailed compilations were prepared showing the estimated weekly population at any location in the PPG. These population estimates were useful in determining such things as camp locations, camp size, MATS transportation required, and over-all camp support required of H&N. In comparing the estimates made during the fall of 1953 with the actual strengths, it is to be noted that the latter consistently ran approximately 80 per cent of estimated.

The total number of quarters in all camps requested by the Task Group exceeded the total population by about 20 per cent. The excess was required to permit some personnel who moved frequently between locations to have permanent quarters in two camps. During the operation it was discovered that many persons who had requested a billet only in some camp other than

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Parry were required to be on Parry part of the time with a consequent crowding of that camp. Especially after the land camps at Bikini were no longer habitable, personnel came to regard the Parry camp as headquarters and desired to have a permanent billet there. Since the Task Group had too few spaces on Parry to assign each member a billet for exclusive occupancy, a "hotel" system was used, and persons visiting Parry from other camps were billeted wherever space was vacant. This system was inconvenient and unsatisfactory, but it was the only solution to the excess of persons over quarters. It is recommended for future operations that each person have a permanent space in the base camp, regardless of the time he may spend at other locations.

Each individual traveling to the Forward Area was required to complete a minimum of processing prior to his departure. This processing was controlled by the Adjutant General at Los Alamos. Additional personnel-processing points were established at UCRL, Livermore, and at Lookout Mountain Laboratory, Los Angeles, to accommodate the personnel from these stations. This processing included the following:

1. Preparation of travel orders for each individual.
2. Preparation of identification cards for those persons not already possessing them.
3. Notification to each individual of the immunization requirements for travel west of Hawaii and the procedure for obtaining this immunization.
4. Issuance of necessary government transportation requests to military personnel required to use commercial transportation within the Zone of Interior (ZI).
5. Notification by teletype to the TG 7.1 senior representative at PPG of the expected time of arrival of each individual.

The movement to the Forward Area was by individual rather than by unit. Most nongovernment employees traveled from the West Coast to Hawaii via commercial airline and thence to the Forward Area by MATS. Military personnel and DOD civilian employees, with few exceptions, traveled from Travis Air Force Base, California, to the Forward Area via MATS. A small percentage of personnel, both military and civilian, were transported by MSTS or naval ships.

Eniwetok Atoll was considered the base of operations for the entire Forward Area. The largest portion of the Task Group personnel was located at this Atoll. Bikini Atoll was used as a forward working area for those units participating in the shots fired at this location. A maximum population of 1027 was attained in the Forward Area on Feb. 27, 1954 when 536 persons were at Eniwetok Atoll (including 16 at other miscellaneous islands), and 491 were at Bikini. A complete chart, showing the total personnel present by week, is shown in Fig. 3.3.

Although the majority of personnel were present at Eniwetok and Bikini Atolls, a few of the project personnel of TU-13 were based at Guam, Wake, Kwajalein, Ponape, Kusaie, Johnston, and Rongerik. These projects situated at outlying sites were primarily concerned with long-range fall-out, biomedical studies, ionosphere recordings, water-wave studies, and micro-barography.

All arrivals at Eniwetok Atoll were processed by the Headquarters Commandant for TG 7.1 at Parry Island. This processing included billeting, arrangement for transportation to other locations, and an orientation with regard to facilities and procedures in the Forward Area. An accurate daily account by name was kept to show individuals present at each of the major locations.

3.5.2 Equipment

Movement of equipment of the Scientific Task Group was accomplished by two means of transportation, namely, by water and by air from the ZI to the Forward Area and will, therefore, be discussed in separate subsections.

(a) Water Every effort was made to move the maximum possible amount of equipment to the Forward Area by water from the Naval Supply Center, Oakland, Calif., and to so schedule the arrival of cargo at the Naval Supply Center that it could be moved on regularly scheduled MSTS cargo ships which sail about once a month to Kwajalein and Eniwetok. However, owing to the large number of large trailer vans and other heavy lifts which required deck loading, it

[redacted]

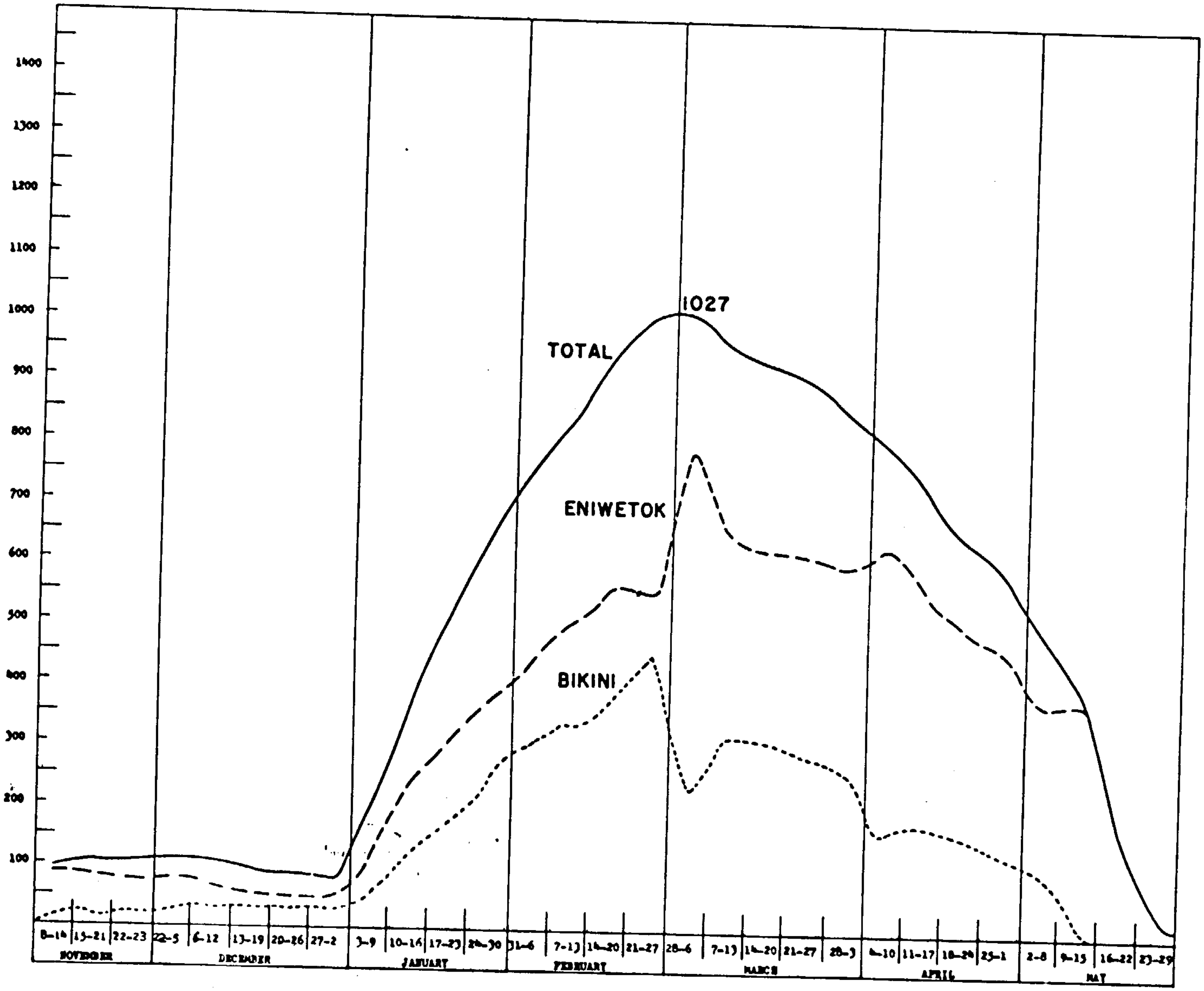

Fig. 3.3—Task Group 7.1 weekly average population at the Pacific Proving Grounds, November 1953 through May 1954.

[redacted]

was necessary to schedule two ships for both November and December of 1953. Water movement of equipment began in August, reached a peak in November and December, and was completed by the ship in January 1954.

J-4 assembled data from the routine monthly status reports of various projects relative to the shipment of equipment and material including the type and volume of equipment to be shipped and also the time the shipper could have the cargo arrive at Oakland. By coordinating with J-3, J-4 was able to determine when it was operationally necessary for the equipment to reach the Forward Area. Projects were then informed by letter of the date cargo should reach the Naval Supply Center. In many cases project equipment was scheduled to move over a three- or four-month period. Close contact was maintained between the J-4 Office at Los Alamos and the J-4 Liaison Officer at the Naval Supply Center to control loading of vessels in accordance with operational priority requirements. Movement of all water-lifted cargo was accomplished on schedule and without loss of any equipment and with only minor damage to two trailers during the off-loading of equipment in the Forward Area. Ships were routed to discharge cargo at both Bikini and Eniwetok Atolls, which eliminated unnecessary shuttling of equipment from Eniwetok to Bikini.

Water Shipments (MSTS), ZI to PPG

October 1953, 286 L/T	January 1954, 984 L/T
November 1953, 375 L/T	February 1954, 393 L/T
December 1953, 939 L/T	March 1954, 15 L/T

April 1954, 2 L/T

Total: 2994 L/T

Seventy-nine large van trailers were included in the above tabulations.

(b) Air. Air shipments of equipment to the Forward Area were placed in the MATS system at Travis Air Force Base. Control of air shipments was maintained in the J-4 Office at Los Alamos by means of restricting the issuance of air priorities to that office. Every effort was made to restrict air shipments to material and equipment which, owing to its sensitive nature, such as film or delicate instruments, or owing to the rush requirement for operational use, precluded shipment by water. Also certain weapon components were shipped by air, as discussed in Sec. 3.6.

All air shipments were consigned to Eniwetok and, when necessary, forwarded by daily C-47 shuttle to Bikini.

Air Shipments (MATS), ZI to PPG

October 1953, 8,000 lb	January 1954, 74,000 lb
November 1953, 18,000 lb	February 1954, 61,254 lb
December 1953, 42,000 lb	March 1954, 27,033 lb

April 1954, 12,049 lb

Total: 242,336 lb

3.6 MOVEMENT OF DEVICES AND COMPONENTS

Movement of devices and components from the ZI to the Forward Area was accomplished by shipment on the USS Curtiss and by four USAF Special Air Mission (SAM) flights.

A warehouse was reserved at the Oakland Naval Supply Center to receive and hold Castle weapon components as they arrived from the laboratories and fabricators. Material was shipped by AEC guarded motor convoys from Los Alamos, Albuquerque, and Livermore to arrive at the Naval Supply Center prior to Jan. 1, 1954. Other small components were flown from Kirtland Air Force Base and Boulder, Colo., to Alameda Naval Air Station for loading

[redacted]

on the USS Curtiss. Material assembled at the Naval Supply Center was loaded on the USS Curtiss Jan. 8 and 9, 1954, and care was taken to place material for selective discharge at three different sites in the Forward Area. The vessel then moved to Port Chicago, Calif., to take on components such as detonators and high explosives and sailed on Jan. 10, 1954.

Since the classified weapon components used up all the carrying capacity of the USS Curtiss, dummy weapons were shipped on the last cargo vessel in December under an armed M. P. guard.

Cargo was discharged at the following places on dates indicated: Rojoa, Jan. 24, 1954; Parry, Jan. 25 and 26, 1954; and Eninman, Jan. 27, 1954.

Four SAM flights carrying weapon components flew from the ZI to the Forward Area as follows:

One C-124 arrived at Eniwetok, Mar. 5, 1954
[redacted] beta case
[redacted] handling gear
[redacted] component
Polonium and curium source

One C-124 arrived at Eniwetok, Mar. 9, 1954
[redacted]
Allied equipment

One B-36 arrived at Eniwetok, Apr. 16, 1954
[redacted]

One C-124 arrived at Eniwetok, Apr. 16, 1954
B-2 trailer and allied equipment

Return of weapon components to the ZI was accomplished as follows: [redacted]tain TU-4 spare components left over from other weapons, as well as TU-14 spare parts left over [redacted] were loaded on the USS Curtiss for return to the ZI. The USS Curtiss sailed from Eniwetok on May 14, 1954 for Port Chicago, Calif., where cargo was to be discharged for return to the respective laboratories at Los Alamos and Livermore.

3.7 ON-SITE OPERATION AND REHEARSAL

3.7.1 General

In planning Castle the philosophy involved was to consider Eniwetok as the base and Bikini as just another shot island. Within limits this plan was carried out; but the magnitude of the Bikini effort, the distance involved, communication difficulties, and the abandonment of many shore-based facilities at Bikini after the first shot made it necessary to provide a much larger staff and more facilities at Bikini than had been assigned to any shot island in the past.

Throughout the operation many programs, task units, and all staff sections were well represented at both atolls, and toward the end of the operation all projects involved at both sites had representatives at both locations and were ready to shoot at either of them on 18-hr notice or less. In this respect greater flexibility was achieved than had been the case in any previous operation.

3.7.2 Test Facilities

Criteria for the design and construction of test facilities and estimates of labor and equipment support required by TG 7.1 were collected from the various Task Unit Commanders, Program Directors, and Project Officers by J-6. Conflicts were resolved, locations were assigned, completion dates were established, and the total requirements were passed to TG 7.5 for execution. In addition to the foregoing basic responsibility, J-6 also prepared the work orders necessary for the actual support of the various projects; operated a system of machine shops for the convenience of the experimenters; furnished a representative at each of the LASL

[redacted]

zero points to coordinate the activities of the various projects in these congested areas; and assigned tent, trailer, and laboratory space as required.

J-6 was composed of 10 men representing the DOD, UCRL (Livermore), and LASL, with the LASL group serving as the final clearing house for all three agencies in transmitting the requirements of TG 7.1 to TG 7.5. During the planning phase the four UCRL representatives functioned from their own laboratory, whereas the DOD representative established residence at Los Alamos. During the instrumentation and shot periods these three groups combined in the Forward Area, and representatives of this combined group were stationed at the various sites throughout the PPG where major activities concentrated. Under this method of operation in the field, individual members of the group were not restricted to problems of their parent agency and frequently assisted other agencies in accomplishing the over-all mission of the Task Group.

During the period from October 1952 to May 1953, devices or weapons and experiments were added or deleted from the operation with a frequency that produced a continual revision of the test facilities required by the resulting scientific programs. However, at the end of May 1953, it was estimated that the basic criteria necessary for the design of 95 per cent of the scientific structures had been transmitted to the AEC Field Manager, Eniwetok Field Office. The technique employed during this period was to delineate items which would be required in the operation regardless of the concept of the day. This included items such as the Parry assembly area, the Bikini submarine cable system, modifications to the Parry cryogenic plants, and the basic major scientific stations. This approach was necessary because the time involved in design, procurement, and construction precluded waiting until the concept was firm and locations were selected before gathering the test-facility criteria.

Final zero positions for the six shots then in the program were selected in June, and the location of all stations with respect to these zero points was completed and published in a preliminary instrument chart. The addition of the seventh shot in August did not require additional facilities beyond the barge from which it was to be fired.

By mid-July construction was sufficiently advanced to necessitate opening the J-6 Office in the Forward Area to maintain close coordination with the construction forces. Upon arrival of the experimenters in January and February of 1954, the major portion of the test facilities were ready for use.

The revisions in the shooting sequence and locations resulting from the effects of the first and subsequent shots had little effect upon the facilities required beyond an expansion of the existing capability of firing a barge shot in the Mike crater at Eniwetok Atoll.

In the course of the operation approximately 700 scientific stations were constructed, nearly 1500 work orders were prepared, and 21 man-months of machinist time was expended in the J-6 Shop in support of the mission of TG 7.1.

3.7.3 Intra-atoll Airlift

Local airlift between the islands of the Bikini and Eniwetok Atolls was required owing to the widely scattered experiments which were conducted during Castle. The operating agency for these airlift services was TG 7.3 at Bikini and TG 7.4 at Eniwetok.

Late in 1953 the Bikini intra-atoll airlift was put into operation with a total of seven H-19 helicopters operated by an Air Force detachment. In January regularly scheduled flights originating at Eninman Island proceeded around the atoll in clockwise and counterclockwise directions alternately, stopping at Enyu, Romurikku, and Namu Islands. Ten daily flights were ample to handle the traffic when augmented by special flights until the last week in January, when an increasing atoll population required a total of 12 flights daily to meet the traffic demands. At this time the Marine Corps Helicopter Squadron arrived and assumed the responsibility for the airlift. The Air Force detachment continued to provide a portion of the airlift service in coordination with the Marines until they and their aircraft were phased out to Eniwetok just prior to the first shot.

During February the Marine Corps aircraft, although based for maintenance aboard the carrier, were based for operation on the beach at Eninman, where they could be more easily

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handled and dispatched in the airlift service. All requests for the use of helicopters, whether on regular flights or for special missions, were handled through the J-3 Section, which controlled the dispatch of the helicopters through a central H&N dispatcher, who handled the arrival and departures of passengers and cargo. A separate radio net for the dispatcher greatly facilitated the flow of traffic, which during the peak period in February hit a rate of about 3000 helicopter passengers per week.

With the loss of the land base at Eninman Island DELETED this picture was altered somewhat. All helicopter flights became special missions which, in most cases, were requested and laid on the previous night. The requests were normally submitted by project leaders and Task Unit Commanders to the J-3 Section on the USS Estes who relayed them to the J-3 representative on the USS Bairoko. The consolidated requests were then submitted to the ship's Operations Officer, and the schedule for the following day's missions was drawn up. In addition to these, there were perhaps again as many requests for transportation submitted during the day; therefore one day's operation might consist of the dispatching of as many as 40 helicopter missions, many of which represented combined missions.

The Eniwetok intra-atoll airlift employed three types of aircraft: the L-13 liaison aircraft, the H-13 two-seated helicopter, and the H-19 helicopter. The L-13 was used to transport passengers to the four islands having landing strips where an H-13 would be available to shuttle passengers to nearby installations. The H-19 was used for lifting groups of people and heavy equipment directly to their destinations.

For this service, TG 7.4 provided five L-13, four H-19, and two H-13 aircraft which were controlled from the Parry airstrip by the Operations Officers of TG 7.4. This number of available aircraft fluctuated so that occasionally there was a shortage of H-19's which somewhat hampered the operation.

3.7.4 Interatoll Airlift

The Bikini-Eniwetok airlift was operated by TG 7.4 as a scheduled airline over the 180 nautical miles between the two atolls. Four C-47 aircraft were available to provide four round-trip flights daily, which were ample to handle the normal traffic load through January and February. Two PBM aircraft were also available for augmenting the interatoll airlift.

Requests for space aboard the flights were submitted to the J-3 Section at either Bikini or Eniwetok, which made the necessary arrangements with the H&N dispatcher for the handling and manifesting of passengers. During a representative week in February there were 300 TG 7.1 passengers carried between the atolls, along with about 25,000 lb of priority cargo arranged for by the J-4 Section.

With the Bikini airstrip out of commission DELETED the PBM aircraft were used to provide limited airlift between the atolls. The choppy waters of the lagoon and the inherent difficulty of handling small boats for the transfer of passengers greatly limited their use, however, and the C-47 lift was reinstituted when the radiation levels permitted reentry to the airstrip.

In view of the fact that the C-47 aircraft were utilized for flights other than those between Bikini and Eniwetok, the schedule of four flights per day was difficult to maintain for an extended period. Therefore, if the same number of flights are required on a future operation, more transport aircraft should be available.

3.7.5 Motor-vehicle Transportation

Two main motor pools for general- and special-purpose vehicles were established on Oct. 30, 1953, one at Parry Island and the other at Eninman Island. These pools became the control points for the utilization of all vehicles on the respective atolls.

All maintenance and repair of the vehicles of TG 7.1 were accomplished by H&N. Their dispatching was a function of the J-3 Transportation Officer, who assigned vehicles on a permanent or daily basis to the various units of TG 7.1 according to previously established vehicular requirements. Daily dispatching was practiced for all vehicles in order to utilize them most efficiently.

[redacted]

The new military vehicles were procured by JTF SEVEN and shipped to the Forward Area where they were processed and issued by TG 7.2 on memorandum receipt to the J 4 Section. Some additional vehicles, World War II types of general-purpose vehicles, were made available by the AEC and Project 1.8. Project 1.8 also authorized the temporary use of some of the jeeps which were later to be used as test vehicles, and two of the projects, Naval Radiological Defense Laboratory (NRDL) and Lookout Mountain Laboratory, provided a number of their own vehicles.

During the peak of the operation there were 121 vehicles of all types in use by TG 7.1 on Eniwetok and 110 similarly in use on Bikini Atoll. By types and owners these were as follows:

Owner	Type	Number
JTF SEVEN	$\frac{1}{4}$-ton (4 × 4)	72
	$\frac{3}{4}$-ton (4 × 4) w/winch	20
	$\frac{3}{4}$-ton (4 × 4) w/o winch	47
	$2\frac{1}{2}$-ton (6 × 6) w/winch	5
	$2\frac{1}{2}$-ton (6 × 6) w/o winch	5
	5-ton (6 × 6) truck-tractors	3
	$2\frac{1}{2}$-ton decontamination trucks	2
	$1\frac{1}{2}$-ton trailers, water, 450 gal	2
USAF	$7\frac{1}{2}$-ton truck-tractors	3
	$2\frac{1}{2}$-ton (6 × 6) flat bed trucks	2
	5-ton wrecker	1
	7-ton wrecker	1
AEC	$\frac{1}{4}$-ton (4 × 4) (World War II)	19
	$\frac{3}{4}$-ton (4 × 4) (World War II)	6
	$1\frac{1}{2}$-ton (6 × 6) (World War II)	6
Project 1.8	$\frac{1}{4}$-ton (4 × 4) (test vehicles)	27
NRDL	$\frac{1}{4}$-ton (4 × 4)	5
TU-9	$\frac{3}{4}$-ton (4 × 4)	5

Prior to the first shot, most of the vehicles on the upper islands of Bikini Atoll were evacuated to Enyu and Eninman where they were used by TG 7.1 personnel in preparing for subsequent shots. These were gradually evacuated to Eniwetok as the shot schedule progressed so that [redacted] the total number of TG 7.1 vehicles at Bikini was eight. DELETED

At Eniwetok a concerted effort was made to reduce the number of assigned vehicles by turning them over to the J-4 Section, particularly after the departure of UCRL personnel [redacted] The vehicles were turned in to the H&N maintenance shops for first and second echelon maintenance and then returned to TG 7.2 for disposition.

3.7.6 Intra-atoll Boat Service

The intra-atoll boat service was set up to provide efficient boat transportation for both Bikini and Eniwetok. The system provided for scheduled runs between established island camps and for nonscheduled trips to outlying islands and lagoon stations. It was also necessary to furnish boat transportation for evacuation of both personnel and material and to provide for boats and DUKW's for the recovery of records and samples after the shots.

At Eniwetok the surface lift was handled by the H&N boat pool which maintained an average of ten LCM's, four LCU's, and two water taxis in operation. Dispatching of boat trips was accomplished by the H&N Marine Department. Requests for trips by the Scientific Group were made to the J-3 Section which in turn scheduled the trips with the H&N dispatcher and issued boat request forms. In cases of conflict or when there were insufficient boats available, the

[redacted]

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J-3 Section resolved the problem by arranging alternate solutions. During the period D−3 to D+3 boats were scheduled in writing in advance after consultation with experimental personnel. This was necessary because of the large number of trips involved.

Regular passenger and freight runs were made between Parry and Eniwetok Islands and between Parry and Rojoa Islands. Nonscheduled trips were sent as requested to virtually all the other islands of the atoll and to the many lagoon raft, buoy, and barge stations. There was considerable nonscheduled traffic between Parry Island and ships anchored in the lagoon for both passengers and freight.

At Bikini the surface lift was handled jointly by the H&N boat pool and by the TG 7.3 boat pool. The H&N boat pool maintained an average of nine LCM's, five LCU's, and eight DUKW's in operation, whereas the Navy boat pool maintained an average of sixteen LCM's, five LCU's, and eight DUKW's in operation. Dispatching of all boat trips was accomplished through the H&N Marine Department, to which the Navy boats were assigned daily as required. Requests for trips by the Scientific Group were handled in the same manner as those at Eniwetok, through the J-3 Section. After operations at Bikini became entirely waterborne, all boat trips were dispatched by the H&N boat dispatcher on the USNS Ainsworth who worked in coordination with the Navy boat dispatcher on the USS Belle Grove.

The Bikini service provided for regular passenger and freight runs between Eninman and Namu, Aomoen and Enyu, and Namu and Aomoen Islands. Special runs were made to virtually all other islands of the atoll and to the numerous lagoon raft, buoy, and barge stations. There were, in addition, a large number of trips between ships and the islands and from one ship to another. When the camps had been closed and the entire operation became waterborne, there were regular boat trips among the ships.

In addition to the boat-pool craft for common use, there were a number of project boats and boat-pool craft which worked exclusively with certain groups. Among these were the buoy boat and whale boats of Project 1.6 and the specially fitted LCU's and LCM's for Projects 3.2 and 1.4, respectively.

Prior to the shots the Scientific Group requested an average of seven boat trips per day at each atoll. During the period D−3 to D+3, the average number of requests was 14 per day. These figures cover special trips in direct support of scientific work. An average of 14,000 persons per month moved by boat at Eniwetok, and an average of 15,000 persons per month were moved at Bikini. The freight handled at each atoll amounted to an average of 50,000 measured tons per month. These figures include personnel and freight concerned with H&N support as well as direct scientific support. Boat maintenance was performed at Eniwetok by the H&N Marine Department shops. At Bikini work on H&N boats was performed at Eninman Island until the camp was abandoned, and then it was performed by the USS Belle Grove. All work on the TG 7.3 boats was done by the USS Belle Grove.

3.7.7 Interatoll Surface Lift

The interatoll surface lift was set up to move large amounts of cargo from Eniwetok to Bikini during the early period and to move large amounts in the reverse direction during the later period. This lift also provided space to move passengers between atolls. Regular runs were made by LST 762 and LST 551 except for a period when LST 551 required repairs and a substitute vessel took her place. These ships alternately made round trips which averaged six days each. The trips were scheduled by the H&N Shipping Department which arranged for all loading and unloading. Scientific materials, trailers, and special shipments were handled by J-4 through H&N shipping personnel. The surface lift moved large quantities of scientific equipment as well as support supplies. An average of 1100 long tons of freight and equipment belonging to TG 7.1 was moved between atolls each month until the first-shot day. The figure was considerably reduced after this event. The lift proved to be adequate at all times.

During the period when the Eninman Island airstrip was unserviceable, one ship of TG 7.3 sailed each day from both atolls to assist in moving freight and passengers. The type of ship used in these trips ranged from LST's through fleet tugs to destroyers. The USS Belle Grove made two trips between atolls carrying loaded LCU's in order to move H&N heavy equipment

[redacted]

which could not be carried in other types of ships. Each time the LSD moved a shot barge, the extra space in the well was utilized to carry loaded LCU's between atolls.

3.7.8 Off-atoll Activities

Owing to the expanded facilities at Eniwetok and the inclusion of Bikini Atoll in PPG, off-atoll activities were reduced in comparison to the number of such activities in Operation Ivy. Of a total of nine off-atoll projects, eight were sponsored by DOD.

Five of the off-atoll projects required no active or continuous support from this headquarters other than notification of shot delays. In general these were concerned with long-range effects and used existing facilities within their own organizations.

The projects involved in off-atoll activities were as follows:

1. Project 1.2: Acoustic pressure signals in water, with various stations in the Atlantic and Pacific oceans.
2. Project 1.6: Water-wave studies, a project participating both locally and at stations at Midway, Wake, Guam, and California.
3. Project 4.1: Biomedical studies, which were established [redacted] at Kwajalein to study the effects of the inadvertent fall-out on the residents of Rongerik and Rongelap Atolls.
4. Project 7.1: Electromagnetic radiation calibration, with stations in the United States, Hawaii, Alaska, Scotland, and Greenland.
5. Project 7.2: Detection of airborne low-frequency sound, with stations in Japan, Hawaii, Alaska, Greenland, and Germany.

The four other projects operating off-atoll for which direct support was arranged by this headquarters were as follows:

1. Projects 2.5a, 2.5b: Fall-out distribution studies at Kwajalein, Ponape, Kusaie, and Majuro.
2. Project 17.1: Microbarography, with stations at Kwajalein and Ponape.
3. Project 6.6: Ionospheric effects studies at Rongerik.

The gross fall-out collectors of Projects 2.5a and 2.5b required no support during the operation and were collected [redacted] The microbarographic stations on Kwajalein and Ponape required weekly visits for rotation of personnel. Scheduled MATS airlift was used when possible, but an occasional special PBM or SA-16 flight was required to accomplish this rotation. Boat transportation to secondary stations, necessarily several miles removed from the base stations, was provided locally.

The greatest support difficulties were experienced in connection with Rongerik Atoll and Project 6.6, where LST 551 was damaged during unloading of equipment on the beach in January and was out of commission during the critical build-up period. The station had to be abandoned in March [redacted] and was only reactivated in April by providing off-shore support for the personnel in the form of a PC or DDE. The project people lived aboard the vessels and manned the station through expected shot times. The rotation of these people and those of Project 17.1 at Ponape was frequently hampered by a critical shortage of aircraft space.

3.8 SHOT-PHASE EVACUATION

3.8.1 Planning

As soon as it was determined that consideration of blast and radiological hazards would require complete evacuation of personnel except the Firing Party from Bikini Atoll for the first test [redacted] and probably for subsequent tests, planning for such evacuations commenced in the ZI to be sure that adequate facilities, especially seagoing vessels, were provided.

For planning purposes the monthly status reports of the projects yielded much information with regard to the location of instrumented stations, the numbers of people involved, and their distribution throughout the atoll. Because of the size and scope of the operation, it was planned to establish a chronological check list for each of the shots, listing the activities to take place

[redacted]

during the five days prior to shot time. It was believed that this would provide for an orderly movement of personnel and equipment with minimum interference to experimental preparation during the critical period.

After arrival of the various commands in the Forward Area, detailed planning was started. Conferences among JTF SEVEN and the several Task Groups were held to settle such matters as appointment of Transport Quartermasters, ship positions, ship movement, allocation of shipboard space to the various Task Groups, and muster. Planning by TG 7.1 was accomplished, based on the information discussed at these meetings.

The [redacted] evacuation plan was the most detailed of those issued during Operation Castle since it was to cover the initial evacuation, establishing procedures which would be followed in subsequent evacuations. Each event description on this check list included the names of the people involved, the times, and the support required. The final [redacted] plan was issued on February 20, as an appendix to TG 7.1 Operation Plan No. 1-54. It included information on ship positions; evacuation deadlines; instructions for the use of boats, helicopters, interatoll surface and air transportation; trailer movements; and other general subjects. As the events on this check list took place, they were checked by J-3 to ensure completion. The check list was kept current by nightly conferences. It was necessary for the J-1 and J-3 Staff Sections to work in close cooperation to determine the disposition of the Task Group personnel aboard ship. It was agreed that as soon as an individual's contribution to the shot was completed, he would be evacuated either to Eniwetok Atoll or to one of the evacuation ships, depending upon the location of his required postshot activities. The operational functions of the principal evacuation ships were as follows:

USS Estes: Command, Staff, and Advisers
USS Curtiss: Weapons assembly and shot barge support
USS Bairoko: Rad-Safe and recovery parties
USNS Ainsworth: Personnel required in the area but not assigned to other vessels

Instructions issued to personnel to be evacuated [redacted] included disposition of classified documents, personal effects to be taken aboard, shuttle boat schedule between ship and shore, and the like. A passenger list for each ship was initiated [redacted]-10 day. On [redacted]-3, corrected and final passenger lists were submitted to JTF SEVEN. Each individual at Bikini was issued a card indicating his assignment to a room aboard a specified ship.

Subsequent evacuation planning at Bikini became a much simpler process owing to the waterborne nature of the operation [redacted] With island camps no longer available, the movement of personnel and equipment between ships and islands was more subject to control, and preshot evacuation became largely a matter of moving the vessels out of the lagoon. Planning for these evacuations accordingly was simplified and consisted of check lists for the final day's activities.

At Eniwetok a plan to evacuate the upper islands was prepared [redacted] but the evacuation was halted when the shot was canceled on [redacted]-2 day. Most of the personnel and equipment were drawn out of the upper islands of Eniwetok Atoll, and the Ursula camp was abandoned soon afterward. [redacted] a similar plan was prepared and executed.

3.8.2 Personnel Evacuation and Muster

On [redacted]-2 the evacuation to the ships began for this shot. J-1 representatives went aboard their respective ships prior to the embarkation of passengers to assist Task Group personnel in locating quarters, offices, etc. A majority of personnel moved to shipboard on the morning of [redacted]. At approximately noon on [redacted] the vessels left their anchorages off the various islands and assembled at anchorage off Enyu. Here the remainder of the personnel were taken aboard, and personnel were transferred as necessary to be located on the proper vessel. The ships then left the lagoon.

The plan for a complete sight muster involved assignment of Task Group personnel to 25 muster groups, each representing a specific organization or working unit. For each muster group a muster officer was appointed. Muster lists were prepared by J-1 and distributed to the muster officers, and at a predesignated time a sight muster of all Task Group personnel in PPG was conducted.

Muster [redacted] was taken simultaneously at both atolls on [redacted]-2 at 1800 hours. Each muster officer turned in to the J-1 representative at his location a signed muster sheet indicating that portion of his personnel he had sight-mustered. The J-1 representatives then reported that portion of the muster he had received to the Task Group Muster Officer for his atoll. The Task Group Muster Officers for Bikini and Eniwetok then consolidated the entire muster, accounting for all personnel in the Forward Area. Upon completion of the muster at Bikini, J-1 representatives were stationed at each ship's gangway to register personnel embarking and debarking. These arrivals and departures were then reported to the Bikini Task Group Muster Officer. A running account of the movement of each individual was kept, and the muster was completed at about 1830 hours on [redacted]-1 when all personnel were afloat.

As a result [redacted] the land areas of Bikini Atoll were closed except to work parties, and all personnel were quartered aboard ship, which simplified the personnel-evacuation problems for subsequent tests. Since shipboard space was limited, the numbers of personnel at that site between shot times were reduced to half of the peak reached in the latter part of February. Similiarly, the numbers present at Bikini for muster at shot time were often only half [redacted]. For shots subsequent [redacted] mustering on the Estes, Curtiss, and the Bairoko was accomplished personally by the J-1 representative aboard. On the Ainsworth, where the population was the greatest, a modified system of muster groups was used. Once the muster commenced, gangway checks were maintained to assure the complete accountability of all Task Group personnel. At Eniwetok the system used [redacted] was continued throughout the operation.

[redacted] exact muster times varied with each shot and depended upon existing conditions, but, in general, a minimum amount of time was permitted for mustering purposes. Similarly, not all musters were concurrently conducted at Bikini and Eniwetok. It is to be noted that [redacted] a muster was conducted at Bikini only. Complete control of personnel movement to and from Eniwetok, close liaison with J-3, and good communications proved to be the solution to an easily completed muster.

3.8.3 Evacuation of Property

[redacted] personnel of J-4 were stationed at strategic points during critical phases of evacuation and reentry to facilitate the expeditious handling of property of TG 7.1 requiring movement to and from various points both at Bikini and Eniwetok.

[redacted] the original planning called for evacuation of all TG 7.1 property from sites Bokobyaadaa, Namu, Yurochi, Romurikku, and Aomoen to sites Eninman and Enyu as well as movement on [redacted] day of a number of semitrailers and certain special cargo from Bikini to Eniwetok by LST. In order to implement the above, J-4 personnel were stationed at Namu, Romurikku, Enyu, and Eninman to see that the evacuation was carried out without difficulty, which was accomplished with the exception that it took 3 hr longer than planned to complete the off-loading and placement of final loads of vehicles evacuated to Enyu.

Original planning called for reentry and normal operation from ashore sites [redacted] when it was found that ashore operation was impossible, it became necessary to evacuate a large amount of TG 7.1 property from Eninman and Enyu to Eniwetok. There was a period of three weeks of unexpected shipping activity required by immediate evacuation of vehicles and operational support property no longer needed at Bikini owing to afloat operation and the possibility of further damage to property not required for operational use which could be evacuated to Eniwetok. During this period over 30 semitrailers and 50 motor vehicles of various types, along with tons of other general property, were moved from Bikini to Eniwetok. This movement was carried out by work parties from ships in the lagoon. There was only one point where an LST could beach, and difficulty was encountered on several occasions because of LST grounding on a sandbar at beaching site. There was only one crane available for loading. No property was left behind, but the operation was very limited in the amount of

[redacted]

property that could be evacuated at one time. Subsequent to the evacuation of material [redacted] only normal expected activity was encountered in connection with evacuation for the various scheduled shots.

3.9 OPERATIONS AFLOAT

[redacted] Headquarters, TG 7.1, was transferred to the [redacted] February 28. With the advent of fall-out and damage to the Eninman complex [redacted] it became necessary to maintain TG 7.1 Headquarters on the USS Estes for the remainder of the Bikini Operation, which included all but the last shot, and to conduct operations from afloat.

The Bikini phase of the operation involved a total of five vessels, each with a special task. The USS Estes was the command ship fitted out for the control of aircraft used in tests. The USS Curtiss was especially suited for the support of the shot barges and classified material, whereas the USNS Ainsworth housed the bulk of the experimental and support personnel. The USS Bairoko and the USS Belle Grove provided helicopter and boat support, respectively; in addition the USS Belle Grove transported the shot barges from Eniwetok to Bikini Atoll. Besides these major vessels, there were a total of five ATF's, two LST's, four DDE's, one PC, and assorted special-purpose craft involved in support of lagoon experiments.

Operationally, the majority of the planning for each day's activities originated aboard the USS Estes where the Commanders of the Task Units and representatives of service organizations were located. These plans were organized into missions which were then relayed to either the USS Bairoko or the USNS Ainsworth, depending upon the type of support required for each mission.

The J-3 representative aboard the USS Bairoko, in turn, worked out a schedule of flights to meet these demands and present the requirements to the Operations Officer who coordinated the schedule with other requests and dispatched the flights. In practice the two individuals cooperated in making up the schedule so that the most efficient use of helicopters could be realized in view of the demands placed on the USS Bairoko by other agencies. The importance of giving highest priority to the requirements of the experimenters was understood by the Operations Officers.

Boat requests were relayed to the J-3 representative on the USNS Ainsworth, who presented them to a boat panel comprised of representatives of TG 7.3 and 7.5 who allocated boats to meet these requests. Again, the requirements of the Scientific Group were given first priority. The only real difficulty with the operation came out of the delay inherent in the operation of boats in the choppy lagoon waters.

The operation was greatly facilitated by the communications systems between the vessels, which consisted of the 10-, 30-, or 60-watt Motorola transmitters and receivers and the "Joshua" circuit, an HF voice link between the USS Estes and Parry Island Headquarters of TG 7.1.

A ship-based operation of the magnitude of Castle would seem to be feasible only if the instrumentation of experiments is complete prior to the shot phase. The activities necessary to keep up the stations; rework them between shots; and support all the numerous service activities such as power generators, timing and firing stations, and other nonexperimental but vital installations were sufficient to tax the capabilities of the fleet available for Castle. Boat operation is in itself a hazardous occupation in the rough water of Bikini lagoon, limiting the amount of traffic and loads necessary at the onset of such an operation.

An important factor in operating afloat is the psychological approach of personnel to the business of running a complex operation in what at first seems to be a vacuum of isolation. This can be alleviated in the future by sending representatives of the TG 7.1 staff to the vessels early in the operation so that they may become acquainted with the ship's company and the physical conditions and locations of their office space. This may save much confusion on future operations.

[redacted]

The problems involved in the recovery of experimental data following each shot were quite similar for all shots in the Bikini area since the conditions established [redacted] held throughout the operation. Despite earlier qualms regarding the complexities of shipboard operation, most recoveries were effected as early as could have been expected, any real delay being for the most part due to radiological considerations.

A certain amount of study of the recovery problem had preceded the overseas phase of the operation. Recovery methods were discussed, and the various support items were laid on. In the field further discussions of recovery methods resulted in a firm operating plan which was then given a full rehearsal with such vehicles, helicopters, or boats as the mission required.

The [redacted]covery plan was issued on February 22 as a result of these discussions. It detailed the movements of each project for the period from shot time through [redacted] days when it was felt that the majority of the recoveries would have been accomplished. The results [redacted] caused this plan to be abandoned, and recovery of data went at a much slower rate than planned due to the extensive fall-out in the islands. This experience led to the conclusion that detailed plans based on assumptions of yield and fall-out patterns were of little value except as they served to acquaint the operations people with the problems involved. Subsequent plans were far less elaborate, allowing leeway for conditions which could not be predicted. Essentially these were lists of the participating projects, the locations of the instrument stations, and the types of vehicles and other support most likely required.

Following each shot the CTG 7.1 left the USS Estes to make an initial survey of the atoll to determine the damage to the stations and the radiation levels in critical areas. Upon his return the approximate times for the recovery missions were decided upon, and the early missions were dispatched. Some of these were made while the vessels were at sea, but the majority of the recoveries waited for the reentry of the fleet into the lagoon, when the recovery teams could be collected and dispatched by helicopter or boat. In all cases the recovery missions were closely coordinated with the Rad-Safe Control Officer, who determined that the personnel were properly badged and clothed, and accompanied by a qualified monitor before proceeding into a contaminated area. The J-3 representative aboard the USS Bairoko directed the helicopter missions and made certain that the crews and project personnel were properly briefed. It was found that confusion and misunderstanding could be avoided by requiring that all helicopter recovery missions originate on the carrier in order to bring the people together to talk over the missions.

Of the total of 63 projects participating in Operation Castle, approximately 75 per cent took part [redacted] Of these, about 30 per cent were able to make at least limited recovery on shot day, using helicopters to get into the hot areas for short visits. Generally, the recovery time depended on the distance of the station from Ground Zero, but the majority of the recovery missions went out on the day following the shots when the radiation levels had fallen somewhat. The exceptions to this were [redacted] when all recoveries were delayed due to extensive fall-out, and [redacted] when the low yield permitted immediate reentry into the islands.

Precautionary measures were observed on those missions entering hot areas, where engine failure or other mishap could result in dangerous radiation overdose. Helicopters flew in pairs on such missions, passengers were provided with signal flares, battery-operated Motorola sets were established in isolated bunkers, and, of utmost importance, special attention was given to the briefing of the crews and passengers on signals to be used. It was apparent that the simplest approach to the problem was the best and that the success of any system was entirely dependent upon the mutual understanding of that system by the pilot and passengers.

3.11 POSTSHOT REENTRY

It became apparent [redacted] that the Bikini portion of Castle would be conducted from aboard ship. In a way this simplified the operation because the evacuation and reentry problems

[redacted]

became largely those of the movement of ships rather than large groups of people. Water contamination in the anchorage, which would have posed a very real problem to the operation, was never serious, and the fleet was able to reenter the lagoon soon after each shot.

Upon the arrival of the LSD, USS Belle Grove, the M boats which she carried in the well were released and began the transfer of people between vessels by regular taxi service. M boats and LCU's moored in the anchorage during the shot suffered fall-out from at least two of the shots and required decontamination prior to their use. These boats were needed for the bulk of the work that went on between events, carrying workers, fuel, and equipment into the instrumented islands.

The movement of people within the atoll was closely coordinated with the Rad-Safe Control Officer at all times during the operation. Boat and helicopter traffic into contaminated regions was required to clear through the Rad-Safe organization for protective clothing, film badges, and monitoring equipment when necessary. By monitoring the radiation levels throughout the atoll, the Rad-Safe Control Officer could redefine the limits of restricted areas and clear them for traffic as radioactive decay and water dispersion reduced the contamination to safe levels.

The employment of the "houseboat" LCU's with expanded living quarters by Programs 13 and 15 proved to be exceptionally fortunate. Since trailers and equipment were aboard as well, these groups were able to rework their stations after each shot with a minimum of the support which would otherwise have been required.

The main camp islands, Eninman and Enyu, contaminated by rather heavy fall-out from [redacted] were reentered two days after the shot for the purpose of recovering equipment and supplies and to prepare the UCRL and DOD installations [redacted]

This work went ahead without further delay since the fall-out problem was not encountered to any great degree from subsequent shots. Eninman airstrip, which was out of commission for eight days [redacted] was placed back in use when the radiation levels permitted working parties to clear away the debris. During this time PBM type aircraft provided a limited airlift between Eniwetok and Bikini. The wave [redacted] again put the airstrip out of commission, but it was cleared and back in use within three days after the event.

At Eniwetok Atoll the reentry problem never arose since the lower islands were not evacuated [redacted] Reentry into the upper islands of the atoll was limited to the recovery of data and equipment.

3.12 SAMPLE RETURNS

Prior to the overseas phase of Castle, a study of the transportation requirements for delivery of radioactive samples to ZI laboratories was submitted to JTF SEVEN. As a result of this study and subsequent discussions, the following flight schedule for the return of samples was established:

Flyaway 1, H+6 to 10 hr
Flyaway 2, H+6 to 10 hr
Flyaway 3, H+24 to 36 hr
Flyaway 4, H+4 to 5 days

In addition to these flights, which were to be made after each shot, provisions were made for the transport of samples by first priority MATS flight when necessary. During the course of the operation this service was utilized to return Project 21.4 gas samples, with a departure time of about H+48 hr, which Flyaway 3 could not meet because of other requirements.

The Flyaway aircraft generally followed the planned schedule with average departure times of H+8 hr for the first two, H+36 hr for the third, and H+5 days for the last. Flyaways 1 and 2 were C-97 aircraft, capable under normal wind conditions of arriving at Albuquerque within 20 hr from take-off, including a 10- to 20-min stop at Hickam Air Force Base. Flyaways 3 and 4 were generally the slower C-54 aircraft.

The J-3 and J-4 Staff Sections of TG 7.1, through their representatives on Eniwetok, received the radioactive samples from the projects, made sure that they were properly packaged,

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marked, and monitored, and informed JTF SEVEN of the load and estimated time of departure of the aircraft. Each Flyaway aircraft was assigned a Sample Project Officer, whose responsibility was the delivery of each sample to a representative of the laboratory concerned, although most projects had monitors aboard as well. A message was dispatched to each laboratory having samples aboard, giving estimated time of arrival of the aircraft so that the representative could meet the aircraft and assume custody of the samples.

Flyaways 1 and 2 acted as backups for each other, the particulate cloud samples being split for transport on the two planes. Both proceeded directly to Kirtland Air Force Base, and Flyaway 1 then went to O'Hare Air Force Base, whereas Flyaway 2 went to Alameda Naval Air Station and Travis Air Force Base. LASL, UCRL, and AFOAT-1 had primary interest in these flights. Flyaways 3 and 4 also carried samples for these laboratories and for NRDL and Chemical and Radiological Laboratories as well.

The sample-return program was successful, performing its function on schedule and without mishap. The number of aircraft assigned and the number of flights scheduled were both ample to meet the needs of the experimenters.

3.13 COMMUNICATIONS

The communications mission of TG 7.1 was as follows:

1. To procure, install, operate, and maintain special electronic and communications equipment required by the Scientific Task Group.
2. To initiate voice time broadcasts for all elements of JTF SEVEN.
3. To coordinate the processing of TG 7.1 messages with responsible agencies.

Task Group requirements in the PPG for timing signals, radio teletype service, and commercial type radio equipment were the responsibility of EG&G, and the requirements for military type radio equipment and telephone and buoy cable systems were the responsibility of TG 7.5, H&N. The AEC Communications Facility at Los Alamos was assigned the mission of operating the Los Alamos Terminal of the Eniwetok–Los Alamos RATT circuit and providing communications support of TG 7.1 Headquarters, Los Alamos. One cryptographic security officer and one enlisted assistant, attached to TG 7.1, were assigned at the AEC Communications Facility, Los Alamos, to handle messages encrypted in military cryptographic systems. CTG 7.2 maintained and operated the Eniwetok terminal of the Eniwetok–Los Alamos RATT circuit. CJTF SEVEN and H&N maintained and operated teletype stations on Parry connected with the Eniwetok terminal.

The planning for communications facilities and services was based largely on the requirements submitted by the various projects of the Task Group in their monthly status reports. During this period close liaison was maintained with the J-5 Section of JTF SEVEN, EG&G, and the Communications Sections of the other Task Groups. In this way requests for services could be consolidated and frequency assignments coordinated. Two trips were made to the PPG by the Task Force Communicators in April and November 1953 to plan communications equipment installation, view site locations, and meet operating personnel. The Task Force command ship, USS Estes (AGC-12), was visited in San Diego on September 21, and plans were made for the allocation of space and the installation of new equipment. On October 27, TG 7.4 conducted Operation Tigercat off the West Coast. This was a rehearsal, both to shakedown the Estes communications system and to provide a mock shot-time air operation. The initial Electronics and Communications Plan for TG 7.1 was submitted to JTF SEVEN in August of 1953, and the final plan was included in the Task Group Operation Plan No. 1-53, submitted in December of 1953.

The Communications Section of TG 7.1 set up operations at the PPG during the first week of January 1954. Some scattered installations of telephones and radios as outlined in requirements to EG&G and TG 7.5 had taken place prior to this time. By January 20 the TG 7.1 RATT and HF voice circuits between Eniwetok and Bikini Atolls were in service, together with 80 per cent of the required radios and telephones. The Bikini Contol Point (CP) and all remaining communications circuits for the Task Group were in operation by early February.

[redacted]

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With the decision not to reestablish shore bases in the Bikini area, DELETED the following changes in communications were made:

1. Communications Headquarters was shifted afloat to the Estes.

2. TG 7.1 RATT circuit was discontinued.

3. HF voice net was terminated aboard the USS Estes by remoting the circuit, using an AN/TRC link from Enyu to the ship.

4. An additional VHF voice link was installed on five afloat stations to provide Rad-Safe with necessary communications.

5. Stations were added or removed from the existing seven TG 7.1 VHF radio nets as the work load dictated.

Communications to TG 7.1 projects located at Okinawa, Guam, Ponape, and Rongerik were handled by using existing facilities at those stations.

The CP DELETED was located in Station 70 on Enyu and was manned through shot time by CTU-6 and the Firing Party, and TG 7.1 Headquarters was located in Flag Operations aboard the Estes. These stations were linked by two voice circuits, a primary net using Ciphony equipment that was cleared for classified traffic including Secret Restricted Data and a secondary Motorola net for unclassified messages. CTG 7.1 was in communication with all Task Units located aboard ships in the immediate area by three separate commercial radio voice nets. Messages of classification Secret and below to CTG 7.1 (Admin) at Eniwetok and all off-site stations were transmitted and received over the Estes "On Line" RATT circuit with Samson (synchronous mixer) through the relay-crypto center at Eniwetok. All Top Secret and Restricted Data traffic was enciphered "Off Line." The voice time broadcast was transmitted manually over the Baker channel and the TG 7.1 Admin net on the Estes from −3 to −1 hr, at which time a tape recording synchronized with the sequence timer automatically took over at Station 70 on Enyu.

The CP and TG 7.1 Headquarters [redacted] were located in Flag Operations aboard the USS Estes. This CP functioned by employing three 250-watt Motorola radio links to start the timing signals and the sequence timer, and to actuate the emergency stop in Station 70 on Enyu. The voice time broadcast was transmitted in the same manner [redacted] with the exception that only the last 15 min were tape recorded and automatically transmitted from Station 70 on Enyu.

The CP [redacted] was located in Building 311 on Parry, with TG 7.1 Headquarters in Building 209 on the same island. These stations were in contact by a telephone "Hot Line," normal telephone, and two VHF voice radio nets. CTG 7.1 was in communication with the Estes, the Air Control ship, on station 20 miles off Parry, by AN/TRC radio through the Parry switchboard. Messages, Secret and below, to other elements of TG 7.1 in the Bikini area and all off-site stations were transmitted and received over the Parry Task Force "On Line" RATT circuit with Samson (synchronous mixer) through the relay-crypto center at Eniwetok. All Top Secret and Restricted Data traffic was enciphered "Off Line." The voice time broadcast was transmitted manually from the CP over the Baker and TG 7.1 Admin nets from −3 hr through zero with an automatic tone signal replacing the Hack for the last 15 min.

3.13.1 Communications by Electrical and Electronic Equipment

Various types of electrical and electronic communications equipment were used to provide TG 7.1 with the means to maintain close liaison between the separated projects in the Forward Area. These types included an intercommunications net between offices, telephones, six separate VHF radio circuits, an HF voice radio circuit, and a radio teletype circuit. The radio teletype circuit was installed and maintained by EG&G and operated, with the exception of the Crypto-Samson (synchronous mixers) processing which was the responsibility of CJTF SEVEN, in conjunction with the Mail and Records offices. The transmitting and receiving stations for this net were located at Parry, Enyu, and Eninman and were in operation normally seven days a week from 0730 to 2330 hours and on a 24-hr day at the discretion of CTG 7.1. This circuit was cleared for messages up to and including Secret Restricted Data and was available to all

[redacted]

TG 7.1 personnel; as a result it proved to be invaluable in providing a rapid and secure means of communications during the build-up phase.

Communications to addressees outside the PPG were transmitted through Headquarters JTF SEVEN Communications Center, Parry Island. These messages were examined for classification, content, and involvement of other task units or agencies and released by one of a group of seven persons designated by CTG 7.1. All postshot messages which released data, regardless of their destination, were released personally by CTG 7.1.

3.13.2 Mail Service

A Mail Room was established in the Forward Area to process all official mail of the Task Group Headquarters and of personnel of LASL. This section was responsible for logging all classified incoming correspondence and teletypes and all outgoing correspondence and teletypes, both classified and unclassified. Distribution of these documents was made from the several locations of this section. Personal mail for the personnel of the Headquarters and LASL personnel was also distributed through this section, which maintained a centralized file of correspondence and a master file of teletypes.

This section operated primarily at the Headquarters on Parry Island. Because of the two-atoll operation it also operated a section on Eninman and aboard the USS Estes. Additional logs were maintained for correspondence and teletypes between atolls.

The Mail Room also assisted other organizations of the Task Group, such as Camco, Rad-Safe, Lookout Mountain Laboratory, and DOD projects of TU-13, by keeping an accountability of all teletypes and occasionally processing their official mail.

3.14 SECURITY

With the formation of TG 7.5 for AEC participation in Operation Castle, a large part of the security responsibilities formerly exercised by the J-2 Section of the Scientific Task Group was transferred to TG 7.5. The security responsibilities remaining with TG 7.1 were certain aspects of personnel security and a security liaison function, which were delegated to J-1 and the Classification Officer, respectively.

The personnel-security function involved coordination with numerous agencies and units of AEC, DOD, and their contractors during the preparatory and planning phases to assure that all personnel expecting to participate in Castle at the PPG satisfied security requirements before leaving the continental United States. J-1 maintained a roster showing the clearance status of all personnel known to be scheduled for participation. Verification of existing clearances was obtained from AEC sources. In some cases the applications of previously uncleared personnel were handled through J-1 to Headquarters JTF SEVEN. J-1 was not an authorized source of clearance data but used its contacts and familiarity with the numerous projects to be of assistance in clearance matters.

Q clearances were processed in several ways, according to the applicant's organizational connections and his situation. Most military personnel were processed through their parent service to AEC, Washington, and some through CTG 7.1 and CJTF SEVEN to AEC, Washington. Most civilian personnel were processed through their employing agency to AEC, i.e., an employee of a firm having a contract with LASL was processed through his own personnel office to the Los Alamos Field Office of AEC. A civilian contractor of the Department of the Navy processed his employees through the Navy personnel and security channels to AEC, Washington. By liaison, J-1 maintained cognizance of the status of applications until clearances had been granted. In a few cases where clearances appeared doubtful, applications were withdrawn and applicants did not participate. At the conclusion of Castle, J-1 requested, through CJTF SEVEN, termination of all Q clearances that were granted on behalf of, or extended to, JTF SEVEN. CTG 7.1 had no authority to grant military clearances; when required, this was done by CJTF SEVEN.

Prior to the overseas phase, badge requests were prepared for personnel of TG 7.1 and forwarded to CTG 7.5, and security examinations and certificates were accomplished. In cases

[redacted]

where these requirements were not satisfied prior to departure for PPG, they were completed as soon as possible after arrival of personnel at PPG.

Security policies for Operation Castle originated with CJTF SEVEN and TG 7.5. TG 7.1 made suggestions and comments on policy matters as requested but was not responsible for promulgation. Once policies were established the J-1 Section of TG 7.1 disseminated the information to members of the Task Group.

3.15 CLASSIFICATION ACTIVITIES

3.15.1 Classification

Several classification items unprecedented in past operations were involved in Operation Castle. The inclusion of two firing sites, one at Eniwetok and the other at Bikini, almost 200 miles distant, required a representative at each site. The problem of native evacuation from other atolls and the accompanying medical program at Kwajalein introduced unanticipated classification problems and resulted in even another source of classified material. The fact that two separate laboratories participated in the program of devices to be detonated required decentralization of the preoperational activities. However, a uniform classification policy throughout the Task Force was ensured by the designation by the AEC and CJTF SEVEN of the Scientific Task Group representative as over-all classification authority.

It is to be noted that classification practices were more realistic during the present operation. Based on experience from earlier operations, the Castle classification guide recognized as no higher than Official Use Only those items of no security significance. Incidentally, the President's speech before the United Nations, the Ivy film declassification, and the routine announcements made after several of the shots all contributed materially to the avoidance of many problems and the more realistic approach to security classification.

Another important factor in the maintenance of respect for security and classification was the support given by the Security Section of the Communications Staff (J-5) of JTF SEVEN. Early in the operation that section was briefed on classification policy by the Classification Officer, and agreement was reached that apparent violations of communications security would be reviewed by the Classification Office to avoid improper allegations of security violations that in the past proved unnecessarily disturbing to the alleged violators, with the consequent disrespect for all security procedures.

Good first-hand guidance for proposed general classification-guide changes was provided by the meeting at the test site of the Nuclear Weapons Classification Subcommittee of the senior reviewers.

The Classification Group undertook the review of Forward Area files for regrading in accordance with Executive Order 10501 and implementing AEC directives, particularly in the regrading of Restricted Security Information material.

3.15.2 Security Liaison

In accordance with the policy of avoiding duplication of effort and maintaining uniform security standards, the Scientific Deputy and CTG 7.1 eliminated a separate security (J-2) staff within TG 7.1. Reliance is placed on the security education programs of the respective home stations of the several participants and the over-all program of JTF SEVEN and the AEC TG 7.5.

(a) Physical Security. The physical security aspects in so far as AEC materials are concerned were almost exclusively the function of the Security Office of TG 7.5. The Classification Officer indicated operations, areas, and equipment that involved security significance and the Security Staff of TG 7.5 provided the physical security protection and access procedures, including a badge system.

(b) Communications Security. The communications security was handled by the J-5 (Communications) Security Section of JTF SEVEN, with close liaison as noted earlier with the Classification Office.

[redacted]

(c) Information Security. The information security, particularly document control, was an internal function of TG 7.1, mainly handled by the Mail and Records Section of J-1, with Top Secret control being retained in the Office of CTG 7.1. Policies followed in document control were monitored by the Classification Officer as security liaison to be certain that practices were in conformance with the appropriate AEC or military regulation as previously coordinated with J-2 of JTF SEVEN and the Security Office of TG 7.5. The security liaison representative reviewed all such coordinated documents before issuance to be certain that they were realistic and did not materially interfere with operations. Incidentally, J-4 of TG 7.1, working with TG 7.5 and the Classification Office, disposed of considerable classified material.

3.15.3 Photographic Control

Control of photography, in a sense, was part of the security liaison function but was of sufficient magnitude to be considered a separate responsibility. In addition to the current review for classification of photographic records, it was necessary to advise on special practices relating to security control of photographic materials. To avoid the excessive tentative marking of photographs as Secret Restricted Data pending official classification in accordance with JTF SEVEN regulations, the Classification Office kept substantially current with all photography, thus avoiding unnecessary security procedures and possible confusion as to the actual classification of such material.

The change of procedure for this operation which permitted some Scientific Task Group personnel to take their own pictures instead of using the official photographic units, TU-8 and TU-9, introduced some new security problems. It is believed that the whole photography system must be reexamined. Associated with the problem of photography is the control of binoculars and telescopes. The present strict controls on these optical instruments are time-consuming and fruitless in view of the ready access to similar official optical equipment, e.g., on the bridge aboard the several ships of the Task Force.

3.15.4 Legal Advisory Problems

As in the past, the Classification Officer provided preliminary legal advice on patent matters, income tax, and miscellaneous investigations. The Classification Officer spent a considerable time as a Claims Board member and processed claims for contractor employees of the AEC.

3.15.5 Organizational Matters

The original classification guide was prepared at the home station of the Classification Officer, submitted for review by several of the participating organizations, and approved by AEC and DOD authorities. Preoperational classification questions were handled by AEC Headquarters in Washington, the Classification Officer, and the classification representative of Livermore. When the Task Force moved to the Forward Area, a representative of the Classification Officer opened up the Classification Office in the Task Force Headquarters. About two weeks before the first detonation, the Classification Officer with one associate undertook the operation of the Classification Office with the aforementioned associated activities. Meanwhile, the home representative of the Classification Officer, supported by AEC Headquarters and Livermore's classification representative, handled the numerous Stateside problems associated with the operation. For most of the period the Classification Office was comprised of two persons, with a third man part of the time.

3.16 TECHNICAL REPORTS

The primary responsibility for completion and editing of technical reports is one handled Stateside in the postoperational period. However, a good practice adopted in this operation was the preparation, while in the Forward Area, of current summary reports for each detonation,

[redacted]

also interim reports on the results of the Military Effects projects. One member of the Classification Office spent some time in a technical editing capacity on scientific reports.

3.17 DISPOSITION OF FORCES (ROLL-UP)

3.17.1 General

Roll-up or the redeployment of TG 7.1 from the PPG to the ZI commenced shortly after [redacted] Mar. 1, 1954, and continued through the latter part of May 1954. Personnel moved to the United States in a steady stream during March, April, and early May, and after [redacted] May 14, 1954, the remaining personnel phased out rapidly. Property roll-up proceeded in much the same manner; property and materials no longer required were returned at the earliest practicable date.

3.17.2 Phase-out of Personnel

Estimates regarding the phase-out of personnel were obtained from the monthly status reports submitted by the various elements of the Task Group throughout the latter part of 1953. The statement of concept of operations issued on Oct. 20, 1953, planned for the last detonation to take place on April 22, and, consequently, all personnel phase-out estimates were predicted upon that schedule.

Despite schedule changes the over-all rate of personnel phase-out through March and April was approximately as predicted in 1953, although particular individuals or units may have changed plans several times. The predictions made in 1953 envisioned the Task Group strength on April 24 (two days after the final test as conceived on October 20) to 67 per cent of the peak of February; in actuality, the April 24 strength was 63 per cent of the February peak. From this date on personnel phase-out was directly related to the completion of the remaining tests.

The Headquarters Commandant at Parry Island made all the necessary arrangements for the departure of each individual. This included endorsement of orders, MATS reservations, reservations for personnel traveling from Hawaii to the mainland via commercial carrier, and clearance from various offices on Parry Island. It was at first planned that at least four days' notification of departure be given the Headquarters Commandant. However, due to the rapidly changing situation and operational necessity, this four-day notification was waived as a requirement, and many persons were processed with 12 hr or less advance notice.

The great majority of the Task Group personnel were airlifted by MATS to Hickam. The military personnel and government-employed civilians continued on to Travis Air Force Base on MATS, whereas nongovernment civilians proceeded via commercial carrier from Hawaii. A few of the Task Group people traveled back from the Forward Area by MSTS and naval vessel.

The decrease in population is shown graphically in Fig. 3.3.

3.17.3 Property Roll-up

The property roll-up of TG 7.1 can be divided into two phases: first, the gradual phase-out of property during the actual operational stage and, second, the final complete roll-up [redacted]

The first phase took care of equipment that was excess or had served its operational purpose and included all the equipment of UCRL, since they were able to roll up all of their projects, with the exception of a small chemistry group, [redacted] Property from the first phase was returned to the ZI on the Dalton Victory and the Leo, MSTS cargo vessels.

The final phase of roll-up [redacted] was to continue until [redacted] 21 days. The following MSTS cargo vessels were scheduled to move the remainder of the property to the ZI: Sgt Gammon, May 17, 1954; Pvt Merrill, May 30, 1954; and Pvt Joe E. Mann, June 25, 1954.

It was originally planned to have Bikini equipment prepared for shipment to the ZI and out-loaded from Enyu. Because of the damage done to the camp facilities and the high rate of contamination at that site caused by the Bikini series of shots, it was necessary to return all property to Parry for packing and return to the ZI. Return of equipment and heavy trailers was scheduled on a priority based on future needs for the equipment.

3.17.4 Headquarters Roll-up

As of 2400 hours, May 21, 1954 (Eniwetok time), Forward Area Headquarters of TG 7.1 closed. After this date all electrically transmitted messages were processed by the AEC Resident Engineer. Mail service continued to be handled by the J-1 Office on Parry Island until May 31, 1954, when this function was also assumed by the AEC Resident Engineer.

On May 15, five boxes of classified records of the Headquarters departed the Forward Area for Los Alamos via Flyaway 63. On the following day an additional 19 boxes departed on a SAM records flight. All records were air-shipped to Kirtland Air Force Base where they were transshipped to Los Alamos by AEC truck. Records were boxed in footlocker-size boxes. The total weight of the 24 boxes was approximately 2400 lb. Classified records belonging to DOD (TU-13) were escorted by their own personnel to appropriate destinations.

All H&N furniture and equipment were left in place, and all AEC and DOD accountable equipment was returned to appropriate supply rooms.

3.18 OPERATIONAL CONCLUSIONS AND RECOMMENDATIONS

3.18.1 General

The support offered to TG 7.1 by other task groups was outstanding. The flexibility shown by those task groups in meeting the uncertain and continually changing conditions of the operation contributed immeasurably to its success.

In spite of very ambitious weapons development programs involving two laboratories, the DOD effects programs took approximately 60 per cent of the total support effort. It is suggested that attempts be made to reduce this proportion in future overseas operations.

In order to submit requirements for military support far enough in advance to meet DOD planning criteria, they are normally turned in from nine months to a year before the operational period. At this time planning has not progressed to the point where it is possible to predict detailed requirements with a great degree of accuracy. Late DOD and other projects, and changes in projects, introduce additional requirements, as do maintenance difficulties at the far end of a long pipe line, large peak requirements, and the possibility of late substantial changes in the operational concept and schedules. It is therefore necessary, in order to be able to complete one of these operations successfully in an acceptable length of time, that support elements have a reasonable reserve of men and equipment above the bare minimum estimated to get the job done.

Although strenuous efforts were made by the Task Force and Task Group communications personnel, long-range communications were not satisfactory, particularly aboard the USS Estes where Task Force and Air Task Group communications interfered because of limited space and antenna space. Ship-based operations should be avoided, if possible, but if they are necessary, even as a stand-by measure, the Scientific Task Group needs a ship of its own (possibly shared with TG 7.5) for its headquarters.

The TU-9 effort in the field is, in the opinion of the Task Group Commander, appreciably larger than necessary to accomplish its mission. A great deal of time was expended by members of the Task Group posing for photography that may not be used in any official report. Great amounts of still photography were taken, very little of which is of any value to the experimenters. It is suggested that the official commitments of TU-9 can be carried out in the future with approximately one-half of the field effort involved in Operation Castle.

[redacted]

3.18.2 J-1 Section, Personnel and Administration

Augmenting the Task Group with temporary-duty military personnel from various sources proved helpful in meeting operational requirements with a minimum staff of permanent personnel. Since Q clearances are required for all TG 7.1 personnel in the Forward Area, allowances will be made in the future for delays or denials of clearance by requesting nomination of temporary-duty personnel somewhat in excess of requirements so that lack of clearance for some individuals will not hamper operations.

The working space for TG 7.1 on the USS Estes was wholly inadequate for continuous operation over several months. Space was limited, ventilation was poor, and noise level was extremely high. If shipboard operations are planned for the future, even as a contingency, more adequate facilities must be provided.

Airlift of personnel to and from the PPG was not entirely satisfactory. Although the overall support provided by MATS was excellent, mechanical difficulties often made it impossible to meet published schedules. In some cases delays of several days were involved. There was a tendency at MATS terminals to call passengers in too early and to keep them waiting indefinitely without any announcements whatever as to cause and probable length of delays and when it was expected that flights would be called. MATS passenger relations should be substantially improved. It is recommended that a field grade representative of the Pacific Division, MATS, be assigned to CJTF SEVEN as liaison during the operational phase, at least during build-up and roll-up.

3.18.3 J-3 Section, Plans and Operations

(a) Helicopter Operations. Early in the planning phase TG 7.1 submitted its requirements for helicopter support. These requirements were computed to fulfill the needs of the Scientific Task Group in accomplishing its mission. At Bikini Atoll the number of aircraft supplied by the Air Force Detachment and Marine Squadron was sufficient to satisfy the needs. This was primarily due to the fact that there was a minimum of outside requests. The relatively small number of H&N requests were easily integrated. However, at Eniwetok the demands of Headquarters JTF SEVEN and the requirements of TG 7.4 and others reduced the availability of aircraft to TG 7.1 to a point below requirement. To further complicate the problem, as the operation lengthened the maintenance problems reduced the number of operational helicopters.

Although TG 7.1 is the largest user of helicopters during operational periods, TG 7.5 has substantial concurrent requirements. The Task Force and each of the other task groups also have requirements, some of which occur during the peak TG 7.1 load. In arriving at total Task Force requirements, these combined needs should be carefully considered. In submitting requirements it is recommended that the number operational be indicated rather than the total number to be assigned.

During the first half of the operation, the TG 7.1 airlift requirements at Eniwetok Atoll were arranged directly with the H&N air dispatcher by J-3 Section. This system functioned well for routine requests. However, in most cases, any requests involving nonroutine flights or missions outside of normal working hours had to be referred to higher staffs. This often resulted in delays. The difficulty was later corrected when TG 7.4 Operations Officers were stationed at the airport with the authority to act on all requests. Thus the scientific requirements can best be fulfilled when J-3 can place the requirements directly with the supporting elements.

(b) Off-site Activities. The support of certain off-site experiments was not satisfactory in that the support was irregular and difficult to arrange. Although the requirements of this Headquarters were generally small, they were recurrent and irregular; however, in the interest of maximum aircraft utilization, attempts were made to integrate them with flights intended for support of the weather stations whose locations were common to the locations of the off-site experiments. Because these flights originated from both Eniwetok and Kwajalein, often on short notice, integration of TG 7.1 requirements with the flights was not always possible.

[redacted]

It is recommended that off-site support be planned such that TG 7.1 Headquarters could be aware of the support to be available. This could be accomplished in a number of ways, e.g., by creating a regular support schedule or including a TG 7.1 representative when planning off-site support activity.

(c) Communications. An unclassified voice circuit from the PPG to Los Alamos (using commercial facilities east of Honolulu if economical and practical) is required.

The radio teletype and HF voice circuits installed and operated by the Scientific Task Group for communications between Eniwetok and Bikini Atolls proved most successful in providing a close liaison between the various projects until the operation became shipborne. It is recommended that this same service be provided for future PPG operations and the capability of operating the teletype from afloat be added.

The 10-watt Motorola radio proved to be the most satisfactory type of radio because of its dependability and portability. It is recommended that this type radio be provided by the military supply system for all DOD scientific projects for future operations.

(d) Boat Support. Boat support at each atoll proved adequate at all times. Although the boat pools were severely strained on many occasions, especially when breakdowns occurred, no work was left undone for lack of boat support. The need for a small number of fairly fast boats, for Firing Party and other purposes, was again demonstrated. Such a boat should be capable of a speed of about 20 knots in rough lagoon waters, of going alongside firing barges and ships' accommodation ladders, should be rugged and reliable, and should have two engines and a good covered passenger-carrying capacity.

Interatoll surface lift was adequate as long as there were two LST's in service. On the occasions when one LST was withdrawn for repairs or because of damage, the lift became overloaded and a freight backlog developed. For an extended operation it is recommended that three LST's be available.

(e) Evacuation. [redacted] the J-3 Section published a detailed chronological evacuation check list for the period −5 to −1 day. This elaborate plan was necessary to ensure that the evacuation of the atoll was accomplished with as little interference as possible to the scientific preparations. As the operation progressed the plans were less detailed because personnel became more accustomed to the part which they played, and teamwork developed. In the last stages of the operation, outline plans were published on the J-3 blackboard in lieu of detailed written plans. Although the need for lengthy written plans diminishes as the operation progresses, the requirement for well thought-out plans still exists.

3.18.4 J-4 Section, Logistics

J-4 tried the system of having supply trailers to provide on-site supply support for ready access of operating groups. It is recommended that future operations of this nature and size be afforded such necessary service in view of the favorable reaction received.

Transportainers and trailers have proved most satisfactory, and they have undoubtedly paid for their investment in the form of reusable shipping containers, temporary field laboratories, and storage units. Their continued use is strongly recommended.

The TG 7.1 vehicle requirement, which the Task Force fulfilled, was based on careful analysis, curtailment, and integration of requests received from the various TG 7.1 users. Additional requirements, due largely to expanded and added projects, continued to build up after the initial requirement was placed on the Task Force. As a result there would have been a shortage of $\frac{1}{4}$-ton vehicles, and readiness would have suffered accordingly had it not been for the 27 World War II, Class X vehicles which were available to supplement the regular allotment during peak requirements. These occurred in January and February, when there were seven camps in operation and build-up was at a maximum.

[redacted]

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CHAPTER 4

SUMMARY OF TASK UNIT ACTIVITIES

4.1 TASK UNIT 1, LASL PROGRAMS

4.1.1 Objectives

The function of TU-1 was to carry out experiments designed to measure certain properties of the LASL-designed nuclear devices.

These measurements were, in general, diagnostic; they were not performed to measure effects which depend mostly on yield but rather to give information on the performance of the devices to supplement or verify the theoretical calculations on the basis of which the devices were designed.

4.1.2 Techniques

The techniques used to make the measurements are described in Chap. 2, Sec. 2.1.

4.1.3 Operations

In the initial concept of the operation, it was intended that personnel would live ashore, and it was hoped that fall-out on the various stations would allow repeated use of the same buildings where necessary. However, provision was made for some groups to live aboard LCU's if necessary for work on the close-in stations.

All the initial setup work for the stations was done while the operation was land-based. After the first shot it was impossible to live ashore; therefore it was necessary to utilize shipboard space for personnel.

Except for those groups which had made provision for living on LCU's, this move increased the difficulties of the operation tremendously. Only the good cooperation received from the various ships' companies made it possible to have each shot ready on schedule, although the schedules were often changed owing to weather delays on previous shots.

The helicopter shuttle system gave reliable transportation on short notice throughout the operation. It was essential to the success of an operation of this magnitude.

The Rad-Safe problem was difficult but well handled. After a short transition period in the sudden change to a ship-based operation, there was little delay caused the experimenters by Rad-Safe requirements, and no TU-1 personnel received large or unexpected overdoses.

4.1.4 Results

Results are given in Chap. 2, Sec. 2.1.

[redacted]

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4.1.5 Conclusions and Recommendations

1. Where possible, the decentralized LCU setup with personnel living at their working place is very satisfactory.

2. In order to cause the least disturbance to shipboard routine and passengers, it would be desirable in future operations to mess and quarter the experimenters aboard ship in separate quarters or on ships of the MSTS type.

3. Communications for experimenters were unsatisfactory when a number of channels had to be operated in close quarters, as on shipboard.

4. It is absolutely essential that the number of persons between the experimenter and his transportation be kept to a minimum. This is largely because of the unpredictable nature of the transportation requirements.

5. The success of this operation was largely due to the centralization of operational control on each atoll in one man familiar with the experimental phases of the operation.

4.2 TASK UNIT 2, PRODUCTION

The function of TU-2 during Operation Castle was to produce the necessary cryogenic fluids.

To fulfill this obligation additional personnel, both cryogenic operators and mechanics, were hired. A training program was initiated July 1, 1953, at the facilities of Herrick L. Johnston, Inc., Columbus, Ohio, to give basic instructions in cryogenics during a two-week period. The training program was then transferred to the plants in the PPG for practical plant experience. This program continued until Dec. 15, 1953, and included the making of necessary plant modifications.

The majority of the plant changes effected were designed to promote ease of operational techniques. The hydrogen pot of the liquefier, Building 344, Parry Island, was modified to contain a catalyst so that 95 per cent converted liquid hydrogen could be delivered to a transport Dewar. The installation of another 200 liter/hr liquid-nitrogen generator provided reserve capability for the production of this fluid.

The production of considerable quantities of liquid nitrogen was required primarily for the liquefaction of hydrogen and deuterium by TU-2. Additional liquid nitrogen was supplied to TU-3 as a refrigerant for their transport Dewars and for experimental purposes and to TU-12 for the latter reason. Pure high-pressure nitrogen gas was available to all organizations as required. It should be noted that pure compressed air deliverable from the nitrogen generator was used to pressurize aqua lungs for members of the Task Force. TU-2 produced 15,641 liters of liquid hydrogen and 1036 liters of liquid deuterium for delivery to TU-3, as well as the purified gases at high pressure. Helium was compressed in the hydrogen plant to fill gas cylinders for TU-12.

[redacted] the liquid deuterium and 6000 liters of liquid hydrogen were returned to raw storage and sent back to the ZI. The plants were mothballed in a semipermanent condition until their disposition could be determined.

4.3 TASK UNIT 3, SPECIAL MATERIALS AND FACILITIES

The mission of TU-3 for Operation Castle at the PPG was threefold. Liquid hydrogen was to be received, stored, and transported for TU-14's use; liquid deuterium was to be received, stored, and transported for use [redacted] and the colon for [redacted] all cryogenic support equipment [redacted] were to be assembled, thoroughly tested, and operated. Cambridge Corporation, with field offices in Boulder and Denver, Colo., was responsible for all TU-3 activities.

TU-3 was under the direction of the Task Unit Commander. To aid in administration, several groups who were under the direction of group leaders were organized according to their specific functions.

[redacted]

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Extensive planning at Boulder indicated the desirability of dividing the work load at the Forward Area into two phases.

The first phase was devoted principally to the receiving of equipment and supplies, activating the CMR working area, and activating and completely checking out the refrigerated transport Dewars. The second phase was a period of heightened activity during which liquid hydrogen and liquid deuterium were in storage in the refrigerated transport Dewars for use and delivery.

The [redacted] system was assembled, thoroughly checked out, reassembled aboard the Station 40 barge [redacted] DELETED [redacted] checked out; and finally a trial run was made to simulate the final run to Bikini. The [redacted] program embraced the delivery of six refrigerated transport Dewars [redacted] liquid hydrogen to the [redacted] zero compound. Official word was received that the [redacted] device would not be fired on [redacted], and work began immediately on the disassembly, crating, and packaging of the equipment for return to the ZI.

Official word was received on Apr. 13, 1954, [redacted] DELETED [redacted] and the refrigerated transport Dewars were returned to the CMR area, the liquid hydrogen was returned to TU-2 for storage in tube banks, and the units were deactivated and prepared for shipment.

Roll-up of all TU-3 equipment and supplies was completed on Apr. 16, 1954, and was turned over to J-4 Section for return shipment to the ZI.

4.4 TASK UNIT 4, LASL ASSEMBLY

TU-4, the LASL-directed assembly group, consisted of members of the Laboratory and personnel directly involved in fabrication assembly. [redacted] the American Car and Foundry Co. (ACF) personnel had actually made the direct fabrication assemblies of the devices with which LASL was concerned. [redacted] DELETED [redacted] full trial assemblies of each device were made at the Albuquerque plant of ACF before shipment to Eniwetok. Each device was jigged to match its final support stand. The only assemblies not performed in Albuquerque involved the installations of the actual "primary bombs" and capsules. Extensive "dummy primary bomb" installations were performed, and actual ballistic device dummies were shipped to Eniwetok for final installation tests.

All the units, [redacted] were shipped to Eniwetok by surface vessel the first week in January 1954.

TU-4 operations actively got under way during the first week in January, when the first group of people arrived in the Forward Area. Some slight revisions of facilities were required, as well as some modifications to the device installations. Trial runs with dummy units were initiated as soon as practicable, involving the actual movement of [redacted] dummy to shot location at Bikini; movement of the [redacted] dummy, on its barge, to final Bikini anchorage; and trial loadings of dummies [redacted] barge.

Since original plans called for detonation of four devices [redacted] on barges and one [redacted] on land, all on a fairly [redacted] time scale, the majority of TU-4 personnel were assigned to work on specific devices. The over-all TU-4 responsibility for each device was given to the LASL project leader who had followed the design and fabrication of the device.

With the arrival of the devices the detailed operation plans and manuals began to fulfill their real purpose in the direction of the multiphased operations. Close coordination with TU-3, prior to and after arrival at Eniwetok, was accomplished in matters involving [redacted] check-outs and installations. Over-all plans were coordinated through the Staff of TG 7.1. [redacted]

[redacted]

Since several of the shots involved a certain number of weather delays, the following chronological listing should be sufficient to point out the highlight dates in the history of each device:

[redacted]

Jan. 25	Unit arrived at Eniwetok
Feb. 17	Final assembly completed
Feb. 18	Shipped to Bikini and transshipped to cab on Feb. 20
Feb. 22	Installation in cab completed
Feb. 27	[redacted]
Feb. 28	
Mar. 1	[redacted] detonated

[redacted]

Jan. 25	Unit arrived at Eniwetok
Mar. 4	Final assembly completed
Mar. 5	Unit installed on barge
Mar. 7	Barge departed for Bikini in LSD
Mar. 9	Anchoring completed [redacted] and cables checked out
Mar. 11	Exchanged [redacted] cylinders (used small one)
Mar. 12	[redacted]
Mar. 27	[redacted] detonated

[redacted]

Jan. 25	Unit arrived at Eniwetok
Mar. 2	Assembly completed
Apr. 8	Reassembled after postponement and loaded on barge
Apr. 9	Barge departed for Bikini in LSD
Apr. 10	Anchoring completed and cables checked out
Apr. 15	[redacted]
Apr. 26	[redacted] detonated

[redacted]

Mar. 5	Unit arrived at Eniwetok by air
Apr. 10	New [redacted] cylinder [redacted] received and installed
Apr. 14	Final assembly completed after postponements and loaded on barge
Apr. 16	Barge towed to Mike crater at north end of Eniwetok lagoon, anchored, and cables checked out
Apr. 17	Support jacket removed and dummy lugs attached to the case
Apr. 27	[redacted] and nuclear arming completed
May 14	[redacted] detonated

[redacted]

Apr. 16	Unit arrived at Eniwetok by air
Apr. 26	Final assembly completed
Apr. 27	Loaded on barge
Apr. 30	Barge departed for Bikini in LSD
May 2	Anchoring completed [redacted] and cables checked out
May 4	[redacted]
May 5	[redacted] detonated

In general, the detonation of these devices on barges seems to be a satisfactory method and quite practical. Methods for logistic support of the barges were revised during the operation

[redacted]

to best suit the local conditions. However, barge support should be closely examined for future operations. Future operations may well look to the barge method as a useful plan for localizing assembly and delivery operations in a consolidated installation.

4.5 TASK UNIT 6, FIRING PARTY

TU-6 had the responsibility for arming and firing the nuclear devices detonated during the operation. In general, two teams were utilized for the operation: one was the arming team, which made test checks of the X units and firing racks prior to the final assembly of the devices and the inspection and test checks of the firing circuitry involved, including the proof testing of the Go-No-Go interlock circuits; the other was the firing team, which operated the control equipment used for this purpose. The work of TU-6 was accomplished in close liaison with TU-4 (assembly for LASL devices), TU-14 (assembly for UCRL devices), and TU-15 (EG&G signal and firing circuits). The missions of the arming and firing teams were accomplished with the aid of detailed check lists which enumerated each operation and the essential measurements associated with the arming and firing of each of the nuclear devices. The general plan of operations used by TU-6 is given separately in the TU-6 Operations Plan.

The original plans provided for firing the various devices from land-based control stations located on Enyu Island, Bikini Atoll, and Parry Island, Eniwetok Atoll, from which wire electrical circuits originated. These circuits terminated at the various zero points. The first detonation of the series [redacted] for which the firing was accomplished by manually operating the control board at Station 70, Enyu Island. However, immediately following this shot it was decided to fire the remaining devices at Bikini Atoll from aboard the command ship, the USS Estes, by means of a radio link from the ship to Station 70. The final shot of the Castle series, [redacted] was fired from the Control Room on Parry Island. This was the only detonation of the series made at Eniwetok Atoll.

During Operation Castle no misfires or other delays were encountered which were due to the arming or firing operations. Weather difficulties did interfere with the firing schedule, however, and these delays necessitated arming and disarming all but two of the devices more than once.

4.6 TASK UNIT 7, RADIOLOGICAL SAFETY

4.6.1 Introduction

TU-7, the Rad-Safe unit for TG 7.1, was a continuation of the Rad-Safe Unit of TG 132.1. Preliminary to the Castle operational phases, personnel to staff the unit were requested from the Army, Navy, and Air Force. The Army furnished 34 persons, and the Navy furnished 11. Civilian technical advisers of Health Division, LASL, and the U. S. Public Health Service added to the unit just prior to and during the overseas period.

4.6.2 Task Group Organization for Radiation Safety

Early concepts for Castle indicated a high requirement for radiation-safety monitors. In past operations these monitors were furnished from personnel of the Rad-Safe Task Unit. The continuation of this policy would have meant a large unwieldy organization and an expensive service. An alternative was proposed and accepted by the Task Group Commander. This alternative was to place radiation-safety responsibility with the commanders and project leaders and to require each project to provide its own trained monitors. Training of Rad-Safe monitors was to be accomplished by Rad-Safe Task Unit personnel. A reserve monitor pool was also to be established by TG 7.2 in case of emergency need. The monitor, from the unit concept, would act as radiation-safety adviser to the project leader.

Establishment of this policy enabled TU-7 to reduce its operational personnel to a small skeleton staff of 43 personnel supplemented by project monitors of LASL, UCRL, and DOD.

[redacted]

The skeletal organization was divided between Eniwetok and Bikini along the following lines:

(a) Bikini Rad-Safe (Afloat)

1. USS Bairoko
   a. Control element for helicopter missions
   b. Laboratory elements of instrument repair, photodosimetry and records, and radiation analysis
   c. Personnel decontamination and supply sections
2. USNS Ainsworth (barge)
   a. Control element for boat missions
   b. Personnel decontamination and supply sections
3. USS Curtiss
   a. Control, personnel decontamination, and supply sections
4. USS Estes
   a. Information and administrative center

This organization resulted from the emergency situation, wherein the field Rad-Safe center at Eninman was destroyed and prolonged shore-based operations became radiologically unsafe.

(b) Parry Rad-Safe

1. Control element for boat and helicopter missions
2. Laboratory elements of instrument repair, photodosimetry and records, and radiation analysis
3. Decontamination elements for personnel and equipment
4. Supply base for Bikini and Eniwetok

The activities of these elements and various sections will be discussed in subsequent paragraphs.

4.6.3 Training

An extensive training program was initiated by the unit some six months in advance of operations in order that a skilled group of technicians could be available to the unit. Four Navy electronic technicians attended a four-week instrument repair course at the U. S. Navy Atomic Defense School, three Navy medical technicians attended a special two-week radiochemical laboratory course at Evans Signal Laboratory (ESL), and eight Army photodosimetry technicians also attended a special one-week course at ESL.

The unit conducted several project monitor schools to qualify project personnel in the fundamentals and techniques of radiation safety. The first school was conducted at the Nevada Proving Grounds in the second week of November 1953. A second school was conducted at the Eninman Rad-Safe Center in the middle of February 1954. A third school was conducted at the Parry Rad-Safe Center early in April 1954. A total of some 275 AEC and project personnel were qualified as project monitors as a result of these courses and similar courses at NRDL, UCRL, and EG&G.

A general indoctrination course was conducted for TG 7.1 and 7.5 personnel through the use of AFSWP training films covering basic physics of atomic weapons, medical aspects of nuclear radiation, and field decontamination. These films were shown along with the usual movie programs at all camps at Bikini and Eniwetok.

4.6.4 Control Element

The control element exerted supervision of TG 7.1 and 7.5 activities within radiologically contaminated areas. Control stations were established at Parry, USS Bairoko, USNS Ainsworth, USS Curtiss, and USS Estes. Radiological situation data were maintained in the form of situation maps at these stations. These maps were used to control activities in contaminated areas.

These stations constituted clearance stations for all working parties entering contaminated areas of 100 mr/hr or greater. Records of activities within contaminated areas were main-

[redacted]

tained as a check on film-badge exposures. In several cases personnel exposures were revalued from information gathered from these preentry forms. Several instances were noted in which individual film badges had high readings of exposure, but investigation revealed that the film badges had been left in highly contaminated areas and did not represent actual exposure.

The limitation of exposures to the test Maximum Permissible Exposure (MPE) of 3.9 r encountered many difficulties due to certain set policies of "burning up" personnel and then not using them in contaminated areas. The practice of using men continuously in contaminated areas until the records reached the MPE led to a high number of individuals with exposures between 3.9 and 5.0 r. The practice of returning personnel to home stations before the completion of the operations necessitated a number of waiver requests for exposure of 3.9 r. A small number of TG 7.1 or 7.5 personnel exceeded a two-calendar-quarter MPE of 7.8 r.

4.6.5 Laboratory Element

The laboratory element acted to provide technical service to all agencies of the Task Force and consisted of the following:

1. Radiochemical Section. The center of operations for this section was a Signal Corps radiochemical laboratory trailer located on the hangar deck of the USS Bairoko. A smaller installation was operated at the Rad-Safe building on Parry for analysis of samples obtained at Eniwetok Atoll. This section received, prepared, and assayed solid and liquid samples submitted by other elements of the Joint Task Force as well as those samples arising from the activities of this Task Unit. Results were furnished in accordance with the request of persons submitting the sample and included such information as decay rates, specific activities, beta energies, gamma energies, and particle-size determinations of air-borne and water-borne activities.

2. Photodosimetry and Records Section. Two film-badge processing points were established and ran concurrently during the entire operation. The photodosimetry section afloat operated in a laboratory type trailer adjacent to the radiochemical trailer on the USS Bairoko. The photodosimetry section ashore operated in the Rad-Safe building, Parry. Film badges were calibrated against Co^{60}, and only gamma dosages were recorded. Du Pont packet 559 was used; controls and standards were developed with each batch of film processed. At the completion of the operation a master list of exposures was prepared. A report of exposure for each civilian participating was sent to his home station, whereas in the case of military personnel this report was made to the appropriate military organization. The final repository for the records of exposure will be the AEC Division of Biology and Medicine.

3. Electronics Section. This section supported the activities of the above sections by the repair and maintenance of densitometers, voltage regulators, scalers, count-rate meters, and scintillation counters. Individual survey type instruments were repaired as soon as practicable after breakdown. In addition, instruments issued and utilized by this Task Unit were calibrated and serviced at regular intervals throughout the operation.

4.6.6 Decontamination Element

The Task Unit operated personnel decontamination stations at Parry and aboard the Bairoko, Ainsworth, and Curtiss. No significant skin contamination was noted in personnel processed through these stations.

Equipment decontamination became a major activity at Parry [redacted] Vacuum cleaning, water washing, and steam cleaning were accomplished in a newly constructed decontamination area. Decontamination of various items from survey instruments to laboratory trailers was practically accomplished. Equipment was released to using agencies when decontaminated to 15 mr/hr.

It was noted during these decontamination procedures that the current instruments were only measuring about one-half of the total radiation present. It was also noted that the protective clothing was absorbing approximately one-half of the total incident radiation. The extremely low energy of the residual radiation made sealing practices very acceptable.

[redacted]

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4.6.7 Supply Element

Supply stations were originally set up on both atolls, Parry station on Eniwetok and Eninman on Bikini Atoll. In addition to its normal functions, Parry supply was responsible for shipping, receiving, and recording all supplies and keeping supplies moving to Forward Areas as required. Eninman station was a base supply, and its function was to maintain sufficient stocks on hand in case additional substations were required to cope with the operational situation. [redacted]the Eninman supply station was contaminated and was therefore eliminated as a supply point. A sea-going barge was procured and set up as a Rad-Safe Control and Supply Station. The construction aboard the barge consisted of two squad tents and portable salt-water showers. One tent was jointly utilized by control and supply elements; the other was a dressing and change station. Two transportainers were procured for storage purposes, and a wooden hot locker was constructed for radiac instruments. The barge was tied up alongside the USNS Ainsworth during recovery and salvage operations.

A table of equipment for this operation was set up and contained a total list of supplies and equipment for this unit. The majority of items listed therein were shipped from Los Alamos and processed through J-4. These articles arrived on dates due and in good condition. Military items of issue were placed on LX orders, to be furnished by the Supply Officer of TG 7.2.

Facilities for laundering contaminated clothing at Parry were adequate.

4.6.8 Radiological Situation Data Summary

(a[redacted]A partial Rad-Safe survey was conducted[redacted]with incomplete results (Table 4.1). Results of this initial survey were conclusive enough to cancel all activities

Table 4.1—[redacted]RADIATION SUMMARY IN ROENTGENS PER HOUR*

Island	Extrapolated H+4 hr	[redacted] +2 days	+7 days
Enyu	40–60	1.0–3.0	0.38–0.40
Bikini	70–125	6.0–9.0	0.8–2.1
Aomoen	25–180	1.2–9.0	0.75
Romurikku	400	20	0.90
Yurochi	600	30	1.0
Namu (Sta. 1200)	125	6.0	0.45–0.6
Crater		0.1	0.02
Bokonejien	1500	75†	
Bokobyaadaa	280	15	2.0
Spit south of Bokobyaadaa (Sta. 1341)	65	3.0	
Airukiiji through Bokororyuru	6.0–10	0.1–0.22	0.025–0.035
Bairoko (30 miles southeast of Enyu)	0.25		

*All readings with radiac instrument AN/PDR-39 except as indicated.
†AN/PDR-18.

for[redacted] The first complete survey was conducted on[redacted]+2 day. As a result of wind conditions[redacted]areas had become spotty in nature; therefore the extrapolated values representing the H+4 hr readings can only be considered approximate. These extrapolated values are based on a $t^{-1.2}$ decay, whereas laboratory analyses indicate a $t^{-1.8}$ decay during this period, thus indicating values in excess of those noted in the table.

[redacted]

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Bikini lagoon contamination of consequence was confined to lagoon areas containing suspended sediment. For the first few days this area was confined to the western quarter of the lagoon. This radioactive sediment washed over the western reef, out through the southwest passage, or settled to the bottom of the lagoon in a period of three days.

No alpha activity was detected in swipes about the living areas of the Task Group.

(b) [redacted] A partial Rad-Safe survey was conducted [redacted] with incomplete atoll results (Table 4.2). Results of this survey indicated no extensive recontamination of the atoll

Table 4.2—[redacted] RADIATION SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H+4 hr	[redacted] +1 day	+2 days	[redacted] back-ground [redacted]
Enyu	0.03	0.03	0.06	0.03
Bikini*	0.20	0.12	0.14	0.12
Aomoen*	0.80	0.80	0.60	0.22
Romurikku*	1.6	1.7	0.75	1.1
Uorikku*	0.8–1.4	1.4	0.85	1.2
Yurochi*	0.8–1.0	1.3	1.0	1.3
Namu*	2000		100	0.6
Bokobyaadaa*	1000	50.0†	55	1.2
Ourukaen	0.04	0.10‡	0.16‡	0.04
Arriikan	0.02	0.40‡	0.32‡	0.02
Eniirikku	0.005	0.005	0.05	0.01
Airukiiji	0.02	0.01	0.08	0.01
Eninman	0.012	0.012	0.06	
Crater		1100§		
Ships			0.02–0.04	

*Contamination [redacted]
†200-ft altitude.
‡Radiation shine from water in southwest passage.
§At 300 ft.

except within the Bokobyaadaa-Namu chain. An unforeseen fall-out of radioactive material less than 5 μ in size did occur [redacted] This fall-out covered the atoll and raised radiation levels by approximately 100 mr/hr. Because of the late period of fall-out, this radiation level would have corresponded to 3.5 r/hr fall-out at H+2 hr.

Because of small particle size this fall-out was much more difficult to decontaminate than the macroscopic particles [redacted]

Secondary fall-out leveled off between 0700–0800M, [redacted] Residual topside levels on ships were Ainsworth, 8 mr/hr; Estes, 12 mr/hr; and Bairoko, 30 mr/hr. Maximum levels were 20 to 45 mr/hr.

Lagoon contamination covered the western quarter of the lagoon [redacted] Lagoon flushing through the southwest passage materially increased background-radiation levels in the vicinity of Ourukaen, Bokoaetokutoku, and Bokororyuru.

(c) [redacted] A partial Rad-Safe survey was conducted [redacted] with incomplete atoll results (Table 4.3). Results of this survey did indicate that Bokobyaadaa, Namu, Eniirikku, Bikini, and the Yurochi-Aomoen chain were materially contaminated. Reentry and recovery were accomplished to a large degree on shot day. No secondary fall-out was detected as results of this shot.

Lagoon contamination was restricted to a V-shaped pattern with apex at Eninman and tips covering the Bokobyaadaa-Aomoen area. A reading of 100 mr/hr was obtained over the Enin-

[redacted]

man anchorage at H + 4 hr. Enyu anchorage was clear of contamination whereas Bikini anchorage showed traces of contamination at H + 4 hr.

The [redacted] crater was materially different [redacted] in that radiation levels within the crater were dependent on "shine" from the lip of the crater and surrounding "sand dunes."

(d) [redacted] A damage and radiation survey was conducted [redacted] (Table 4.4). This survey covered the eastern and northern islands of the atoll and was conclusive enough to limit reentry to Enyu, Bikini, and Airukiiji on the first day. The survey [redacted] indicated that recontamination was limited to the Yurochi-Aomoen and the Bikini-Enyu sequence of islands. No material secondary fall-out was encountered at Bikini as a result of this detonation.

Table 4.3—[redacted] RADIATION SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H + 4 hr	[redacted] + 1 day	+ 7 days	[redacted]
Enyu	0.03	0.03	0.03	[redacted]
Bikini*	5.0	0.67	0.07	0.10
Aomoen*	20.0	2.5	1.6	0.35
Romurikku*	10.0	1.6	0.80	0.50
Uorikku*	5.0	1.0	0.60	0.47
Yurochi*	5.2	1.0	0.60	0.45
Namu*	250	30.0	16.0	1.5
Bokobyaadaa*	600	*	16.0	9.0
Ourukaen*	0.60	0.08	0.02	0.012
Arriikan*	0.50	0.07	0.01	0.008
Eniirikku*	210.0	2.4†	1.8	0.008
Eninman			0.02	0.010
Airukiiji	0.02	0.02	0.02	0.018
Crater	5000	50‡	60	

[redacted]

†Reading at 100 ft.

‡Reading at 200 ft.

Lagoon water was materially contaminated with radioactive sediment. Readings of 4.2 r/hr were obtained at an altitude of 500 ft over Ground Zero. This contamination moved to the west and southwest so that small-boat operations could be conducted in the area. Lagoon flushing through the southwest passage materially increased radiation levels in the vicinity of Ourukaen, Bokoaetokutoku, and Bokororyuru.

(e) [redacted] A damage and radiation survey was conducted at H + 4 hr [redacted] (Table 4.5). This survey covered the islands of the atoll and was conclusive enough to limit reentry to Enyu and Airukiiji on the first day. This survey indicated that recontamination was extensive throughout the atoll and lagoon both to the east and west. No significant secondary fall-out was encountered at Bikini as a result of this detonation.

Lagoon water was heavily contaminated with radioactive sediment. Readings of 1 r/hr were obtained at 100-ft altitude in the vicinity of zero point [redacted] Floating objects revealed readings of 1 to 3 r/hr on shot days. Small boats and barges in Bikini-Enyu anchorage were contaminated to a moderate degree (1–6 r/hr). Lagoon flushing through the southwest passage materially increased radiation levels in the Eniirikku-Bokororyuru area.

(f) [redacted] A damage and radiation survey was conducted at approximately H + 4 hr [redacted] (Table 4.6). This survey covered the islands of the atoll and was conclusive enough

[redacted]

Table 4.4 - [redacted] RADIATION SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H+4 hr	[redacted] +1 day	+4 days	[redacted] Background [redacted]
Enyu*	0.75	0.10	0.03	0.01
Bikini*	70	8.5	0.80	0.03
Aomoen*	140	15.0	2.0	0.40
Romurikku*	140	15.0	2.4	0.40
Uorikku*	85	10.0	1.0	0.36
Namu			1.0	2.5
Yurochi*	85	10.0	1.0	0.40
Bokobyaadaa		1.2	2.2	4.0
Ourukaen		0.01	0.50‡	0.01
Arriikan		0.01	0.60‡	0.01
Eniirikku		0.06	0.10‡	0.90
Eninman Crater		6.5	4.0	100
Airukiiji		0.01	0.01	0.01
Crater*			0.01	0.00

[redacted]
†Reading at 500 ft.
‡Shine from contaminated water.

Table 4.5 - [redacted] RADIATION SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H+4 hr	[redacted] +1 day	+5 days*	Background
Enyu†	18	2.0	0.44	0.02
Bikini†	225	25	2.0	0.32
Aomoen†	50	6	0.80	1.0
Romurikku†	65	7.5	1.2	1.0
Uorikku†	95	12	2.0	0.25
Yurochi†	95	12	4.0	1.0
Namu†	10		1.0	0.80
Bokobyaadaa			0.95	3.0
Ourukaen†	3.5 (?)	0.50‡	0.12‡	0.01
Arriikan†	1.3	0.60‡	0.10‡	0.08
Eniirikku†	0.18	0.01	0.01–1.0	0.03
Airukiiji†	0.505	0.01	0.01	0.01
Crater		1.0§		
Lagoon			80 (west)	

*Final aerial survey. [redacted]
‡Radiation shine from water in southwest passage.
§Reading at 100 ft.

[redacted]

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to limit reentry to the southern and eastern islands of the atoll. This survey indicated that radioactive contamination extended north of a line from Bogallua to Piiraai. Secondary fall-out amounting to 2 mr/hr was experienced at Parry [redacted]

Lagoon water was moderately contaminated in the vicinity of the Bogallua-Teiteiripucchi chain and cleared within two days.

Table 4.6 [redacted] RADIATION SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H + 4 hr	[redacted] + 1 day*	+ 2 days
Eniwetok	0	0	0
Parry	0	0	0
Japtan	0	0	0
Chinimi	0	0	0
Aniyaanii	0	0	0
Chinieero	0	0	0
Runit	0	0	0
Piiraai	0.05	0.006	0.006
Aaraanbiru	0.08	0.01	0.01
Rojoa	0.10	0.01	0.01
Biijiri	0.12	0.014	0.01
Aomon	0.17	0.02	0.02
Eberiru	0.17	0.02	0.02
Rujoru	0.10	0.012	0.02
Aitsu	0.14	0.016	0.02
Yeiri	0.17	0.02	0.02
Bokonaarappu	0.17	0.02	0.02
Kirinian	0.35	0.04	0.04
Muzin	0.42	0.05	0.06
Engebi	0.70	0.08	0.08
Bogon	0.98	0.12	0.14
Bogairikk	?	0.22	0.60
Teiteiripucchi	60.0	6.8	7.0
Cochiti	70.0	8.0	12
San Ildefonso	75.0	8.4	1.0
Ruchi	8.0	0.80	0.36
Bogombogo	3.9	0.44	0.36
Bogallua	2.2	0.26	0.28
Rigili	0	0	
Giriinien	0	0	
Ribaioni	0	0	
Pokon	0	0	
Mui	0	0	
Igurin	0	0	

*Period preceded by heavy rainfall.

4.6.9 Laboratory Data Summary

The bulk of the samples analyzed by the radiation-analysis section of TU-7 were water samples. The specific activities in microcuries per milliliter of approximately 675 lagoon- and drinking-water samples were determined during the course of the operation. Lagoon sampling was carried on to ensure that ships' anchorages were not excessively contaminated. As the operation progressed it became evident that excessively contaminated water could be observed

[redacted]

as a result of the sediment deposited in the water and could be evaluated adequately using only an AN/PDR-39 survey type meter. The maximum contamination encountered in the lagoon anchorages was 8.4×10^{-3} microcurie per milliliter. The average activity varied from 1×10^{-4} to 3×10^{-4} microcurie per milliliter. No ship's drinking water was found to contain any detectable radioactive material.

Air samples collected in fall-out areas by vacuum type air filters and cascade-impactor slides constituted another type of sample analyzed in the field laboratory. Upon those occasions when fall-out was detected on board the USS Bairoko, portable air samplers were periodically turned on as a means to determine whether fall-out was still occurring. The entire filter paper was counted and the activity was noted in counts/min per cu ft of air. Air samplers were also used by the initial survey party. A cascade impactor, installed in the radiac repair shop on board the Bairoko, was utilized to evaluate the inhalation hazard associated with the radioactive particulate matter by determining the percentage of the total activity associated with particles less than 5 μ in diameter. The air samples collected on March 1, when the USS Bairoko received a substantial fall-out [redacted] indicated activities ranging from 455 to 2740 counts/min per cu ft of air. The only cascade-impactor data were also obtained during the fall-out that occurred on the Bairoko. An average of 65 per cent of the activity was found to be associated with particles less than 5 μ in diameter.

Decay-rate measurements and energy determinations were made on various types of samples throughout the operation in an effort to obtain detailed information on the fundamental properties of the radioactive particulate matter. Gamma energies were difficult to obtain accurately due to the low counting efficiency of G-M tubes for gamma radiation and the apparent low energies involved. The latter also made beta-energy determinations more difficult. Gamma energies measured on very active samples varied from 600 to 25 kev. The low gamma energies measured were somewhat surprising. Beta energies varied from 0.2 to 2.2 Mev.

Log-log plots of counts per minute vs time after detonation were utilized to obtain decay-rate data. Samples studied included fall-out samples on the Bairoko, water samples from the lagoon and drinking-water samples from Rongelap, crater samples, and air samples. The following results represent a cross section of the different types of samples studied and the calculated slope of the line obtained by plotting the log of the activity vs the log of the time after detonation.

1. Fall-out sample on the flight deck of the Bairoko [redacted] 1.62.
2. Lagoon sample collected 1220 Apr. 7, [redacted] 1.03 at +8 days and 1.31 at +25 days.
3. Air sample collected Apr. 26, [redacted] 1.19.

The six drinking-water samples from Rongelap indicated an average slope of −1.48 from [redacted] +4.2 days t[redacted] +10 days and a slope of −1.80 until last counted.

Miscellaneous tasks assigned to the radiation-analysis section included the analysis of urine samples for tritium content; examination of food, soil, and water samples obtained on a resurvey mission to Rongelap and Uterik; a study of the decay characteristics of contaminating material on vans being shipped to the United States; and analysis of water samples obtained during a water survey [redacted]

4.6.10 Conclusions and Recommendations

(a) Conclusions. The present maximum permissible exposure of 3.9 r per 13-week test period is not a realistic MPE in consideration of heavy work loads in extensively contaminated areas. The use of waivers to cover exposures in excess of this MPE becomes a needless routine without much significance when operations are conducted in large contamination areas without much interval between detonations. A large number of individuals did exceed 3.9 r, but very few exceeded 6.0 r.

The utilization of project personnel as monitors proved itself with few exceptions.

Procurement and clearance of personnel must be accomplished at least four months in advance of operations in order that selection and training can be completed and in order that the unit can be completely assembled prior to movement overseas.

(b) Recommendations. The test MPE should be based on calendar quarters of 3.9 r and should consider the preparatory phases as well as the operational phases of the overseas test.

A pool of experienced monitors must be made available to the Rad-Safe Unit to support independent construction operations and supplement project-monitor activities.

Personnel-procurement planning should be initiated at least one year prior to operations, and personnel should be selected for training at least four months prior to operations.

4.7 TASK UNIT 8, TECHNICAL PHOTOGRAPHY

The following were the assigned responsibilities of TU-8 during Operation Castle:

1. To make all negatives necessary to provide full report coverage for TG 7.1 scientific programs, units, and staff sections in black and white and color still and motion pictures.
2. To provide construction, accident, and general record coverage.
3. To make technical documentary records in still and motion pictures of each operation.
4. To provide facilities and aid to scientists in the processing of scientific photographic records.
5. To store, issue, process, and account for technical documentary film in accordance with security and classification instructions.

These responsibilities were fulfilled. To implement the necessary coverage, 17 men were phased in and out of the Forward Area from Graphic Arts in Los Alamos. Individual phasing cycles approximated six weeks. In addition to these men, six military men were assigned to TU-8 Forward. After the first shot two photographers operated under a section leader from the ships based at Bikini.

Statistics are as follows:

4200 black and white negatives were made, and two prints were made from each negative.
700 color transparencies were made, including those made at Kwajalein for Project 4.1.
15,000 ft of 16-mm stock footage was made.

TU-8 processed many units of scientific records and provided darkroom space, equipment, and supplies to many scientific groups.

4.8 TASK UNIT 9, DOCUMENTARY PHOTOGRAPHY

4.8.1 Mission

Operation Castle was documented on film, both still and motion picture, aerial, ground, and underwater, as a basis for a photographic record for historical purposes and subject matter for a considerable number of motion pictures depicting the scope and conduct of various phases of Operation Castle.

4.8.2 Organization and Command Relation

The Joint Chiefs of Staff at the request of CJTF SEVEN established a military requirement for the USAF Lookout Mountain Laboratory to support Operation Castle, and Headquarters USAF approved its employment to organize and support a technical photographic unit (TU-9) as part of TG 7.1.

4.8.3 Requirements

(a) Preliminary Requirements

1. Photography of General Clarkson, Dr. Graves, Admiral Bruton, and General Estes delivering security lectures was taken and used for showing in the Forward Area to all Task Groups.

[redacted]

2. Thirty security trailers emphasizing the need to guard against carelessness were made for the purpose of showing to Task Groups in the Forward Area.

3. Operation Tigercat. Documentary coverage was made of the TG 7.4 dress rehearsal for Operation Castle at San Diego, Calif., in October 1953.

(b) Final Requirements

Complete documentary motion picture and still coverage of Operation Castle was required and obtained to produce the following:

1. Six "Quickies" (one for each shot). Each Quickie contained a description of the device used, major instrumentation utilized, operational difficulties encountered, anticipated results, and actual results. Narration in all cases was restricted to Maj Gen P. W. Clarkson, Alvin C. Graves, or a member of TG 7.1. These Quickies were primarily intended to be a method of informing the top officials of the AEC and the White House of the progress made in the Forward Area, and Classification was Top Secret Restricted Data. This program was sponsored by JTF SEVEN, and print distribution was limited to two prints for DMA, Washington, D. C., and one print for CJTF SEVEN.

2. Task Force Commander's Report. This was a consolidated factual report narrated by Maj Gen Clarkson and Dr. Graves, summarizing the operational problems, expectations, and results of Operation Castle. Classification was Secret Restricted Data. This program was sponsored by JTF SEVEN, and exact print distribution is to be determined later.

3. Department of Defense Picture. This was sponsored by JTF SEVEN with emphasis on military participation and military effects as related to high-yield devices. It was intended as a training film. Classification is Secret Restricted Data, and exact print distribution will be determined later.

4. Public Release Picture. This was sponsored by AEC and was Unclassified. The purpose was to inform the public of the recent tests conducted at the PPG, and print distribution will be determined at a later date.

5. Cloud-study Photography. Rate of rise and spread of nuclear cloud from time zero to zero + $1\frac{1}{2}$ hr. Footage was exposed from four separate aircraft orbiting around point zero and then around the cloud as it dispersed. Sponsored by AFSWP. Photography and processing by TU-9 and interpretation by EG&G.

6. Crater-survey Photography. Oblique and vertical motion-picture photography of all craters was made. Photography and processing was done by TU-9, and interpretation was done by Army Map Service, with final evaluation by Stanford Research Institute.

7. Base-surge Photography. High-altitude coverage of base surge was carried out.

8. All film exposed on Operation Castle, both still and motion picture, is being catalogued and indexed. Cataloguing is being accomplished by the use of the microfilm process with one copy of the final catalogue distributed to LASL, Los Alamos, N. Mex., and one copy to AFSWP, Washington. AFSWP is to be the coordinating authority for additional prints required by DOD agencies of any stock footage shown in the catalogue.

4.8.4 Operations

(a) Wheeler Laboratory. The requirement for Quickie type films containing live photography and synchronized sound necessitated a radical operational change so that delivery in Washington could be accomplished five to seven days after each shot. This change consisted of the acquisition of a laboratory at Wheeler Field, Oahu, T. H., and staffing it with TU-9 personnel to cut transportation time required for ZI processing. This laboratory functioned above expectations and averaged 9 hr processing time from receipt of shot footage until required prints were ready for return to the Forward Area. The adoption of this procedure saved an estimated 36-hr in-transit time which would have been required if work had been accomplished at Lookout Mountain and thereby permitted TU-9 to meet all Washington delivery dates on schedule.

(b) Bikini-Eniwetok Operations. During the early portion of Operation Castle, elements of TU-9 were based on both Bikini and Eniwetok Atolls. This divided effort was necessitated

[redacted]

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primarily by the amount of activity occurring simultaneously at both atolls, but transportation problems for men and equipment were a contributing factor. The main disadvantage to this split activity was the inability to pool equipment for joint use. Occupancy of the Eniman complex was concluded earlier than expected, after which all TU-9 operations were carried on from aboard ship or from Parry Island.

(c) Ground Crews. A total of five camera crews and one sync sound crew exposed the bulk of the footage on Operation Castle. Each camera crew was augmented by one still photographer, was mobile, and was completely equipped. The maximum number of Lookout Mountain Laboratory personnel overseas at any one time was 50. Personnel were returned to the ZI as soon as the workload permitted.

(d) Aerial Crews. Three C-54 aircraft were obtained on loan from MATS and modified at Norton Air Force Base to accept camera racks and associated equipment fabricated at Lookout Mountain. One RB-36 provided the platform for the high-altitude cloud studies. All four aircraft participated in one practice mission prior to departure from the ZI and one practice mission before the first shot. No C-54 aircraft aborted on any of the photographic missions.

4.8.5 Remote Installations

Six remote camera installations were utilized on most shots. These installations were designed and fabricated by Lookout Mountain and were located at various strategic points adjacent to Ground Zero, yet so positioned to facilitate recovery by helicopter or M-boat.

Owing to unforeseen circumstances beyond the control of TU-9 (heavy fall-out, irradiation of film, tidal waves, inability to recover, etc.), not all footage obtained was utilizable. That which was salvaged, however, yielded some photography.

4.8.6 Film Exposed

As of May 15, 1954, the following amount of film, both still and motion picture, had been exposed during Operation Castle:

16-mm KCO	83,600 ft
16-mm B/W	64,600 ft
35-mm B/W motion picture	23,100 ft
35-mm EK motion picture	20,100 ft
4 × 5 B/W stills	3,540 ea
K-20 B/W	150 ea
K-20 EK	150 ea
K-20 and K-24 EK $5\frac{1}{2} \times 5\frac{1}{2}$	3,360 ea
4 × 5 EK still	732 ea
K-17 $9\frac{1}{2} \times 9\frac{1}{2}$ EK	1,600 ea
K-17 $9\frac{1}{2} \times 9\frac{1}{2}$ BW	8,400 ea
$2\frac{1}{4} \times 2\frac{1}{4}$ BW	1,200 ea
$2\frac{1}{4} \times 2\frac{1}{4}$ EK	96 ea

4.9 TASK UNIT 12, UCRL PROGRAMS

TU-12 was created for the purpose of carrying out diagnostic measurements [redacted] Some personnel of TU-12 assisted TU-1 in making some specific measurements [redacted] for LASL. [redacted] The work of this Task Unit was organized under four programs. Program 21, Radiochemistry, in cooperation with LASL Program 11, made measurements on all the shots at Operation Castle. The summary of the techniques and results of this program, as well as those of the other programs, is given in Sec. 2.3. Program 22, Reaction History, was to carry out the Ganex, Tenex, and alpha measurements [redacted] Program 23, Scientific Photography, attempted to

[redacted]

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study hydrodynamic motion [redacted] and to measure yield by fireball. Program 24, Phonex, measured the energy spectrum of the neutrons [redacted] In general, all experimental equipment worked satisfactorily, but bad weather caused a serious loss of data in Program 23.

4.10 TASK UNIT 13, DOD PROGRAMS

TU-13 was assigned the mission of directing the activities of the various DOD groups participating in the Military Effects Program of the operation. A total of ten officers and five enlisted men were assigned to the Task Unit Headquarters Staff. The total personnel in the participating projects varied from 150 to a peak of 350 during March and April. Of the Headquarters personnel, six officers served as Program Directors for the six DOD programs, and the remainder performed necessary administrative and operational support functions. In addition, several of the Program Directors performed various support functions outside their particular program.

Because of the split nature of the operation between Bikini and Eniwetok, it was not possible to maintain as complete a staff at both atolls as would have been desirable. In general, project planning was done at Eniwetok since this was the main base of operation. The majority of the on-site preparatory work was done at Bikini, where five of the six detonations took place. The principal staff agency of TG 7.1, with whom continuous coordination had to be effected during the operation, was J-3, and, since coordination of all Bikini operations was exercised by a J-3 office in that area, it was frequently impossible, because of the limited number of supervisory personnel in the Headquarters of TU-13, to maintain the close liaison which is essential in an operation of this type. This situation was further aggravated by the shift to a ship-based operation [redacted] and by the necessity for maintaining readiness status for two shots, one at Bikini and one at Eniwetok, simultaneously.

In spite of the above, participation of TU-13 in the various shots was in close agreement with the original plan. In some instances the scale of participation had to be reduced considerably. This was due to loss of equipment in a fire on Eninman, the attrition of test equipment due to repeated delays, and the lack of sufficient equipment to maintain complete readiness at both atolls. However, in other cases (for instance the fall-out program), the weather delays allowed sufficient interpretation of results to conceive and carry out additional measurements which contributed appreciably to the success of the over-all program. Results of the various programs are summarized in Chap. 2.

In general, it is felt that participation in the operation was successful, particularly in view of the many changes which were necessitated by weather delays, changes in yield, changes in shot locations, and the cancellation of one shot for which a complete blast line had been constructed. In future operations of this type it is believed that the DOD test organization should follow the general pattern of TU-13. Closer supervision of project activities and better liaison and coordination with other Task Units and Task Group Headquarters should be sought. Individual projects to be included in a future test of this scale should be designed with a much greater degree of flexibility.

4.11 TASK UNIT 14, UCRL ASSEMBLY

TU-14 was concerned with the design of two devices to be tested at the PPG during Operation Castle. During the continental phase of this program, this group was concerned with the design, fabrication, and mock-up assembly of the two devices, [redacted] In addition, coordination work was done with GMX, W, and J-Divisions of LASL; Camco; NBS Boulder; and Consolidated Western Steel, who constructed and assembled the case and supporting structure.

The associated components for the two devices were shipped to the PPG in December 1953, and the classified components were sent aboard the USS Curtiss. [redacted]

[redacted]

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Assembly [redacted] was done in a shot cab on Eberiru, Eniwetok Atoll, starting early in January 1954 and was completed, including the necessary cryogenic testing, by Mar. 8, 1954. [redacted] When the decision not to fire [redacted] was made, disassembly of the device was started, and parts were stored in the Camco building in the CMR area on Parry. The SF components are being shipped to the ZI for reclamation.

One difficulty encountered during the assembly of the [redacted] cryogenics was the appearance of an air plug in the deuterium venting line, which gave rise to a nonexplosive bursting of several of the cryogenic components. Approximately one week's effort was necessary to return the cryogenic system to the operating condition that existed before the accident.

The [redacted] device was constructed in a shot cab on Eninman Island, Bikini Atoll, during the latter part of January and February. [redacted] the construction was essentially completed. [redacted]

The [redacted] device was detonated at 0625 local time, Apr. 7, 1954.

4.12 TASK UNIT 15, TIMING AND FIRING

Prior to the operational phase of Operation Castle, TU-15 had planned to fire all the devices from the manned CP, Station 70 on Enyu at Bikini, and Building 311 on Parry at Eniwetok. Installations were made first at Bikini Atoll with the timing system controlled and monitored from Station 70 where the radio signals were also generated.

The first shot [redacted] with its attendant radiological and personnel safety problems, demonstrated the undesirability of manning the control station at least for large devices.

TU-15 reassembled and supplemented the Operation Ivy radio control equipment and installed it on board the USS Estes with the receiving and decoding equipment on the 300-ft Enyu tower. This system was checked out within a week [redacted] and was used to fire the remaining Bikini shots.

No difficulties were experienced with the hard wire or radio signals, although some Blue Boxes at great distances did not fire because (1) the transmission in general was low along the line of sight and (2) as in Mike the first light emitted was of relatively low intensity and predominantly red in color.

The Eniwetok shot was fired from a manned station on Parry, with the device located in the Mike crater, and again no difficulties were experienced; the television and tone monitoring systems were not used because of the cancellation of their respective shots.

The only timing-system failure reported on the operation was the failure to get a 1-min radio signal by Sandia [redacted] The equipment had not been dry-run, but an analysis of the failure will be attempted.

The Bhangmeters are considered a part of the timing system within the EG&G division of responsibility and are reported herein.

The standard Bhangmeters did not trigger on shots where the transmission was low, but a Bhangmeter in a B-36 airplane gave correct results on all shots at tactical distances and hence proved the usefulness of the device for yield measurements from aircraft.

An experimental oscillographic Bhangmeter gave results on all shots and yielded much information on the relative red and blue light levels as seen by photosensitive surfaces.

TU-15 had no great difficulty in maintaining timing systems for alternate firing in both atolls and was in fact prepared to radio-fire in both atolls.

TU-15 would recommend that, in the future, preparations be made to radio-fire all large devices and to expand the radio time signal system so that hard wire need only be used in congested locations and for critical experiments. In this way the most satisfactory and economical system can be used.

[redacted]

APPENDIX

MAPS OF ENIWETOK AND BIKINI ATOLLS

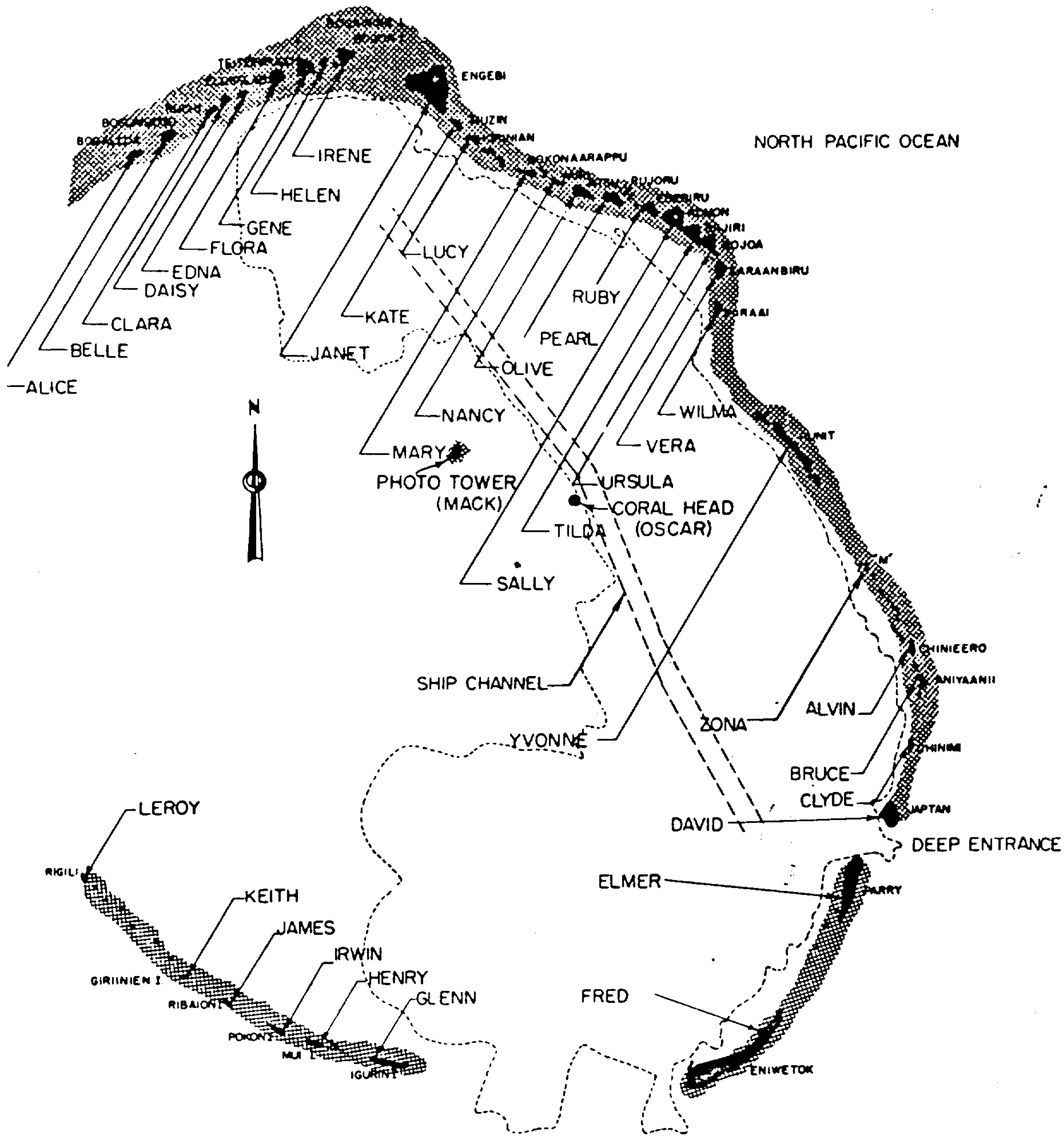

Fig. A.1 — Map of Eniwetok Atoll.

[redacted]

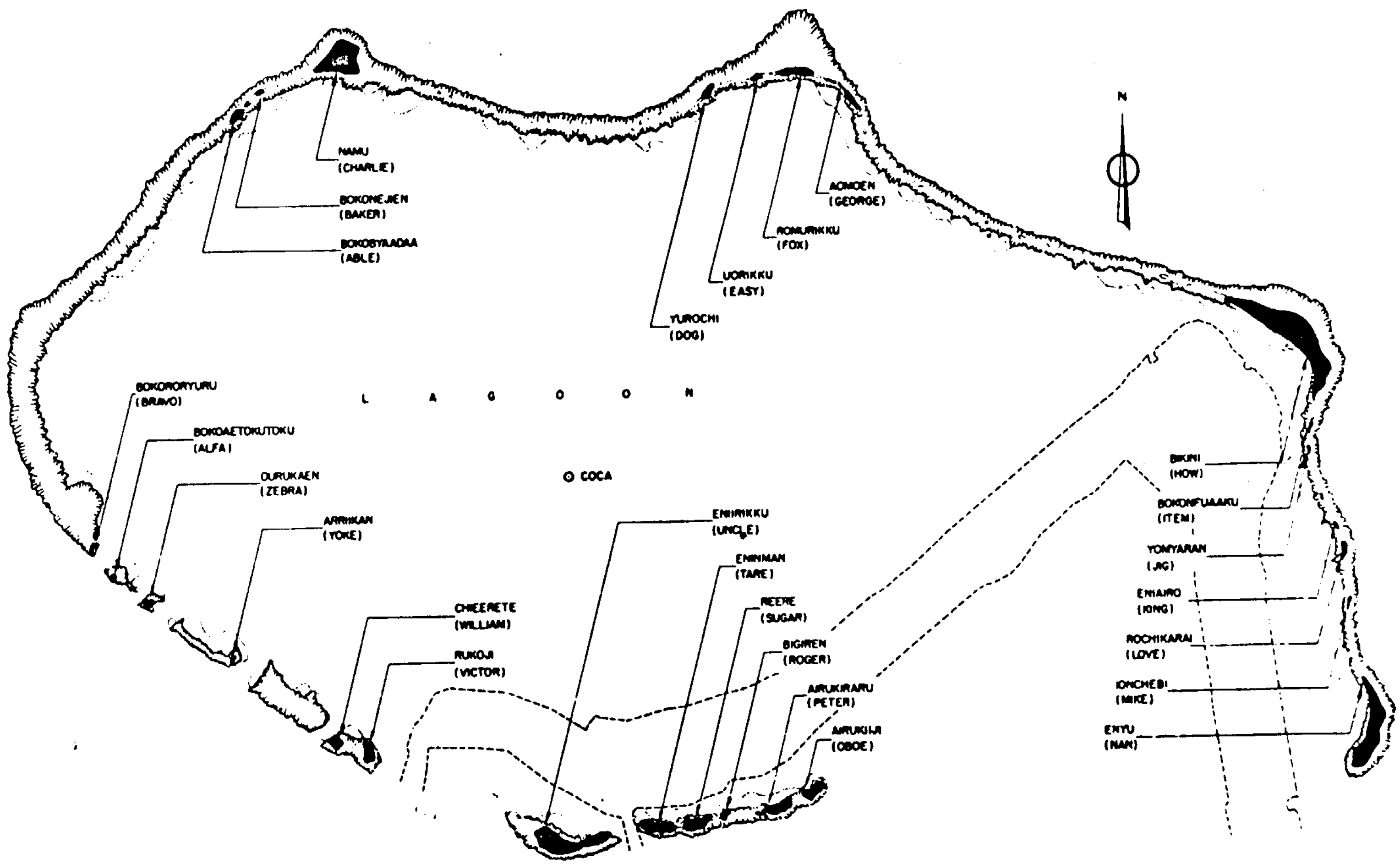

Fig. A.2—Map of Bikini Atoll.

[redacted]

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5.2

[redacted]

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