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COMMANDERS REPORT

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CHAPTER I

OBJECTIVES, DEVICES, AND WEAPONS

1.1 LOS ALAMOS SCIENTIFIC LABORATORY

1.1.1 GENERAL OBJECTIVES

A total of 14 full scale tests and one safety test were carried out by LASL in Operation HARDTACK. Two of the tests were hevily instrumented and for this reason were fired on land. The other thirteen were fired on barges to facilitate readiness and minimize contamination problems.

The major objectives of the Laboratory at the beginning of the operation could be grouped around six main headings:

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CHAPTER I

OBJECTIVES, DEVICES, AND WEAPONS

1.2 UNIVERSITY OF CALIFORNIA RADIATION LABORATORY

1.2.1 Objectives.

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1.3 DEPARTMENT OF DEFENSE

Under the authority of Secret letter, file SWPWT/960, Chief, Armed Forces Special Weapons Project, dated 2 June 1953, subject: "Tests Involving Nuclear Detonations Participated in or Conducted by Agencies of the Government of the United States Outside the Continental United States," the responsibility of the Preparation, Operation and Post-Operation Phases of Operation HARDTACK was assigned to the Commander Field Command, AFSWP.

The Joint Chiefs of Staff authorized AFSWP to plan and impliment, in coordination with the various services and the AEC, the following:

1. Appropriate test programs to be conducted in conjunction with the following detonations:

   a. VHA balloon-borne - [redacted] DELETED
   b. UHA (250000 ft) Missile-borne -
   c. VHA (125000 ft) Missile-borne -
   d. Sub-kt

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2. The selection of the appropriate nuclear devices.

The Chief, AFSWP formulated these plans and also a number of separate projects to be conducted on selected development detonations.

The Director, Weapons Effects Test Division, a staff agency under the Commander Field Command, AFSWP, was assigned the functions of detailed planning and field implementation of the DOD Weapons Effects Program, Operation HARDTACK. The joint AEC-DOD scientific organization, Task Group 7.1, was charged with conducting the scientific tests during the operational phase at the EPG. The approved military weapon effects tests projects in Programs 1 through 6 and 8 and 9 are outlines below and discussed in Chapter 2.

Colonel E. A. Pinson, USAF was assigned as the Technical Director to the Directorate of WETD, FC, AFSWP, and acted as Deputy Commander, Task Group 7.1 during the operation. The DOD Weapons Effects Programs were organized as Task Unit 7.1.3 of Task Group 7.1 and commanded by Colonel K. D. Coleman, USAF.

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The DOD program participation in HARDTACK was of greater magnitude than in any other Pacific Operation.

<u>Program 1</u>. This program was designated primarily to obtain data from underwater bursts, such as blast overpressure and ground motion records. This information was necessary to ascertain the effects of underwater burst geometry and to understand the conditions which various structural objects, such as missiles and underground structures, are subjected at various locations from an underground detonation.

<u>Program 2</u>. This program objectives were:

1. To determine the gross radiological hazards resulting from underwater bursts. Included were free-field measurements, deck and selected compartment contamination measurements, and measurements of ingestion and inhalation of contamination entering the ship via ventilation and combustion air systems.

2. To collect neutron energy spectrum data to supplement the presently inadequate knowledge of neutron energy spectrums from thermonuclear weapons. Prompt neutron measurements were to be determined from a VHA small yield weapon.

3. To measure radiation in the nuclear cloud which contributes to world wide contamination.

<u>Program 3</u>. This program was designed for determination of the effects of underwater bursts on surface and sub-surface vessels, and for the study of various types of land structures under various loading conditions. The information obtained by both programs 1 and 3 will be used to aid in formulation of operational doctrine, particularly insofar as delivery ranges and tactics for both surface and sub-surface vessels. The information obtained on the response of ship structures will be used to provide criteria for future designs. Data obtained from various earth-covered flexible arches tested under both long and short duration air blasts, and deep reinforced concrete slabs tested under blast loading, will be used to determine construction criteria for future underground structures.

<u>Program 4</u>. This program will participate only at Johnston Island.

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Program 5. This program was designed to determine the effects of nuclear weapons on aircraft structures. Nuclear weapon delivery by manned aircraft is often affected by the weapons' blast and thermal effects on the delivery aircraft and by nuclear radiation on the crew. Test data has indicated that blast inputs and skin temperature rise can be predicted within satisfactory limits, but that predictions of the aircraft's response to these inputs is much less reliable. In order to perfect delivery tactics, where safety margins are critical, manned B-52D, A4D-1 and FJ4 aircraft were to fly several missions each, collecting data on the results of various inputs.

Program 6. This program was to study effects in 4 categories:

1. Electronic equipment located at various distances from the zero point was to collect data to determine the feasibility of using the EM pulse from a nuclear burst for long and short range detection, and to study the fireball and nuclear cloud with radar for determing ground zero and yield.

2. Investigations were to be undertaken of the ionization effects of high altitude deton tions, particularly as they might effect communications systems dependent on the ionosphere for propogation.

3. Investigations were to be made on the deleterious effects on fuses and their components as a result of gamma rays and neutrons from nuclear explosions.

4. On the underwater shots, experiments were to be made to determine the feasibility of using nuclear explosions for clearing of mine fields.

Program 8. This program included the evaluation of laboratory methods of scaling thermal effects with weapons yield. Probably the most important part of the program participation was to investigate the little known thermal phenomena and the parameters which have a direct relationship on the damage producing thermal effects from the fireball of high altitude detonations and the prediction of those parameters for other heights and yields. Included was to be the photographic measurement of the fireball radius time history of high altitude detonations.

Program 9. This general support program included a study of effect of de- 16 tonations on ICBM Weapons in flight. Included were heat studies, studies of effects on radar and communications as well as basic effects studies. A special project (Project 9.2) was assigned the mission of lifting a weapon and related equipment by balloon, to the desired altitude of approximately 90,000 feet.

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CHAPTER I

OBJECTIVES, DEVICES, AND WEAPONS

1.4 SANDIA CORPORATION

1.4.1 Program 32.

The mission and designed purpose of Program 32 of Operation HARDTACK was to measure phenomena of interest to the Atomic Energy Commission, to develop and test instrumentation techniques compatible with phenomena associated with large nuclear bursts at very high altitudes, and to measure effects of interest to the Department of Defense. Program 32 also provided the support required by the AEC in furnishing the warheads for these tests.

1.4.2 Program 34. Support.

Program 34 included ten Sandia service projects which were performed for elements of Task Group 7.1.

The objective of Program 34 was to provide information, devices and systems to Task Units 7.1.1 through 7.1.4.

The projects within this program not only met every requirement but in general provided even more information than was expected.

CHAPTER II

SUMMARY OF EXPERIMENTAL PROGRAMS

2.1 TASK UNIT 3, DOD PROGRAMS (TU-3)

2.1.1 PROGRAM 1, BLAST AND SHOCK MEASUREMENTS

An accurate knowledge of free-field blast and shock phenomena is one of the essential ingredients needed by the DOD in evolving offensive and defensive strategy and in designing defensive structures and equipment. HARDTACK Program 1 Projects were aimed at extending knowledge of air blast and ground shock Phenomena gained in previous operations to higher pressures, larger yields, and a different soil type. In addition, blast and shock studies on HARDTACK were aimed at producing information from several shot environments for which little or no data was previously available.

1. Blast and shock phenomena from underwater shots.

2. Characteristics of a blast wave from a burst at an altitude of about 90,000 feet.

Ground Shock. The entire DOD effort on study of ground shock phenomena was concentrated on two surface shots, Cactus and Koa. Complete air blast lines were installed on these shots also so that the air blast input contributing to underground effects would be known. Shot Cactus was chosen to provide a low yield tie-in of underground data with similar data obtained on Operation Plumbbob at NTS. Shot Koa was instrumented so that comparisons (Cactus vs Koa) could be made between data from low and high yield shots under similar soil conditions.

All five projects participating on Shots Cactus and Koa successfully obtained the larger part of desired data. Results of individual projects are summarized below.

Airblast. Complete air blast data were obtained on both shots. Overpressures ranged from 343 psi at 470 feet to 1.85 psi at 7868 foot ground range

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on Shot Cactus and from 1160 psi at 1830' to 30.8 psi at 6024' on Shot Koa. Dynamic pressures data at 3' heights require further data reduction before results can be reported. Maximum overpreassures from both shots when scaled to 1 kt at standard sea level conditions agreed well with a 1.6 kt free air pressure curve. Neither shot showed any evidence of a precursor; in the case of Koa, this was contrary to predictions. Cactus overpressures show an unusually slow and as yet unexplained decay for the first 25-40 msec.

Free-field Ground Accelerations And Relative Displacements. Instrumentation to measure accelerations at various depths to 100' and relative displacement between the ground surface and the 50 and 100 foot depths was installed on both shots at ranges corresponding to predicted pressures of 600, 200 and 100 psi. Ground accelerations up to 1120 g on Koa and 616 g on Cactus were recorded. Acceleration wave forms were more complex than those obtained at NTS; wave forms were influenced considerably by energy transmitted through the earth from ranges closer to the burst. Horizontal accelerations were higher than expected. Peak vertical accelerations showed a more rapid decay with depth than at NTS at similar pressure levels. Relative displacements were smaller than observed at Nevada, largest being less than 5 inches.

Craters. Cactus crater dimensions of 180' radius and 36' depth agreed well with predictions. Koa crater dimensions of 1825' radius and 160' depth were significantly larger than predictions; it is believed the large water tank surrounding the Koa device may have increased the energy coupling with the ground.

Simulated Structures. Twenty two foot diameter drums, in both horizontal and vertical orientations, were buried for both shots at various depths to 20 feet at the predicted 200 psi pressure range. Results from the few drums recovered at this writing and from limited electronic data available indicate soil pressure decreased with depth to 10 feet and then rose to surface level values at 21

20 foot depths. As at NTS, the more flexible drums sensed the least pressure.

Vibrating Reed Gages. Canisters with vibrating reed gages were buried, at ranges of 75 to 200 psi on both shots, with their tops flush to the ground and mounted to the floor of Project 3.2 underground structures. Each reed gage provided a reading of maximum vertical or radial displacement for a given frequency; frequencies from 3 to 300 cps were used. Cactus and Koa results show no simple correlation with Plumbbob data. Vertical and radial displacements for Koa were much lower than expected from NTS data. Vertical displacements at frequencies less than 10 cps were lower and for frequencies greater than 100 cps were higher on shots Cactus and Koa than on Plumbbob. Radial displacements at 110 psi range for Cactus were about the same as for Plumbbob up to 10 cps and were two to four times greater at higher frequencies. At similar pressure ranges, Cactus vertical displacements were higher at frequencies above 50 cps than those of Koa. Cactus radial displacements at 10 to 50 cps were higher than those of Koa.

Air Shock at High Altitudes. Theory indicates that the effect of increasing the burst altitude reduces the energy appearing as air blast. On shot Yucca, the objective was to determine the characteristic of a blast wave at altitudes of about 90,000 feet in order to provide an accurate basis for scaling to higher and lower altitudes. Five canisters containing gages were to be suspended by a nylon line at ranges of 750' to 3000' from the device. Blackout of telemetering due to ionization was expected at zero time, but data was to be recorded and transmitted continuously for several minutes after the burst. Canister functions, including turning on the recorders, were to be controlled by a command transmitter aboard the USS BOXER. Project did not obtain its objective because of failure of this transmitter about two minutes before shot time. One pressure record from the 3000' canister was obtained from the direct transmission but appeared to be spurious.

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Blast and Shock Phenomena from Underwater Shots. Seven projects investigated free-field blast and shock phenomena on underwater shots Wahoo and Umbrella. Their primary objective was to obtain the free-field input data needed for determination of safe delivery and critical damage ranges for submarines, aircraft, and surface vessels operating in the vicinity of underwater nuclear detonations. In general, there was a rather thorough amount of information available on free-field blast and shock phenomena from HE tests. The only two nuclear underwater tests, Crossroads Baker and Wigwam, however, had left many basic questions unanswered. The blast and shock projects therefore were generally aimed at confirming and expanding Crossroads Baker and Wigwam results, providing a tie-in between data from nuclear and HE tests, providing input data to ship's damage projects, and generally increasing knowledge of underwater explosion effects.

Deep Water Shot - Wahoo.

Underwater Pressures. Two organizations, the Naval Ordnance Laboratory (NOL) and the Naval Electronic Laboratory (NEL), collaborated in measuring underwater pressures. Their main technical objectives were to confirm Wigwam results on scaling for isovelocity conditions and to study the effects of refraction. Pressure data were obtained at 5 to 9 stations instrumented; peak pressures ranged from 100 to 1300 psi. Of 4 target ship stations, an adequate number of pressure-time histories (at various depths to 1850') were obtained at the EC-2 (2346') and DD-593 (3887'). Only a few peak pressures were recorded at the DD-474 while at DD-592 no data was obtained. The data generally confirmed Wigwam results. Thermal gradients showed considerable effect on the pressure field at 3887' range and also influenced peak pressures at depths less than 300' at the range of the EC-2. The pressure-time data will be thoroughly analyzed, primarily by NEL, for refraction effects using the shot time underwater temperature field provided by ONR - Hydrographic Office 22 personnel. ONR-H.O. obtained its estimate of shot time underwater temperatures on the basis of bathythermograph (bt) readings from the DD-593 at H-15, H-5, and H-1 minutes and pre-shot bt data taken from three points in the array starting on D-7 day.

Air Overpressure. The NOL installed three near surface gages on vessels in the array and two balloons, each supporting self-recording gages at heights of 500' and 1000'. Records were obtained from two gages from the balloon station at 3413' and two surface gages at 2346' range. Records showed two distinct pulses; it is believed the first pulse results from underwater shock transmitted across the water-air interface and the second from bubble effects. Maximum pressure recorded was 0.21 psi at 30' elevation, 2346' range. Peak pressures showed general agreement with predictions based on HE results.

Surface Phenomena. The Scripps Institute of Oceanography (SIO) measured water waves and NOL studied all other surface phenomena i.e. spray domes, plumes, base surge, etc. Photography from 4 aircraft and several surface stations was the principal means of data collection. With the clear weather, photographic coverage was excellent. Film analysis in progress at this writing is expected to provide thorough documentation of the phenomena of interest. Surface phenomena bore a marked resemblance to Wigwam. Water waves containing approximately 4% of the weapon energy were observed.

Hydrodynamic Yield. The Armour Research Foundation (ARF) failed in their attempt to measure the close-in propagation of the shock front. The technique used by Armour was the previously successful Wigwam method. The lack of a stable platform was the principal cause of failure.

Shallow Lagoon Shot - Umbrella.

Underwater Pressures. NOL successfully measured underwater pressures at sixteen stations. Records obtained at distances of 500 to 8000 feet from surface zero, at depths from 10 feet down to 130 feet, covered the pressure range

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between 50 psi and 9000 psi. Peak pressures were in agreement with theoretical predictions and high explosive work. Peak pressures decayed with distance at a significantly higher rate than would occur in free water. The main shock was preceded by a small gradual increase in pressure which was induced by ground shock. At close-in stations, near ideal wave forms were observed; at 3000' range and beyond, wave forms were complex. A cavitation pulse was observed at all stations at 750' range and beyond; maximum cavitation pressure measured was 314 psi at 1884' range.

Air Overpressures. NOL used a combination of 32 rockets, five balloon stations, and seven surface stations to document the air overpressure-time field at ranges to 8000' from surface zero and to altitudes of 15,000'. Nine of twenty rockets recovered yielded usable data; eight additional rocket records may yield usable data after further evaluation. Five of the seven surface stations and one balloon station produced good records. Surface data show good agreement with predictions based on HE results and indicate the use of 100% efficienty in scaling HE data to the nuclear case is reasonable. Peak pressures from rocket records were low compared to HE predictions. Maximum pressure recorded, 1.88 psi, was at 2500' altitude at range of 2000 feet from surface zero.

Surface Phenomena. NOL investigated surface phenomena in general while SIO concentrated on water waves. EG&G provided excellent photographic coverage of surface phenomena from 4 aircraft and several surface stations. NOL obtained good records of temperature and humidity changes at 5 stations within the base surge. These records show well defined temperature changes which correlate well with arrival of base surge as visually observed. SIO successfully measured the waterwaves from a number of stations and by a variety of means. The most interesting of these were three stations about 1700' from surface zero which indicated the highest wave was the first of the wave train.

It was steep fronted and had a 22 foot span from crest to trough.

Hydrodynamic Yields. ARF attached two strings of blast switches and one doppler system to a taut cable running outward from the Umbrella device with the aim of measuring the time interval between closures of the blast switches and the rate of phase change of an r.f. signal fed into the doppler cable. Data was received in the zero LCU and telemetered to a remote location. Records were obtained for the blast switches only as the doppler cable was crimped during installation. Preliminary data analysis yielded an effective hydrodynamic yield of about [redacted] pressure-distance curves from which hydrodynamic yields are determined, however, showed an as yet unexplained deviation from the slope expected from Wigwam results.

Crater Dimensions. ONR and H.C. measured the Umbrella crater by means of pre-shot fathometer survey and a post-shot lead-line and fathometer survey. A crater of about 20' depth and 1500' diameter was found.

2.1.2 NUCLEAR RADIATION AND EFFECTS

Program 2 included ten projects, which could be grouped into four categories:

1. Underwater detonations
2. High-altitude detonations
3. Developmental shots
4. Nuclear radiation from a very-low-yield device of particular interest to the Army

Underwater Shots, Wahoo and Umbrella.

Shipboard Radiation Vulnerability. It was the object of this study to document the gamma-radiation phenomena generated aboard three target destroyers by shots Wahoo and Umbrella. Both total gamma dose and gamma dose-rate histories were measured by film-badge dosimetry and gamma-intensity-time-recorders (GITR's), respectively. Unshielded GITR stations and film badges 27 supplied data on radiation at locations representing major battle stations; underwater GITR instrumentation supplied data on radiation in the water; and directionally shielded GITR stations mounted on deck supplied information on radiation from remote sources.

Radiation histories were obtained on only one destroyer during shot Wahoo, because of ship's power failures on the other two. Radiation histories were obtained on all three ships during shot Umbrella, although some data was lost because of shock damage. Preliminary results indicate that weather-deck dose buildup ranged between 600 r received within 0.5 minute at 2,000 feet from surface zero and 45 r received within 2 minutes at 8,000 feet. Dose reductions by factors less than 6 were obtained for all compartments above the waterline, and dose reduction factors greater than 9 were obtained only in machinery spaces below the waterline. Transit radiation appeared to represent a high percentage of the total radiation observed aboard the ships. In the one case where the data was obtained, the underwater radiation did not contribute to the total radiation measured aboard ship. Data on gamma-ionization decay was obtained for the period from 0.1 to 34.8 hours after Umbrella.

Shipboard Contamination Ingress. This was a study of the external and internal radiation hazards existing within typical interior compartments of a destroyer-type vessel as the result of the ingress of contaminant from nearby underwater nuclear detonations. Four compartments of the DD-592 were instrumented with total and time-incremental air samplers, surface samplers, animals (mice and guinea pigs), and GITR instrumentation. Rates of air flow for ventilation and boiler combustion for the instrumented compartments were controlled so as to be representative of those expected under nuclear-attack conditions.

Due to the failure of ship's power on the DD-592 during shot Wahoo, only 26 surface-sampler and animal data were obtained. The failure of a project timing circuit during shot Umbrella resulted in loss of time-dependent air-sampler data, although total air samples were obtained.

Estimates of the internal dose due to inhalation in the test compartments during Wahoo indicated that the doses were below the threshold for acute exposure but that possible chronic effects might be produced. Similar estimates for Umbrella indicated the doses were below the threshold for chronic effects, with the possible exception of the internal dose received in the engine room.

Umbrella estimates of the external-dose rates in the test compartments due to ingress of contaminants showed them to be a small fraction of the compartment's total dose rate.

Radiological Environment. This study was to document the radiological environment resulting from underwater nuclear detonations. The gross gamma fields from shots Wahoo and Umbrella were defined by means of GITR instrumentation located on coracle platforms, as well as on the major target ships. These measurements were supplemented by those of total gamma dose made with floating film packs located throughout the target array. Incremental collections of radioactive material deposited from the resultant base surge and cloud permitted resolution of the gross gamma fields into initial, free-field, and residual doses and dose rates. Underwater probes were used to obtain information on radiation from radioactive materials suspended in the water.

During both Wahoo and Umbrella, it was found that nearly all of the total gamma dose occurred within 15 minutes after zero time and was due to the passage of air-borne radioactive material. However, the records of gamma dose rate versus time obtained from the two shots show pronounced and characteristic differences in the transiting gamma fields. Gamma doses in excess of 27

100 r occurred within the first 15 minutes at downwind distances less than 16,500 feet for Wahoo and 11,000 feet for Umbrella. In both shots the dosage due to deposited radioactive material on the ships and coracles was from light to insignificant. A study of the downwind gamma data showed that a distance of approximately 23,000 to 28,000 feet from surface zero should be maintained in order to assure a total free-field dose of less than 25r.

The High-Altitude Shots, Teak, Orange, and Yucca.

Neutron Flux and Gamma Radiation Measurements. This participation for the Johnston Island part of the Operation is covered in the summary pertaining to Teak and Orange.

The measurements of the neutron flux-spectrum and total prompt-gamma-ray flux resulting from the detonation of shot Yucca, [redacted] at an altitude of approximately 90,000 feet was planned. Neutron time-of-flight measurements were to have been made with an Li^6I scintillator-photodiode detector, from which determination of the energy spectra of the neutrons could be made. A similar detector, using natural Lithium (LiI), was included to provide correction data for the gamma response of the detector. Two types of gamma detectors were used.

1. A CsI scintillation detector.

2. A KBr crystal, whose darkening was measured as a function of time.

All data were to have been recorded and subsequently telemetered to a recording ground station. The instrumentation was contained in a canister suspended 2,750 feet below the nuclear device by means of a nylon line. Due to failure of the command transmitter, which controlled the canister operational functions, the instrumentation was inactive at zero time, and no data was obtained.

Projects Participating during Developmental Shots.

Neutron Flux Measurements. This was a program to document the neutron flux

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and spectrum as a function of distance for [redacted] shots. To achieve this objective, the project participated during shots Yellowwood and Walnut. The measurements were extended during the field phase of the operation to include shot Quince, and this participation is covered in the portion of this report relating to that detonation. To make the necessary measurements, threshold-activation and fission detectors were exposed as a function of distance from the Yellowwood and Walnut zero points. These detectors included gold, cadmium-plated gold, plutonium, neptunium, uranium, sulfur, and zirconium. Since land masses of sufficient size were not available for displaying the detectors with distance, a buoy line was used. The line extended from 917 to 4,100 yards from ground zero for both shots. Due to the radiological situation that existed after these detonations, recovery could not be effected until D+1 day. As a result, only limited neutron flux and dose data was obtained. Early results indicate that the neutron dose for shot Yellowwood was lower than prediction (by TM-23-200) by a factor of 2.3 and the Walnut doses were low by a factor of 2.0.

Fallout Sampling. This was a determination of the relative contribution of certain isotopes to both local and world-wide fallout and the use of this information, if possible, to determine the fraction of total bomb debris deposited in the local area. The project was divided into two separate efforts.

1. The collection of early cloud samples by means of newly developed rocket samplers.

2. The collection of residual cloud samples and fallout debris by aircraft.

The rocket sampling was to have been accomplished with rockets being developed by UCRL Project 21.3. Gas and particulate sampling of the residual cloud was accomplished by B-57D aircraft under the technical supervision of LASL personnel. Fallout samples were collected at various times after the

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detonation, based on predictions furnished by the Fallout Prediction Unit. These collections were made at an altitude of 1000 feet by WB-50 aircraft. The fallout collection was supervised by personnel of the U. S. Naval Radiological Defense Laboratory.

The project participated during shots, Koa, Walnut, and Oak, as it was desired to obtain a comparison between the fallout from land-surface and water-surface megaton-range detonations. Due to various technical problems, satisfactory rocket samples were not collected from shots Koa and Walnut, and this portion of the project was cancelled prior to Oak. Successful B-57D and WB-50 samplings of the Koa fallout were made; however, early analysis of the samples indicated they had been contaminated by debris from shot Fir, fired the previous day at Bikini. For this reason, project participation was extended to include Oak. Successful sampling was accomplished during Walnut and Oak. Collected samples were returned to the continental laboratories for analysis, and the resultant data was not available at the time this report was written.

Very-Low-Yield Detonation, Quince. Projects 2.9, Gamma Dose Measurements; 2.10, Residual Radiation from Sub-Kiloton Yields, and 2.11, Neutron, Thermal, and Gamma Measurements at Various Altitudes up to 1500 Feet, were approved after shot Quince was scheduled as part of Operation HARDTACK. Project 2.4, Neutron Flux Measurements, was extended to include neutron documentation of this shot. The discussion of the participation of these projects is included in the portion of this report devoted to shot Quince.

2.1.3 STRUCTURES AND EQUIPMENT

The objective of this program was to provide information on the effects of nuclear bursts on ship structures and equipment, and on various land structures, under certain conditions that have not been heretofore investigated. Five of the eight projects were concerned with the ship structures 31 and equipment response from underwater bursts, and three projects were concerned with land structures response to air blast.

Preliminary to Operation HARDTACK a series of tests were run employing high-explosive tapered charges against the destroyer DD 592 off Santa Cruz Island, California in January 1958. A series of four large, special shaped (tapered) H. E. charges weighing from 1400 to 4400 pounds was planned to simulate underwater nuclear attack against the DD 592. The series of tests was carried up to the threshold of shock damage, but stopped after detonation of the third charge to avoid the probability of serious damage to the DD 592 prior to the later main HARDTACK full-scale nuclear tests. The results indicated that the shock wave pressure satisfactorily simulated the initial shock waves from a nuclear detonation.

Four unmanned major target ships, 3 destroyers, and an EC-2 merchant ship, were instrumented and exposed to the Wahoo and Umbrella underwater detonations. In addition, three manned fleet operating ships, submarine SSK 3 and destroyers DD 728 and DD 826, had a minor amount of instrumentation aboard and were also exposed to Wahoo. The SSK 3, unmanned, and a 4/5 scale submarine model, SQUAW 29, were also exposed in Umbrella. The shock response of equipment, as well as equipment foundations which included hulls, bulkheads, decks and superstructures were documented by the use of a total of 325 velocity time meters and self-recording shock-spectrum gages and 40 high-speed motion-picture cameras. The following tentative conclusions with respect to damage to machinery and equipment may be made.

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For Umbrella, the submerged 4/5 scale submarine model, SQUAW 29, at a range of 1600 feet, was instrumented with strain gages, pressure gages, deflection gages, high-speed cameras, and roll, depth and flooding indicators. The hull was plastically deformed but did not rupture. Four of the ten external ballast tanks ruptured and all were seriously dished resulting in some loss of buoyancy. SSK 3 was submerged at periscope depth and operated by its crew at 18,000 ft. from Wahoo surface zero. In Umbrella, SSK 3 was unmanned and located bow-on at a range of 2900 feet. No permanent hull deformations on SSK 3 occurred from either shot. The following preliminary conclusions may be made:

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Failure criteria of prefabricated, corrugated steel, flexible arch-shell, structures confined within non drag-sensitive earthwork configurations of coral sand, simulating partially underground structures was studied. Three structures were tested in the 80 to 180 psi peak overpressure region from a 1.4 Mt surface shot to empirically determine the response of such structures. A fourth structure was tested in the 90 psi peak overpressure region from a 17 kt surface shot to determine the effects of short-duration blast loading upon a similar structure and environment. The 25-foot span by 48-foot, 10 gage arch-shell structure subjected to 90 psi peak overpressure partially collapsed on the side away from ground zero. The collapse apparently was initiated by bearing failure of the shell plates at a bolted horizontal seam, approximately 5 feet above floor level on the collapsed side of the structure. The following results have been noted on the other 3 structures:

1. A similar 25-foot span structure and the 38-foot span by 40-foot 1 gage arch-shell structure, subjected respectively to 78 psi and 100 psi peak overpressure from shot Koa suffered a complete collapse symmetrically about the crown. The third 25-foot span structure subjected to a 180 psi peak overpressure collapsed completely.

The dynamic behavior of deep (thick) reinforced concrete slabs in the high overpressure regions of 175 to 600 psi was studied to provide the basis for establishing design criteria for massive reinforced concrete structures under blast loads. Thirty one-way and fifteen two-way slabs placed flush with the ground surface were tested. The clear span was 6 feet and the ratios of depth to span varied from 0.15 to 0.78. Because of excessive post-shot radiation at the slab locations, data recovery has not been completed.

2.1.4 AIRCRAFT STRUCTURES

The Air Force was concerned with determining the structural response of a B-52D aircraft when subject to side loads. This determination had as an ultimate objective the definition of the delivery capability of the aircraft for multiple delivery tactics. The data obtained was successful in verifying that the predictionsof weapon effects and the analysis utilized in predicting structural responses were satisfactory. A range of angles with respect to ground zero from 35 degrees head-on to 180 degrees tail-to in azimuth, including three different elevation angles, were utilized in verifying the analysis and predictions. It was concluded that the data obtained was sufficient to verify the analysis used to predict structural side loads from which the nuclear weapon delivery capability for multiple delivery tactics could be defined.

The Navy sponsored a project, in which two A4D-1 aircraft participated jointly in several shots, in order to measure weapon in-puts and structural responses to high yield weapons. The final objective was the correlation of the data with that of the Plumbbob tests in order to define the high-yield (Megaton range) weapon delivery capability of the A4D-1. From the preliminary data obtained it was determined that measured stresses were consistent with predictions obtained from the analytical techniques employed. It is anticipated that additional data obtained from wing pressure instrumentation will assist in further refining the dynamic analysis. Thermal input data was generally substantially lower than predicted although the temperature response calculations based upon measured inputs in general showed good correlation. It was concluded that the data obtained, when combined with that obtained from Operation Plumbbob and the aircraft performance characteristics, will permit the definition of the nuclear weapon delivery capability of the A4D aircraft.

Effects input and structural response information of two FJ-4 aircraft was measured. The information obtained was concentrated in inputs and effects from higher yields in order to correlate with data obtained from the lower yields of Plumbbob and confirm the Class D delivery capability of the aircraft. In general, excellent correlation of blast response data was obtained, verifying the dynamic analysis used for predicting structural responses. It was concluded that response data had been obtained over a sufficiently wide range of yields and incidence angles to permit subsequent definition of the Class D delivery capability of the FJ-4B aircraft.

2.1.5 TEST OF SERVICE EQUIPMENT AND MATERIALS

This program, consisting of five projects had a wide range of project station locations: Wake Island and Eniwetok, Bikini, Kwajalein, Kusaie, Wotho, and Rongelap atolls.

One project to study the wave form of electromagnetic pulse from a nuclear detonation, used two sites: Kusaie, 420 miles from Eniwetok, and Wotho, 240 miles from Eniwetok. The objective was to make broad-band measurements from 0 to 10 Mc at ranges up to 460 miles. The measurements were not expected to be radically new. Although improvements in equipment were incorporated, the primary concern of this project was to increase the cataloging of wave forms.

The data, which is in good agreement with that obtained during Operation Redwing, indicates that device yield and range and the presence of a second stage can be determined from wave-form parameters.

Another project with stations at Wahi Island and Kusaie studied ionospheric effects of large-yield surface detonations. In agreement with results of Operation Redwing Project 6.3, the energy responsible for the first disturbance in the ionosphere above Kusaie was propagated with a mean volocity of 20 km/min. Also corroborating previous results, the second disturbance resulted from energy propagated with a mean velocity of about 13 km/min. The first effect has been postulated as due to a compressional wave and the second to a hydromagnetic wave. The fact that the first effect was seen approaching but not receding is indicative of the shape of the ion-density variation associated with the disturbance.

Two projects participated during shot Umbrella to obtain effect data or feasability of using nuclear weapons as a naval-mine counter-measure. One of them, sponsored by The Naval Ordnance Laboratory was to determine the ranges at which typical stockpile bottom mines would be neutralized by a shallow-water burst.

To set up the experiment, a total of 120 mines, consisting of Mines MK-25-2, MK-39-0, MK-50-0, MK-52-1, MK-52-2, MK-52-3, and MK-52-6 were laid on the Eniwetok Lagoon, north of ground zero for shot Umbrella, at distances from ground zero from 1,400 to 8,100 feet. The operation of 23 of the mines (planted at distances greater than those at which damage was expected) were monitored during the shot by means of a system of internal recorders designed to begin recording when the mines were armed and to continue recording until the mines were recovered. The depth of water at the mine field varied between 120 and 150 feet. The results of the test indicate that:

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The Navy Mine Defense Laboratory was the sponsoring agency of the other project participating in underwater experimentation. The overall objective of the project was to determine the feasibility of the employment of nuclear 36 weapons for wide area mine clearance by influence means. The specific objectives of their experimentation program were to:

1. Measure and record the amplitude, duration, and extent of mine actuating influences (pressure, acoustic, and magnetic) that may be generated at the sea bottom by the explosion of a low-yield nuclear weapon in shallow water (approximately 150-depth).

2. Determine the reaction of certain instrumented naval mines to the influences generated.

Three LCU instrumentation platforms were located at distances of 5,300, 20,150, and 44,750 feet from the Umbrella surface zero. Instrumentation was provided to obtain:

1. The time-pressure history resulting from the shot, including pressure changes due to waves, swells, and the shock wave.

2. The time-history of the magnetic-field changes.

3. The time-history of the sound-pressure leve, 2 cps to 40 kc.

4. The time-history of displacement of the bottom.

5. The mine readtion, including such items as search-coil output, plate-voltage rise, pressure-switch opening, fires, and "looks".

6. Correlation of all influence measurements and mine reactions with respect to time.

From the Umbrella shot the following tentative conclusions were made:

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The fifth project studied the effects of nuclear radiation on electronic fuse components and materials, sponsored by the Diamond Ordnance Fuze Labora- 3 tory.

Electronic component parts were placed in special test circuits to emphasize the property to be measured. The signals were fed into a magnetic-tape recorder, which recorded the performance of the components during the detonation. In addition, the telemetering points of a Corporal fuze syst were monitored, and departure from normal operating level was recorded on the tape.

At the time this report was prepared, the project was still participating. A brief description will be given, however, of the project's participation during two shots.

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2.1.6 THERMAL RADIATION MEASUREMENTS

It was the purpose of the program to:

1. Study the effects of megaton range atomic weapons on materials and to evaluate a skin simulant as a substitute for animate skin in these studies.

2. Obtain spectroscopic measurements on a high altitude burst of thermal irradiance as a function of time.

3. Measure by photographic means the fireball size of a high altitude burst as a function of time.

4. Obtain a photographic record with high time and spectral resolution

of the early time spectra of a high altitude burst.

5. Make measurements of the size, persistence and spectral irradiance of the fireball in the infra-red from a high altitude burst.

6. Study material ablation from specimens inside the fireball, and test the neutron vulnerability of various materials to be used in the Teak and Orange experiments.

For the high altitude vent, shot Yucca, two RB-36's were modified to serve as instrumentation platforms. Special windows and shelves were provided for the instrumentation and special wiring installed and the aircraft were provided with special radar equipment to track the balloon assembly and position themselves. The AOC-CIC aboard the USS CVS Boxer, which also served as the balloon launching platform, was utilized for control and as a back-up positioning system.

On shot Yucca, both the RB-36 aircraft were well positioned so that all instruments had the burst in their fields of view. Excellent records were obtained by all projects whose instrumentation was aboard.

In addition to its participation on shot Yucca, Project 8.5, making infra-red measurements also participated on shots Butternut and Koa as instrument checks and to obtain correlation data.

The P2V also participated on events Butternut and Koa as instrumentation checks and to obtain data for correlation of a surface detonation with the two high altitude shots Teak and Orange. On Butternut the monochromator failed to function properly, but the mapper functioned satisfactorily. On Koa both instruments operated well.

No data were received from the cannister instruments on the drag line.

Tentative conclusions which can be made at this time are:

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The experiments on effects of atomic weapons on materials and evaluation of a skin simulant were carried out on shots Yellowwood and Walnut. Approximately 30 skin simulant specimens in various configurations including bare and blackened unclothed samples, samples clothed with contact and spaced fabrics, and samples with various apertures were exposed. Time temperature histories of the specimens were recorded. In addition, recording calorimeters and radiometers were used to measure the thermal radiation incident at the station.

The ablation and neutron vulnerability studies were carried out on shot Cactus. For the experiments on ablation of material two specimens designed to determine the rate and depth of melting of a spherical surface were exposed on a 100 ft. tower so as to be within the fireball. These specimens contained instruments for measuring and recording the time history of the temperature of unprotected metal at various depths, specimen acceleration, late fireball overpressure, and shock arrival time. Two additional specimens rigidly spaced 10 feet apart and rigidly connected were placed on the ground at a distance of 250 feet to measure the speed of sound inside the fireball. These specimens contained transducers and recorders for measuring the time of arrival of weak shocks from a series of small explosions set off at successive times after zero time. From these measurements it was hoped to calculate a time history of the gas temperature of the fireball.

As yet no results are available from the ablation and neutron studies carried out on shot Cactus. The area in which the neutron study specimens were placed is, at this writing still too hot radiologically to permit a party to spend sufficient time in the area.

2.1.7 SUPPORT PHOTOGRAPHY

The mission of Program 9 was to provide documentary and technical photographic support to participating DOD agencies. The documentary support consisted of both still and motion picture coverage of project activities to depict the scope of the project's effort, and to show significant results of their effort, for historical and report purposes. Still photography, in support of projects for illustrating preliminary and final reports, was conducted by TG 7.1, TU-1. Motion picture coverage to be used in the production of a Weapons Effects Film was provided by JTF-7. Technical photography, such as high-speed, time-lapse, and function-of-time photography, was furnished by TU-5 (EG&G).

During the planning phase of Operation HARDTACK, it became evident that the needs of the various projects for photographically collected data would fall on the five military effects events; two high altitude rocket detonations, one high altitude balloon detonation, and two underwater detonations. Because of the varied nature and location of the detonations, more extensive and sophisticated camera installations were needed than on any prior operation.

For the high altitude balloon detonation, RB-36's were used with a back-up camera installation mounted on the USS Boxer.

The photographic equipment used for all three high altitude detonations consisted of streak, high and medium speed motion picture, rapid sequence still, and Zenith cameras.

The photographic instrumentation for the two underwater shots was basically the same for each shot. The stations common to both shots consisted of a camera station on Parry Island, camera station on Igurin Island; an LCU camera station anchored in the lagoon; an RB-50 aircraft directly over surface zero at 25,000 feet altitude; three C-54 aircraft orbiting at 20,000 feet range at altitudes of 1500 feet, 9000 feet, and 10,000 feet; and one RB-50 aircraft which provided vertical aerial photographic coverage of the target array before and after each shot.

For the Wahoo shot, an additional camera station was installed in the hold of the EC-2 to record effects of a deep-water detonation on the ships' structure.

For the Umbrella shot, in addition to the basic installations, a camera station was installed on a barge 20,000 feet from surface zero; another camera station was installed on Mui Island to photograph rocket firings, and a tri-metrogon camera array was installed on a H-19 helicopter to photograph wave action at two surface instrument platforms.

In addition to the major effort on the five military effects shots, a somewhat smaller effort was expended on some of the AEC diagnostic shots. A camera station was installed to record the effects of the thermal pulse on certain materials. Several aerial photographic surveys were accomplished of craters produced by land surface detonations; aerial surveys were accomplished to locate strings of gages placed in the water prior to several shots; and mosaics were flown of Johnston Island, and all the islands of both Bikini and Eniwetok Atolls for planning purposes.

For documentary purposes, approximately 60,000 feet of original 35MM Eastman Color Negative film was exposed from which a military effects motion picture film report will be prepared after the operation.

For historical and report purposes, approximately 3500 black and white still negatives were exposed during the operation.

2.1.8 YUCCA VHA PROGRAM

The overall objectives of the VHA program were to determine the effect of extreme altitude on partition of energy in anuclear explosion, and on the radii of effects of the various phenomena, and to determine scaling laws of these effects as a function of altitude and yield. Scientific results have been discussed in previous sections of this chapter, and of interest here are the weapon system, the baloon carrier, and aircraft modifications. One project supplied the warhead, the fusing and arming, the radio command system, and the monitoring functioning for the [redacted] device. Another project provided the carrier, and supplied a 128 foot, 2 mil polyethene balloon which was to lift the device and associated scientific equipment to altitude. Test flights from various launching sites conducted over the previous 18 months had shown that launch from aircraft carrier, with a deck wind velocity of near zero, was the most reliable method.

The balloon was launched from the USS Boxer. The total weight of the system was 1295.5 pounds with a payload of 761.5 pounds. The payload consisted of the device and five canisters containing instrumentation for measuring pressures, thermal and gamma radiation, neutron flux and the electromagnetic pulse.

Due to command transmitter failure prior to zero, no weapons effects data of significance was received from the five suspended canisters. Aircraft instrumentation was successful in fulfilling project objectives.

2.2 TASK UNIT ONE, LASL PROGRAMS

2.2.1 INTRODUCTION

Task Unit One carried out experiments to determine the performance of the devices fired; to measure physical quantities of interest in weapon design; and to understand the mechanisms by which the various effects of the devices are produced. In Operation HARDTACK new methods were used to determine the configuration of the active material during the reaction period.

2.2.2 PROGRAM 10 FIREBALL PHYSICS

Objectives:

1. To determine the yield of a nuclear detonation by observation of the various parameters associated with fireball hydrodynamics.

2. To measure the time interval between the primary and secondary reactions in two stage devices by optical means.

3. To study the phenomena taking place in the rarified air o[redacted] DELETED [redacted] DELETED

Techniques:

1. Several methods of calculation were used to derive the yield of the device from fireball photos.

2. Optical narrow pass filters were used with photomultipliers and oscilloscope to record gamma induced light from the air about two stage devices.

3. Techniques were used which allowed observations of narrow bands of the optical spectrum by means of photomultipliers and oscilloscopes with high time resolution.

Results:

1. A list of yields obtained by program 10 is given in table 2.1.

2. Some information about relative intensity of early gamma induced light is given in table 2.2.

3.

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[redacted]

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2.2.3 PROGRAM 11 RADIOCHEMISTRY

Objectives:

1. To determine the fission yield of the device.

2. To ascertain when possible what nuclear reactions take place in the device.

3. To study specific aspects of the reactions by radiochemical tracers placed within the device.

4. To determine the production of specific activities in certain areas of the devices arising from materials included in them by design necessity or by intent.

Techniques:

1. Samples of radioactive material from the cloud were obtained by manned aircraft equipped with especially designed sampling tanks.

2. Radiochemical analyses were made at LASL to determine the fraction of the bomb included in the sample and the number of fission events. From these data the fission yield was determined.

3. Radiochemical analyses were made of these samples to determine the production of various radioisotopes of interest from the bomb materials or from detector samples placed in or near the device.

Results:

1. The results of measurements of fission yields by various methods are included in table 2.1.

2. An investigation of water samples taken from the lagoon shortly after Walnut shot showed marked fractionation, indicating that such samples were not an adequate replacement for aircraft sampling.

2.2.4 PROGRAM 12 EXTERNAL NEUTRON MEASUREMENTS

Objectives:

1. To determine the configuration of the active material of certain devices during the nuclear reactions.

Techniques:

1. A neutron collimating "pinhole" is placed between the device and detector. A pinhole camera image of the device is formed on the detector, which is a sandwich of various materials to be activated by the neutrons. The sample may be cut into segments and counted on a scintillation counter or placed against a photographic film to produce an autoradiographic image.

Results:

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2.2.5 PROGRAM 13 ALPHA MEASUREMENTS

Objectives:

1. To measure alpha as a function of time for the fission devices or primaries in order to determine whether they worked properly and in case they did not, to aide in diagnosing the trouble.

2. To obtain and telemeter measurements indicating the "transit time" for the HE implosion and time from load ring pulse to very early gamma levels in the device.

Techniques:

1. Alpha detectors, each consisting of a plastic fluor and photocell or multiplier combination in a light-tight can, were mounted at appropriate distances from the devices to give a wide range in sensitivity. The signals were conducted over coaxial cables, shielded against gamma, neutron, and electromagnetic radiation, to concrete bunkers. These signals then were displayed on a series of high speed oscilloscopes together with timing frequencies and were recorded by cameras.

2. Similar detectors, very near the device, gave signals which were telemetered by a wide band ultra high frequency transmitter-receiver combination and recorded on oscilloscopes.

Results:

1. For details on results of the alpha measurements the reader is referred to the project reports.

2.2.6 PROGRAM 14 PHONEX-PINEX

Objectives:

1. To obtain neutron spectra at a number of positions on the secondary of a two stage megaton device.

Techniques:

1. By means of a pinhole placed in a mile long vacuum pipe neutrons were allowed to form an image of the source on a hydrogen containing thin plastic foil. Recoil protons from this foil passed through a collimating system and were recorded on nuclear emulsion plates. Track were counted and measured to determine the spectrum of the incident neutrons.

2.2.7 PROGRAM 15 PHOTO-PHYSICS

Objectives:

1. To obtain radius time data for hydrodynamic yield determinations.

2. To determine the nature and behavior of a nuclear detonation by photographing the light produced during the initial stages of the detonation.

3. To study the reaction rate in the secondary of a megaton two stage device by means of gammas and neutrons emitted from the secondary at various positions.

Techniques:

1. Framing cameras were operated from several photo stations on each snot to record the growth of the fireball.

2. Very high speed streak cameras were used to record the history of the light arising near the bomb in the first few microseconds.

3. A pinhole in a mile long vacuum pipe was used to collimate gamma rays and neutrons onto a plastic fluor. Light from the fluor was photographed with high speed streak cameras to record the gamma time history and the arrival rate of the neutrons. The latter makes possible the determination of the neutron spectrum at various places.

Results:

1. Results of this program are given in the individual project reports.

2.2.8 PROGRAM 16 TEMPERATURE MEASUREMENTS

Objectives:

1. To determine the temperature induced in a two stage device by the explosion of the primary.

Techniques:

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Results:

1. Results of this program are given in the individual project report.

2.2.9 PROGRAM 17 ELECTROMAGNETIC MEASUREMENTS

Objectives:

1. To determine the time interval between primary and secondary of two stage devices by measurement of the electromagnetic signal.

2. To study the electromagnetic signal in order to determine the mechanisms by which the various stages of the signal are produced.

Techniques:

1. The electromagnetic signals accompanying nuclear detonations were by an antenna and recorded on fast oscilloscopes.

Results:

1. The results of this program are given in the individual project report.

2.2.10 PROGRAM 18

2.2.11 WEAPONS ASSEMBLY

The weapons assembly group was responsible for preparation of the various devices for firing. They assembled and checked out all bomb components, installed the device at its firing site, and operated a system for telemetering information essential to the readiness of the device for firing.

The use of barges as zero sites plus the high degree of efficiency reached by the assembly personnel enabled DELETED

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The weapons assembly group functioned on every LASL shot and in addition assembled the LASL furnished primary on one Livermore shot.

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CHAPTER 2

SUMMARY OF EXPERIMENTAL PROGRAMS

2.3 TASK UNIT 2, UCRL PROGRAMS

2.3.1 Program 21, Radiochemistry.

a. Experimental Techniques.

The main objectives were to determine the fission yields and the relative thermonuclear and fission efficiencies in different regions of the UCRL devices. Samples of the particulate debris were collected after each test and analyzed in the Z1. Gaseous samples were collected on selected shots and were analyzed in the FA where necessary for short-lived products; the rest were sent to Livermore for analysis.

Airplane sampling was used on all tests; rocket sampling was attempted on several. Rockets, it was hoped, could be used to supplement and perhaps later obviate the need for manned aircraft. For the present at lease, sampling aircraft seem to be here to stay.

b. Results are shown in Table I.

2.3.2 Program 22, Reaction History.

a. Experimental Techniques.

Program 22 had the responsibility for Pinex as well as the reaction history measurements on all UCRL events. Devices were fired from four different locations with measurements as follows:

1. Tare, Bikini. The three events (Nutmeg, Hickory and Juniper) fired in the Zuni crater were extensively diagnosed. The coverage included measurements of high explosive transit time, high explosive pins, alpha vs time, boost time, boost temperature and yield from Koala, Pinex, and [redacted] where applicable. Pinex was the only entirely new technique employed .

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[redacted]

TABLE I

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although several new problems arose from the use of barges; e.g., effects of barge motion on collimation and the effect of water shine on neutron measurements.

2. Charlie and Fox, Bikini. Seven events (Fir, Sycamore, Maple, Aspen, Redwood, Cedar and Poplar) were fired from various north Bikini locations. Several remote diagnostic schemes were developed for these shots: 1) alpha was measured by a photoelectric telescope picking up light from a fluor wall mounted on the shot barge; 2) high explosive transit time and pin data was obtained by a pulse telemetry system; 3) [redacted] were measured from Teller Light by sweeping cameras and a photoelectric telescope; and 4) interval times were measured by an electromagnetic pickup station.

3. Janet, Eniwetok. Three UCRL events (Dogwood, Olive and Pine) were fired off Janet. Edgerton, Germeshausen & Grier, Inc., provided the electronic support for the following diagnostic measurements: 1) peak primary alpha on Dogwood and Olive; 2) secondary alpha on Dogwood; 3) [redacted] 4) secondary interval time on all three.

4. Yvonne, Eniwetok. The last two UCRL shots (Quince and Fig) were fired on Yvonne. EG&G operated the diagnostic station for UCRL. Complete alpha vs time curves and high explosive transit time data was obtained.

b. Results.

The results of these experiments are contained in the preliminary shot reports and in the various technical reports written by the groups involved.

2.3.3 Program 24, Phonex.

a. Objectives.

To measure the number and energy distribution of the neutro leaving the surfaces of devices associated with the Maple and Hickory events.

b. Technique.

The neutrons were detected by observing proton tracks left in nuclear track emulsions by protons ejected from a thin polyethlene radiator. The number of neutrons was determined from the density of proton tracks in the emulsion coupled with the known geometry of the experiment. The energies of the neutrons were determined from the ranges of the protons in the emulsion. In order to protect the emulsions from blast and radiation, the cameras were placed in heavily shielded collimators. For the Maple event, three such collimators were placed on Fox at distances of 500, 700, and 900 yards from the device. For the Hickory event two collimators were placed on Tare at distances of 240 and 400 yards.

c. Results.

The emulsions were successfully recovered from all stations and will be processed and scanned at Livermore. The data will not be available for a period of several months.

2.3.4 Program A, Weapons Assembly.

The function of Program A was the field assembly of the large weapon devices.

In the field each assembly team was headed by a Project Physicist and a Project Engineer thoroughly familiar with the theory, design, fabrications, and assembly of their device.

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Each device, prior to shipment, was completely trial assembled except that dummy primaries were used. All devices were air-shipped frcm Travis AFB and delivered to their final shot site without incident.

The following devices were all assembled for testing at EPG:

CODE NAME	DEVICE NAME	REMARKS
Fir		Fired in Bikini lagoon
Sycamore		Fired in Bikini lagoon
Aspen		Fired in Bikini lagoon
Maple		Fired in Bikini lagoon
Buckeye	DELETED	Not tested because the [redacted] series met the Polaris Warhead requirements.
Redwood		Fired in Bikini lagoon
Cedar		Fired in Bikini lagoon
Dogwood		Fired in Eniwetok lagoon
Poplar		Fired in Bikini lagoon
Olive		Fired in Eniwetok lagoon
Pine		Fired in Eniwetok lagoon

2.3.5 Program B, Weapons Assembly.

The function of Program B was the field assembly of small weapon devices.

In general personnel were organized and devices were handled as described under Program A. Much advance experience in assembly was obtained during the extensive hydrodynamic program required to develop the designs fielded. Devices were never completely assembled prior to shipment because of safety limitations, but components and sub-assemblies were pre-fitted wherever possible.

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CHAPTER 2

SUMMARY OF EXPERIMENTAL PROGRAMS

2.4 TASK UNIT 4, SC PROGRAMS

2.4.1 Program 32, DOORKNOB.

The original intent of Program 32 was to measure the neutron, X-ray, total thermal, and gamma-ray emission from megaton range nuclear device burst at an altitude of 250,000 feet, Additional measurements were incorporated in the program as techniques became available for attempting them. These were a sampling of the radioactive debris, optical coverage of the burst, and a measurement of RF attenuation and refraction caused by the ionization of the atmosphere.

The techniques designed to accomplish the mission of the Program and the specific measurements involved are as follows:

1. Stations for measuring the neutron, gamma-ray, X-ray, and total thermal emissions were put at specified locations by one and two stage rocket propelled instrument carriers. The propulsion units were modified LaCrosse, solid propellant, motors. The auxiliary hardware was designed specifically for these tests. The carriers were unguided, rail launched ballistic rockets with variations of weight and drag for altitude control.

   The stations were located at 40,000, 50,000,60,000, and 80,000 feet altitude directly beneath the burst and at 30,000 feet from the burst along the bomb axis and perpendicular to it.

   Each carrier had a 226-235 mc. band telemetering system aboard with from four to eight subcarriers. The FM-FM receiving and recording station was located near the launch site on Johnston Island.

   All six carriers contained transducers for measuring neutron and gamma-ray fluxes. The neutron transducer consisted of activation foils that were counted by a scintillometer circuit during the fall-time of the nose. Gamma-rays were measured as dose-rate by scintillometers and as total dose by Silver activated phosphorglass and a densitometer.

In addition the two stations 30,000 feet from the burst measured X-ray and total thermal inputs at their locations. Both transducers utilized ballistic calorimeters containing resistance wires that were connected in a four-arm bridge. The total Thermal was absorbed by a polished Aluminum cone mounted inside of a truncated cone. The X-rays were filtered through Beryllium discs of 50 and 70 mil thickness. The remaining energy impinged upon the calorimeter.

These six carriers also contained film packs for measuring high gamma flux and material samples for effects evaluation. The noses were designed for parachute retardation and for recovery from the ocean.

2. The Redstone carried two 4 Kmc diagnostic systems for measuring HE transit time and early alpha of the primary bomb. This system and the WH fuzing system was monitored by 226mc. telemetry equipment.

All six instrument carriers and the Restone were tracked by two MIDOT (radio interferometer positioning system) stations for relative positioning of transducers and the burst. The transmitters aboard each carrier served as the beacon.

3. Two Radio-Chemical sampling noses were to be carried through the TEAK debris by two-stages of the modified LaCrosse motors. These sampled, sealed, and lowered to the water a collection of the burst residue for laboratory analysis.

4. A system for measuring wind velocity at 250,000 altitude was designed to permit adjustment of the Rad-Chem Sampler trajectories to increase the liklihood of sending the sampler through the densest debirs. This measurement was made by carrying 5 cm. chaff to altitude on a Deacon-Arrow II rocket, ejecting the chaff, and tracking it with a MSQ Radar.

5. The RF attenuation measurements were made by carrying eight transmitters (four operating near 225 mc and four near 1500 mc) aloft on eight two-stage rockets and recording received signal strength at two separate locations. Six of these carriers were Deacon-Arrow II combinations and two were Viper II-Arrow II combinations.

6. Optical instrumentation included high speed and longer time photography through three different narrow band filter, a high resolution spectral record, burst position by plate cameras located at each MIDOT station, and black and white and color documentray photography.

7. The warheads used on the high altitude shots were modified, installed, checked out, and armed by Program 32.

TEAK Conclusions

All equipment used on TEAK operated as designed with the following exceptions:

1. The two Rad-Chem Samplers appeared to suffer structural damage at the time of 2nd stage burning, became unstabl and fell back to the reef near Johnston Island. Many of t parts were recovered by skin diving and the type of failur was deduced, if not the primary cause.

2. The two Viper II-Arrow II beacon carrying rockets failed at 1st stage burn out and fell back onto the Western half of Johnston Island. A subsequent test firing verifie this failure.

3. The displaced burst point was outside of the beam of the antenna receiving the 4 Kmc diagnostic signal and no information was received for this reason. The signal, though weak, was seen at the r eceiving station and operation of this system was verified by the 200 mc monitor telemetry.

4. Two of the instrument carriers, the 50,000 foot and 80,000 foot stations were not recovered. The RF signals indicated the chutes operated satisfactorily, but the long time spent in searching for other nose cones and pods may have allowed these two noses to take on water and sink.

The displaced burst caused the stations to be considerably outside of the intended interest areas, but it appears that most of the desired data will be forthcoming from the records and the four recovered noses. The amount of optic data lost has not been determined at this time.

After TEAK Program 32 was asked to participate in the ORANGE shot to a larger extent than was originally designed. No attenuation measurements nor instrument carriers were originally scheduled for ORANGE.

The measurements actually attempted on ORANGE test are as follows:

1. Four Rad-Chem Samplers.

2. Three instrument carriers, one at 80,000 feet altitude and 95,000 feet horizontally displaced from the burst; and two at burst altitude, one 40,000 feet North and one 40,000 feet West of Air Zero.

3. Eight Deacon-Arrow II RF attenuation rockets.

4. MIDOT tracking of the three instrument carriers, two of the beacon carriers, and the Redstone.

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5. The 4 Kmc diagnostic measurement.

6. Photo coverage as on TEAK plus documentary coverage from French Frigate Shoals.

7. Warhead.

ORANGE Conclusions

1. The four samplers were recovered, but only the sample collected 40 seconds after burst contained any activity. Analysis by LASL will determine if this was adequate.

2. Telemetered data from the three instrument carriers appears satisfactory. The station 40,000 feet North of the burst was not recovered.

3. Only seven RF attenuation rockets were fired. Three 225 mc. systems recorded good data. The 1500 mc. measurements are not, as yet, determined.

4. MIDOT tracking was good.

5. The 4 Kmc. diagnostic measurements gave transit time and may give a figure for early alpha.

6. The photo coverage was lost because of cloud coverage.

7. The WH apparently operated as expected.

2.4.2.1 Project 34.1.

Project 34.1 was responsible for the telemetry of high-time resolution data relative to several areas of interest.

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An experimental early alpha system was tried out on 15 LASL shots with at least partial success. The interpretation of these data is not yet complete. The system operates by telemetry of two narrow pulses corresponding to two known gamma levels or generations. The time between the pulses divided by the delta is an average alpha for that period. The making of these measurements and interpretation of the data was complicated considerably by their transmission over channels already crowed with other data.

2.4.2.2 Project 34.2 - Yucca Warhead System.

The responsibility of Project 34.2 was to apply the device fuze, and fire a DELETED device in support of the DOD sponsored very high altitude balloon test. This test device for YUCCA consisted of DELETED pressurized and hermatically sealed, and fuzed with a radio command system backed up with a baro controlled timer. The radio command system also supplied signals to actuate the cannister deployment weapon reel out, and emergency cutdown. Cutdown signals were also supplied by the fuze backup time and two clock timers

Radio command and monitoring of the system was accomplished from a trailer van control station located aboard the USS Boxer. The EG&G timing system was utilized to initiate the arm and fire sequence. After five proof-test flights during HARDTACK, the YUCCA system was launched on 28 April 1958 at 1125 hours from the flight deck of the USS Boxer at 164°, 30' E Longitude and 11°, 45' N Latitude. At launch plus 8 minutes, altitude 7,000 feet, the five instrument cannisters were deployed by radio command, and at launch plus 13 minutes, 12,000 feet, the YUCCA device was reel-deployed by radio command. The balloon borne system reached a floating altitude of 86,000 feet at launch plus 88 minutes. Later a dealy was requested by TG 7.4. YUCCA was detonated by radio command at H-hour Prime, 1440 hours, at 12°, 37' N Latitude and 163°, 01.5'E Longitude.

The yield for YUCCA, estimated from the history of [redacted] firings, was given by R. E. Watt, LASL, as [redacted] The only major operational problem encountered during the test was caused by radio interference with the fuzing command system. After all unnecessary radio circuits below 300 mc. were closed down, all interference disappeared.

2.4.2.3 Project 34.3.

The objective of Project 34.3 was to procure, assembly, and check out the devices for the two underwater detonations, WAHOO and UMBRELLA, sponsored by the DOD.

Procurement of the needed parts included the design and purchase of the water-tight device cases, the underwater signal cables, and the necessary firing and assembly equipment. Electrical equipment for both checkout and firing was purchased as regula device components or designed and fabricated by project personnel. Nuclear components were obtained from standard production through the AEC.

On of the major phases of the project activities was coordination with DOD agencies and other support groups to devise a workable emplacement and firing system. This included taking part in various conferences and test from the initial planning stages through preliminary sea trials of the suspension system and dry run activities prior to detonation. Checkout and assembly was completed prior to placing the devices in firing position. The device case and underwater signal cables were water-pressure tested before acceptance from the manufacturer. The electrical equipment for firing was tested on numerous dry runs for satisfactory operation. The two devices were detonated satisfactorily without any major difficulties or delays. Some trouble was encountered on the WAHOO event from fairly rough seas which made the zero instrument platform (LCM hull) very unstable. This was not only uncomfortable for personnel, but created very unfavorable working conditions and deteriation of equipment. These conditions were corrected on the UMBRELLA event through the use of a larger platform (LCU hull) in an anchored position.

A few trouble spots developed in the fabrication of equipment, such as the zero instrument platform, for use by several agencies. These conditions were brought about by poor coordination between the users and fabrication agencies.

For any future test of a similar nature, the following recommendations are offered concerning the activities of Project 34.3:

1. Although the emplacement, suspension, and firing system as used during Operation HARDTACK was employed successfully on the two events, a different system, which should include a more stable platform for the zero firing and instrumentation system, would be desired.

2. More time should be allowed for the various support groups to determine their requirements and procure and fabricate special equipment. This action would permit better coordination for preparation of facilities.

2.4.2.4 Project 34.4.

The Microbarograph Project recorded blast waves from HARDTACK.

The primary purpose of this project was to measure blast waves from the teak and orange events. High temperatures or wind speeds in the upper atmosphere may cause portions of a blast wave to be returned to the ground at great distances. Microbarograph stations at Johnston Island, Lualualei, Oahu, T.H. and French Frigate Shoals were to record these refracted sounds, arrival time and incidence angles. From these records it is anticipated that winds and temperatures at 100,000 to 180,000 feet where the blast waves were returned to the ground, may be interpreted.

The secondary purpose of Project 34.4 was to measure blast waves generated near the ground at the Eniwetok Proving Ground. These waves are bent by refraction as they propagate through the upper atmosphere and were recorded at microbarograph stations located at Eniwetok, Bikini, Kwajalein, Utirik, Wotho and Ujeland.

The Microbarograph station at Johnston Island recorded an overpressure of 8.4 millibars or approximately 0.12 psi. Arrival time for the blast wave at the recording instrument was approximately 193 seconds. This data was obtained for the teak event and together with the orange data will be evaluated in terms of wind 105

[redacted]

speed and temperature. The same will apply to the recorded data from Lualualei and French Frigate Shoals. The Microbarograph data from Eniwetok is being forwarded to Sandia Corporation for evaluation.

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2.4.2.6 Project 34.6

Project 34.6 has responsibilities in three distinct and unrelated areas as follows:

1. Systematics, which consists generally of an intimate and current knowledge of the complete device firing systems with staff advisory responsibilities to the Commander Task Unit 2.

2. Procruement, test, and field support for X-unit cables for all UCRL events.

3. Detonator electrical test prior to, during, and after assembly of the complete device.

The systematics function was a "1st time" venture and was conceived by Dr. H. B. Keller, CTU-2. SCLB furnished this support at the request of UCRL. This function was particulary valuable in the pre-operational period and was chiefly one of coordination between various "interconnected" agencies during the planning phase. In the operational period this function, although still valuable, suffered somewhat from manpower shortages in as much as the other two functions are absolutely necessary to a shot and systematics is not.

For future operations it seems that the Arming and Firing Coordinator would be in a better position to handle the function with a minimum of duplication of effort. It was valuable however, for the systematic coordinator to be located physically near UCRL in order to better handle the valuable pre-operational phases.

The detonator test function is self-explanatory. Electrical tests were made on loose detonators or detonator cable assemblies at the request of any of the Device Field Teams, and generally at four steps in the history of the device as follows: 61

1. Prior to device assembly.
2. After device assembly, prior to transfer to Zero Site.
3. After transporting to Zero Site.
4. At pre-arm.

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2.4.2.7 Project 34.7.

The objective of Project 34.7 participaton the the QUINCE event was to study prompt nuclear dose rate effects on weapon materials and components. This interest stems from the need to reduce the vulnerability of nuclear weapons to other nuclear bursts and environments, and from observed instances of deviation in radiation damage criteria between in-reactor exposures as compared with prompt nuclear bursts.

Specimens of transistors, diodes, capacitors, resistors, plastics, semi-conducting materials, detonators and high explosive materials were exposed to prompt nuclear dose rates in the range from DELETED The effect produced in these specimens will be compared to effects produced in similar specimens exposed in reactors to the same total neutron dose at much lower rates.

2.4.2.8 Project 34.8.

The objectives of Project 34.8 were:

1. Make the necessary measurements on QUINCE event to deleniate the fallout gamma radiation yield produced by a surface detonation on land of a DELETED

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2. Using data collect by this project and by Projects 34.9 and 34.10 construct a fallout model for use with any wind pattern, and evaluate extremes in militarily significant interesities for the same yield range.

3. Define the attendant plutonium contamination problem. The site for QUINCE event was Runit (Yvonne) Island of Eniwetok Atoll. Only about 400 feet of land in the prevailing downwind direction was available for radiation monitoring, necessitating placement of bulk of the instrumentation in the lagoon. There were 92 lagoon stations, 46 land stations, and 8 reef stations. The bulk of fallout instrumentation consisted of sticky pan fallout collectors. Sticky pan collectors were mounted on small buoys in the lagoon and on steel pipes in the reef area. After exposure, pans were counted in a fixed geometry. Lagoon and reef pan readings were calibrated in terms of full yield intensities by dose rate measurements over the available land and old flat-topped barges which were anchored in the lagoon. Dose rate readings on land and on the barges were made by hand-monitoring and by automatically recording instruments.

2.4.2.9 Project 34.9.

Project 34.9 was responsible for photographing the cloud produced by the QUINCE event. The amin objective was to determine the cloud dimensions as a function time. These measurements were necessary to assist Project 34.8 in constructing a fallout model.

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2.4.2.10 Project 34.10.

One of the objectives of Project 34.10 was to measure the pre-shot wind conditions over expected cloud heights for the shot time decision to assure that expected fallout would be adequately sampled by the instrument temporarily of Project 34.8.

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[redacted]

A second objective was to measure the post-shot wind conditions to aid in construction of a fallout model by Project 34.8. Both objectives were completed satsifactorily.

Projects 34.7, 34.8, 34.9 and 34.10 were concerned with events QUINCE and FIG.

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[redacted]

2.2.2 and 2.2.10 Addendum. Programs 10 and 18. Teak

Objectives.

The objectives were to measure the total thermal, thermal power, time interval and optical-spectroscopic observation of high altitude fire-ball phenomena.

Total thermal measured at Johnston Island was [redacted] calories per cm^2. Assuming atmospheric transmission of 63% which was the mean noon value on four preceding days, the corresponding thermal energy release from the bomb was DELETED DELETED This low thermal energy release (as seen from sea level) is not unrealistic because a large fraction of the early high temperature fireball radiation resides in the ultra violet which is absorbed in the atmosphere, particularly in the ozone layer. The duration of the thermal pulse for deposition of 90% of the incident energy was [redacted]

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The results of the experiments designed to attain the third and main objective of the two programs were unfavorably affected by the burst location error. Specifically, information on the very early development of the fireball could not be obtained, since none of the collimated instrument channels

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covered the true burst location. The most interesting phase of the fireball development could therefore not be observed. However the limb and so called envelope spaces, between radii of 4 km and 12 km, yielded interesting time resolved spectroscopic data for times up to 5 minutes after the burst. They require much specific attention and analysis. Generally one can say that the records will provide information on the fluorescent yield of gamma ray and x-ray excited air, on the energy deposition in the air versus distance from source, and thus indirectly on source strength; information on transition processes in the medium and low energy deposition range, on gas temperatures and cooling rates; also about early recombination processes. One record shows neutron flux effects on air. Cursory inspection of the spectrograms and oscilloscope traces indicates higher temperatures, a greater degree of ionization at a given radius than expected and thus larger dimesions of the luminous fireball. This is born out by the observation that the emission by molecular species at 12 km from burst center was of almost equal magnitude as the originally expected signal from the 6 km location. Closer in, singly and doubly ionized atomic species show up where the appearance of molecular species was expected. On the other hand there are indications that the core area of the fireball was less bright than predicted indicating a higher rate of colling by radiati. flow towards the edges.

The project plans to analyze also high speed photographic data for radius versus time and brightness versus time information. With some good luck the combined information may suffice to check and revise current theory and provide a reasonably comprehensive understanding of high altitude fireball phenomenology.

2.2.9 Addendum. Program 17. Teak, Orange

A variety of electromagnetic signals were recorded on both shots. No analysis has been attempted yet.

2.2.2 and 2.2.10 Addendum. Programs 10 and 18, Orange

Objectives.

Objectives were the same as for Teak. After failure to obtain early fireball core data from Teak shot, an attempt was made to obtain such data from Orange although one had to expect very high reaction rates, DELETED

DELETED Many instruments were therefore pointed at the burst location and were set for highest possible time resolution. Unfortunately the shot was fired under deteriorating weather conditions and at the critical time the recommendation of the responsible program officer to hold or to delay the shot was not accepted, (much to the astonishment of the projects, which had been made to believe that clear vision from Johnston Island was mandatory for the shot). At shot time the altostratus cover over the Island was 8/10 (not 5/10 as officially reported for the Johnston Island area), resulting in a mean diffuse optical transmission of only 6%; the transmission for the collimated observation channels was even less. Instrument and station performance record was good. Not one single NRL operated instrument failed; at the LASL end 57 oscilloscope channels recorded out of a possible 61 and Bowen and spectrograph channels operated.

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The majority of the spectrographs and cameras registered either no or only weak signals. However three instruments (two NRL - one LASL) recorded relatively late time information which appears valuable. Also many photoelectric channels wrote a readable signal. These data describe qualitatively the fireball behavior from approximately 1 millisecond on. Information for earlier times is not entirely absent but very sketchy. Nevertheless there is a fair chance that one will arrive at a useful qualitative picture of Orange fireball development, expecially if the spectroscopic data analysis can be supplemented by analysis of the EGG high speed photographic records taken from airplanes.

CHAPTER III

GENERAL ACTIVITIES OF TASK GROUP 7.1

3.1 MISSIONS

Part of the mission assigned to JTF-7 by agreement between AEC and DOD was:

1. Prepare for and conduct in the spring and summer of 1958 tests of such experimental devices as may be approved by the DOD or AEC.

2. Prepare for and conduct in association with the above tests experimental measurements necessary for the successful completion of the tests as approved by the DOD or the AEC, and such weapons effects programs as may be approved by the DOD or the AEC.

3. Maintain the EPG as a closed area within the capability of forces available.

4. Assume responsibility for safety of populated islands relative to hazards introduced by the operation.

In order to accomplish their mission, JTF-7 assigned the following responsibilities to TG 7.1:

1. Position, arm, and detonate the nuclear test devices as authorized by CJTF SEVEN.

2. Conduct such experiments on each nuclear explosion as are needed to fulfill the technical requirements determined by appropriate authority within the AEC and/ or DOD, and are in addition operationally feasible.

3. Provide such technical information, guidance and services to all participating elements of the Joint Task Force as may be required for the conduct of their respective missions.

4. Ascertain and transmit to the appropriate headquarters the requirements for services to be furnished to Task Group 7.1 by other participating elements of the Joint Task Force.

5. Submit check lists of tasks to be accomplished for period prior to, during and after each detonation.

6. Submit a written final report no later than 15 days subsequent to the last detonation of the HARDTACK test series.

3.2 ORGANIZATION AND COMMAND RELATIONSHIPS

3.2.1 Organization. The Task Group 7.1 organization for HARDTACK, shown in Figure 3.1, represented a change in ~~and improvement over~~ the Redwing organization in the following respects.

1. Task Units were reduced from twelve to six by absorbing the assembly and documentary photography functions within the major task units and by establishing Arming and Firing as a special staff office instead of a task unit. Task Units 1 to 4 remained major programmatic task units; Task Unit 5 continued to provide all timing and firing and to do some experimental work for Task Units 1, 2 and 3; and Task Unit 6 provided the usual RadSafe services.

2. Additional deputy commanders were provided and ~~it was~~ when intended that no limitations be placed on their use. This facilitated somewhat independent operations in two locations, and later three when Johnston Island was added. Unfortunately one of the deputies was made available for only two months; and another was limited as to the nature of his employment by the agency which provided him.

3. On October 1, 1957 Dr. Gaelen L. Felt terminated his employment at LASL, Mr. Don B. Shuster of the Sandia Corporation replaced him as Commander Task Group 7.1. As a result, the Command Section was represented by each of the five major Task Units. Neither the commander nor any of the deputies performed any special Task Group functions for their parent organizations.

4. During the operational phase Task Unit 7 was added to take care of the UN shot. Because of the purpose and nature of the shot, the limited amount of data to be acquired, and the fact that much of the preparation was outside of the Task Force organization, Task Unit 7 bore little resemblance to any of the others.

The organization chart of Joint Task Force SEVEN, shown in Figure 3.2, differed from the Redwing chart by omitting a dotted line called "Scientific Supervision" from the AEC to the Deputy Commander for Scientific Matters to Task Groups 7.1 and 7.5.

3.2.2 *Command Relationships*. Command relationships were closer to the military pattern than they were to those for operations at the Nevada Test Site.

One important difference from normal military command relationships was that the Task Group 7.1 concept of operations and operation plans stemmed from the Laboratories' and DOD device and weapons programs and experimental programs, over the composition and extent of which the Task Group and Task Force had little or no control. Because of this, were independent and because support of the Task Group 7.1 effort was among the principal functions of the Task Force and of the other Task Groups, their plans and operations depended in many ways on those of 7.1.

CJTF SEVEN authorized direct relationships among the various Task Groups once he had established plocy and major items of support.

Relationships of 7.1 with the Joint Task Force and with the other Task Groups were good and resulted in generally excellent supprt for the accomplishment of 7.1 missions.

Although RADM Tyree did not report for duty as Commander Task Group 7.3 until January 1958, his appreciation of the operational problems of the scientific task group was outstanding. Task Group 7.1 enjoyed the closest relationship with him and his staff and the best support yet received from a Navy Task Group.

Relationships within Task Group 7.1 were close and cordial. During the planning stage the Task Group Commander and members of his staff made frequent visits to the Field Command and UCRL, and to program and project sites as necessary to get firsthand information on plans and requirements; and to insure operational feasibility, safety, coordination and adequate support. Many visitors were received from the Task Units, programs and projects. Necessary meetings were held at locations most convenient for the bulk of the participants--Los Alamos, Albuquerque, Livermore, Travis AFB, Cape Canaveral, and San Diego, to name a few.

3.3 PLANNING AND TRAINING

3.3.1 Programs, Concepts and Schedules. Planning for HARDTACK was compli-
which the major participants were committed
cated by the lateness of the Nevada Plumbbob, and by delays in a decision as
operation
to whether or not a third Pacific test site, Taongi, would be developed and available. Lateness in the availability of AEC funds for work at the EPG, uncertainties regarding the starting date for HARDTACK, and failures of the arming and firing systems of the Redstone test missiles added to the planning difficulties.

The first shot of Plumbbob was fired on May 21 and the last shot on October 7, 1957, making it relatively later and considerably longer than any previous test in Nevada. The major TG 7.1 HARDTACK participants were heavily committed in Plumbbob; and the results of the Plumbbob tests vitally affected the shots to be fired and the experiments to be done on HARDTACK.

The possible use of Taongi, in conjuntion with an instrumented ship for diagnostic measurements, proposed by UCRL for their large shots, in order to take advantage of presumably better firing weather there than at Bikini, affected shot schedules and locations, scientific and base facility construction, and military and AEC support. The decision by the AEC that Taongi was not to be used was not made until June 7, 1957. Until that time two alternative uses of bases had to be considered in all 7.1 HARDTACK plans.

AEC funds for base facility construction were not made available until late September 1957. This made base facility compete with scientific construction for personnel, material, facilities, and services, and delayed both of them.

On October 22, 1957, the Commission decided that, subject to Presidential approval, the starting date for AEC tests would be May 1, 1958, and that

DOD tests might start one to two weeks earlier, depending on readiness and scheduling problems. Until this time 7.1 had to plan on both an assigned starting date of April 1, which seemed impractical and inefficient, and a recommended starting date of May 1.

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ending in March, 1958, and imposed a heavy additional load on many Task Group, program and project personnel.

By the summer and fall of 1956 the three services had decided on the shots they planned to sponsor for HARDTACK and the major projects they wanted to carry out. After review and recommendations by AFSWP, there emerged a program of five DOD shots which remained virtually unchanged throughout the operation. It consisted of one [redacted] balloon shot at 90,000 feet altitude; two [redacted] underwater shots, one at the bottom of Eniwetok lagoon in about 150 feet of water, and one in nearby deep water in the open sea at a depth of 400 (later 500) feet; and two missile shots of [redacted] at 250,000 feet and 100,000 (later 125,000) feet.

By the time an informal Eniwetok Planning Board with representatives of LASL, UCRL, Field Command AFSWP, Sandia Corporation, and Task Group 7.1 met at Los Alamos on January 31, 1957, the following LASL and UCRL shots, in addition to the five DOD shots, were being considered for Operation HARDTACK and served as a basis for discussion:

	Number of Shots	Yield range	Method of Mounting
LASL:	1		barge
	6		barge
	2		surface
	1	DELETED	barge or tower
	2		tower
UCRL:	4		barge
	4		1 surface, 3 barge
	1		tower or barge
	1		tower or barge
	4		tower

LASL's concept of its HARDTACK experimental program was that yield measurements would be required on all devices, and time interval on all two-stage devices. Alpha measurements would probably be required on all large devices. and possibly on all devices.

DELETED. DELETED Only the two surface shots would be heavily instrumented. Although the above listing did not include an official LASL list of shots, and although shots might be cancelled, added, or substituted, the magnitude of effort involved and the total number of events required by the Laboratory should not change appreciably.

UCRL was planning very simple diagnostics, to be measured at a distance on the six low-yield devices. They were mainly interested in yield, alpha, DELETED On the large two-stage devices UCRL was planning to measure time interval. They might include photo pipes on some of the barge shots, but were presently planning on only one heavily instrumented shot. (It was later decided to not fire a heavily instrumented shot in the "HARDTACK" operation).

Concept Of Operations:

1. Length of operational period should be minimized.

2. Dual capability for large shots was required.

3. Mutual interaction between agencies should be minimized.

4. Joint use of firing sites by different agencies should be eliminated.

5. Capability for operation if Taongi is not made available should be provided, if possible.

6. Any proposed shot can be done on Bikini.

7. Eniwetok shots should be limited to 5 Mt maximum.

The above principles were agreed upon as being a desirable basis for planning, and led to the following tentative concept.

UCRL would plan to do the four large shots on Taongi, and the remainder of its shots on Bikini Atoll, using the Eninman (Tare) complex as the central base of operations. There was some possibility that they might desire to divide the shots in the [redacted] region between Taongi and Bikini. LASL would plan on doing all of its shots on Eniwetok Atoll, with the possible exception of one greater than [redacted] Because of the high estimated yield of that shot [redacted] it might not be feasible to use Eniwetok because of principle 7 above. (It was later decided that it was feasible.) It was suggested that, for planning purposes, the DOD consider splitting its shots between the two atolls, with high altitude shots at Bikini and underwater shots at Eniwetok. UCRL agreed that if Taongi were not made a part of the proving ground they would attempt to put all of their shots on Bikini using a diagnostics ship for recording data. Livermore agreed to try to accommodate a LASL large shot position in the Bikini Romurikku-Aomoen (Fox-George) region, and LASL agreed to try to maintain a Livermore tower site possibility on Eniwetok.

It was further agreed that a target date of May 1 for the first shot should be established. UCRL estimated 6 weeks as the length of their operation if Taongi were available, or ten weeks without. LASL estimated that 2 to 2½ months would be needed. Thus, a combined operation would require perhaps 3½ months of shooting.

Additional aircraft would be required ~~in~~ if the HARDTACK concept of operations included the detonation of two large shots within twenty-four hours. Because of the number of aircraft involved, the AEC should consider this concept and approve. If the Commission accepted a program such as outlined above for HARDTACK, a dual capability appeared to be mandatory.

Each Laboratory required six samples per shot and, under such circumstances, a dual capability required twelve operating aircraft plus two operating control aircraft, plus spares. Because of the altitude requirements and 8 weather problems during summer months, this should include ten B-57B and four B-57D type aircraft.

From this and other meetings of the Eniwetok Planning Board, from the device and experimental programs of the two Laboratories, and from the experimental programs of the DOD and Sandia Corporation and the AEC/DOD support programs, Task Group 7.1 developed an Operation HARDTACK General Concept, given limited distribution in draft form on April 12, 1957. It was issued on June 1, 1957. The foreword stated, "--as usual at this stage of an overseas operation, prior to receipt of JTF SEVEN planning documents and without CJTF SEVEN approval, in order to provide the early planning guidance needed by the personnel of Task Group 7.1 who will participate in the operation." The shot schedule given in the Concept included 27 shots, listed in Table 3.2.

Planning assumptions and basic principles included the following:

1. Operation HARDTACK will be similar to Operation Redwing. However, the number of devices and weapons to be tested will be greater.

2. Both Bikini and Eniwetok Atolls will be used as shot sites, and shots covering a wide range in yield will be fired at each.

3. So far as possible, firing at either atoll will proceed independently of activities at the other. This concept includes the possibility of simultaneous firings at both atolls.

4. A capability to conduct operations from afloat will be maintained at Bikini Atoll and an emergency evacuation capability will be maintained at Eniwetok.

5. Consideration is being given to the use of Taongi Atoll as a third area of operation. (This provision was eliminated a week after the Concept was issued.)

6. The detonation time for each shot will be determined by pertinent operational and experimental considerations. The probable detonation time for most shots will be between one hour and one-half hour before sunrise.

There were three revisions of the General Concept before Task Group 7.1 Operation Plan No. 1-58 was issued on January 15, 1958. Changes in schedule resulted in a total of 26 shots, including two one-points, plus two contingencies. There were also changes in planning assumptions and basic principles.

Late major changes in this schedule were caused by a decision early in April 1958 that:

1. Teak and Orange would be fired from Johnston Island because of the Flash-blindness problem.

2. Necessity of redesign and return of devices by LASL and UCRL.

3. The addition of devices by those LASL and UCRL because of the proposed moratorium and for other reasons. The total number of shots actually fired was , listed in Table 3.3.

The general concept of operations given in the Operation Plan included the following:

1. A capability will be maintained to conduct independent operations and fire shots simultaneously at each atoll, Bikini and Eniwetok, under the immedi te supervision of a Deputy Commander, TG 7.1 residing at the atoll.

2. The devices to be tested by TU-1 (LASL) will be detonated from sites in the vicinity of the northern islands of Eniwetok Atoll. [redacted] will be detonated at Bikini Atoll with zero sites for their larger yield devices near the northern islands, and for the smaller yields near the southern islands. Both laboratories will normally fire their devices during the last hour of darkness before sunrise.

3. Two of the five DCD nuclear weapons, as warheads in the Redstone Missiles, will be launched from Bikini Island. They will be fired at night at least two hours after sunset but prior to two hours before sunrise. The two underwater shots will be detonated in the vicinity of the southern islands of Eniwetok Atoll, the first in the deep ocean, the second within the lagoon. The high altitude balloon shot will be launched from the aircraft carrier, USS BOXER, positioned in the open sea between the two atolls. These shots will be fired during daylight hours.

4. Dry run tests of firing procedures and electrical signals for the effects and diagnostic systems, as well as rehearsals of special evacuation and re-entry measures will be announced in operational letters for each event. Essentially, after a scheduled ready date, each day will be a D-1.

5. The Bikini Atoll will be evacuated of all personnel (except those involved in firing operations) for the Sycamore and Poplar barge shots off of Namu (Charlie) Island. For the two shots, Teak and Orange, certain experimental stations, not on the Redstone Missile trajectory (or its reciprocal), may be manned under specific authority of CTG 7.1. Otherwise the Atoll will be evacuated of all personnel not involved in launching and firing operations. On other shots, the up-island personnel will normally be evacuated to Enyu (Nan).

6. When evacuation to shipboard is required, normal post-shot RadSafe and recovery operations will be initiated from the Nan base rather than 83

from afloat. (The capability to conduct operations from afloat at Bikini, proposed in the Concept, was not provided

7. If not called off at 1600 on D-1 due to weather or technical reasons shots may be "kept on" until 2300 in order to take advantage of the latest weather forcast. As a result, evacuation at night will be normal and routine.

Arming and Firing.

The Arming and Firing project was responsible for activitie as follows:

1. To meet with other interested agencies prior to the operation in determining suitable specifications and delivery dates for the firing components.

2. To check out the firing components for each shot prior to the first dry run. This was known as the compatibility check and consisted of making a detailed functional check of the zero rack, X-unit [redacted] and associated cabling. Zero rack interlocks were set and checked at this time and all of the equipment was operated by sending signals through the zero rack simulating the actual shot sequence. As a safety measure, the arming cables were then kept under lock and key by the arming and firing coordinator until needed.

3. To check the installation of the firing components at the zero site for reliability, and safety. This included the signal and monitor lines from the control point to the zero site as well as the zero rack and associated firing equipment in the cab.

4. To coordinate dry run data and work with all agencies concerned in determining dry run schedules to fit their needs.

5. To coordinate the activities of the arming party. The arming and Firing Coordinator was in charge of the arming party and was responsible for the security of the device in the absence

of security guards during arming. He was responsible for the proper connections between the various firing components and the device and to see that these were made in an acceptable manner, observing the necessary safety precautions. It was also the responsibility of the Arming and Firing Coordinator to organize the activities of the disarming party in the event of a misfire or routine dis-arming operation, again observing accepted safety procedures.

During Operation Hardtack a total of 32 devices were successfully detonated (total does not include Teak, Orange or Fig). There were no misfires, although many routine disarming operations were carries out, due mainly to weather delays.

An Arming book for each shot will be documented and presented to the Commander, Task Group 7.1 for future reference.

TABLE 3.3

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3.3.2 DETERMINATION OF REQUIREMENTS

The DOD system for planning the support of overseas nuclear tests makes it necessary to submit requirements long before the shot schedule is in any way firm. Therefore, these early estimates are largely governed by the experience gained from the past operation tailored to suit whatever is already known about the coming operation. So far it has proved safe to assume that each operation would be larger and more complex than its predecessor.

Since the underwater and high altitude shots, as shown in the preceding section, were decided on shortly after the conclusion of Redwing, it was evident from the beginning of Hardtack planning that these shots would require a very substantial amount of support in addition to that normally provided.

On October 29, 1956 representatives of the J-3 Section, Joint Task Force SEVEN, visited CTG 7.1 at Los Alamos to discuss Hardtack support requirements, stating that CJTF SEVEN needed these requirements at the earliest possible date. 7.1 estimates at that time are shown in column 2 of Table 3.4 which lists, except for motor vehicles, the principal items of military support of both direct and indirect interest to TG 7.1. No distinction is drawn in the table between items of direct interest to TG 7.1, such as a command and firing ship and effects ships and aircraft, and items resulting from TG 7.1's requirements for services, such as base facilities, transportation and communications, which generate material requirements in the task groups which provide those services.

CJTF SEVEN held a logistics and construction conference on February 19 and a planning conference on February 20, 1957. The first conference discussed base construction, supply, and requirements for vehicles and harbor craft. CTG 7.1 asked for a total of 350 vehicles and was allocated 305. Details of the motor vehicle program are discussed in Section 3.7.5 of this report. Requirements for harbor craft are shown in Table 3.4.

The second conference determined preliminary requirements for military ships and aircraft touched very briefly on communication and transportation requirements. Ship and aircraft requirements are listed in Table 3.4, column 3.

These and later meetings, many exchanges of visits with the Task Force, other Task Groups, and programs and projects, the establishment of a monthly status report system in June, 1957, and the TG 7.1 Project Officers' meeting in July, 1957 resulted in detailed requirements and recommended schedules for meeting them.

In addition to providing the items listed in Table 3.4, the AEC and DOD also supported TG 7.1 as outlined in the following paragraphs.

The Albuquerque Operations Office and Task Group 7.5 provided extensive base facilities throughout the EPG including billeting, construction of scientific stations, shot sites (including 22 barges and 6 LCU hulls) and 7.1's major communication facilities. Among the many services provided by the AEC were boat pool services at both atolls; housekeeping, messing, medical, dental and laundry services; and the badge system.

Headquarters, JTF SEVEN, provided communication and weather and fallout prediction services.

CTG 7.2 operated the base facilities on Eniwetok Island, processed the vehicles, and provided communications facilities and military police for security purposes.

The Navy provided ships, boats, planes, Marine Corps helicopters, and inter-atoll surface lift including transportation of shot barges; helped to establish and support the island scientific stations outside of the EPG; and provided most of the shipboard communications.

CTG 7.3 was responsible for positioning arrays and devices for the underwater shots and assisted extensively in the launching and tracking of the Yucca balloon.

TG 7.3 took an active part in recovery operations including the location and recovery of nose cones and similar items and did most of the work in the decontamination of ships and craft.

The Boxer transported several of the devices to the forward area and MSTS continued to provide regularly scheduled surface lift between the West Coast and the EPG. As the operational period approached, MSTS increased the frequency of sailings and provided two special ships to expedite the shipment of large numbers of scientific trailers. Two MSTS T-LST's were assigned for local surface lift. They, together with the MSTS transport Ainsworth, augmented the Navy's evacuation capability.

The Navy carried out alterations on a number of Naval ships and craft and one MSTS vessel as necessary for their support of scientific functions.

As shown in Table 3.4, the Air Force provided sampler aircraft; effects, photographic and other scientific project aircraft; helicopters at Bikini and Eniwetok; liaison planes; inter-atoll air lift and off-atoll support. Weather planes and much of the weather service were also provided by the Air Force.

MATS provided air lift of military personnel between the West Coast and Eniwetok, and of contractor personnel between Hickam and Eniwetok. In addition, MATS lifted hundreds of tons of urgent freight, furnished all of the sample return services, lifted most of the devices from the United States to Eniwetok, and in several cases, returned them to the US for modification and brought them out again.

Details and statistics of a number of the items of support provided by the AEC and the DOD are covered elsewhere in this report.

3.3.3 Training And Rehearsals. Training and rehearsals for HARDTACK commenced in the United States, and continued overseas throughout the operational period.

The training programs were designed to meet Task Group scientific, operational, technical and safety requirements and, insofar as possible, to allow rotation of individuals without jeopardizing the programs.

In order to make the maximum use of project Rad-Safe monitors, approximately 250 were trained at the EPG. Training courses were conducted at Parry Island, Eniwetok Island and Enyu Island commencing March 17, 1958. Courses were either four days or one day in duration. The training period lasted for nine weeks. Four chemical laboratory technicians were trained in basic radiochemistry techniques at LASL. Seven instrument repair technicians were trained at the US Naval Schools Command, Treasure Island and at LASL. In addition, 39 men participated in the Rad-Safe program at NTS during Operation PLUMBBOB on a training basis. Other training was provided by the US Army First Radiological Safety Support Unit in the normal unit training program.

In preparation for HARDTACK, there were several firings of REDSTONE missiles at Cape Canaveral beginning in the summer of 1957 and ending in March 1958, none of which was completely successful. They did serve, however, to point up serious defects in the arming and firing system and to alert the project personnel to design and procedural factors which might well jeopardize or delay the Bikini tests.

Practice launchings of the Yucca type balloon from the ground were conducted at Eniwetok during July 1957. When these proved unsuccessful because of the normal surface winds velocities experienced at Eniwetok, practice launchings were made from the USS BOXER off San Diego from September 9 to 11, 1957. With the BOXER steaming down wind at the surface wind speed, launchings were consistently successful and this was the method used during HARDTACK. In the EPG there were eleven rehearsal launchings of the YUCCA type balloon from the BOXER, including one with a dummy weapon and high explosive, before the YUCCA shot.

During the period from November 9 to 16, 1957, the USS GRASP (ARS-24), in preparation for, and as feasibility studies of her HARDTACK mission, conducted two positioning tests for underwater devices off OAHU, T. H.

Associated with the TEAK and ORANGE missiles were pods, some of which had to be located and recovered from the ocean after the shots. In addition, there were several rocket programs, including sampling rockets, which required post-shot location and recovery of nose cones and other parts. Preliminary location and recovery tests were held at Salton Sea, California on December 6 and 7, 1957 and off Point Mugu, California between January 20 and 23, 1958.

A full scale Task Force rehearsal of the TEAK event, to include token evacuation of the Bikini Atoll, was cancelled when TEAK was moved to Johnston Island. Commander, Joint Task Force SEVEN then decided to hold a full scale rehearsal of the FIR event, to include those parts of POPLAR and SYCAMORE which required virtually complete evacuation of Bikini. The USS BOXER and USNS AINSWORTH proceeded to their assigned areas of operation approximately thirty miles south of ENYU. Communications were thoroughly tested, but only token evacuation of personnel was directed and carried out.

On Minus-4 day, Joint Task Force SEVEN held a rehearsal of UMBRELLA including positioning of ships, lowering the dummy device, token evacuation from ships of the target array, and a complete test of communications. This was the last full scale rehearsal at the EPG.

In preparation for each shot, Task Group 7.1 held numerous dry runs of the timing and firing systems. The runs were normally conducted twice a day or more often until results were satisfactory, then once a day through shot time or postponement. At least one full-power dry run, and one "hot" dry run, when appropriate, were conducted prior to each shot. At Eniwetok, there were 88 such runs during a typical month of the firing period.

In addition, projects, programs and task units conducted many rehearsals of operations of particular importance to them, particularly where there was some question of safety, feasibility, best technique, stand-by methods, and length of time required, if time was critical. CTG 7.1 also held many communications and frequency interference checks.

These signal runs, project rehearsals and communications checks were of the utmost importance to CTG 7.1 and to the successful completion of the scientific missions.

TABLE 3.1

KEY PERSONNEL OF TASK GROUP 7.1

Unit or Section	Name	Organization
Commander	Don B. Shuster	SC
Deputy Commanders	Walter D. Gibbins	UCRL
	Bernard J. O'Keefe	EG&G
	Ernest A. Pinson, Col., USAF	FC, AFSWP
Deputy for Administration	Duncan Curry, Jr.	LASL
Classification & Tech Rpts	Philip F. Belcher	LASL
	John M. Harding	LASL
	Robert D. Krohn	LASL
	Leslie M. Redman	LASL
Arming & Firing Coordinator	Edwin L. Jenkins	SC
	Robert Burton	SC
	Charles H. Stockley	SC
	John P. Johnson	SC
Safety	Roy H. Reider	LASL
J-1, Personnel & Administration	Armand W. Kelly	LASL
	Samuel R. Whitaker	LASL
	Robert C. Beiler	LASL
Military Executive	Kenneth A. Noseck, LtCol, USA	LASL
J-3, Plans & Operations	Emil A. Lucke, Col, USA	LASL
Assistant J-3	James T. Avery, Jr., Col, USA	LASL
	Robert H. Gattis, Col, USAF	LASL
	John H. Wendell, CDR, USN	LASL
J-4, Logistics & Supply	Harry S. Allen	LASL
	Robert J. Van Gemert	LASL
	John W. Lipp	LASL
J-6, Engineering, Constr & Maintenance	Robert W. Newman	LASL
	Rea Blossom	LASL
TU-1, LASL Programs	Bob E. Watt	LASL
	R. Lee Aamodt	LASL
	Herman Hoerlin	LASL
Advisory Group	Keith Boyer	LASL
	Alfred T. Peaslee, Jr.	LASL
	David A. Liberman	LASL
Technical Assts	Andrew M. Koonce	LASL
	Alvin L. Embry	LASL
J-1	William B. Sayer, LtJG, USN	LASL
J-3	Santo Italia, Maj, USAF	LASL
J-4	John W. Lipp	LASL
J-6	Rea Blossom	LASL
J-7 Design	James H. Hill	LASL
Photo	Robert C. Crook	LASL
	Robert Perlee	LASL
Reports	John M. Harding	LASL
Computers	Paul E. Harper	LASL
	Reginald E. Martin	LASL
Weapons Assembly	R. Keith Young	LASL
Program 10	Herman Hoerlin	LASL
Proj 10.1	Joseph F. Mullaney	LASL

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Proj 10.2, 10.3	Donald Westervelt	LASL
Program 11	George A. Cowan	LASL
Proj 11.1	George A. Cowan	LASL
Proj 11.2	Paul R. Guthals	LASL
Proj 11.3	Philip F. Moore	LASL
	Charles I. Browne	LASL
Program 12	R. Lee Aamodt	LASL
Proj 12.1	Wendell A. Biggers	LASL
Program 13	John S. Malik	LASL
Proj 13.1	Robert B. Patten	EG&G
Proj 13.2	Robert G. Scharrer	SC
Proj 13.3	Sidney N. Singer	LASL
	Leland K. Neher	LASL
Program 14	John Brolley, Jr.	LASL
Program 15	Arthur N. Cox	LASL
Proj 15.1	Herbery E. Grier	EG&G
Proj 15.2	Robert S. Fitzhugh	LASL
Program 16	Neel W. Glass	LASL
Program 17	Ralph E. Partridge	LASL
Proj 17.1	Ralph E. Partridge	LASL
Proj 17.2	Maurice Janco	LASL
Proj 17.3	Ralph E. Partridge	LASL
Program 18	Herman Hoerlin	LASL
Proj 18.1	Harold S. Stewart	NRL
	Frank Harrington	NRL
TU-2, UCRL Programs	Harry B. Keller	UCRL
Alternate	Charles E. Violet	UCRL
Asst to Commander	Jerry Zenger	UCRL
Advisory Group	Harold Brown	UCRL
	John S. Foster	UCRL
	Kenneth Street	UCRL
	Louis F. Wouters	UCRL
Rad-Safe	William E. Nolan	UCRL
Safety	John A. Vineyard	UCRL
	Bruce Linkous	UCRL
Electrical Systems	Walter Maupin	SC
	Robert Tockey	SC
Device Systems Coordinator	Walter F. Arnold	UCRL
Assembly Facility Coordinator	Walter Decker	UCRL
	Arthur Werner	UCRL
	Kenneth J. Copenhagen	UCRL
Support Staff Sections		
Coordinator	Vernon Denton	UCRL
Alternate	Clifford M. Bacigalupi	UCRL
Field Services	Roland W. Wallstedt	UCRL
L-4	Daniel J. Murphy	UCRL
L-6	Robert B. Petrie	UCRL
Documentary Photo	Raymond H. Jaeger	UCRL
Program 21	Robert H. Goeckermann	UCRL
Proj 21.1	Robert H. Goeckermann	UCRL
Proj 21.2	Roger E. Batzel	UCRL
Proj 21.3a	Edward H. Fleming	UCRL
Proj 21.3b	Edward H. Fleming	UCRL
Proj 21.4	Floyd F. Momyer, Jr.	UCRL
Proj 21.5	Norman A. Bonner	UCRL
Program 22	Myron W. Knapp	UCRL

Proj 22.1	William F. McMaster	UCRL
	Arnold F. Clark	UCRL
Proj 22.2	Ervin C. Woodward, Jr.	UCRL
	Jack N. Shearer	UCRL
Program 24	Francis C. Gilbert	UCRL
TU-3, DOD Programs	Kenneth D. Coleman, Col, USAF	FC, AFSWP
Technical Asst	William R. Hammond, Maj, USAF	FC, AFSWP
Operations	John C. McClure, LtCol, USAF	FC, AFSWP
Requirements Branch	William A. Mowery, LtCol, USA	FC, AFSWP
Administrative Office	Charles A. Swartzell, Capt, USA	FC, AFSWP
Reports Branch	Walter J. Miller	
Logistics	George P. Forsyth, Maj, USAF	FC, AFSWP
Deputy Commander, Eniwetok	Alfred H. Higgs, Capt, USN	FC, AFSWP
Special Asst, Navy	Corwin G. Mendenhall, Capt, USN	FC, AFSWP
Special Asst, A/C Mod	Jack G. James, LtCol, USAF	FC, AFSWP
Classification	Charles R. Moorhead, LtCol, USA	FC, AFSWP
Deputy Commander, Bikini	Harold Black, LtCol, USA	FC, AFSWP
Special Asst (ABMA)	Roger Ray, Maj, USA	FC, AFSWP
Special Asst (VHA)	Harry C. Henry, LtCol, USAF	FC, AFSWP
Program 1	John W. Kodis, LtCol, USAF	FC, AFSWP
Proj 1.1	Elijah Swift, Jr.	NOL
Proj 1.2	Peter Hanlon	NOL
Proj 1.3	Elijah Swift, Jr.	NOL
Proj 1.4	Andrew W. Patterson	ERDL
Proj 1.5	Tom McMillan	NEL
Proj 1.6	Lewis W. Kidd	SIO
Proj 1.7	Julius J. Meszaros	BRL
Proj 1.8	Lawrence M. Swift	SRI
Proj 1.9	Edward H. Bultmann, Capt, USAF	AFSWC
Proj 1.10	Jack T. Pantall, Jr., Capt, USAF	AFCRC
Proj 1.11	Francis B. Porzell	ONR/ARF
7 Proj 1.12	James F. Halsey	AFBMD
Proj 1.13	James W. Winchester	ONR
Program 2	Gordan C. Facer, CDR, USN	FC, AFSWP
	John A. Chiment, Maj, USA	FC, AFSWP
Proj 2.1	Michael M. Bigger	NRDL
Proj 2.2	Michael M. Bigger	NRDL
Proj 2.3	Evan C. Evans, III	NRDL
Proj 2.4	John W. Kinch	CWL
Proj 2.6	Thomas D. Hanscome	NRL
Proj 2.7	Paul A. Caldwell	NRL
Proj 2.8a & b	Richard R. Soule	NRDL
Program 3	John F. Clarke, LCDR, USN	FC, AFSWP
	Charles W. Gulick, Jr., LT, USN	FC, AFSWP
Proj 3.2	Gifford H. Albright, LTJG, USN	NCERL
Proj 3.3	Harry L. Rich	DTMB
Proj 3.4	Edward H. Bultmann, Capt, USAF	AFSWC
Proj 3.7	William J. Flathau	CCE
Proj 3.8	James J. Kearns	BUSHIPS
Program 5	Frank E. O'Brien, LtCol, USAF	FC, AFSWP
Proj 5.1	William R. Lounsberry, Capt, USAF	WADC
Proj 5.2	Paul A. Anderson, LCDR, USN	BUAER
Proj 5.3	Morris A. Esmiol, Jr., LCDR, USN	BUAER
Proj 5.4	Frank E. O'Brien, LtCol, USAF	FC, AFSWP
Program 6	Edward G. Halligan, LtCol, USA	FC, AFSWP
	Severino Martinez, LtCol, USA	FC, AFSWP

Proj 6.3	Edward E. Conrad	DOFL
Proj 6.4	Felix J. Lavicka	USASIGRDLAB
Proj 6.5	Gerald Carp	USASIGRDLAB
Proj 6.6	Cecil W. Bastian	USASIGRDLAB
Proj 6.7	Glenn M. Davidson	NOL
Proj 6.8	Robert E. Lee, LCDR, USN	MDL
Proj 6.9	Burton D. Jones, 1st Lt, USA	USASIGRDLAB
Proj 6.10	George J. Gassmann	AFCRC
Proj 6.11	Lambert Dolphin	SRI
Proj 6.12	Gerald Carp	USASIGRDLAB
Proj 6.13	Berne L. Lynn	MIT, Lincoln Lab
Program 8	William C. Linton, Jr., Maj, USA	FC, AFSWP
Proj 8.1	Willard L. Derkson	NML
Proj 8.2	Richard M. Brubaker, Maj, USAF	AFCRC
Proj 8.3	Lewis Fussell, Jr.	EG&G
Proj 8.4	William B. Plum	NRDL
Proj 8.5	Ralph Zirkin	BUAER
Proj 8.6	Charles J. Cosenza	WADC
Program 9	William M. Sheaham, LtCol, USA	FC, AFSWP
	William S. Isengard, Maj, USAF	FC, AFSWP
Proj 9.1d	Russell E. Loftman	ONR
Proj 9.2a,b,c	Arlo E. Gilpatrick, Maj, USAF	AFCRC
Proj 9.3a,b	George P. Elliott, LtCol, USA	ABMA
TU-4, Sandia Programs	Carroll B. McCampbell, Jr.	SC
Deputy Commanders	George P. Stobie	SC
	Clarence E. Ingersoll	SC
Scientific Advisor	Melvin L. Merritt	SC
Administrative Support		
A-1,3,4	Clifford A. Blossom	SC
A-6	Hugh R. MacDougall	SC
Photo	Henry G. Sweeney	SC
Program 32	Morgan L. Kramm	SC
	Charles G. Scott	SC
Scientific Advisor	Thomas B. Cook, Jr.	SC
Proj 32.1	Richard L. Eno	SC
Proj 32.2	John A. Beyeler	SC
Proj 32.3	James L. Dossey	SC
Proj 32.4	Charles G. Scott	SC
Proj 32.5	David E. Henry	SC
Scientific Advisor	John R. Banister	SC
Proj 32.6	Vincent G. Redmond	SC
	Theodore P. Krein	SC
Scientific Advisor	Harold R. Vaughn	SC
Program 34	Hans E. Hansen	SC
	A. Dean Thornbrough	SC
Scientific Advisor	Maynard Cowan, Jr.	SC
Rad-Safe Support	Harold L. Rarrick	SC
Proj 34.1	Robert G. Scharrer	SC
Proj 34.2	Tom H. Takahashi	SC
Proj 34.3	Ira D. Hamilton	SC
Proj 34.4	Robert A. Jeffrey	SC
Proj 34.5	Edwin L. Jenkins	SC
Proj 34.6	Walter A. Maupin	SC
	Robert A. Tockey	SC

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Proj 34.8	Raymond E. Butler	SC
Proj 34.9	Henry G. Sweeney	SC
Proj 34.10	Deacon G. Palmer	SC
Program 40	Allyn H. Seymour	AEC DBM
Proj 40	Lauren R. Donaldson	UWAFL
TU-5, EG&G Programs	Herbert E. Grier	EG&G
Deputy Commander	Lew Fussell, Jr.	EG&G
	Francis I. Strabala	EG&G
Technical Admin-Bikini	Donald F. McClellan	EG&G
	Roderick G. Morrison	EG&G
	Ralph L. Cadwallader	EG&G
Timing & Firing	Michael F. Warchol	EG&G
Radar & Weather	Ernest F. Wilson	EG&G
Photo	Frederick E. Barstow	EG&G
Photo Processing	Charles W. Wyckoff	EG&G
Alpha	Robert B. Patten	EG&G
	William R. Poe	EG&G
Communications	Joseph B. Shrock	EG&G
	F. Glenn Wilhelm	EG&G
Analysis	Daniel F. Seacord	EG&G
	Bruce M. Carder	EG&G
	Donald J. Barnes	EG&G
Construction Admin	Erick R. Spiess	EG&G
	Jess C. Cauble	EG&G
Office & Security Admin	M. Boyd Carpenter	EG&G
	Frank E. James	EG&G
	Edward J. Finn	EG&G
	Edward K. Raschke	EG&G
TU-6, Rad-Safe	Gordon L. Jacks, Maj, USA	LASL
Deputy, Eniwetok	Fred E. Rosell, Maj, USA	1st RSSU
	Rudolph S. Ruddee, Capt, USA	CMLC
Deputy, Bikini	Robert L. Harvey, LCDR, USN	LASL
	Ralph N. Whistler, Lt, USN	LASL
Instrument Repair	Robert D. Higgins, 2Lt, USA	1st RSSU
Photo Dosimetry	George Zimmerman, SFC, USA	LASL

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TU-3 QUINCE, ADDENDUM

Unit or Section	Name	Organization
TU-3 Forward	Corwen G. Mendenhall, Capt, USN	FC AFSWP
Operations	Robert L. Dickenson, LtCol, USA	FC AFSWP
Program 1, 8 and 9	William S. Isengard, Maj, USAF	FC AFSWP
Program 2 and 10	William B. Sheehan, Capt, USA	HQ AFSWP
Requirements	John E. Thomas Jr, Capt, USA	FC AFSWP
Administration	George R. Osbourn, CWO, USA	FC AFSWP
Project 1.7	Daniel P. Lefevre	APG
Project 2.4	David L. Regotti	CWLACC
Project 2.9, 2.10	Manfred Morgenthaw	CWLACC
Project 2.11	David L. Regotti	GM Inc
Project 6.3	Bruce E. Lackey	DOFL
Project 8.4C	Norman Alveres	USNRDL
Project 8.7	Jerry J. Mahoney	CWLACC

TU-3 JOHNSTON ADDENDUM

Unit or Section	Name
Commander	K. D. Coleman, Col, USAF
Deputy	H. Black, LtCol, USA
Operations	R. M. Elliot, LtCol, USMC
Program A	J. L. Delaware, LCDR, USN
Project 1.7	J. J. Meszaros
Project 2.6	T. D. Hanscome
Project 5.4	R. E. Geopfert, Maj, USAF
Project 8.6	C. J. Cosenza
Project 9.1D	R. E. Loftman
Program B	E. G. Halligan, LtCol, USA
Project 4.1	J. E. Pickering, Col, USAF
Project 6.5	T. Viars
Project 6.6	C. W. Bastian
Project 6.11	L. T. Dolphin
Project 6.12	S. E. Bania
Project 8.1	H. Korbel
Program C	Jack James, LtCol, USAF
Project 6.13	V. L. Lynn
Project 6.10	Dr G. J. Gassman
Project 8.2	R. M. Brubaker, Maj, USAF
Project 8.3	J. H. Knight
Project 8.4	E. C. Y. Inn
Project 8.5	R. Zirkind
Program 9.3A	R. Ray, Maj, USA
	G. P. Elliot, LtCol, USA

TABLE 3.2

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TABLE 3.4 CON[redacted]

MAJOR ITEMS OF SUPPORT

Type of Aircraft, Ship, or Surface Craft	Recommended by CTG 7.1 Oct. 1956	Recommended by CJTF 7 Feb. 1957	On Hand During HARDTACK	Purpose and Remarks
DD	?	4	4	Security patrol, weather observations, recovery operations
DER	-	?	1	Security patrol, weather observations, recovery operations
DE	?	1	1	Program 40
ATF	4	5	5	General towing and mooring
ATF	?	1 AR	1	Support for underwater shot programs
ARS	?	1	2	Support for underwater shot programs
ASR	?	?	1	Support for underwater shot programs
APD	1	0	0	Personnel and cargo transport; telemetering station
SERVICE AND HARBOR CRAFT, LANDING CRAFT, AND BOATS				
AFDL	-	1	2	Support 7.5 marine operations
YT B	1	2	2	Target array mooring, TG 7.3
YTL	-	2	2	TG 7.5 port operations, Eniwetok
YFNB	-	1	1	Support 7.3 boat pool
YCV	2	2	2	Helicopter landing barges
YC	?	?	6	TG 7.5 - 3 helicopter barges, 1 cargo barge, 1 fuel barge, 1 unassigned
YC	-	?	2	TG 7.5 - 1 dredge, 1 unassigned
YOS	-	1 YOG	1	Fueling smaller units at Eniwetok
LCU	8	10	4	TG 7.5 houseboats for TG 7.1 scientific projects
LCU	9	23	23	TG 7.5 boat pool, 7.1 recommendation based only on 7.1 needs
LCU	5	4	3	TG 7.3 boat pools
LCM	29	31	28	TG 7.5 boat pools, 2 LCM on loan from Army for trial purposes. Excellent fast support for Arming party
LCM	19	21	19	TG 7.3 boat pools
LCM	?	12	12	Target array support, TG 7.3
Water Taxis	3		3	TG 7.5 boat pool, Eniwetok; arming party support
DUKW	45	50	46	TG 7.5 boat pools
LCPL	-	6	4	1 CJTF 7 barge, 1 CTG 7.3 barge, 2 SOPA Bikini

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TABLE 3.4

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MAJOR ITEMS OF SUPPORT

This material contains information affecting the n[illegible] of the [illegible] States within the m[illegible] Title 13, U.[illegible] transmission o[illegible] in any manner to [illegible] is prohibited [illegible]

Type of Aircraft Ship, or Surface Craft	Recommended by CTG 7.1 Oct. 1956	Recommended by CJTF 7 Feb. 1957	On Hand During HARDTACK	Purpose and Remarks
	SAMPLING, EFFECTS, AND SCIENTIFIC PROGRAM AIRCRAFT			
B-57B (AF)	9+1 B-57C	10	10	Sampling - Programs 11 & 21; project 2.8
B-57D (AF)	2	6	6	Sampling - Programs 11 & 21; project 2.8
B-52 (AF)	?	1	1	Effects - Project 5.1
A4D1 (Navy)	?	1	2	Effects - Project 5.2
FJ-4 (Navy)	?	1	2	Effects - Project 5.3
C-54 (AF)	?	3	3	Program photography
RB-36 (AF)	?	2	2	Technical photography, Project 8.4
C-97 (AF)	?	?	1	Project 6.10
P2V-5F (Navy)	?	?	1	Project 8.5
RB-50E (AF)	?	?	2	Wahoo and Umbrella photography and land crater mapping
B-47 (AF)	?	?	3	Indirect Bomb Damage Assessment (based on Guam)
		SUPPORT AIRCRAFT		
H-19 (AF) helicopters	12		6	Eniwetok inter-island airlift - also Bikini until arrival of USMC helicopters
H-21 (AF) helicopters		10	9	Eniwetok inter-island airlift
HRS-3 (USMC) helicopters	20	15	15	Bikini inter-island airlift
L-20 (AF)	12	8	8	Inter-island airlift - 5 Eniwetok, 3 Bikini
C-54 (AF)	5 C-131A	2+1 C-123	5	Inter-atoll airlift
WB-50 (AF)	-	10	10	Weather reconnaissance (Special sampling Project 2.8)
SA-16 (AF)	7	7	7	Search and rescue; off-atoll support
UF-1 (Navy)	-	8	7	Augment SA-16 service; proficiency flying
L-19 (AF)	-	2 L-21	3	VIP and proficiency flying for General Officers
P2V-5F (Navy)	-	16	16	Air surveillance, danger area
	SCIENTIFIC PROGRAM SHIPS AND SURFACE CRAFT			
LST #511 & 2 YAG	1	0	0	Recommended BU Ships leave instrumented after Redwing for possible Hardtack use. Not used

[redacted]ENTIAL

TABLE 3.4 [redacted]

MAJOR ITEMS OF SUPPORT

Type of Aircraft Ship, or Surface Craft	Recommended by CTG 7.1 Oct. 1956	Recommended by CJTF 7 Feb. 1957	On Hand During HARDTACK	Purpose and Remarks
DD	?	?	3	#474, 592, 593. Target array, instrumented, not manned.
EC	?	?	1	#2, SS Michael Moran. Target array, instrumented, not manned
SSK	?	?	1	#3, USS Bonita. Target array, instrumented and manned.
SQUAW	?	?	1	#29. Target array, instrumented, not manned
YFNB	2	2	1	#12. Target array, instrumented, not manned
YC	?	18	8	Target array, instrumented, not manned
BC	?	?	23	Shot barges (22 actually used)
BC	1	1	1	Rad-Safe barge
LCU hulls	?	?	10	6 shot barges; 3 project 6.8; 1 photo barge
LCM hulls	?	?	2	Zero site instrumentation, Wahoo and Umbrella
		SUPPORT SHIPS		
CVS (USS BOXER #21)	1 CVA	1 CVHA	1	Afloat command post for CJTF 7, CTG 7.3 and 7.4; command and firing post for CTG 7.1; launcher for Yucca balloon; helicopter base
AGC	-	1	0	Command ship CJTF 7 and CTG 7.1. Functions combined on Boxer when it was decided not to provide continuing afloat capability at Bikini
AV	0	1	0	Command and firing ship CTG 7.1. Functions combined on Boxer when it was decided not to provide continuing afloat capability at Bikini
TAP (USNS Ainsworth)	1	1	1	Housing afloat at Bikini; CTG 7.5 afloat Command Post
APA (USS Renville, #227)	-	1	1	Emergency evacuation Eniwetok; housing for 7.3 personnel working on target array
LSD	1	2	2	Inter-atoll shot barge and other movements; support for underwater shots, Bikini boat pool, off atoll. Ships rotated to provide 2 in EPG at all times
LST	3	3	3	Inter-atoll and off atoll support
L T 887	?	?	1	Support project 6.7, mine clearance
LSM	?	?	1	ALOTO #444. Inter-atoll cargo service. On long time loan to AEC (H&N)

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TABLE 3.4

MAJOR ITEMS OF SUPPORT

Type of Aircraft, Ship, or Surface Craft	Recommended By CTG 7.1 Oct. 1956	Recommended by CJTF 7 Feb. 1957	On Hand During HARDTACK	Purpose and Remarks
LCPR	-	2	2	TG 7.3 boat pool
40' utility launches	-	?	2	TG 7.3 boat pool

? = requirement not known at the time

\- = requirement of indirect or no interest to TG 7.1 at the time

[redacted]

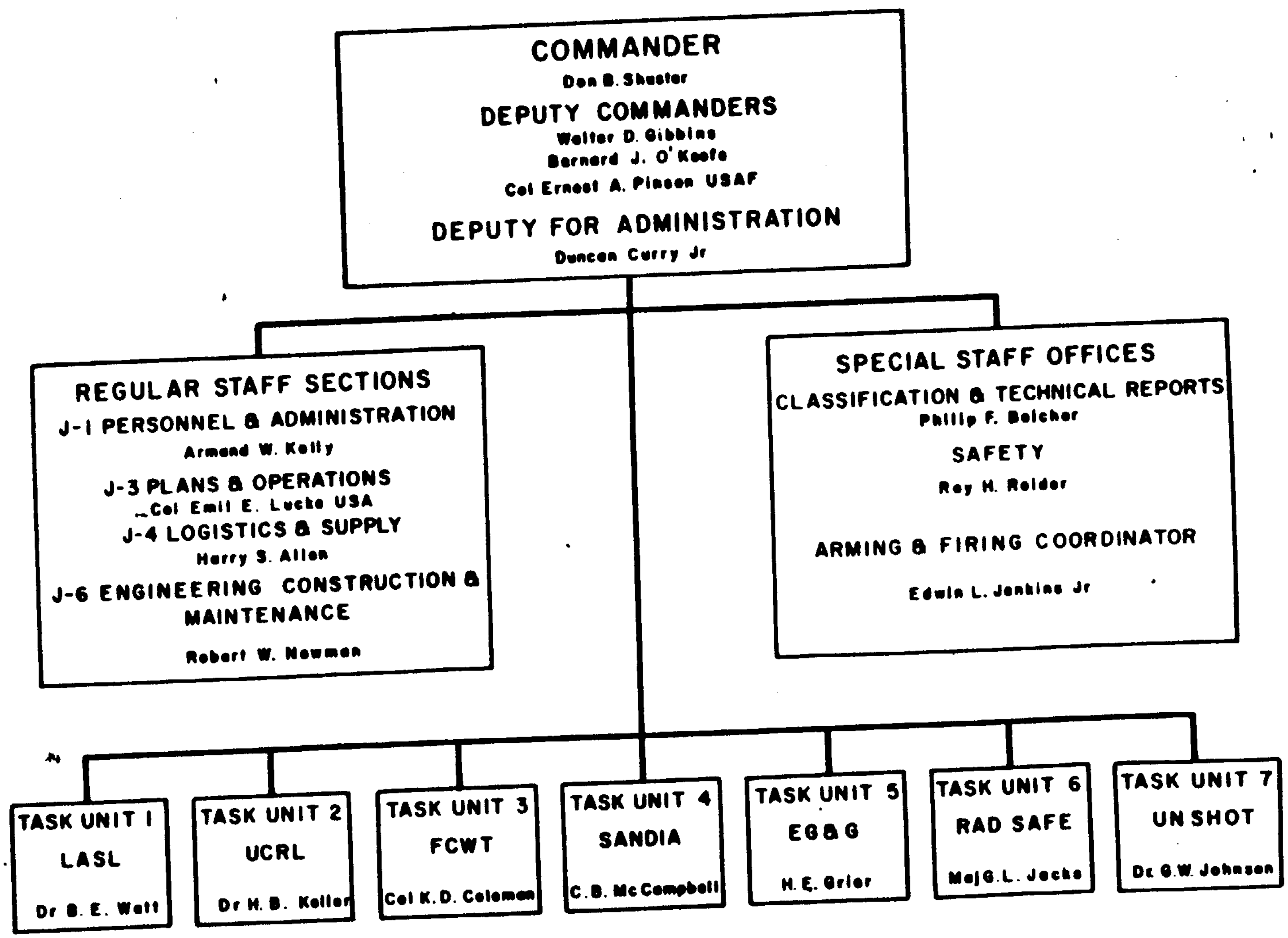

Fig. 3.1 Organization Chart – Task Group 7.1

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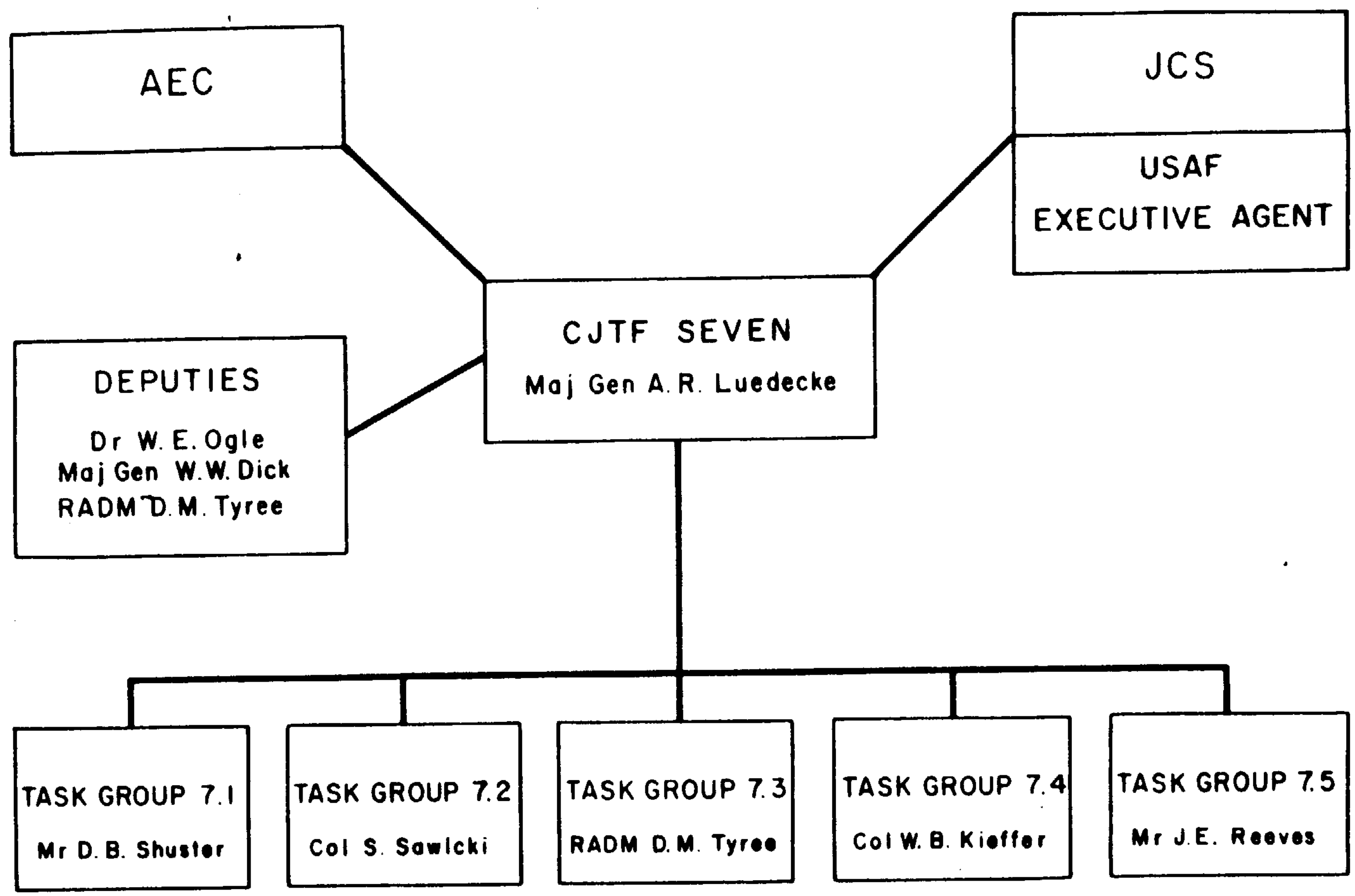

Fig. 3.2 Organization Chart – Joint Task Force 7

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3.4 MOVEMENT TO THE FORWARD AREA

3.4.1 Personnel

The major portion of administration and coordination for orderly movement, by individual, from the numerous duty stations and places of employment to the EPS was accomplished by the Adjutant General's Section and the Liaison Officers at Travis and Hickam Air Force Bases.

All military and Department of Defense civilian personnel (except DOD contract civilians) were moved commercially to Travis Air Force Base, and by Military Air Transport Service from Travis through Hickam to Eniwetok. Exceptions to this were the movement of a few of these individuals by Military Sea Transport vessels, and the authorization for use of commercial air to Hawaii by Naval Research Laboratory DOD civilians. All AEC and DOD contract civilians normally travelled commercially to Hawaii and entered the MATS or MSTS system at that point.

During Operation HARDTACK, a portion of the travel order issuing responsibility was separated from the Adjutant General at the Headquarters, Task Group 7.1, and delegated to Assistant Adjutants at the University of California Radiation Laboratory (TU-2), and the Weapons Effects Test Division, Sandia Base (TU-3). These assistant adjutants were responsible for writing orders and making the necessary arrangements for the movement overseas of the personnel of these two major Task Units. This decreased considerably the work load at the Headquarters. There, the adjutant General continued the order-issuing support of Task Units 1,4,5,6 and the Headquarters.

The number of travel orders issued during the operation is as follows:

Issuing Office	Number
Adjutant General Headquarters Task Group 7.1 Los Alamos, N. M.	543
Adjutant General Task Unit 2 (UCRL, Livermore, Cal.)	230
Adjutant General Task Unit 3 (WETD, Sandia Base)	542
Adjutant Generals Forward Areas (APOs 105 and 437)	190
Total travel orders issued	1,505 (covering 2665 individuals)

A new system for MATS "reservations" was initiated during HARDTACK which greatly simplified the flow of personnel through the ports of embarkation (Travis and Hickam) and decreased the lost-time element experienced during past operations. Individual reservations were made by telephone to the Liaison Officer at Travis--or by wire message to the Liaison Officer at Hickam--and each individual was given the reporting time and departure schedule with his travel order brochure.

The Task Group 7.1 Administrative Plan No. 1-57 was published on November 1, 1957, and its subsequent distribution to all AEC, Contractor, and DOD agencies who were to participate in HARDTACK provided the necessary administrative procedures required of the individual and the organization for movement into the Forward Area. In addition, a pamphlet titled "Instructions and Information for Personnel Departing for the EPG" was published and attached to each set of travel orders.

Several of the individual participating agencies also published instructions which covered their own institutional procedures.

Organizationally, the participating units, in compliance with procedures outlined in the Administrative Plan, submitted for each individual a "Request for Civilian Travel Orders," or a "Request for Overseas Travel Orders," a "Badge Request Form," an "Identification Card Request Form," and a certificate of personnel clearance under the provisions of CinCPac Serial 020. The complete packet of orders and allied papers were published by the cognizant adjutant and returned to the individual or agency.

All arrivals at Eniwetok Atoll (Eniwetok Island for air passengers, individual ships for surface passengers) were met by J-1 representatives. Security badges, liquor ration cards, and radiological safety film badges were issued at those points, and contraband certificates were signed.

Efficiency of the Task Group 7.1 Port of Embarkation operation at Eniwetok Island was greatly improved during HARDTACK. Incoming passengers were processed expeditiously and were on site within Eniwetok Atoll, enroute to Bikini, or billeted overnight, if necessary, for further transportation to Bikini Atoll, within two hours. This one element of the operation, previously marred by lengthy, repetitious security briefings and baggage checks for contraband, considerably eased inter-Task Group relations after the exhausting ~~MATS flight~~.

trip from the [illegible]

3.4.2 Equipment

The movement of the Scientific Task Group equipment from CONUS was accomplished through the facilities of MSTS, the U. S. Navy, and MATS.

As the monthly progress reports were received, the shipping requirements were projected and submitted to the Task Force. Projects were kept advised when ships would be on berth at Oakland, enabling the project people to move their equipment to the port in time to meet sailing dates with a minimum waiting period. The J-4 Liaison Officer at Oakland kept the J-4 Office informed regarding the receipt and movement of cargo at the port.

Equipment began arriving at the Naval Supply Center Oakland in November 1957. Approximately 19,416 measurement tons of cargo were moved to the Pacific Proving Grounds by MSTS vessels. All cargo vessels were both discharged and loaded at the deep water pier at Parry Island. Cargo was lifted on reefers, regular cargo vessels and in one instance a commercial cargo ship. Three trips were made by the Brostrom, a C-4 type cargo ship which is ideally suited for the type of cargo that Task Group 7.1 ships, which consists primarily of large scientific trailer vans. The Brostrom arrived in the PPG as follows: 23 January, 25 February, and 2 April 1958. Over one hundred and seventy heavy lifts were made to the Proving Grounds, of which there were 117 vans of over 2,000 cubic feet each. In addition there were approximately 46 smaller trailers and truck vans that did not meet the 2,000 cubic feet criteria of a large van. The peak of water shipments was during the months of February and March 1958.

WATER SHIPMENTS - ZI TO PPG

	VANS		GENERAL CARGO
Month	Number	M/T	M/T
November	0	0	80
December	2	2	366
January	38	2,273	945
February	72	4,809	2,578
March	49	4,427	2,280
April	1	62	83
May	0	0	60
June	1	94	66
July	0	0	176
	163	11,819	6,634

In addition to trailers lifted to the PPG by MSTS vessels, there were two vans and eleven helium tube bank trailers lifted to the PPG on the USS Boxer in February 1958.

Newsreel: Water lift

In order to support the "Newsreel" phase of "Hardtack," the bulk of the equipment involved was shipped from the PPG to Johnston Island by means of LST and LSD, as facilities for unloading heavy lifts from regular cargo ships do not exist at Johnston Island.

WATER SHIPMENTS - PPG TO JOHNSTON ISLAND

	VANS		GENERAL CARGO
Month	Number	M/T	M/T
May	50	3,386	2,164
June	8	533	518
July	0	0	40
TOTAL	58	3,919	2,722

In addition, equipment was shipped from the CONUS to Honolulu for trans-shipment by LST and by barge to Johnston Island as well as for use by projects at Honolulu and Maui. The total tonnage is small but is reported to complete the shipping picture.

WATER CARGO - ZI TO HONOLULU FOR JOHNSTON ISLAND

Oakland to Honolulu for Trans-shipment to Johnston 554 M/T

Oakland to Honolulu to be used at Honolulu - 85 M/T

Oakland to Honolulu for Trans-shipment to Maui - 10 M/T

Air Shipments:

Air shipments of cargo the PPG were all consigned to Eniwetok and if necessary forwarded to Bikini on the C-54 "Reflector" flights. Air cargo for Johnston Island was usually scheduled on MATS flights stopping there enroute from Honolulu to Eniwetok or vice versa. On 1 April a weekly C-54 flight was established between Eniwetok and Johnston. On 12 July a C-54 shuttle was established between Johnston and Hickam and operated on a as needed basis. Both of these flights carried cargo and personnel.

Following is a tabulation of MATS cargo shipments excluding weapons lifted on SAM flights:

AIR SHIPMENTS (MATS) - ZI TO PPG

January	7,963
February	41,758
March	171,772
April	135,110
May	32,975
June	43,747
July	69,120
TOTAL	502,445 pounds

AIR SHIPMENTS (MATS) - PPG TO ZI

April	21,572
May	40,316
June	52,337
July	105,550
August	38,000 (estimated)
TOTAL	257,775 pounds

AIR SHIPMENTS (MATS) -- PPG TO JOHNSTON ISLAND

May	329
June	31,995
July	17,664
TOTAL	49,988 pounds

In addition tow special MATS flights were completed between Newburgh, New York and PPG carrying 46,000 pounds of IBM equipment. This same equipment was returned from PPG to Albuquerque, New Mexico in like manner.

[redacted]

Liquid Nitrogen:

In order to supply liquid nitrogen to the scientific froups using this item, it was ascertained that it would be too expensive to rehabilitate the liquid nitrogen plant in the CMR Compound and hire trained personnel to operate it. A six thousand liter dewar trailer partially filled was shipped on the "Brostrom" to Parry. This large storage dewar was kept filled by semi-weekly shipments from Honolulu by air in 500 liter dewar trailers. 13,000 liters of liquid nitrogen were purchased by LASL from Gaspro in Honolulu for air shipment to Parry.

Liquid Hydrogen:

It was decided that it was impractical to operate the liquid hydrogen plant for the same reasons as for not operating the liquid nitrogen plant. To meet our requirement for this item one 6,000 liter dewar trailer of liquid hydrogen was shipped by water to Eniwetok just before it was needed. Re-supply of this item was not required.

3.5 MOVEMENT OF DEVICES AND COMPONENTS

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The Redstone Missiles while not experimental devices, we
of such a special nature that they are covered in this section of the report. The movement by Spcial Air Missions were scheduled as follows:

Seven C-124 SAM's from Huntsville, Alabama to Eniwetok between 4 March and 4 April 1958.

Because of Newsreel the following flights were scheduled to move the Redstone gear to Johnston Island:

DATE	ACFT	NR	PURPOSE	CHANNELLING
9-10 June	C-124	2	25-T	HUNTS-JON
12 June	C-124	2	2 Thrust Units	ENT-JON
12 June	C-124	2	2 Aft Units	ENT-JON
15 June	C-124	1	2 Warheads	ENT-BARBERS POI
20 June	C-124	1	2 Warheads	ENT-BARBERS POI
25 June	C-124	1	1 Warhead, plus 5,000#	ENT-BARBERS POI
10 July	C-124	1	1 Thrust Unit, plus 11-T	HIK-JON
11 July	C-124	1	1 Aft Unit, plus 11-T	HIK-JON
13 July	C-124	1	1 Loaded Nose Cone	BARBERS POINT - JON
2 August	C-124	1	Standby	BARBERS POINT
12 August	C-124	1	1 Thrust Unit	JON-HUNTS
13 August	C-124	1	1 Aft Unit, plus 6-T	JON-HUNTS
15 August	C-124	1	1 Nose Cone, plus T-T	HIK-HUNTS
20 August	C-124	2	25-T	JON-HUNTS
Sept.	C-124			JON-HUNTS

There were no unsolvable problems connected with the movement of the weapons or devices, and it is believed that MATS provided outstanding service in this respect when called upon to move this most sensitive cargo.

3.7 ON-SITE OPERATIONS

3.7.1 General. During Operation HARDTACK, as in Operation REDWING, Task Group 7.1 had its main base of operations on Parry Island at Eniwetok Atoll. Command and staff sections, task units, programs and projects again provided sufficient qualified personnel to man offices at both atolls, Eniwetok and Bikini, and later at Johnston Island. Each atoll maintained an independent firing capability.

This operation found LASL devices detonated at Eniwetok Atoll and UCRL devices detonated primarily at Bikini. However, some UCRL devices were detonated at Eniwetok later in the operation. This was done principally because of the more favorable firing weather at Eniwetok.

The task group staff sections moved to the EPG well in advance of the first planned ready date in order to orient new staff personnel, to become acquainted with their counterparts in the other task groups, to work out the final details of the plan of operations, and to expedite all matters of construction, transportation and services which would enable the laboratories to meet the first ready date.

In coordination with the other task groups present, standing operating procedures and schedules were drawn up for the different modes of transportation. The principal change from the original concept of transportation control was the delegation to J-1, of the staff responsibility for booking passengers on Reflector flights between Eniwetok and Bikini and to the off atoll sites.

Of all of the scheduled events for HARDTACK, the two shots, Teak and Orange, had the greatest impact on operations in the EPG. To meet advanced ready dates for the launching of the Redstone missile from Bikini Island, priorities of construction, transportation, and communications were given to this effort.

 When the decision was made to transfer these two shots to Johnston //

Island, an evaluation was made of the capabilities to support both operations with personnel and equipment from resources available in the EPG. In addition, an allout effort was directed towards the dismantling of the launch tower and other AEMA facilities on Bikini Island for shipment to Johnston Island prior to the first large UCRL shot. Prolonged bad weather delayed this first shot and the island was evacuated completely without difficulty. Johnston Island operations will be discussed in Section 3.7.8.

Experience in the evacuation of Bikini Atoll gained from previous operations was put to good use during this operation. The evacuations conducted for the atoll were all accomplished with no serious delays.

The TG 7.1 J-3 Section published Operational Letters for each shot as follows:

Prediction of Effects and Operational Planning Factors.
Ready Date and Shot Times.
Evacuation and Re-entry Check List.
Organization and Movement of the Arming Team.

In addition, many of the early events which had heavy participation by the scientific projects required operational letters outlining the scientific frequency allocation and the plan for the movement and positioning of the device from the weapons compound to the zero site area.

It was originally intended that the calculations for blast and thermal effects would be performed by a staff section of JTF SEVEN (FOPU). However, the Fallout Prediction Unit of JTF SEVEN did not arrive in the area until approximately 10 April and became operational several days after that date. In view of the early planned ready dates for some of the shots it was necessary that computations be performed for Teak, Orange, and other planned early events. These computations were performed by the J-3 Section. After FOPU became operational, assistance in determining blast and thermal data for several shots was provided the J-3 Section but for the most part it was a case of verification of the compilation of predictions. In future 120 operations it would be well to clearly define who or what agency is responsible for the calculating of predictions. ~~It~~ IF it is to be the J-3 Section, assurance must be had that a qualified atomic weapons staff officer be included in the section.

Operations at Johnston Island took on a very different complexion from those at Eniwetok, and Bikini in particular, ~~as~~ a result of a drastic change in command relationships. ~~From the~~ task group and project level, NEWSREEL appeared to be more of a military operation than the usual scientific endeavor. This was caused by a decision to go "austere", the confined area of operations including an emergency air base, and the assumption by the Task Force staff of many of the details of operations which had formerly been handled at task unit or project and never higher than task group level. Additional problems came about early in the operational phase by a division of the final planning effort-part being done at Eniwetok while the major part was being undertaken at Johnston. Once the entire Task Force closed in, this problem ceased and important decisions became more readily available.

[redacted]

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 the J-6 section. Conflicts were resolved, locations assigned, completion date established, and our total requirement 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 machine shop for the convenience of the experimenters; and assigned tent, trailer, and laboratory space as required.

J-6 was basically composed of seven men augmented locally by 4 men from TU-1, 6 from TU-2, 6 from TU-3, 4 from TU-4, and 3 from TU-5. At times, personnel from the Task Units have been designated to officially represent J-6 at Bikini, Johnston Island and Hawaii.

From February 1958 until the close of the operation, J-6 personnel from Task Units 1, 2 and 3 were present at every camp site and zero area continuously. On islands other than Elmer or Nan, the J-6 representatives frequently assisted other agencies in accomplishing the overall mission of the Task Group.

During the summer and fall of 1957 the basic pattern of operations was established and some firm criteria furnished to the AEC. Unfortunately, the AEC did not receive its '58 budget money until late October. As a consequence much Permanent Accountable construction was delayed until it interferred with some of the scientific construction. However, most of the scientific requirements were submitted late also. Construction lagged considerably behind planned dates, this being mainly the effect of non-delivery to jobsite of necessary materials. The final result of the late money, the late criteria and the late construction was that, again, experimenters were squeezed for time for preparation of their stations. The initial shots, however, were delayed only briefly by the construction delays.

The construction required by revisions to the firing schedule, starting with the Teak and Orange move and ending with the Quince move, were handled entirely in the field. Its accomplishment was made possible by the initial overstocking of equipment for shot barges and "T" boat hulls and by the extreme cooperation of the contractor's construction forces. On April 1st the contractor estimated that to move Teak and Orange and supporting experimentation to Johnston Island would require over six months. Three months later, on July 7, all Johnston Island construction had been completed. After the operation was well under way 12 new shots, including 5 BC type barges, 5 "T" boat hulls (one a pirex type) and Fig and Quince ground shots were added to the schedule; construction on each of these was accomplished within the time set at the beginning of its construction.

The work order system in effect during HARDTACK makes it impossible to estimate the number of work orders and specific tasks laid upon the contractors. The operation required the construction and support of a total of 1155 stations. Nearly 5500 man-hours of machinist time were expended in the J-6 shop in support of the TG mission.

[redacted]

3.7.3 Intra-Atoll Airlift. In accordance with CJTF SEVEN Operation Plan, CTG 7.3 and CTG 7.4 provided aircraft for inter-island airlift of personnel and cargo as follows:

	CTG 7.4 ENIWETOK ATOLL		CTG 7.3 (HMR 361) BIKINI ATOLL
H-19	6		15
H-21	9		
L-20 Liaison	6	3	~~3 (CTG 7.4)~~

Initially, J-3 was to control personnel movements and J-4 to control cargo, but it soon developed that J-3 was able to control both since the priority cargo was ordinarily associated with an urgent operation which required concurrent movement of personnel.

The following summary of support aircraft performance records gives a realistic picture of the scale of inter-island airlift operations during the construction, operational and roll-up periods:

Support Aircraft Performance Records

ENIWETOK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
H-19 & H-21 Helicopters								
Missions				391	707	569	399	
Flying Hours	398	478	~~579~~	735	900	685	475	
Passengers	1833	1864	~~3934~~	~~5658~~ 6117	6746	5583	3686	
Cargo (lbs)	11968	19750	~~86200~~	52400	74600	53350	28100	
% in Commission			68	73	70	77.1	70.1	
L-20 Aircraft								
Missions	245	549	772	854	1140	837	419	
Flying Hours	175	260	435	301	415	295	143	
Passengers	1409	1832	2513	1661	2851	2089	625	
Cargo (lbs)	2763	3490	~~6993~~	10736	10561	8757	5835	

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	Jan	Feb	Mar	Apr	May	Jun	Jul
% in Commission			80	65	77	88.1	65.8

BIKINI

	Jan	Feb	Mar	Apr	May	Jun	Jul
H-19 (HMR 361) Helicopters							
Missions		554	6241	3063	2015	1346	95
Passengers		2082	6507	6118	4566	2609	223
% in Commission			77.5	78.0	75.8	83.2	74.0
L-20 Aircraft							
Missions		254	546	860	862	1073	727
Flying Hours			125	180	195	231	158
Passengers		635	1222	1807	1927	2299	1587
% in Commission			93.0	85.5	90.0	82.2	65.0

Air traffic was doubled when the operational period began on 15 March. At Eniwetok it was virtually doubled again when Cactus and Koa went on site. From the first Cactus-1 on 20 April through Wahoo-2 on 18 May, transportation and operational requirements for L-20's and helicopters were at a sustained maximum. During this period Cactus, Butternut, Koa and Wahoo were detonated. The overlap of preparatory and recovery operations for these shots severely taxed the available airlift. Right at this critical time, unfortunately, Air Force technical directives on replacement of H-21 rotor blades reduced the availability of those aircraft to less than 50% of the 9 assigned. The extensive and complex recovery operations associated with the four shots required most of the available H-19 flying time. This left no backup for the routine up-island transportation schedule, except for L-20's which could operate only into Janet until Cactus was fired.

L-20's:

After an initial effort to limit the personnel who could use L-20's for transportation between Parry and Eniwetok, a regular shuttle operating between ~~0730~~ and 1630 was established. Experience proved ~~that this was~~ generally adequate to serve the legitimate requirements of TG 7.1 users. There was a minimum of abuse of this service. Later in the operation, the L-20 schedule was maintained on an "as needed" basis~~. This was~~ due to the lack of passengers for regularly scheduled ~~hourly~~ flights. ~~If a person authorized the use of a L-20 needed transportation to Eniwetok or Parry, the L-20 was set up for him in accordance with the schedule.~~

Special L-20 flights for operational missions to islands with suitable airstrips were arranged by J-3 as necessary. This supplement to the helicopter service was especially valuable during April and May (the pre-Cactus to Koa period) when the demands for transportation were heaviest. Subsequent to Koa, such flights frequently were not feasible because the up-island runways were covered with debris following the barge shots.

Special L-20 transportation for personnel of suitable military or equivalent civilian rank arriving on MATS or Reflector flights was first arranged by J-3, but it soon developed that this task was easier for the J-1 Representative on Eniwetok Island to do since he had early access to the passenger manifest.

During the operational period at Eniwetok, an average of six (6) L-20's were assigned, although loss of one in an accident in April and assignment of another to Bikini in June reduced the number available ~~at any time~~ to five (5). With a 70% in-commission rate, three (3) aircraft were normally operational with a maximum of four (4) flyable half the days of a month.

H-19's and H-21's:

Because of their greater payload capacity, H-21's were used to maintain scheduled inter-island airlift thru the entire operation at Eniwetok. The H-19's were used for special missions to islands unsuitable for H-21 landings and for photo missions because they were more stable platforms than the H-21's. The H-19 was the primary aircraft for rad-safe surveys and sample recoveries in high radiation fields because the engine position reduced the radiation hazard to the pilot to about 40% of the H-21 exposure rate.

At the start of the operational period, night flights and over-~~water~~ flights were generally arranged with no great difficulty. After the unfortunate H-19 accident in which of UCRL was killed on 7 April, there were so many restrictions placed on night and over-water flying that it practically stopped. Personal examination by CTG 7.4 of requests for such flights resulted in many delays in getting TG 7.1 requirements accepted. In ~~many~~ events, particularly Wahoo and Umbrella, the various scientific projects were hamstrung by the limitations on helicopter operations. This was relieved somewhat by use of ~~marine~~ helicopters which had fewer operational limitations.

The major problem was that arrangements made between the TG 7.1 and TG 7.4 staffs were frequently cancelled by CTG 7.4 shortly before the planned time of execution. To experimenters operating on a closely timed schedule of events, such cancellations were almost ruinous. After many discussions between J-3 of TG 7.1, CTG 7.4, and finally J-3, JTF SEVEN, TG 7.4 developed a noticably less reluctant approach toward supporting TG 7.1 requirements. This became evident during May; and, by the ~~1st~~ of June, the situation had improved to the point where staff level arrangements could again satisfy most operational requirements.

On 4 July, in a discussion ~~between the~~ J-3 ~~Section of~~ TG 7.1, ~~and Air Operations of TG 7.4~~ the term "special missions" ~~was defined. All helicopter~~ flights requiring hovering over open water, were defined as "special missions". All other flights were defined as routine, and could be handled by the HMN dispatcher at the Elmer airstrip. Special requirements ~~had to be~~ phoned into TG 7.4 Air Operations, ~~except on minus one days and shot days.~~

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~~On these days~~ TG 7.4 Air Operations had a ~~representative at the Elmer air-strip who could handle~~ special ~~requirements.~~

As a result of the provisions of Annex C, Transportation, JTF SEVEN Admin Plan 1-58, administrative and operational control of L-20 and Helicopter missions was exercised from Eniwetok Island. Booking of both transport and operational flights was done thru a TCA (Transportation Control Agent) appointed in accordance with the cited Annex. It was immediately evident that the TCA on Fred could not be responsive to the major operational requirements existing on Parry. Despite attempts by J-3 of TG 7.1 to separate the operational requirements such as recovery practice missions from the transport system, TG 7.4 insisted that control and bookings both be centralized at Eniwetok Island.

On the first minus one day (Cactus-1), it was evident in the first hour that control must be exercised from Parry. It was also evident that the aircraft must be at Parry in order to be responsive to TG 7.1's immediate and urgent requirements. Accordingly, a TG 7.4 Helicopter Operations Officer took charge of operations at Parry, and the aircraft supporting 7.1 were dispatched and controlled from Parry.

Although it had been planned to run all helicopter flights on minus ones and D-days as special missions, it became evident on the first minus one that the demand for transportation with two devices on site made this approach impractical. Accordingly, the regular schedule was re-established within two (2) hours of the start of Cactus-1 day. All subsequent minus ones ~~have had~~ maintained the normal ~~schedule~~ schedule operating. In addition, normal hourly schedules ~~have been~~ were resumed as soon as the rad-safe survey and recovery missions ~~are~~ were completed on D-day.

By the 15th of May it became obvious that two-thirds of the remaining days of the operations, as then scheduled, would be minus one or D-days.

Consequently, it was established with TG 7.4 Operations that sufficient aircraft for the day's missions under the control of a T.G. 7.4 Helicopter Operations Officer would be present at Parry on all D-days and on minus ones when the expected scale of activity made maximum flexibility in use of aircraft a necessity. It was subsequently agreed that J-3 TG 7.1 would provide TG 7.4 Operations with a daily summary of the following day's special missions.

Thus, in effect, the TCA was eliminated from the inter-island transportation system as well as from the control of operational missions. The continued location in Eniwetok Base Operations of the radio facility for control of helicopters and L-20's was acceptable, but it would seem more efficient to move the facility to Parry so that the instructions of the Helicopter Operations Officer could be transmitted directly to the aircraft instead of being relayed and delayed at Eniwetok. In addition, if the tracking of the aircraft were done at Parry, diversions of airborne aircraft to handle emergency requirements could result both in more rapid response and increased utilization of aircraft flexibility.

At Bikini Atoll aircraft assigned for intra-atoll airlift consisted of 15 H-19 helicopters of USMC Squadron HMR 361 and 3 L-20 aircraft of TG 7.4. During the Jan-Feb period before the arrival of the majority of Task Force personnel, only 7 helicopters were available at Bikini and the third L-20 aircraft was not assigned until the ~~last~~ week of ~~May~~. However, during all phases of the operation the aircraft and helicopters assigned were able to provide adequate airlift.

HMR 361 managed to maintain an average helicopter in-commission rate of approximately ~~80%~~ 75% and the L-20's maintained an average rate of 85%. These higher than average in-commission rates were in part the reason that adequate airlift was available at all times at Bikini.

Both helicopters and L-20's averaged about 2 passengers per mission.

While this appears to be a rather poor utilization of aircraft, closer examination disclosed that many missions were flown with priority passengers going one way, and the return trip, which was also considered a mission, was frequently flown without passengers. Therefore, the ~~actual~~ number of passengers on ordered or scheduled missions actually average between 3 and 4 passengers per mission.

Scheduling of TG 7.1 passengers on intra-atoll flights was initially done by J-3. However, it soon became apparent that this was an unnecessary step in the procedure and arrangements were made for all personnel to make reservations with the H&N dispatcher either directly or through their Task Units. J-3 continued to schedule all flights on minus one days and shot days in order to insure maximum utilization of aircraft and to keep track of personnel movement for muster purposes. This arrangement was satisfactory to all concerned and no problem was encountered in the scheduling of passengers at Bikini.

During the Sycamore event which required evacuation of the entire atoll, the L-20 aircraft were evacuated on an LST and were not available ~~after~~ noon ~~on~~ minus one days ~~and on all~~ subsequent minus one days. Although deprived of the use of L-20's for a week during the Sycamore event, there was no critical shortage of aircraft since sufficient helicopters were available to fill in for the L-20's. For the Poplar event, however, the L-20's were flown to a position some 20 miles south of Enyu during time of detonation. During these periods of total evacuation, the helicopters were evacuated on minus one days to the Boxer (Monticello in case of Poplar). This was done just before dark each day, at which time the need for airlift had terminated. Since the copters debarked shortly after daylight on days when the shot had been postponed, no impairment of operations was caused by evacuation of the helicopters to the Boxer.

3.7.4 Inter-Atoll Airlift

Cargo from Eniwetok to Bikini was accomplished by means of a morning and afternoon C-54 flight from Fred to Nan.

Cargo arriving at Fred via MATS marked for IJUR was segregated and booked on the C-54 "Reflector" flight, without cargo being first sent to Parry, as on previous operations. This procedure saved valuable time as well as cutting down on the wear and tear on cargo due to additional handling. This service was performed by a H&N air cargo man stationed permanently at Fred.

Air cargo for IJUR originating at Parry was documented by J-4 for movement through the H&N Shipping Section. This system worked quite well with very little time lost in movement of this type of air cargo.

Air cargo excluding weapon movements was as follows:

Cargo Airlift, Eniwetok to Bikini, Excluding Devices

February	3,170 pounds
March	40,318 pounds
April	45,536 pounds
May	30,275 pounds
June	32,283 pounds
July	8,151 pounds
TOTAL	159,733 pounds

Cargo airlifted from Bikini to Eniwetok during the entire operation amounted to 102,306 pounds.

3.7.4 Inter-Atoll Airlift

Initial planning implemented at the start of the operation was based on the Eniwetok Airlift Office (EAO)--Transportation Control Agent (TCA) concept. This concept required each Task Group to designate a TCA. The responsibility of Task Group TCA'S was to consolidate all requirements for airlift for th... respective Task Groups and forward the total requirement to the Joint Task Force Seven Air Priorities Agent (APA), who was located in the EAO. The APA consolidated the requirements of all of the TG's and made the necessary arrangements for adequate airlift support with TG 7.4.

TG 7.1 appointed two TCA's; one from J-1 to handle all passenger requirements and one from J-4 to handle cargo requirements.

During the early stage of the operation, one flight daily was made between Eniwetok and Bikini Atolls. This was later increased to three flights daily (except there was only one flight on Sunday) during the peak period of the build-up phase April 8 through May 7.

C-54 aircraft were utilized on the Eniwetok-Bikini Shuttle These aircraft replaced the twin-engine C-47 transports used in Redwing and immensely improved the shuttle service, since they could carry more passengers and were more comfortable.

Task Group 7.1 utilization of passenger airlift between Eniwetok and Bikini was as follows:

February	131	June	458
March	614	July	431
April	932	August 11, 1958	15
May	662		

Procedures used in booking passengers for Off-Atoll were the same as those used to book personnel on the Eniwetok-Bikini Shuttle. Generally, SA-16 aircraft were used in Off-Atoll flights, except that C-54's were used at locations that had air strips large enough to handle this type of aircraft. There locations were Nauru, Tarawa, Guam, and Johnston Island.

TG 7.1 utilization of Off-Atoll flights during the opera tion was as follows:

Site	Mar.	Apr.	May	June	July	Aug.
WOTHO	4	14	22		2	
KAPINGAMARANGI			5	1	2	
*NAURU		4	8			
UTERIK	7	2				
KUSAI	4	6	19		2	
RONGELAP	9	21	10		3	
*TARAWA			7			
UJELANG	4	2				
*JOHNSTON ISLAND		7	8	16	8	6
KWAJALEIN		8	3	13	5	
WAKE		3	2			
*GUAM		2	1	3	6	

*Denotes C-54 aircraft

Occasionally due to operational requirements it was necessary to set up special flights between Eniwetok and Bikini or to Off-Atoll locations. These flights were handled on an individual basis and generally did not cause any serious problems.

3.7.5 Motor Vehicle Transportation. Vehicles arrived in EPG in sufficient time for processing and issue. All requested vehicles except 35 weapons carriers were issued to Task Units by 1 Mar 58. No inconveniences or delays were experienced as vehicles were shifted between Task Units as required to perform a mission. This was made possible due to relocation of Teak and Orange events.

JTF SEVEN allocated CTG 7.1 a total of 305 vehicles in January 1958. The following tabulation indicates the type of vehicles allocated and a breakdown by individual Task Units as to their location on 1 June 1958: (See Table 3.7.5)

Maintenance of TG 7.1 vehicles was in accordance with a maintenance agreement executed on 11 June 1958 between TG 7.2 and TG 7.5. This agreement did not outline in sufficient detail the responsibilities of TG 7.5. The term "organizational maintenance" was not clear to TG 7.5 and should have been spelled out in detail. This resulted in vehicles being scheduled thru TG 7.5 shops every two weeks for what amounted to a lubrication job. No system was employed at this time.

Vehicles on various islands of Bikini and Eniwetok were maintained in similar manner by portable units. Temporary camp sites were in existence at Yvonne and Janet at Eniwetok Atoll, and Oboe and How at Bikini Atoll.

Some problems in the maintenance of vehicles developed when it became difficult to get project personnel to bring vehicles to the maintenance facilities as requested. A tighter control of vehicles should be exercised in order to get the maximum utilization out of all vehicles.

A program of turn-in of vehicles to TG 7.2 was started on 11 June 1958. Vehicles were turned into TG 7.2 and then processed by TG 7.5 in accordance with instructions published by TG 7.2. As of 20 June, 35 vehicles had been returned to TG 7.2 and 30 vehicles had been shipped to Johnston Island for -

Operation NEWSREEL.

Because of limited space on Johnston Island the number of vehicles assigned to the Task Group was reduced to eight (8) from an initial request of forty seven (47). The difference was made up by having the projects draw daily on a first come first serve basis a vehicle on a U-drive-it system from the Task Group 7.5 Central Motor Pool. A bus line using two twelve passenger "Toonerville" units circled the small island on a fifteen round trip schedule.

As the build-up increased the inadequacy of this transportation system became more apparent. A request for more bus service was disapproved because of the inability to get full utilization at all hours of the day of the vehicles that were dispatched from the pool. The problem was finally overcome by having H&N hire additional drivers to operate a taxi system.

A somewhat similar problem occured at Hickam Air Force Base when vehicles promised to the TG 7.1 projects were not provided. That problem was solved by task units renting cars from a Hertz system.

Although the Johnston Island phase of the operation was successfully accomplished with ~~the~~ reduced number of vehicles, the administrative attention required as well as frustrations and harassments ~~of~~ both staff and technical personnel seemed to outweigh any of the hoped for advantages.

[redacted]

Table 3.7.5

VEHICLE BREAKDOWN BY LOCATION

JUNE 1958

CJTF 2 ALLO	VEHICLE TYPE	TU-1 E	TU-1 B	TU-2 E	TU-2 B	TU-3 E	TU-3 B	TU-4 E	TU-4 B	TU-5 E	TU-5 B	TU-6 E	TU-6 B	STAFF E	STAFF B	POOL E	POOL B	TOTAL E	TOTAL B
145	*1/4 T Jeep	22	1	4	31	27	3	6	4	10	6	-	-	12	7	~~4~~ 10	2	~~90~~ 91	54*
53	*1/2 T Pickup	7	-	~~5~~ 4	8	~~5~~ 6	-	-	1	3	3	3	3	4	1	6	4	~~31~~ 33	20*
70	3/4 T Weapons Carriers	8	-	3	9	22	2	4	3	6	1	-	-	-	1	11	-	54	16
4	*1 1/2 T Truck	-	-	-	-	-	-	-	-	-	-	-	-	2	-	~~-~~ 1	1	~~2~~ 3	1*
17	*2 1/2 T Truck (6X6)	-	-	-	-	~~2~~ -	-	-	-	-	-	~~1~~ -	-	2	-	~~3~~ 11	4	~~8~~ 13	4*
3	5 T Tractor	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	2	1
6	500 Gal Water Trailer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	5	1
3	1/2 T Trailer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-
4	2 1/2 T Decon Trucks	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	2	2
105	TOTAL													TOTAL				~~197~~ 206	99

Note - * Discrepancy

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3.7.6 Intra-Atoll Boat Service. An outstanding job of supporting Operation HARDTACK by surface craft was performed by TG 7.5. Throughout the entire period they satisfied requirements as they arose. During the early part of the operation regularly scheduled boat runs were made to up-island sites at both atolls. Later, as the need for up-island traffic diminished, the trips were made on an as-needed basis. J-3 TG 7.1 controlled all boat trips made by TG 7.5 boats. All trips were dispatched by the H&N Marine Dispatcher, with requirements made through the J-3 TG 7.1. This system greatly facilitated control, and expditious use of the boats.

During Wahoo and Umbrella events the TG 7.5 boats were augmented by use of the TG 7.3 Boat Pool Detachment which made shceduled runs to the target arrays.

Regularly scheduled water taxi service between Parry and Eniwetok was maintained throughout the operation. Water taxis were also very effectively used by the Arming Team in many instances for after dark movement to the zero sites.

As of 1 July, TG 7.5 boats were assigned as follows:

ENIWETOK		BIKINI
16 - LCM	9 - LCU	12 - LCM
12 - DUKW	3 - Houseboats (LCU)	12 - DUKW
3 - Water Taxis	2 - YTL (Tugs)	8 - LCU
1 - LCM Pusher		1 - Houseboat

Houseboats were LCU's that were especially configured to supply messing and sleeping facilities for arming team members and other project personnel who were working at or in the vicinity of the barge zero sites. Having such facilities immediately available at the zero site often expedited work that had to be done on a crash basis. Continued use of these boats in 137

[redacted]

future operations is strongly recommended.

Water taxis were again available at Eniwetok Atoll. This greatly eased the up-island travel problem, particularly when the temporary camps at Yvonne and Janet were in operation. The Arming and Firing Coordinator made good use of the water taxis by utilizing them for transportation to the zero sites in the event of marginal weather. He would wait until the 2200 weather briefing, and then proceed to the zero site if the shot was still scheduled.

The complete cooperation afforded TG 7.1 by the TG 7.5 Marine Department insured that there never were any problems in obtaining boat service. There were few days when all boats were not in operation.

Especially good use was made of the MK-8 LCM in cases of quick movement or evacuation. More use of this type craft (it is larger and faster) is definitely recommended for future operations.

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3.7.7 <u>Inter-Atoll Surface Lift.</u> As in the last operation, surface lift between the two atolls was accomplished by two MSTS LST's. In addition, the M.V. ALOTO was under the operational control of the TG 7.5 Supply Department. Cargo for TG 7.1 to be shipped between the two atolls was turned over to J-4 who paked it and made the necessary arrangements with TG 7.5.

Should we J-4 report with figures!

RHK

3.7.8 Off-Atoll Operations. Although the Commanders' Report for Operation REDWING recommended that plans for off-atoll stations in future operations be finalized prior to movement to the EPG, this was still not accomplished in some instances in this operation.

Off-atoll sites were operated at Wake Island, Rongelap, Utirik, Ujelang and Wotho Atolls, and Kwajalein Island. Off-atoll sites were serviced by SA-16 aircraft and surface runs by the M.V. ALOTO.

For the NEWSREEL events there were 11 manned stations located on Johnston and Sand Islands, 10 for scientific purposes and one for support needs (firefighting crews, etc.). Outlying TG 7.1 scientific stations included a maximum of five stations afloat (USS Boxer, Belle Grove, Dehave, Cogswell until replaced by the Epperson, Lansing and the Hitchiti), 10 airborne scientific stations, plus units on top of Mount Haleakala in Maui, Wheeler Field and Lualualei in Oahu, and French Frigate Shoals.

3.7.9 Test Rockets. Extensive rocket firing tests were characteristic of the Teak and Orange operation at Johnston Island. A total of 37 firings were accomplished between 10 July and 12 August 1958. These included five types of rockets: The Nike-Cajun, Nike-Asp, Deacon-Arrow, Viper-Arrow, and the Modified/Lacrosse.

The operation at Johnston Island was basically affected by:

1. The proximity of the inhabited area to the launchers.
2. The air traffic congestion thru the Johnston Island air space.
3. The location of the Navy ship support anchorage in the firing lanes.

These features were in wide variance with the conditions that existed at Bikini Atoll.

JTF SEVEN decided that the firing conditions at Johnston Island required a central control agency for firings which had the authority to:

1. Dispatch CAA "Notices to Airmen" (NOTAMS) to air traffic influencing the complete Pacific air traffic system throughout the Hawaiian/Johnston airways system.

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2. Dispatch orders to the TG 7.3 ships requiring boat movement at designated times.

3. Request security personnel and material for zoning danger areas and maintaining them over extended periods of time.

4. Install a system of communications with count-down interconnecting firing bunkers, control tower, MP roving stations, instrumented MIDO stations, MSQ stations and others into a centralized control agency of JTF SEVEN, with the code name Alaska, all of which was not requ for the operation at Bikini.

Detailed control of the arming and firing was exercised by JTF SEV

Alaska.

Essentially, J-3, TG 7.1 published weekly schedules which were forwarded to JTF SEVEN for approval and necessary support action. This acti consisted of:

1. NOTAM safety notices.
2. Air traffic control alerts.
3. Navy boat movement from the anchorage.
4. MP stations being manned for local safety precautions.
5. Siren alert signals to the local population that a firing was abou to be conducted.

3.8 EVACUATION, RECOVERY, AND RE-ENTRY PLANNING

Planning for this aspect of the operation took place in three phases.

1. Early in 1957, the basic concepts and general plans of evacuation were determined. Based upon this, requirements for ships, boats, and aircraft were determined and requested of JTF SEVEN.

2. Later, as projects began to submit their monthly status reports, more detailed information was compiled in the J-3 Section of the Task Group. This was published early in February 1958 in an abbreviated form in the two atoll event booklets as appendixes to the Task Group Operation Plan 1-58.

3. Final detailed planning took place at the Proving Grounds when each task unit, one to two weeks before each shot, submitted its project's evacuation and re-entry cards to the J-3's on Bikini and Eniwetok Atolls. With this latest data, a detailed check list, arranged chronologically, was prepared for each shot and given wide distribution to other task groups so that adequate support could be scheduled.

Whereas evacuation and re-entry problems for HARDTACK were similar to those encountered during REDWING. Rocket sampling of the radioactive clouds added a new recovery problem. Nose cones were designed to pass through the atomic cloud and parachute to the earth. Their points of impact varied with their trajectories, so that sometimes they landed in the lagoons, but more often several miles to sea.

Two nose cone recovery tests were conducted - one at Salton Sea and the other off the Southern California coast.

The Evacuation and Re-entry Operation at Johnston Island had none of the complexities that were present at Bikini Atoll. The mission was to accomplish a simple direct evacuation and re-entry from a single camp to the ships at anchorage.

A most important problem arose; however, in determining the loading technique to be used in rough waters at the ship's anchorage. Prior to the Teak Event various methods were tried such as loading platforms and loading nets, all of which proved unsatisfactory. Finally, it was decided to build a loading cage. This railed platform was approximately 10' X 10' with a protective roof. It was capable of lifting 40 to 50 people at one time, but was limited to 35 for safety reasons. A single lifting lug was welded at the center point to receive the snatch block hook from the ship's boom. Four ropes were tied to the corners and used to steady the cage during lifting and lowering operations. On the whole, the technique worked quite satisfactorily.

The primary evacuation and re-entry vehicles were LCU's which were scheduled at various times. Helicopters (H-19's) were used to load priority personnel, late evacuees, and early re-entry personnel.

JTF SEVEN appointed an Evacuation Officer for this operation through whom the task groups coordinated their requirements. Muster lists, manned stations list, boat loading lists, helicopter lists and priority re-entry personnel lists were published as a basis for task group transportation requirements and forwarded to JTF SEVEN for coordination and necessary action. 142

The evacuation was singularly characterized by the inflexibility of the personnel movement schedule which made changes due to technical reasons very difficult to accomplish. During the re-entry phase, the lack of command control and coordination of movement of priority personnel, helicopters and ships caused abnormal delays and loss of some data.

The importance of recovery operations to the complete success of a nuclear experiment is such that all actions and movements not directly connected with data recovery must receive low priority. The need for one person with command authority to move ships, aircraft and people in the recovery operations again became apparent during the Orange Event. This individual must have complete appreciation of the type of data to be recovered and its relative importance with other similar data.

3.9 PERSONNEL EVACUATION AND MUSTER

3.9.1 Musters

On April 8, 1958, the TG 7.1 plan for the conduct of sight-musters in the EPG was published. This plan established a Task Group Muster Officer, and two Atoll Muster Officers for Eniwetok and Bikini Atolls, respectively. The plan also provided Muster Officers to represent the Headquarters, and each of the various Task Units.

Muster rosters were prepared by J-1, TG 7.1 at varying times, depending upon thenumber of changes occasioned by arrivals and departures from the EPG. During HARDTACK a new system was initiated for compiling these muster rosters. An IBM card was punched for each individual in TG 7.1 participating in the operation. When an individual arrived at the EPG, his card was placed in the active file; cards of departed personnel were held in an inactive file. The active file, which included anticipated arrivals, was used by the IBM 704 Computing Section to prepare the rosters on IBM equipment. This new method of preparing rosters saved many man hours of work previously required to type dittos and assembly rosters.

The first muster was conducted on April 11 and 12, 1958, as a Teak rehearsal, and the last one on August 18, 1958, for Fig. Musters were normally conducted on D-1 or D-Day in order to minimize the false starts. Where the shot was being detonated and the time of H-Hour determined the commencement time of the muster and the details of operation. Therefore, the following is a discussion of only the mist commonly used procedures.

a. Shots at Eniwetok and/or Bikini Atoll

1. Muster of personnel at both Eniwetok and Bikini commenced at 1800 on D-1.

2. Task Unit Muster Officers mustered all personnel of their units present in the EPG at either Eniwetok or Bikini Atolls, resolved any discrepancies in reported locations, and reported by name to the Atoll Muster Officer only those personnel of their organizations who were in the danger area (normally all islands in Eniwetok Atoll except Parry and Eniwetok Islands and all islands in Bikini Atoll except Enyu Island). In addition, Task Unit Muster Officers reported the moveme of all of their personnel who moved eithe into or out of the danger area. When all personnel of the Task Group were out of t danger area, a report of the completion o the muster was submitted to CJTF SEVEN by the TG Muster Officer.

b. Shots at Bikini Atoll Requiring Evacuation to Ship

1. Muster at both Atolls commenced at 1800 o D-1.

2. All personnel at Bikini Atoll were consid ed to be in the danger area; therfore, Ta Units reported all of their personnel at Bikini Atoll by name to the Atoll Muster Officer. This muster was conducted, and

completed, prior to evacuation and its purpose was to insure that all persons listed on the J-1 records as being at Bikini Atoll were accounted for.

3. TG 7.1 had J-1 representatives aboard the USS BOXER, USS MONTICELLO, and the USNS AINSWORTH. Each member of TG 7.1 was mustered upon boarding. When all personnel listed on the pre-evacuation muster list were aboard a ship the muster was completed and the final muster report was then submitted by the Task Group Muster Officer to CJTF SEVEN.

c. Shots at Johnston Island

1. Due to the limited ports of entry, the small land area, and the small number of TG personnel present, muster of personnel for shots at Johnston Island was a relatively simple matter and was handled separately from the muster of personnel at Eniwetok and Bikini Atolls. A muster plan for the conduct of sight-musters at Johnston Island was published July 20, 1958. This plan was very similar to the plan used in the EPG, in that it established a Task Group Muster Officer, Task Unit Muster Officers, etc.

2. A Pre-evacuation muster of personnel at Johnston was made as described in b.1 and b.2 above, except that the muster commenced

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at 0900 on D-1 and was limited to only those personnel on Johnston Island. The muster was checked against the J-1 records and any discrepancies were resolved prior to evacuation.

3. TG 7.1 had J-1 representatives aboard the USS BOXER, and when all personnel to be evacuated were aboard ship the evacuation was complete and an evacuation report was then submitted by the Task Group Muster Officer to CJTF SEVEN. A Muster Officer was also appointed for each ship other than the BOXER. This Muster Officer reported all TG 7.1 personnel aboard a specific ship by radio to the TG 7.1 Muster Officer aboard the USS BOXER.

4. Since a large number of TG personnel remained at Johnston Island in manned stations, it was necessary to appoint a Muster Officer for each of these locations. A Manned Station Muster Officer located in the Command Post was responsible for coordinating the muster of all manned stations ashore and reporting to CTG 7.1 when all TG personnel were in safe locations.

d. Postponements

In the event a shot was postponed after the muster was completed, an attempt was made to retain the validity of the muster if the delay was for less than 12 hours. Generally if the delay was 12 hours or more a new muster was conducted.

From the experience gained during this operation it is believed that the complete sight-muster at both atolls is no longer an operational necessity. A muster at the atoll when a shot is scheduled would be sufficient to assure safety of all personnel. If for operational reasons it is not possible to control completely acess to the danger area, then an independent muster of the atoll involved should be sufficient.

3.9.2 Evacuation

The extent of personnel evacuation at Eniwetok and Bikini Atolls depended on the magnitude of the shot. The maximum, at Eniwetok Atoll, involved withdrawal of all personnel from the upper islands to Japan, Parry, and Eniwetok, with a limited number of project personnel permitted on Aniyaanii.

At Bikini personnel were generally evacuated to Enyu Island; however, on large shots all personnel (except the arming party which was located in station 70 on Enyu Island) were evacuated aboard ship. The average evacuation time at Bikini, including readying and buttoning up instrument stations, was eight hours.

In general, afloat housing at Bikini was assigned as follows:

USS Boxer (CVS-21) - Joint Task Force SEVEN, TG 7.3, TG 7.4, and TG 7.5 commanders and staffs, TG 7.1 Command and Staff Sections, key scientific personnel, Rad-Safe team, and persons scheduled for early re-entry and recovery by helicopter. The USS Monticello (LSD-35) was substituted for the USS Boxer in July and August when the Boxer was at Johnston Island.

USNS Ainsworth (TAP-181) - J-1 and J-3 representatives, project personnel, and Holmes and Narver civilians.

Assignment of berthing space (cabin and troop) was as follows:

Name of Ship	Agency Making Berthing Assignments	When Berthing Assignments Were Made
USS Boxer	J-1 Bikini	D-3
USNS Ainsworth	Same as Above	Same as Above
Other Ships	Representative of Ship's Captain	Upon Embarkation

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[redacted]

At Johnston Island, for the Teak and Orange events, all personnel except those required in manned stations ashore, were evacuated aboard ship. The USS Boxer was the only ship used for evacuation except that there were a small number of individuals on various project ships. The evacuation procedures used were the same as those used at Bikini.

The number of personnel evacuated to ship at Bikini Atoll and Johnston Island varied with project participation. The peak number of personnel evacuated was __________ officer grade personnel and _____________ enlisted grade personnel for the TEAK event. Numbers evacuated to ship were substantially lower than would have been required if it had been necessary to operate from ship for prolonged periods. Except for the carrier, which was badly overcrowed, billeting facilities afloat were adequate. On the carrier, for TEAK and ORANGE, cots were placed on the Hanger Deck to handle the overflow of personnel when all cabin spaces were filled. Utilizing the Hanger Deck for this purpose is satisfactory for billeting personnel overnight, or for emergencies. It would not have been satisfactory if it had been necessary to operate from afloat for an extended period of time.

Task Groups 7.3 and 7.5 maintained a capability to evacuate all personnel at Eniwetok and Bikini aboard vessels in event of severe fallout or other emergency. This capability provided standing room only and would be used only to protect life and health from extraordinary hazards.

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3.10 Property Evacuation

J-4 made pre-shot surveys to ensure that all excess equipment and material had been evacuated from the shot island and those areas subject to significant effects. J-4 assisted H&N in getting material to the beaches and in relocating it when it was received on the base islands.

Vehicles, trailers, and other equipment which would no longer be required at Bikini after a particular shot were turned over to J-4 prior to the shot for further shipment to Eniwetok.

The shot phase evacuation of scientific trailers involved, besides the users, J-3, J-4, J-6 and H&N. In general, the procedure was for J-3 to determine when the scientific users could afford to release the trailers, particulary those aboard houseboats, and also to determine the facilities required during evacuation and re-entry, such as power for dehumidifiers and air conditions. water for Photo Lab tanks, etc. The actual movement of the trailers was accomplished by H&N personnel under J-4 supervision.

3.11 OPERATIONS AFLOAT, RECOVERY AND RE-ENTRY

3.11.1 Operations Afloat. Since the base camp at Enyu, Bikini Atoll, was not contaminated by any shot, sustained operations afloat were not necessary. However, the capability for such an operation was maintained. Complete evacuation was made for the Sycamore and Poplar events.

For the Sycamore shot the USNS Ainsworth (TAP-118) and the USS Boxer (CVS-21) were utilized. In general, the majority of TG 7.1 personnel were evacuated to the Ainsworth with personnel essential to maintaining the operational capability of the Task Group evacuating aboard the Boxer. All Bikini based helicopters were also evacuated to the Boxer so that recovery missions could be intiated from afloat.

Evacuation to ship on minus one days was carried out on three occasions due to the shot being postponed twice after the Task Force had embarked. Embarkation proceeded smoothly on all occasions, but a minor delay was experienced during debarkation due to the time necessary to begin operation of the boat pool.

TG 7.1 communications aboard the Boxer in addition to ships telephones consisted of Command Net and Administrative Net radios, ciphony telephone and AN/TRC telephone. Primary communications requirements were contact between the Task Force Headquarters Afloat and CTG 7.1 in Station 70 on Enyu and CJTF SEVEN at Eniwetok. Communications were generally satisfactory.

For the Poplar event the USS Monticello (LSD) was substituted for the USS Boxer since the Boxer had departed to participate in the Johnston Island Operation. Basically the evacuation and operations afloat were the same as for the Sycamore event. Helicopters were evacuated to the USS Monticello but since it was a daylight shot L-20 aircraft were flown and orbited in an area approximately 20 miles south of Enyu for the detonation.

3.11.2 Eniwetok Recovery and Re-entry. The operational phase of HARDTACK commenced with two (2) temporary camps in operation; at Yvonne a camp was established in support of the Cactus event while at Janet a camp was established and operated in support of the Koa event. The permanent base camp for scientific operations was established at site Parry. Personnel having primary interest in the early Eniwetok events, particularly Cactus and Koa, lived at the temporary camp sites.

All recovery and re-entry operations were controlled from the base camp at Parry. The normal re-entry - recovery operation was as follows:

1. Requirements for re-entry - recovery operations were submitted by project personnel on special cards designed specifically for this purpose.

2. After cards were edited, they were published as an annex to the evacuation and re-entry letter which served as the Task Group operation order for the event.

3. After publishing the evacuation and re-entry letter changes were posted to a master copy in the J-3 Office. On minus two all project personnel who had established requirements for the event were queried to reaffirm the requirement. This procedure was repeated on minus one to firm up the shot day requirements and was repeated as often as minus one days occurred.

4. Initially it was decided that the Rad-Safe survey would commence at H+3 hours with a survey of the critical recovery areas to be followed by a more detailed survey at H+5 hours to specifically delineate the Radex areas. However, it was determined after the first two events that a survey time of H+1 hour was more realistic and provided a much better working period for the early recovery operations. With the exception of Cactus and Koa, two surface bursts, radiation levels were seldom of an intensity to prevent early recovery of critical scientific data. Critical recoveries were normally completed on shot days although the radiation levels did force a delay or postponement at times. A pre-dawn detonation favors recovery operations, and all other factors being equal, should be sought as the optimum condition.

5. Following the radiological survey of the contaminated areas, recovery teams were immediately dispatched to their respective stations to effect recovery if the radiation dose was suitable to the individual and the stay time involved.

Several unique recovery operations were undertaken during Operation HARDTACK. These included the recovery of floating coracles, film packs,

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and activated pinex samples. Another recovery method effectively employed in HARDTACK was to effect early recovery of fallout by grappling containers from their location on the funnels of the YC's by copter. During Umbrella, early rad-chem analysis was started on some samples at H+40 minutes.

ASP rockets were used to evaluate their effectiveness as cloud sampling vehicles. Despite the extensive efforts put forth in air-sea combined operations to effect their recovery, only a small percentage were located and retrieved. It was later determined that the rockets were not acting properly upon entry into the water and were sinking before recovery operations were organized. The most valuable experience learned from the rocket recovery was the requirement to have an organized sea-air team with common communications and centralized control.

The main camps at Elmer and Fred were not evacuated for any of the shots though extensive shoring operations were performed on the weaker structures prior to shot Oak. Helicopters and light aircraft were evacuated from Elmer to Fred on those events where overpressures were in the neighborhood of 0.3 psi. For shot Oak, helicopters and light aircraft were evacuated to sea by the USS Boxer.

3.11.3 Bikini Recovery and Re-entry. A basic precept of recovery - re-entry was established as follows:

1. Recovery missions did not depart until after the initial Rad-Safe damage survey had determined the radiation levels.

2. Two Rad-Safe missions were flown concurrently - one to the Northern Islands and one to the Southern Islands.

3. Based on data radioed back by these surveys CTG 7.1 gave permission for recovery parties to proceed as he deemed appropriate.

On the Sycamore shot the Rad-Safe surveys and film recovery parties of TU-2 and TU-5 were launched by helicopter from the Boxer. Since Enyu was cleared for re-entry before recoveries were completed the helicopters returned to Enyu upon completion of the missions.

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Recovery operations for the other shots varied from shot to shot depending on shot location and project participation. All early recoveries however, were the same for all shots, being recovery of TU-2 film from Station 2200 on Reere, Station 2300 on Airukiraru and recovery of TU-5 film from Chieerete, and Bikini.

No problems were encountered in making these recoveries during the first two to three hours after detonation.

Re-entry at Bikini was divided into two general categories. Re-entry to the atoll when the Task Force was afloat and re-entry to the Airukiiji Camp when possible after the shots fired from Eniman. For re-entry to the atoll the ships entered the lagoon after a P2V aircraft had made a radiological sweep of the area. As the ships entered, the Rad-Safe surveys were launched, and by the time the ships anchored Enyu was declared open to re-entry. The Airukiiji Camp was re-entered by boat and aircraft from Enyu as the radiological situation permitted.

3.11.4 Johnston Island Nose Cone Recovery. Generally, the nose cone recovery operation was successful on both the Teak and Orange events. The majority of test vehicles were recovered.

The search plan utilized a P2V aircraft, the USS Lansing, the USS Safeguard, and the USS Belle Grove. The ships were stationed at an approximate distance of 25 to 30 miles from Johnston Island and directed to the search area immediately after the detonation. The P2V was airborne at about H+30 minutes from Johnston Island.

The following is a summary of recoveries for both events:

Event	Project	Lost	Recovered
TEAK	8.6	0	1 Pod
	32.5	0	2 Rad/Chem Samplers
	32.6	2	4 Instrumented Rockets

Event	Project	Lost	Recovered
Orange	8.6	1 pod	0
	32.5	0	4 Rad/Chem Samplers
	32.6	1	6 Instrumented Rockets

Although the recoveries were generally successful, certain aspects of the operation can be improved upon. Principal problems were:

1. The difficulty in communications between the shore and search/recovery vessels.

2. The timely return of recovered nose cones from distant sea areas to Johnston Island.

3. Insufficient coordination between the search vessels, the control ship, and the helicopters during the helicopter sweeps of the impact area.

On future operations it would appear that the use of an LSD with a helicopter platform working in conjunction with the DD's and a Carrier would enable recovered nose cones to be rapidly returned to shore. As an alternate plan, the projects might well mount their counting trailers on recovery ships whereby critical data can be promptly analyzed.

3.12 SAMPLE RETURNS

The sample return program was supported by MATS in an outstanding manner. The program developed by the JTF SEVEN Sample Return Director in coordination with MATS and J-3 and J-4 of TG 7.1 provided for three C-97's to support each shot: one each for Flyaways 1 and 2 with the third aircraft for back-up. With two shots scheduled for the same or consecutive days, a fourth C-97 was committed. These aircraft normally arrived at Fred 36 hours prior to scheduled shot time.

Flyaway #1 aircraft for UCRL and LASL shots were routed Eniwetok-Hickam-Alameda or Eniwetok-Hickam-Kirtland, respectively, in order to achieve minimum enroute time to the Laboratory having primary interest in the cloud samples aboard. Flyaway #2 requirements were combined with other flyaways, whenever possible, and routing was determined on the basis of the relative urgency of the samples aboard. All flights terminated at Travis.

MATS provided back-up aircraft at Hickam and Travis AFB's. The Travis back-up's were used to support Flyaways which were routed to both Alameda and Kirtland. As a common practice, MATS transferred the samples and couriers from one aircraft to another at Hickam. This consumed considerably less time than refueling the original aircraft would have; and, in many instances, the samples were airborne again within 5 minutes of their arrival from Eniwetok. Average elapsed time from Eniwetok to Alameda was 21 hours; from Eniwetok to Kirtland 25 hours. Routing through Alameda to Kirtland added less than 2 hours to total elapsed time.

The TG 7.1 Op Plan Annex G placed responsibility for handling Flyaways on J-4 in coordination with J-3 and J-1. The actual working arrangements which evolved were that J-3 determined which samples each Task Unit had to return, the desired departure time, routing and couriers, and informed J-4. J-4 ordered sample return aircraft through JTF SEVEN, operated the sample return compound on Fred, assured that samples were properly packed and marked, delivered them to the Flyaway aircraft and released the aircraft to the JTF SEVEN Sample Return Director. Although use of Flyaways to move passengers was discouraged, J-1 handled any requests for transportation of personnel for urgent official or personal reasons.

The Sample return responsibilities assigned to Commander Task Group 7.1 by Commander JTF SEVEN will be the primary function of J-4 with assistance from J-1 and J-3, (Reference CTG 7.1 Operation Plan - Annex G.)

Responsibilities.

J-3, Task Group 7.1 will:

1. Contact task units participating in each event to determine type and approximate number of samples to be returned on flyaway aircraft.

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2. Monitor recovery of all samples and keep J-4, 7.1 Sample Return Officer advised as to progress and estimated final recovery time.

3. Advise J-4 on anticipated number, size, weight, cube, radiation level of all samples.

4. Coordinate with J-4 on consolidation of samples whenever possible.

J-1, Task Group 7.1 will:

1. Be advised by J-4 as to number of passengers and couriers by name who will accompany flyaway aircraft.

2. Perform the necessary clearance functions, and amend or cut travel orders as necessary.

3. Arrange water, air and/or land transportation as may be required to the MATS Terminal on Fred, and assist in processing, and clearance through U. S. Customs at MATS Terminal.

4. Provide Transportation Section, Task Group 7.2, Fred, 24 hours prior to departure with completed MATS Form 53 (Passenger Booking Form).

J-4, Task Group 7.1 will:

1. Through J-4 JTF SEVEN, determine availability of flyaway aircraft and be advised as to name of Military Courier and number of passengers.

2. Immediately after each shot contact the officer in charge sample recovery unit Fred to determine when last sampler will be down. If there are any unusual ground or water samples to be recovered, J-3 should be contacted immediately after the shot to get an estimated recovery time.

3. Based on information obtained from Sample Recovery Officer and J-3 advise MATS Control Officer of estimated time of departure of flyaway.

4. Collect, inspect for packaging, marking, radiation leve, manifest and load aboard flyaway aircraft all hold back and current samples from previous shots. Also all other classified and unclassified material being returned to the laboratories via flyaway aircraft.

5. Advise MATS Manifesting Section of the total number of pieces and total weight to be placed aboard flyaway aircraft.

6. Advise MATS Passenger Section of number of passengers, civilian couriers and military couriers and destination of each.

7. Insure Rad-Safe Officer has drawn 10 mr line on aircraft floor

8. Release aircraft for flyaway.

9. Prepare and dispatch flyaway message.

In view of the large number of flyaway aircraft required to satisfy the shot schedule, coupled with a reduction of enroute delivery time, the adequate backup support at all times provided by J-4, JTF SEVEN, the combined flyaway program was considered one of the most successful of any operation.

Newsreel:

A requirement of three (3) flyaway aircraft were scheduled for the Teak event. However, requirements did not generate for Flyaway #1 to Hickam. Flyaway #2 C-97 departed Johnston for Hickam at 020330Z August. Load consisted of 14 pieces at 505#. Flyaway #2 terminated at Hickam AFB.

A third flyaway C-54 for Eniwetok with film for TU-5 aborted. This film and courier were placed aboard the Hickam flyaway and forwarded from Hickam to Eniwetok on MATS scheduled flight departing Hickam at 2100 local Hickam on 2 August.

Remarks:

The inclosed flyaway report does not include flyaways for the Fig and Orange events.

3.13 COMMUNICATIONS

Task Group 7.1 was assigned the following communication responsibilities by CJTF SEVEN for Operation HARDTACK.

1. Provide, operate and maintain special communications - electronic equipment required for conduct of scientific test programs.

2. Initiate the voice time broadcasts for all elements of the Task Force.

3. Coordinate special communications requirements originating by sub-ordinate task units.

4. Prepare a TG 7.1 telephone directory for the EPG and Johnston Island.

3.13.1 Teletype and Mail Service.

On February 2, 1958, the Task Group 7.1 Mail and Records Section for Operation Hardtack opened at Parry Island, Eniwetok. On February 15, 1958, a branch office was opened at Enyu Island, Bikini. On June 15, 1958, another office was opened at Johnston Island. Civilian and military personnel were utilized to man the three offices. The maximum strength at Parry Island was nine; the maximum strength at Enyu Island was two; and the maximum strength at Johnston Island was five. The parry Island office was open twenty four hours a day, seven days a week throughout the operation and the other two offices were open from 0700 until 2400 hours seven days a week.

Teletypes. Teletype service was furnished at all locations for the entire Task Group and accounted for the greatest portion of the total work load. During Hardtack, the following listed teletype traffic was processed by the three offices:

Classified Outgoing----1261
Classified Incoming----3293
Unclassified Outgoing--4306
Unclassified Incoming-12272

Total 22132

Official Correspondence and personal Mail. The Task Group Mail and Records Section normally handled official correspondence only for LASL. However, service was provided for non-LASL units until these organizations had their mail system in operation. Personal mail was handled in a like manner.

Inter-Atoll Mail. The Task Group 7.1 Mail and Records Section operated a daily pouch between the mail rooms at Eniwetok and Bikini Atolls. This service was available to all units 161 of the Task Group and provided an expeditious means of transmitting unclassified and classified (up to and including Secret RD) correspondence between sites. A similar service was provided between Eniwetok Atoll and Johnston Island, on the weekly Reflector Flight and on the MATS flight which stopped there once a week.

Reading File. A Task Group Reading File was maintained by the Parry Island office. This file consisted of copies of outgoing correspondence and teletypes, and was circulated among the headquarters staff sections.

3.13.2 Communications (Eniwetok Proving Ground). CTG 7.5 provided TG 7.1 with all the long and short range communications including cryptographic service. The individual projects were responsible for installation, maintenance, and operating of all scientific electronic equipment.

Task Group 7.1 had approximately 13 voice nets including the Eniwetok-Bikini-Boyer ciphony system. The primary net was the Command Net which consisted of each staff section and task unit commanders. In addition, each Task Unit had their own individual net. Two nets were reserved for calibration purposes and proved to be of great value.

The major nets were serviced by a repeater station which was located on towers at 150' levels at each atoll. The installation of antennaes commenced in early February 1958 and the respective radio nets were installed upon the users' request after arrival in March 1958.

The JTF SEVEN Weather Detachment provided communications to the following off-atoll scientific sites - Kusaie, Kwajalein, Rongelap, Utirik, Ujelang, and Wotho. Wake Island was serviced by the CAA at Wake. In addition, the respective off-atoll projects provided their own communications link between their respective sites. Drill messages were sent in April 1958 to provide training to all off-atoll sites in order to expedite the promulgation of the forthcoming shot information.

A radio silence requirement during all shot times was established by

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CJTF SEVEN upon the request of CTG 7.1. This silence consisted of 5 minutes from H-3 minutes to H/2 minutes for the protection of scientific equipment and data during all events. In addition, a daily radio silence period was established at 10OM and 150OM for the scheduled daily dry runs. Due to various circumstances, the dry run schedule was not always consistent with the above mentioned plan; therefore, the requirement for daily radio silence was deleted during the middle of the operation.

The greatest problem that developed during the entire operation was that of interference to the Diagnostic Telemetering Projects sponsored by UCRL and Project 34.1 (Sandia Corp). Project 34.1 experienced serious interference by local radar radiation primarily originating from the U.S. Naval vessels present. CJTF SEVEN directed CTG 7.3 to observe complete radar silence to all vessels while at anchor in port. Close coordination between the respective TG communications officers was required in order to eliminate the electronic interference.

The installation of a 600 automatic dial telephone system by CTG 7.5 on Elmer with integration of the Fred Telephone System provided excellent telephone service at the Eniwetok Atoll. The Eniwetok-Hawaii-Conus Radio Phone Circuit was considered satisfactory and a great improvement from the REDWING operation.

The installation of the TROPO system by CTG 7.5 between Eniwetok and Bikini was a great improvement. This system provided adequate voice telephone lines, hot lines, ciphony and count-down requirements to this task group.

CJTF SEVEN provided CTG 7.1 one ciphony channel which was maintained and operated by NSA trained enlisted personnel assigned to CTG 7.5. The KY-5 equipment selected was cleared for SECRET (RD). Subject equipment provided excellent service and is recommended for future operations.

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Approximately 135 frequencies were assigned to TG 7.1 for scientific use. Early assignments of the frequencies is highly desired in order that participating activities can advise their respective contractors for purchasing their required equipment.

Task Unit 5 (EG&G) provided the voice count-down broadcasts over 153.89 mcs and 243.0 mcs for all elements of the task force. The voice count-down broadcast was capable of patching into the major nets, thereby reducing the requirement for additional voice count-down receivers. This proved to be very beneficial to all the Task Units and their projects concerned.

CJTF SEVEN originally promulgated the order that additional Amateur Radio Stations would not be authorized based on the 5 stations permanently operating in the EPG. However, during the middle of the operation subject order was rescinded thereby opening the door to all task units. Four additional stations were finally authorized by CJTF SEVEN. The procedure for obtaining call signs and licenses from the High Commissioner of the Trust Territory conflicted on several occasions thereby creating a large volume of unnecessary correspondence. The additional respective Amateur Radio Stations were of great morale value and did not cause any interference problems.

The success of communications provided for during operation HARDTACK can be contributed to the frequent communications conferences between Task Force Communications Officers during the interim and build-up period. Subject conferences are deemed necessary in order to obtain close coordination and a working agreement between the respective Task Groups.

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3.13.3 Communications (Johnston Island). Radio communications during NEWSREEL were held down to a bare minimum with maximum utilization being placed on hard-wire circuits. At Johnston Island this was extremely practical due to its size and the concentration of the scientifc stations. Additionally, a special hard-wife circuit was established from the Bunker (J-70) Switchboard to all manned stations for muster and coordination of the scientific effort. This circuit proved to be an extremely valuable adjunct to the installed dial system.

Interference with scientific instruments from all sources was a continuing problem throughout HARDTACK. Interference sources were determined by means of ECM equipment, logic, visual and audible recognition and the "cut and try" method. The ECM solution, was of course, the most factual, in that, bearing could be determined and equipment identified by pulse analization, but was least effective either due to equipment malfunction or inherent equipment design limitations. As a rule normal ECM equipment sensitivity was far below that of the scientific receivers. The solution to this problem was to make the ECM center mobile and "sample" the interference with a probe from the scientific receivers themselves. This approach was tried during the NEWSREEL phase of the operation and proved to be a valid concept.

For future operations involving large scale radio telemetry the mobile ECM concept should be continued, and the equipment be of the latest design that can be procured on a loan basis. Further, spare parts should be available in advance prior to an equipment failure to provide maximum flexibility. A source of independent power should also be provided on a mobile mount.

In order to transmit the count-down to all projects over long distances, it was necessary to install medium high frequency single side-band equipment for the Teak and Orange events. This communications system provided a more

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rapid means of notifying the distant stations using WWV time base, in the case of delays or holds.

The single-side band equipment was installed on Sand Island by Task Group 7.5 and operated by Task Unit 5 in the 7 and 14 mcs bands. These frequencies gave us extremely good coverage throughout the Pacific and unofficial reports from amateur operators in Honolulu indicate that the transmissions were received in Alaska, Australia, and throughout the U.S. Due to the variety and types of receivers being used by projects to copy the count-down it was found necessary to instigate a calibration count-down starting at H-4 hours to enable the users to have their receivers properly tuned. This requirement did not exist before with the VHF count-down equipment as these receivers were crystal controlled and no calibration or tuning count-down was required.

3.14 SECURITY

As during previous operations, the security activities of Task Groups 7.1 and 7.5 were joint responsibilities. Within TG 7.1, coordination for and establishment of security policies was effected by the Classification Officer, while personnel security functions were delegated to the Military Executive, J-1. The aspects of personnel security were redelegated to cover the three broad groups of participants at Los Alamos (LASL, Sandia, EG&G, and 1ST RSSU), Livermore (UCRL), and Sandia Base (DWET).

JTF SEVEN SOP's 205-1 through 205-9, establishing the security policies for HARDTACK, were published between 14 October and 25 November 1957. These nine documents were reproduced by J-1, TG 7.1, combined with TG 7.1 Implementing instructions, and distributed to the staff and subordinate units on 13 December 1958. This file constituted the CTG 7.1 security policies for the operation.

3.14.1 Predeparture Security Indoctrination. A joint Security Indoctrination Letter for Task Groups 7.1 and 7.5 was published on 23 December 1957. This letter established the procedures to be used in the instruction of personnel planning to participate in the operation. It was issued with the concurrence of CJTF SEVEN, and incorporated both the requirements of the AEC Security Manual, Vol. 2000, and the JTF SEVEN SOP 205-2, "Basic Security Indoctrination."

Each HARDTACK participant was required to acknowledge that he had read and had been tested on the contents of this letter. A statement to this effect was forwarded with his request for travel orders, and the signed copy was required before travel orders were issued. All statements were filed in the cognizant Adjutant General's office.

3.14.2 Transmission of Classified Documents in Personal Custody of Individuals. Utilizing JTF SEVEN SOP 205-4, "Courier Instructions", as a guide, 16 an appendix to an annex of the ADMINISTRATIVE PLAN NO. 1-57 was published on 1 November 1957. This appendix incorporated all courier instructions for transmission of documents and material between EPG and other locations, and within the EPG. Although procedures were not always followed, in that written authority was not always obtained prior to couriering classified documents, no security violations were observed.

The problems present during past operations in the shipment of bulky classified materials through the mail were not evident during HARDTACK. This resulted from adequate planning and coordination with Customs by TG 7.5 prior to the operational period.

3.14.3 Access to Restricted Data. JTF SEVEN SOP 205-3, "Security Clearances," specified prerequisites for access to Restricted Data. The exchange of RD between DOD and DOD-contractor personnel and AEC contractors required certification on each individual possessing a military clearance. No travel orders were published on these individuals until proper certification was on file with TG 7.5. Two participant areas were established: certifying officers at Los Alamos processed headquarters and Task Units 1, 2, 4, 5 and 6; certifying officers at FC AFSWP, Sandia Base, processed TU-3. During CASTLE all TG 7.1 personnel requiring access were certified, with the concurrence of CTG 7.1, by CJTF SEVEN, During REDWING and HARDTACK this responsibility was delegated to the Military Executive, J-1, and to FC, AFSWP, with a minimum number of alternates, which resulted in a vast improvement over the JTF SEVEN certification, in that efficiency, facility and closer control were enhanced.

3.14.4 Exclusion Areas. JTF SEVEN SOP 205-6 directed the establishment of policies and procedures on Exclusion Areas. Access was predicated on the Sigma Category indicated on the security badge, and on the "need to know." Access lists for each Exclusion Area were published, and exchange

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badges were maintained for each individual requiring continuing access. Certain individuals were authorized to grant temporary access.

The system utilized was generally satisfactory, except that it often became unweildy under the weight of numerous changes. Initially, task units submitted the names of their personnel who were to have access to these areas. Operational and other requirements, and frequent substitutions of other individuals for those who were to have performed certain responsibilities increased the workload immensely and sometimes made the exchange badge procedure for a specific area obsolete. This could have been eliminated by more careful planning on the part of the using agencies.

3.14.5 Clearances. JTF SEVEN SOP 205-3, "Security Clearances," required each TG 7.1 participant to possess a Secret or Top Secret military clearance, or an active Q clearance. Verification of these clearances was required by J-1 before travel orders authorizing entry into the FPG could be issued. This verification was obtained from three areas:

1. AEC Contractor Personnel: Q-cleared personnel were indicated on the status reports emanating from the subordinate organizations. These lists were compiled at intervals, and forwarded to TG 7.5 to be confirmed. TG 7.5 then notified the Military Executive, J-1, of the confirmation.

2. Military and DOD Civilian Personnel: The Military Executive, J-1, was responsible for the verification of clearances on all DOD personnel assigned to TG 7.1 except for those under the operational control of TU-3. This verification was obtained from the cognizant security officer. As a member of J-2, JTF SEVEN, the Military Executive, J-1, also had the authority to grant military clearances in certain instances. Clearances granted by the Military Executive totaled 37, two of them Crypto clearances.

3. TU-3 Military, DOD Civilian, and DOD Contractor Personnel: Personnel under the operational control of Task Unit 3 were certified for access to RD by FC AFSWP. Since this organization was responsible for the issuance of its own overseas travel orders, verification of clearances was assumed by the unit.

3.14.6 Badge Requests. JTF SEVEN SOP 205-6 outlined procedures to be utilized for badging. Three simplified (over past operations) Sigma Categories were indicated on these badges, and a color system provided identi- 171

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fication of area of access and other than routine authorizations.

The processing of badges was a simple operation, except for numerous changes and resubmissions, and no major problems were encountered. When time limits exceeded the arrival in the EPG of an individual, an OUO message was sent and a badge request form was accomplished on the site.

Photographs were provided by the subordinate units, and badges--based on the badge request forms submitted by Los Alamos, Livermore, and Sandia Base--were fabricated in the field.

3.14.7 Compliance with CINCPAC Serial 020. CINCPAC Serial 020, dated 1 April 1952, "Eniwetok Atoll; Security Instructions," defines the general security requirements for entry into the EPG. Security of the proving ground is a responsibility of CINCPAC.

All TG 7.1 personnel had to be under the provisions of paragraph 4 as "good security risks." This determination was based on certification that each individual was mentally and emotionally stable; that he possessed the integrity, discretion, and responsibility essential to the security of classified information; that his reputation and records revealed no information which tended to indicate any degree of disloyalty to the United States; and that he had been throughly indoctrinated in existing instructions for the security of classified military information.

Each individual was certified by immediate superiors to Los Alamos, to TU-3, or to Livermore under the provisions of the letter. Compiled lists were submitted periodically to JTF SEVEN, CINCPAC, the TG 7.1 LNO's, and to TG 7.2. When the time element demanded, wire messages were sent. Each travel order published by TG 7.2 also certified each individual to the provisions. During HARDTACK a total of 2374 certifications were submitted by roster, and 340 by wire message.

Although the procedures in use during the operations were repetitious and frequently ponderous, no particular problems were posed and in no case was entry denied as a result of a breakdown in the system.

Paragraph 4c of the letter defined those items classified as contraband material. Each individual was thoroughly indoctrinated, and violations were limited to four in TU-2 and eleven in TU-3. The majority of violations resulted from misinterpretations about storage facilities in Hawaii.

3.14.8 Security Briefings. Security briefings held during past operations by TG 7.2 for all TG 7.1 personnel arriving in the EPG were eliminated at the insistence of CTG 7.1. The individual background of experience in stringent security environments at all operating locations in the United States, and the Security Indoctrination letter were considered adequate. In March 1958 the baggage search for all officers and officer-grade civilians was also eliminated, except for spot checks. A certificate was substituted.

3.14.9 Security Posters. Prior to HARDTACK security posters were requested from JTF SEVEN by TG 7.1. These were placed at advantageous locations throughout sites and buildings utilized by TG 7.1. However, the method utilized did not appear to be entirely satisfactory, and could be improved by giving this responsibility to TG 7.2 for Eniwetok Island, and to TG 7.5 for other locations.

3.14.10 Security Violations. Security violations were quite minor to the overall effort, the most serious having been safe files left open.

VIOLATION	HDQTRS	TU-1	TU-2	TU-3	TU-4	TU-5	TU-6
File Safes Open	6	1	13	4	3	4	0
Documents Adrift	0	4	4	2	1	1	0
Contraband Offenses	0	0	4	11	0	0	0
Badge Offenses	7	11	9	9	3	12	4
TOTAL	13	16	30	26	7	17	4

3.14.11 Recommendations. Shipment security instructions should be issued and individuals responsibilities assigned to those concerned at least a month before any classified material is forwarded to EPG. The reason for this is that during the early phases valuable and highly classified shipments arrived and were stored without the recipient being aware of the presence without a tedious trackdown.

The compound area should also be closed and guarded as soon as the Headquarters and other personnel arrive, since classified discussions were taking place while contractor personnel still had access to the compound even though they were not Q cleared.

3.15 CLASSIFICATION

The Task Group Classification Office worked very closely with the Task Force Classification Officer. Except for the beginning of Operation Hardtack, however, there were not many problems for the classification office - which indicated that the guide was adequate, and most personnel knew how to use the guide. Because of the reduced need for the services of classification people, it is suggested that on the next operation one person can handle both 7.1 and JTF-7 HQ responsibilities.

There was very little in the present guide to find fault with. It is suggested, however, that operation plans (stating shot time) for the shots be permitted to be issued as unclassified at least two weeks before the shot instead of the present three days. There is nothing magical about three days, and from an operation point of view, two weeks is logical, provided there is no other reason to classify same.

Also, it is suggested that a general classification policy be accepted, that, what is visible to the general population of an atoll be considered unclassified.

3.17 SAFETY

3.17.1 Preparation. The Task Group 7.1 Administrative Plan for Operation HARDTACK established safety as a command responsibility and assigned a Safety Advisor to Headquarters TG 7.1 for consultation on all [illegible] matters ~~pertaining to accident prevention.~~

The Safety Advisor spoke to the Project Officers at a meeting in Albuquerque in the fall of 1957 on ~~the subject of~~ "Safety Problems in the Forward Area". Individual Project Meetings held in Los Alamos in December 1957, were attended by members of the safety group to acquaint them with the ~~safety~~ problems associated with the projects and to provide the opportunity to recommend safe practices.

Two papers on health and safety considerations at the Eniwetok Proving Grounds were distributed to all personnel before their arrival at ~~the~~ [illegible] ~~test site.~~

~~Close~~ Liaison was maintained with J-4 on ~~the packaging,~~ shipping, handling and storage of hazardous materials and devices. TG 7.1 Safety Officers ~~The members of the group~~ attended ~~a~~ JTF 7 meetings held in San Diego and Travis AFB in January ~~1958,~~ and February 1958 on ~~the~~ problems associated with handling and shipping devices from their point of origin to [illegible] ~~the test site.~~ The Safety Advisor prepared a paper on safety problems and emergency action connected with the test devices. This paper was made the Safety Annex to the JTF 7 Shipping Plan.

In consultation with J-6, plans and specifications for test site facilities and structures were examined for safety considerations.

3.17.2 Personnel. The staff function of Safety Advisor to the Commander, Task Group 7.1, was assigned to Roy Reider, Safety Director of the Los Alamos Scientific Laboratory. In addition to Reider, the post was filled by Staff Members ~~from Group H-3 and CMB and P Divisions~~ of the LASL. Safety Advisors were present at the test site from February 16 to the end of the operation and were located at Bikini and Eniwetok Atolls and at Johnston Islands. Taking part in rotation at the EPG were the following:

Ellis Stout

J. Robert Penland

Roy Reider

James G. Stearns

C. Austin Burch

One Safety Officer was in residence at Johnston Island from June 29 to August 19, 1958.

3.17.3 Operations. The movement of all hazardous materials, including test devices, into and out of the EPG, between and within atolls, was carried out with procedures advised upon by the Safety Advisor who was in attendance at one stage or another during such movements.

Project stations, towers, tower elevators and stations, zero point barges, facilities and equipment, boats and vehicles, and recreational activities were surveyed and examined for safety.

Problems of mutual interest were coordinated with safety personnel of other Task Groups.

Accident reports and forms were completed on all disabling and serious injuries. Forms were distributed to the home offices of the employees involved and to the Bureau of Employees Compensation at their office in Honolulu, T. H.

Safety information was published in the Information Bulletins issued by the Adjutant General's office, J-1.

In connection with test rocket firings from Johnston Island, the Safety Officer was appointed Rocket Range Safety Officer to coordinate safety matters with the JTF SEVEN Control Point. Procedures were developed to assure the safety of personnel involved in test rocket firings, the establishment of danger zones, water, air, and ground exclusion areas, and warning signals to alert the general population.

Routine inspections of ~~scientific~~ stations were carried out, and special attention was given to small boat activities and personnel evacuation.

Safety bulletins were issued for the guidance of personnel in viewing the Teak and Orange events.

3.17.4 Unusual Incidents and Special Problems. Several helicopter crashes occurred during the operation; one resulted in the death of a TG 7.1 scientist. That accident is discussed in the "Accident Summary" and a complete report is on file in the office of the Safety Advisor. Other crashes resulted in minor injuries.

Use of motor vehicles continued to be a problem. There were ~~several~~ instances of abuse to ~~government~~ vehicles, driving in an unsafe manner, ~~too fast for road conditions and vehicle design,~~ and overloading vehicles. (One observer reported eleven men were riding in or on one jeep.) Greater disciplinary action appears to be indicated. ~~Part of the problem lies in the difficulty of indentifying the personnel involved.~~ Several incidents occurred at night and the vehicles were damaged and abandoned.

At the request of JTF 7, shark nets were installed around the swimming areas at Parry, Eniwetok and Japtan Islands at Eniwetok Atoll and at Enyu Island at Bikini Atoll. These were damaged by rough seas and by wave action following detonation of devices. They were intact less than three months. There were no reports during the Operation of injury to personnel of TG 7.1~~, or other Task Groups,~~ from attacks by sea life. One TG 7.5 employee stepped on a Stone Fish in the swimming area off Eniwetok Island and was disabled for a few days.

3.17.5 <u>Roll-up</u>. All stations were given a final check ~~during a five day period~~ after the last event.

3.17.6 <u>Accident Summary</u>.

Personnel.

One fatality occurred to TG 7.1 personnel: , a UCRL senior scientist, was drowned when a helicopter went down in the water off Rojoa Island, Eniwetok Atoll, during a rain squall on a night flight on April 7, 1958. was a passenger in the same craft and was hospitalized for three days. had stopped breathing and was revived by means of artificial respiration applied by , another passenger, and the crew.

The ratio ~~of disabling injuries and diseases to minor injuries appears to be high. Out~~ Of 77 injuries and diseases reported to the dispensaries, 18 resulted in time lost from work.

Of the 18 disabling injuries, nine originated in recreational activities and nine were occupational. Other than the death of and the potentially serious injury of , none of the accidents were serious; none resulted in a lost time of more than three days.

Briefly, lost-time occupational injuries were as follows: Two back injuries resulted from lifting cylinders and while working on a rocket launcher, tip of finger amputated while operating hoist, fragments imbedded in shoulder from blasting cap, injured thigh when equipment shifted on deck of ship, dislocated elbow when employee slipped on greasy deck of ship, fungus infection on leg.

The recreational accidents were as follows: Fractured ankle while playing basketball, dislocated thumb while playing softball, dislocated knee cap while playing volleyball, an infected eye when hit by coconut being tossed, probably insect bite while on beach, laceration from rusty metal on beach, injured back when employee slipped on rock on beach, three days lost due to sunburn, and broken ankle when employee slipped, probably while intoxicated. Another employee was disabled at Eniwetok from sunburn received in Honolulu prior to arrival at Eniwetok.

A preliminary examination shows the following injuries report to dispensories at Johnston Island:

Occupational - 16

Recreational - 7

Total - 23

The recreational injuries were mainly from volleyball, tennis, and water sports. Occupational injuries were mostly from striking stationary objects, the use of hand tools, and falls.

Vehicles.

Six men suffered minor injuries in four vehicle incidents.

Fires.

There were no fires in TG 7.1 facilities or equipment during the Operation.

3.17.7 Special Comment. A recommendation from a previous report is repeated: In future operations consideration should be given to using safety personnel from major participating laboratories, integrating them with individuals who have had previous test operation experience. Such integration should be complete enough to function for the benefit of all elements of the Scientific Task Group without ~~excessive~~ duplication of personnel ~~and efforts.~~

Participating organizations should select test personnel with the proper physical qualifications to meet the demands of the test site environment. The specifications of the Administrative Plan medical requirements are strict enough if interpreted properly.

New test personnel should be thoroughly indoctrinated and oriented with respect to the peculiar hazards and ~~different~~ environment of the ~~test site~~.

A ~~new~~ magazine area should be built on the north end of Parry Island to accommodate the small quantities of hazardous materials and explosives used by TG 7.1. Seperate buildings should be constructed in order to ~~properly~~ store incompatible materials. The area should be ~~surrounded by a~~ fenced in order to store ~~loaded~~ trailers of hazardous materials.

All plans for new structures and facilities should be examined for personnel safety. Safety considerations have been particularly lacking in structures designed for housing personnel.

It should be realized by ~~test-site~~ personnel that proper driving practices and reasonable care of Government motor vehicles are the responsibilities of the individual and particularly of his supervisor. In the past these responsibilities have been taken lightly by some people. ~~Disciplinary~~ Action should be instituted against those who drive in an unsafe manner and those who negligently abuse Government equipment.

Consideration should be given to assigning a Safety Advisor to the Staff of the Joint Task Force. This individual could coordinate the various safety activities and resolve the conflicts that sometims exist between regulations established by different organizations. This Safety Advisor should have a broad background in varied safety work, stature in the field and previous test site experience.

The Safety Officers report a completely cooperative response in dealings with Task Group 7.1 personnel at Johnston Island.

3.18 DISPOSITION OF FORCES (ROLL-UP)

3.18.1 General.

Personnel of the Task Group began to be gradually redeployed from the EPG to the ZI during the last week of April. This redeployment followed the detonation of Yucca on April 28, 1958, and continued through the middle of August 1958. Following the detonation of [redacted] (the last device) on August 18, 1958, the remaining personnel phased out rapidly.

3.18.3 Property Roll-Up

Property roll-up for Hardtack can be broken down into three phases as follows: Bikini Roll-Up, Newsreel Roll-Up, and Eniwetok Roll-Up.

Bikini Roll-Up -- Final roll-up took place after the detonation of Juniper on 22 July 1958. Prior to that date however, due to having no further participation in the remaining shots, a number of projects, principally DOD, closed down their activities at Bikini, and transferred their equipment to Parry for return to the ZI or use at Eniwetok or Johnston.

On 23 July, roll-up began in earnest and it is anticipated at the time of writing this report that it will be completed by 5 August 1958. In many instances final packing of trailers and crated cargo was accomplished at Bikini, however a certain quantity of equipment was returned to Eniwetok for processing and documentation for ZI shipment. J-4 arranged with H&N the usual carpentry and rigger service, and provided rubberized hair, kimpak, silica gel, etc., from J-4 stock for packing equipment for movement by water and air to Eniwetok.

Newsreel Roll-Up -- At the time of submission of this report, the following plans have been made for roll-up of quipment at Johnston.

It is planned to schedule water lift from Johnston to Pearl Harbor in the following manner:

Last shot plus five -- LSD

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Last shot plus ten -- LST

Last shot plus fifteen -- LSD

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[redacted]

Manifests will be flown to the Task Group 7.1, J-4 Liaison Officer at Hickam, and he in turn will pre book this cargo for movement on to the ZI on any available MSTS or commercial vessel.

Arrangements have been made for Task Group 7.2 to have an ordnance team at Johnston for receipt of Task Group 7.1 vehicles, and to process them there for re to the appropriate ordnance depot.

J-4 will provide the normal roll-up services of furnishing packing material from stock, carpenters an labor, and will either document or assist in documenti cargo.

Eniwetok Roll-Up -- Partial roll-up was a continu process that began early in June and continued at a varying pace up until final roll-up. On 18 July com-pletion of TU-1 shots brought on a surge of roll-up activity and again another surge was brought about by the roll-up of activities at Bikini. Starting with t Haiti Victory which saided on 12 June 58, J-4 shipped trailers and general cargo on all vessels returning t ZI or to Honolulu. Various weapon components such as spare parts, HE and gas bottles were returned on Samp Return Flyaways to the appropriate laboratory. Origi J-4 planned to use the Brostrom as a final roll-up sh on 1 September 1958. At the time of writing this rep (1 August 1958) it appears that roll-up will have bee accomplished by moving out remaining cargo after the last shot [redacted] presumably about 10-15 August) by us of the reefer "Carron," and the LSD Monticello which will sail on 14 August.

Due to the late closing date of Hardtack and the impending "Mill-Race" operation at the Nevada Test Site it has been necessary to return an unusually large amount of electronic gear by air for TU-2 and TU-5. Sixty-five thousand pounds were booked in the last six days of July and it is estimated they ship 38,pounds in August.

The IBM 704 computer will be shut down 6 August 1958, and returned to the ZI on two SAM C-124's on 14 August 1958.

3.19 CONCLUSIONS AND RECOMMENDATIONS

3.19.1 General.

Sites and Scheduling.

The separation of weapons laboratory activities into two sites as well as establishment of multiple capabilities at each site proved to be one of the primary means by which the operation was accomplished on a reasonable time scale. It is recommended that future operations follow the same pattern, although substitution of Taongi for Bikini should prove to be extremely advantageous due to the more favorable weather situation at Taongi. The development of techniques for conducting open sea firings should also be vigorously pursued because of their many operational advantages.

It appears that it would be advantageous to seperate weapons development tests from effects tests in time or location. In general, effects tests require a great deal more support, have many more operational limitations, and interposes schedule interferences with development tests.

Organization.

The fact that HARDTACK, which was larger than all of the other Pacific operations combined, was conducted on virtually the same time scale indicates that despite problems the organization functioned efficiently.

Most of the problems which arose during the course of the operation originated because of the split responsibility status of project officers or senior laboratory representatives (Task Unit Commanders). The project officer or Task Unit Commander is charged by his home organization with the responsibility of carrying out an assigned scientific task. This individual's career progression depends to some extent on how well this task is accomplished. On the other hand, the same individual is also a member of the Task Force, and therefore is subject to the direction of Task Group and Task Force command elements. These directions are not always compatible with those

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received from the laboratory or home agency. Problems which arose from such causes were subjected to on-the-spot arbitrary solutions in the interest of "getting the job done." These solutions were not necessarily the most satisfactory from the standpoint of those concerned. It is recommended that prior to the field phase of future operations clear-cut understandings be reached between the laboratory or agency management and Task Group or Task Force command elements regarding division of authority and channels of communication to field personnel. It is not entirely clear that the HARDTACK organization offers the best possible solution to the conduct of a Pacific test operation. Prior to another operation the entire organization picture should be fully explored by all participating agencies.

Operational Limitations.

Because of the fallout difficulty of firing shots of large yield, operational limitations imposed by experimental programs can seriously delay an entire test schedule. Special attention should be devoted in technical planning to means of reducing or eliminating as many factors as possible which could impose limitations as to when, how, or where a shot can be fired. Radiochemical sampling by aircraft imposes more non-fallout associated operational limitations on the firing of average developmental shots than does any other experiment or program. It, in addition, imposes a heavy support load on Task Force or supporting elements. It is recommended that the development of a simple reliable inexpensive rocket sampling system be vigorously pursued.

Personnel and Morale.

Experienced and skilled scientific personnel are the most valuable single asset associated with the nuclear testing capability. In general, less money is spent for attention devoted to these personnel than is devoted to the maintenance, shipment, and protection of the equipment which they design. A

[redacted]

great many of these people have participated in many consecutive test series, and each participation involves a considerable sacrifice of personal comfort and family lift. The skills and talents that these people possess are in considerable demand in other fields of endeavor, and the end of each operation finds a not insignificant number realizing that they can find an equally interesting and probably more lucrative job which does not require the personal sacrifices and discomfort of nuclear testing.

Quarters and recreational facilities at EPG are, whem compared to those available to most of these people in any part of the United States, entirely substandard. Most personnel have no objections to living under such conditions for relatively short periods of time. When this is stretched to several months or many consecutive operations, such facilities become unsatisfactory. It is recommended that in future operations provisions either be made to provide for frequent rotation of personnel at all levels to home laboratories or stations, or a marked and extensive improvement be made in living and recreational facilities at EPG.

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[redacted]

3.19.2 Personnel and Administration

Security.

The Joint Security Indoctrination Letter for Task Groups 7.1 and 7.5 was issued on December 23, 1957, for Hardtack. It is strongly recommended that such a document, as well as other security procedures, be issued no later than 1 September of the year preceding a Spring operation to allow time for distribution and use of the letter before personnel depart for overseas.

For Redwing and Hardtack, the TG 7.1 Military Executive performed additional duty as Security Officer. It is recommended that a full time Security Officer be assigned for future operations, preferably a civilian with experience in AEC security procedures.

CincPac Serial 020 continued to create confusion, delay, and irritation. It is strongly recommended that the need for this directive be reviewed on at least two counts: (1) Since TG 7.1 personnel have either military or AEC clearance before being ordered to EPG, it seems redundant to declare them "good security risks," and (2) The list of contraband items should be reviewed and either eliminated or shortened and clarified.

Transportation.

MATS performed its primary mission of moving personnel and cargo in a satisfactory manner. However, the record of aborts, late departure, and inconvenient schedules continued during Hardtack to the extent that the MATS flights to and from EPG are universally regarded as the worst feature of a generally unpleasant tour of duty. It is recommended that efforts continue toward improving the convenience and reliability of MATS transportation.

The inter-atoll transportation by C-54 aircraft was an improvement over past operations and was appreciated by all personnel.

Morale.

In general the small camps on shot islands were adequate in size and space was available upon arrival of our personnel. The base camps on Eniwetok and Parry Islands, however, were inadequate in most respects. On Parry, quarters were still being constructed on a crash basis when the population neared its peak, and it was necessary to move some personnel several times as new buildings became available. It is again recommended that camp construction be accomplished between operati when it can be done conveniently and economically. Other facilities on Parry were also inadequate, such as the messhal camp store, movie theatre, etc. All such facilities, which are important to comfort and morale, should be designed and constructed to take care of the operational population before another test series is undertaken.

During Redwing and Hardtack a few persons from TG 7.1 were permitted to visit other islands in the Marshall, Gilber and Caroline groups as passengers on official trips to projec sites. These visits were highly regarded as a welcome change from life at the EPG. It is urged that in future operations the opportunities for such trips be expanded so that most persons on extended tours may be able to leave the site for a few days of recreation.

3.19.3 J-3 Section, Plans and Operations.

Communications.

For future operations, it is recommended that the base consoles (20 watt transceivers with line termination equipment) for the major nets be installed in one central location at each respective site. Increases usage of "Remote" units from the base consoles should be used in lieu of base transceivers whenever possible. The consolidation of base console stations will assist the maintenance and security problems.

The switchboard operators at Eniwetok and Bikini Atolls controlled the ciphony calls satisfactory during normal operations. However, it is recommended that an additional small switchboard be installed in Building 204 on Nan to handle the special ciphony calls during an evacuation phase.

The usage obtained from "mobile" radios was very slight. It is recommended for future operations that portable pack sets be used whenever the need arises in lieu of installed "mobile" in all vehicles.

In order to protect scientific electronic equipment it is recommended that modern mobile electronic countermeasure equipment with specially trained operators be provided at each atoll of operation.

Air Operations.

1. Conclusions:

a. The airlift provided was adequate to support the scientific mission.

b. Administrative devices such as the TCA imposed unwieldy procedures on a purely operational requirement for airlift between scientific stations.

c. Control and dispatch of aircraft supporting the scientific mission is most effectively executed at the place where the mission requirement is generated.

d. Maximum use of scheduled airlift provides the most satisfactory service.

2. **Recommendations:**

a. Inter-island airlift at Eniwetok should be considered as an operational matter and should be arranged by normal staff action between operating and using headquarters. The TCA should not be concerned with operational requirements for helicopter missions. ~~any more than he is with requirements for B-36 missions.~~

b. The TG 7.4 operations personnel and TG 7.5 dispatch personnel with proper facilities for control and dispatch of aircraft supporting inter-island airlift should be at Elmer. ~~Since they are there on minus one and D-days, using a different procedure by operating from Fred between shots is not practical.~~

c. Regularly scheduled flights to the scientific stations should be maintained through all minus one days, and should be resumed again on shot days as soon as the Rad-Safe survey, and recovery missions are completed.

d. The operational limitations of the agency providing light aircraft and helicopter support should be established prior to the operation. Then the operation should be planned within the limitations of the support agency or another agency should be selected which can provide the support required.

e. The using agency should not be required to justify its requirements to the supporting agency. If justification is required, then requests for support should be routed thru JTF SEVEN which should make the approved requests directive on the supporting agency.

3. Motor Vehicles:

a. All details on the maintenance of vehicles, to include spare parts, should be worked out between TG 7.2 and TG 7.5 prior to the start of the operation. Spare parts should be on hand and available for use no later than the arrival of vehicles at the Proving Ground.

CHAPTER IV

SUMMARY OF TASK UNIT ACTIVITIES

4.1 TASK UNIT ONE, 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 weapons and nuclear devices; to measure certain physical quantities of fundamental importance to weapon design; and to study the physics underlying certain effects produced by nuclear weapons or devices.

4.1.2 TECHNIQUES

The techniques used to make the measurements are described briefly in Chapter II, section 2.2. They are described in much more detail in the pre-operational and technical reports of the various programs prepared at LASL.

4.1.3 OPERATIONS

The use of barges as firing points for most of the LASL shots, together with the use of two firing sites which could be used concurrently, made possible a speed up in the firing schedule over previous operations and greatly simplified operational problems.

For the more remote land sites and barge operations the flexibility provided to experimental groups by the use of houseboats proved very advantageous.

Helicopter and boat transportation were generally good.

The radiation safety problem was well handled and caused little inconvenience to the scientific personnel during the operation.

Radio and telephone communications were generally good, and service was very prompt when units became defective.

4.1.4 COMPUTERS

The high speed computing facility was very useful to TU-1 experimenters

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and theoreticians. It was a marked advantage to be able to reduce data promptly in the field without laborious hand calculations and to recompute problems as new data became available. Adequate time was available on the machine for TU-1 purposes.

4.1.5 J-7

It was very satisfactory to have an engineering group available in the field to reconcile and coordinate individual experimental construction requirements up to shot time. The J-7 unit was particularly useful when new shots were added during the series.

4.1.6 GRAPHIC ARTS

The photographic requirements of TU-1 were efficiently handled, and in addition graphic arts was able to assist other task units on special problem

4.1.7 RECOMMENDATIONS

It is recommended that the J-1, J-3, J-4 and J-6 sections of TG 7.1 continue to handle the requirements of TU-1 directly rather than to duplicate their functions in the TU-1 organization.

A system to allow dry run tests of shot barge equipment at the Parry barge slip would allow still further acceleration of the shot schedules without decreasing the reliability of the firing system.

Separation of the LASL and Livermore laboratory efforts on two atolls made possible better coordination of the work at each site and should be retained in the future if possible.

In order to maintain morale and improve coordination with the home laboratory, it is desireable to rotate people between field and the ZI more frequently. This is especially important if it is desired to maintain the capacity to add new devices to the shot schedule during the operation.

CHAPTER 4

SUMMARY OF TASK UNIT ACTIVITIES

4.2 TASK UNIT 2, UCRL PROGRAMS

4.2.1 Objectives.

Tu-2 was organized to field UCRL-designed weapons and nuclear devices and to carry out diagnostic experiments designed to measure certain of their properties.

4.2.2 Techniques.

The techniques used to obtain the various measurements are described briefly in Chapter 2, Section 2.3. They are also described, in much greater detail in the preoperational and technical reports of the various programs.

4.2.3 Operations.

The concept of UCRL and LASL limiting their activities to separate atolls was introduced for the first time in Hardtack. It proved to be a very satisfactory arrangement for the major portion of the operation, though a combination of factors resulted in the necessity of shifting several UCRL shots to Eniwetok during the latter stages of the program. Chief among the factors requiring UCRL to shift devices to Eniwetok was the tight production schedules encountered in the fabrication of devices and the inherently poorer shooting weather encountered at Bikini when compared to Eniwetok. Much of the diagnostic support required at Eniwetok was provided by EG&G; without this support the two-atoll operation would not have been possible.

4.2.4 Results.

The Operation was very successful on all counts.

4.2.5 Recommendations.

a. The policy of concentrating an individual laboratory's

[redacted]

major effort on one atoll should be continued.

b. Multiple shot sites should be prepared at each atol
This makes it possible to fire several devices during a short
period of favorable weather.

c. A small number of support craft should be equipped
with radios which would permit personnel aboard to communicat
directly with their Task Unit Headquarters. This could be
limited to one each LCM, LCU, and helicopter.

d. Teletype and telephone service cleared through Secre
Restricted Data should be available to any complex or island
on the atoll that is the site of a major camp.

e. Each shot within an atoll should have a completely
independent timing and firing system, making in possible to
dry run one device while another is at the ready.

f. The Task Unit Commander should have direct communic
tions from the CP with the sample control aircraft at all ti

4.3 TASK UNIT 3, DOD PROGRAMS

Task Unit 7.1.3 was activated in the EPG on 15 March 1958 and was organized to conduct approved weapon effects tests under the operational control of CTG 7.1 and the technical direction of Chief, AFSWP. The organization was broken into three operating units with Task Unit Headquarters and a Deputy for Eniwetok, where the majority of projects were based, and Forward Area Commands at Bikini and, after removal of zero sites for Teak and Orange were authorized, one at Johnston Island. The Bikini staff was reduced to one officer and one enlisted man after the Yucca event, but was again manned in July for the Quince shot, after completion of the Eniwetok participation. Most of the personnel released at Bikini after Yucca, along with a small number from Eniwetok, formed the Johnston Island Staff. This arrangement provided efficient control over operations at both Bikini and Eniwetok as well as the opening of Johnston Island activities with a minimum of overhead.

The Commander, Task Unit 7.1.3 Eniwetok, supported by a small staff supervised the activities of the Directors of 8 Programs and 55 Projects grouped under them. (Figure 4.1 includes Projects 2.6, 2.11, 4.1, 6.10, 6.12, 6.13 and 9.3 which participated only in the Johnston Island phase). During the Operation in the EPG approximately 80 Task Unit 3 Staff Personnel and 900 Project Personnel participated. The peak strength was reached on 12 April when a total of 665 Task Unit 3 Personnel were present in the EPG. Staff Personnel were furnished by Field Command, AFSWP, with a small number of augmentation personnel furnished by the various Armed Services upon the request of the Chief, AFSWP, Project personnel came brom the agencies listed in the Organization Chart, Task Unit 3.

The programs undertaken were extensive and varied, including maximum efforts in three DOD shots, (Yucca, Wahoo and Umbrella). Although data was collected on several shots, the prime objectives of the Program Six study of 19 the ionization effects on the ionosphere could not be accomplished in the EPG. The projects will move to Johnston Island for participation in Teak and Orange. Aircraft instrumentation on the Yucca shot was very successful. Some projects, participating on development shots, had to repeat their experiments or change their activity to other shots due to schedule and yield changes of some devices. In general however, the objectives outlined in Chapter 1.3 were met.

The Task Unit 7.1.3 mission was accomplished without major operational difficulties. Careful management of manpower was necessary to properly maintain TU-3 Staffs at the three operating locations. Although many minor problems were presented, satisfactory solutions were found for all, often with the assistance of TG 7.1 Staff Agencies. Special problems were presented by the projects, with 41 personnel, stationed off Atoll. In many instances, the excellent cooperation of other governmental agencies, particularly the Air Weather Service and the CAA made the final accomplishment of the mission possible.

[redacted]

CHAPTER 4

SUMMARY OF TASK UNIT ACTIVITIES

4.4 TASK UNIT 4. SC ACTIVITIES

4.4.1 Mission of Task Unit 4.

The mission of Task Unit 4 was to organize and field Programs 32 and 34. These programs performed thask for and provided information of interest to the AEC and DOD. These programs were supported by TU-4 staff services consisting of Photo Support, Construction Liaison personnel, and the Task Unit counterparts of J-1, J-3 and J-4.

All service projects being performed by Sandia Corporation for AFSWP, LASL and UCRL were organized into a single program with Sandia project numbers and a Sandia Program Director. This method of organization proved to be highly effective as it not only provided better service to the organization placing the requirement but allowed closer administrative control over Sandia personnel connected with these projects.

4.4.2 Operations in the Forward Area.

Staff elements of TU-4 arrived in the Forward Area in January and February with personnel attached to Program 32 arriving in March. By April 1st most of the personnel attached to Program 34 had arrived. The first personnel peak was reached in April when 111 SC personnel were present at EPG. The second peak occurred in July when 123 SC personnel were present. Over all, a total of 200 SC personnel have participated in Operation HARDTACK in the Pacific Area.

In early April the disheartening decision was made to fire TEAK and ORANGE at Johnston Island. Although this put a considerable strain on supplying staff elements, technical equipment and

[redacted]

[redacted]

qualified personnel, readiness at Johnston was accomplished well ahead of schedule without interfering or delaying operations at Bikini and Eniwetok.

A major objective in TU-4 planning was to do all possible to keep the morale of the participating personnel high. This was accomplished by providing the following:

1. A firm date for departing for home. This was normally a two month period.

2. Amateur Radio "Phone Patch" service to the United States.

3. Boats and motors for water skiing and fishing.

4. Indoor and outdoor sport equipment such as table tennis, tennis, volleyball, fishing poles, etc.

5. Tape recorders. These were used for playing music, taped meassages from home and for sending taped messages home.

4.4.3 Conclusions.

An evaluation of early test data shows that the technical phases of TU-4 participation in the HARDTACK operation were highly successful. These successes were achieved, to a great extent, bu acting upon the below listed recommendations made by Task Unit Four on Operation REDWING:

1. More extensive use of prefabrication and trailer-mounted instrumentation.

2. Use of ECM equipment to locate interference.

3. Better recreational facilities and equipment.

4. Better communication facilities.

The Amateur Radio "Phone Patch" service provided by TU-4 was by far the outstanding contributor to high morale in the forward area.

Even with delays and extensions of the operation, Task Unit 4 morale remained high.[redacted]

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4.4.4 Recommendations.

It is recommended that the organizing of all service projects performed by SC into a single program be continued on future operations.

Amateur radio stations should be encouraged to operate in the forward area. The decided improvement of morale due to phone patch service homme cannot be ignored.

A real effort should be made on future operations in the early planning stage to provide a more realistic shot schedule and length of operation estimate. If this could be done it would permit greater economy in the preparation of components and utilization of manpower.

The shortage of vehicles on Johnston Island caused real delays and unnecessary hardships to TU-4 personnel.

[redacted]

4.5 TASK UNIT 5

4.5.1 Timing and Firing - Communications.

Objectives.

The objectives of the timing and firing program on Operation HARDTACK were as follows:

1. To provide a reliable system for arming and firing the devices.

2. To supply experimenters with accurate wire, radio, and voice timing signals on all dry runs and on all detonations.

3. To furnish personnel as members of the arming and firing parties.

4. To monitor by wire and by radio, vital information pertaining to the readiness of the test devices and of crucial experiments.

5. To determine the time of detonation with respect to world time as broadcast from WWVH, Honolulu, or JJY, Japan.

6. To provide and operate Bhangmeters, where practicable, for the preliminary determination of yield.

Procedure.

Seven timing and firing systems, independent in operation, were installed to provide maximum flexibility in scheduling dry runs and detonations. The Control Point on Enyu Island at Bikini Atoll controlled three systems, one of which was moved to the ABMA Firing Bunker on Johnston Island to control signals for Operation Newsreel shots. Three additional systems were employed for the shots detonated at Eniwetok Atoll, with control exercised from the Control Point on Parry Island. Another system was located on board the USS Boxer for the high-altitude balloon shot.

Each system, except for the Boxer and the Johnston Island installations, included one or more timing signal distribution stations. In addition to the Control Points, a total of eleven

[redacted]

[redacted]

TABLE 1

TIMING AND FIRING STATIONS

STATION	LOCATION
<u>ENIWETOK</u>	
71 (Control Point)	Parry (Elmer)
77.01	Runit (Yvonne)
77.02	Engebi (Janet)
77.03*	Bogon (Irene)
Shipboard	USS Fullam (DD474)
	USS Howorth (DD592)
	USS Killen (DD593)
	YFNB-12
	EC-2
<u>BIKINI</u>	
70 (Control Point)	Enyu (Nan)
74.01	Airukiiji (Oboe)
75.02	Bikini (How)
76	Aomoen (George)
78.01 †	Namu (Charlie)

* - Station 77.03 was disconnected after Shot Koa.

† - Stations 75.02 and 78.01 were decomissioned when the missile system was removed to Johnston Island; late in the operation, however, the equipment at Station 76 was removed and installed in Station 75.02.

[redacted]

[redacted]

distribution stations served experimenters in locations at both atolls, including five shipboard stations operated by the radio-signal system for the underwater shots. These stations are listed in Table 1.

To provide greater flexibility, the basic timing system was completely revised for this operation. By means of a patch-board on the sequence timer, as many as twenty-four separate times could be selected at any half-minute interval from -60 minutes to -2 minutes, and at any half-second interval from -2 minutes to ≠ 1 second. The selected times were transmitted to the timing station over a single pair of wires as a series of 100-millisecond pulses. Another patch-board on the timing station decoder provided the means whereby any of the timing signals received from the Control Point could be selected and distributed to any number of users.

Two radio-tone timing signal systems supplemented the hardwire systems at Eniwetok and Bikini by providing signals to users in locations where hardwire signals were not feasible. Separate radio-tone systems operated the major instrumentation on the two underwater shots and on the high-altitude balloon shot. A similar system was installed at Johnston Island. A firing-tone transmitter furnished the signals for arming and firing the two underwater devices. Users requiring radio signals were supplied with EG&G Tone-receiver units, consisting of a radio receiver, a tone-sensitive relay system, and heavy-duty output relays for operating equipment. To eliminate the possibility of false triggering, two different audio tones were transmitted simultaneously for each timing signal.

[redacted]

On the underwater shots, a zero-fiducial net provided the experimenters with an accurate zero signal.

Voice-time equipment was installed at both Control Points for broadcasting to all users of voice-time signals in synchronization with the timing signals. The count-down was given live from -60 minutes to -15 minutes. At -15 minutes, the tape recorder started, and the count-down was given automatically until zero time. The Boxer and the Johnston Island voice-time installations were similar. When necessary, EG&G supplied users with receiving equipment for the count-down. The voice-count-down was also patched into various user nets at the Control Points. These nets, along with the radio signal nets, are listed in Table 2.

The timing and firing installation on the Boxer included the automatic air-drop sequence timer used on Operation Plumbbob. Run time could be pre-set to any 1/10 second. Signals were manually initiated at the control console from -60 minutes to -1 minute, and the automatic timing sequence began at -30 seconds when the verbal "go-ahead" was received. Both wire and radio signals were transmitted.

The Johnston Island system, originally at Bikini, included a sequence timer identical to those at Eniwetok and Bikini. This timer began the timing sequence and transmitted signals automatically until a specified time prior to zero time. A "ready" signal from the launching site then started the new automatic air-drop sequence timer, which continued to transmit timing signals through zero time. The new air-drop timer was similar to the one used on the Boxer except that it could be

TABLE 2

COMMUNICATIONS NETS

	VOICE NETS	SIGNAL NETS
Eniwetok	Voice-time No. 1	Radio-Time No. 1
	Voice-time No. 2	Radio-Time No. 2
	EG&G Net	DOD Firing Net
	TU-1 (LASL) Net	Zero Fidu Net
	Command (Kleenex) Net	
	TU-4 (Sandia) Net	
	ACC (Air Force) Net	
Bikini*	Voice-Time No. 2	Radio-Time No. 2
	EG&G Net	
	LASL Net	
	Gaslight (UCRL) Net	
	Harvester (Sandia) Net	
	Command (Kleenex) Net	
	AOC (Air Force) Net	
	Tropo (inter-atoll) Net	
USS Boxer	Voice-Time Net (count-down broadcast through nets at both atolls)	Radio-Time Net

* - Voice-time No. 1 and Radio-Time No. 1 were removed to Johnston Island.

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set for a longer run time.

New zero racks were designed for this operation to supply power and arming signals in the proper sequence for the actual firing of all surface, barge, and underwater shots. Three types were employed for the differing requirements of the laboratories and the DOD. Thirty-two of these racks were used, one at each zero site. Prior to detonation, EG&G personnel on the arming party installed the zero racks and made a thorough check of all zero-rack functions before buttoning-up the site.

Strip-chart recorders provided a permanent record of all signals sent out from the Control Point. Monitoring of important functions at zero sites and at experiment stations was accomplished by wire and by radio. Tone-telemetering was the primary method employed for the AEC shots. The monitoring system for the DOD underwater shots was almost completely radio.

For special experiments, EG&G employed strip-chart recorders to monitor temperature, humidity, and pressure at zero-site or station locations.

A new EG&G world-time clock, accurate to a tenth of a millisecond, and four Bhangmèters were located at each Control Point; these units were triggered by light from the explosion.

To assure good photographic records of a detonation, a weather radar console was operated in each Control Point.

Results.

The six timing and firing systems successfully detonated all thirty-three shots of Hardtack series. The two Bikini

[redacted]

systems were used for ten University of California Radiation Laboratory (UCRL) shots. Two of the Eniwetok systems served fifteen Los Alamos Scientific Laboratory (LASL) shots and five UCRL shots. The third Eniwetok system was employed on the two underwater tests conducted by the Department of Defense. The Boxer system detonated the DOD high-altitude balloon shot.

The following signals were selected as standard for the hard-wire system; however, numerous special signals were added as needed:

-60 minutes	-30 seconds
-30 minutes	-15 seconds
-15 minutes	- 5 seconds
- 5 minutes	- 2 seconds
- 1 minute	- 1 second
	0
	+ 1 second (cut-off)

These signals, with the exception of the -60 minute signal, were also transmitted by the radio-tone system. All wire, radio, and voice timing equipment operated properly. Hard-wire signals were accurate to + 0.05 second with respect to zero time. Radio signals were delayed approximately 0.25 second.

The world time clocks recorded the time of detonation for 29 shots. The Bhangmeters operated on all but the underwater shots and recorded the time to light minimum from which an early approximation of yield was made on 27 shots.

4.5.2 Technical Photography

General.

On Operation Hardtack, EG&G performed technical photography of the visible aspects of all detonations as a service to the Los Alamos Scientific Laboratories, the University of California Radiation Laboratories, and the Department of Defense. The major tasks on AEC events were to photograph fireball growth for determination of yield and to record cloud growth and motion. DOD projects involved photography of phenomena resulting from underwater and high-altitude detonations. Specific EG&G photographic commitments, including those for Operation Newsreel at Johnston Island, are listed by project number in Table 3.

Instrumentation.

For the laboratory shots, cameras were located at stations on Bikini and Eniwetok Atolls. These stations are listed in Table 4.

To provide views of the fireball and of cloud formation from different angles, at least two photo stations were used on the smaller AEC shots and as many as four on the larger shots. Because of the complexities of the shot schedule, EG&G had to be prepared to photograph either of two detonations at both Eniwetok and Bikini Atolls; therefore, each of the six photo towers contained two complete sets of cameras and control equipment.

The primary photography of fireball growth was provided by high-speed Eastman cameras, operating at a nominal speed of 2500 frames/sec. In addition, each of the major photo stations included two or three cameras for cloud photography. Mitchell

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TABLE 3

EG&G PHOTOGRAPHIC COMMITMENTS

OPERATIONS HARDTACK AND NEWSREEL

PROJECT NO.	SPONSOR	AGENCY	TITLE
1.2	DOD	AFSWP	Air Blast Measurements
1.3	DOD	AFSWP	Surface Phenomena Measurements
1.6	DOD	AFSWP	Water Wave Measurements
2.3	DOD	AFSWP	Characteristics of Radiological Environment
3.4	DOD	AFSWP	Loading and Basic Target Response for Surface Ships
4.1	DOD		Bio-Medical Documentary Photography
8.1	DOD	AFSWP	Effects of Thermal Radiation Materials
8.3	DOD	AFSWP	Early Fireball Photography
9.1	DOD	AFSWP	General Support (Photography)
9.3A	DOD	AFSWP	Support for UHA and VHA
15.1	AEC	EG&G	EG&G Photography
18.1	AEC	NRL	Hi-Altitude Thermal Measurements

[redacted]

[redacted]

TABLE 4

PHOTO STATIONS

STATIONS	LOCATION	TYPE
BIKINI		
1510	Enyu (Nan)	300 foot tower
1514.03	Bikini (How)	75 foot tower
1514.04	Chieerete (William)	75 toot tower
1515	Airukiiji (Oboe)	6x6 photo truck
ENIWETOK		
1511	Parry (Elmer)	300 foot tower
1513.01	Runit (Yvonne)	24 foot platform (roof of timing station)
1514.01	Piraai (Wilma)	75 foot tower
1514.02	Mack	75 toot tower
1512	Bogallua (Alice)	Photo Bunker
1520*	Runit (Yvonne)	6x6 Photo truck
810.02	Aitsu (Olive)	8.1 Thermal pad

* -- Used on Quince only.

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high-speed cameras operating at 100 frames/sec. recorded early cloud, and Traid cameras operating at 24 frames/sec. recorded late cloud. GSAP cameras at 64 frames/sec. were used for late cloud and color documentary photography. For refinement of zero-time fireball data, Rapatronic cameras were operated at both atolls.

Photographic commitments for the DOD necessitated the use of numerous additional photo stations. The number of stations used on each DOD shot is given in Table 5.

TABLE 5

DOD PHOTO STATION REQUIREMENTS, OPERATIONS HARDTACK AND NEWSREEL

SHOT	SURFACE STATIONS	SHIPBOARD STATIONS	AIRCRAFT STATIONS
Yucca		1	2
Wahoo	2	3	4
Umbrella	3	2	4
Teak	6	3	2
Orange	5	3	2

Photographic coverage of the high-altitude balloon shot was obtained from two aircraft and from the USS Boxer. The primary high-speed photography of the fireball was accomplished by EG&G 70-mm streak cameras operating at approximately 20 feet/sec. These cameras were also used on Operation Newsreel.

On the underwater shots, cameras in four aircraft viewed 211 the detonation. Other photo stations included a barge, an observer ship, and surface stations on Igurin and Mui. In addition, cameras were located inside the hull of a ship to record the effects on the ship's structure of the shock resulting from the detonation. EG&G provided special lighting apparatus for this experiment.

Planning for Newsreel on Johnston Island includes three ship-board photo stations, two aircraft photo installations, and six mobile and stationary ground installations.

Operation of the photo stations was completely automatic. Timing signals from the Control Points activated the control equipment and the cameras. Cam timers permitted cameras to continue operating after the timing signals dropped out at + 1 second. Signals to surface photo stations were transmitted by wire; aircraft, shipboard, and remote surface stations were operated by radio signals.

Film recovery was made as soon as possible after a detonation. EG&G maintained complete film processing facilities on Parry Island at Eniwetok.

Results.

EG&G performed analysis of fireball records at the Eniwetok Proving Grounds. Analysis for other projects will be accomplished, as required, in the United States. Precision equipment was employed to measure fireball diameter, and the data obtained were reduced on an IBM 704 computer. Final Reports containing the fireball yield calculations were issued in the field on all but the last shot. A list of these reports is given in Table 6.

[redacted]

4.5.3 Alpha Measurements

General.

On Operation Hardtack, EG&G performed reaction history measurements on nineteen devices: fourteen detonated as part of the Los Alamos Scientific Laboratory test program and five detonated as part of the University of California Radiation Laboratory test program. These measurements included alpha vs time throughout the required portion of the measurable history;

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Originally the alpha effort was planned for nine LASL experiments; however, LASL added several shots, and late in the operation five UCRL shots were moved from Bikini to Eniwetok. Thus EG&G was requested to employ its existing instrumentation on eight additonal shots. The complexity of the measuring system varied from experiment to experiment, depending upon the diagnostic requirements of the laboratories Table 7 indicates the amount of instrumentation for each shot and the extent of the reaction history measurement.

Instrumentation.

Except for surface shots Koa, Quince, and Fig, all devices on which alpha was measured were detonated from barge locations. On seven tests, EG&G mounted detectors at the ground zero location and recorded the complete measurable reaction

[redacted]

history. On the remaining tests, the detectors were installed in the Alpha blockhouses and viewed the bomb center through collimation holes or pipes. Four Alpha blockhouses were maintained by EG&G to make possible Alpha coverage for the various shot areas. These stations were No. 1310, Yvonne; No. 1312, Janet; and Nos. 1311 and 1525, Irene.

To obtain at the detectors a signal representative of the neutron signal, it was advisable to limit the emerging gammas by an aperture near the device. In addition, collimation at the detectors was accomplished by means of pipes which extended through the thickness of the blockhouse wall. Inside the detector room were adjustable baffle walls containing collimation holes, which were spaced for alignment with the detectors. The system provided for collimation ratios as high as 50:1. The physical properties of the detector areas varied from station to station, but in all cases both the source aperture and the detector collimators were in alignment with the device at the point or points of interest, and the detectors had their center lines along the aiming line. Actual detector alignment was done by transit.

When it was necessary to reduce the gamma signal, attenuators were used. These were in the form of lead shielding placed either in the collimation indentations on the inner blockhouse walls or in front of the detectors on their scaffold platforms.

Simulation of shot conditions in the detectors was accomplished by means of flash tubes which operated near the expected alpha value.

Three basic oscilloscope systems were employed for recording the alpha signal: a 100-ohm three scope system, a 100-ohm two scope system, and a 120-ohm three scope system. Other combinations were used from time to time as the requirements of individual shots dictated. Three types of indicators (Rossi, linear, and creep-Rossi), together with their power supplies and associated test equipment, were rack-mounted in the blockhouse instrumentation room. The EG&G oscilloscopes, types 3343 and 3445, were the basic units in the system; however, they were supplemented by a number of other commercial units.

The alpha stations were operated from three timing signals originating at the Control Point: a - 30 minute signal, which provided the AC power; a -15 minute signal, which turned on the high voltage; and a -1 second signal, which activated relays to open camera shutters and arm each oscilloscope, GO, NO-GO circuitry was used to provide an interlock against failure of the equipment or of the power supply.

Results.

Records of the oscilloscope traces were analyzed by means of precision comparators and the data obtained were reduced for reporting purposes on an IBM 704 EDPM Computer. The detailed results, by shot, are included in reports issued by EG&G at the Eniwetok Proving Grounds; these reports are listed in Table 6.

TU-5 JOHNSTON ISLAND - ADDENDUM

Objectives.

The primary objective of TU-5 was to supply experimenters with an accurate sequence of timing signals, related to burst time, for the purpose of starting and stopping their equipment on both the Teak and Orange events.

Other Objectives of TU-5 were:

1. To determine the time of burst with respect to WWVH.

2. To provide a system of radio links to experimenters stations, over which voice-time announcements synchronized to the timing system could be transmitted.

Procedure.

Early in 1957, preliminary planning for a timing system to meet the special requirements of Teak and Orange was begun. As planning progressed, it became apparent that the regular sequence timing system planned for the surface shots on HARDTACK would not meet the special requirements of Teak and Orange. A new sequence timing system patterned after the air drop system used on Plumbbob for the John event, was developed in our Boston laboratory. This system was integrated into the Bikini hardwire timing system for HARDTACK.

The timing system was assembled and operationally tested under simulated field conditions in the Boston laboratory prior to its shipment to the forward area.

In February, 1958, the equipment was shipped to the forward area and installed as an integral part of the Bikini timing system. The installation was completed and operationally checked out in preparation for the scheduled Teak and Orange events.

With the cancellation of the Teak and Orange events from the Bikini schedule, it was necessary to remove that part of the timing system from the Bikini installation. A redesign of this equipment, to provide for its independent operation, was accomplished in the forward area utilizing the spare components of the Bikini and Eniwetok timing systems. The system was operationally checked out at Eniwetok prior to its shipment to Johnston Island.

Late in June 1958, a group of field personnel was sent to Johnston Island to start field installation of the timing system.

The timing equipment was installed at Station 70 in Building 6002. Preliminary dry runs started on July 10. Dry runs and special rehearsal tests were continued throughout the Teak and Orange series.

A World Time rack identical to that used at EPG on the HARDTACK series was included in the design of the Johnston timing sytem to record actual zero time with respect to WWVH. This measurement was obtained through the use of a 10 KC oscillator, driving the World Time clock, syncronized to WWVH and located in the control room. The initial flash of the detonation triggered a Fiducial Marker on the roof of the CP. This in turn stopped the clock and produced a photographic record of the clock face at zero time.

Voice-time announcements were made from a script by the timing system control operator, referencing the timing sequence indicators. These announcements were transmitted to the remote experimenters stations on 153.89MC, 243MC, 7411KC, and 1468KC.

In order to transmit timing signals to the two RB-36 experimenter stations, a radio timing system was provided. This system was synchronized to the master timing system and transmitted various tone frequencies to radio receivers located aboard the RB-36's, which in turn activated equipment at the station.

Both AC and DC type Blue Boxes were used on both events to provide experimenters with a zero signal of millisecond accuracy.

The following timing signal sequence was provided for the Teak and Orange events:

TEAK	ORANGE
-60 min	-60 min
-30 min	-30 min
-15 min	-15 min
-5 min	-5 min
-170.3 sec (lift off)	-153.8 sec (lift off)
-165.0 sec	-145.0 sec
-151.4 sec	-110.0 sec
-137.2 sec	-98.0 sec
-131.6 sec	-95.5 sec
-76.2 sec	-66.6 sec
-70.0 sec	-60.0 sec
-66.6 sec	-43.0 sec
-60.0 sec	-40.6 sec
-57.8 sec	-15.0 sec
-51.4 sec	-5.0 sec
-46.8 sec	-2.5 sec
-40.0 sec	-1.5 sec
-15.0 sec	-1.0 sec
-5.0 sec	∅ Test
-2.5 sec	+ 12 sec cutoff
-1.0 sec	
∅ Test	
+ 12 sec cutoff	

[redacted]

Results.

The timing system provided by TU-5, proved, on the whole, to be both reliable and satisfactory. Approximately 150 hardwire timing signals were delivered on both the Teak and Orange events, and 14 radio tone signals were delivered to the two RB-36's.

The various other functions of TU-5 were performed on schedule and require no further comment.

TABLE 6:

STATUS OF REPORTS FOR OPERATION HARDTACK

SHOT	AGENCY	DATE OF DETONATION	SHOT REPORT	FIREBALL REPORT		ALPHA REPORT	
			DATE ISSUED	NUMBER	DATE ISSUED	NUMBER	DATE ISSUED
YUCCA	DOD	28 Apr 58	28 April 1958	B-1800	9 May 1958	NA	NA
CACTUS	LASL	6 May 58	8 May 1958	B-1801	12 May 1958	B-1807	28 May 1958
BUTTERNUT	LASL	12 May 58	13 May 1958	B-1803	23 May 1958	B-1810	3 June 1958
FIR	UCRL	12 May 58	12 May 1958	B-1802	17 May 1958	NA	NA
KOA	LASL	13 May 58	13 May 1958	B-1804	24 May 1958	B-1811	7 June 1958
WAHOO	DOD	16 May 58	17 May 1958	NA	NA	NA	NA
HOLLY	LASL	21 May 58	22 May 1958	B-1805	26 May 1958	B-1815	10 June 1958
NUTMEG	UCRL	22 May 58	22 May 1958	B-1806	29 May 1958	NA	NA
YELLOWWOOD	LASL	26 May 58	26 May 1958	B-1808	4 June 1958	B-1816	12 June 1958
MAGNOLIA	LASL	27 May 58	27 May 1958	B-1809	3 June 1958	B-1818	13 June 1958
TOBACCO	LASL	30 May 58	31 May 1958	B-1814	9 June 1958	B-1819	16 June 1958
SYCAMORE	UCRL	31 May 58	2 June 1958	B-1812	7 June 1958	NA	NA
ROSE	LASL	2 June 58	3 June 1958	B-1813	7 June 1958	B-1822	20 June 1958
UMBRELLA	DOD	9 June 58	11 June 1958	NA	NA	NA	NA
MAPLE	UCRL	11 June 58	11 June 1958	B-1817	13 June 1958	NA	NA
WALNUT	LASL	15 June 58	15 June 1958	B-1821	20 June 1958	B-1824	26 June 1958
ASPEN	UCRL	15 June 58	15 June 1958	B-1820	19 June 1958	NA	NA
LINDEN	LASL	18 June 58	19 June 1958	B-1823	26 June 1958	B-1827	4 July 1958
REDWOOD	UCRL	28 June 58	29 June 1958	B-1825	5 July 1958	NA	NA
ELDER	LASL	28 June 58	29 June 1958	B-1828	6 July 1958	B-1833	10 July 1958
OAK	LASL	29 June 58	29 June 1958	B-1826	6 July 1958	NA	NA
HICKORY	UCRL	29 June 58	30 June 1958	B-1829	7 July 1958	NA	NA
SEQUOIA	LASL	2 July 58	2 July 1958	B-1830	8 July 1958	B-1836	21 July 1958
CEDAR	UCRL	3 July 58	4 July 1958	B-1831	8 July 1958	NA	NA
DOGWOOD	UCRL	6 July 58	6 July 1958	B-1832	9 July 1958	B-1834	12 July 1958
POPLAR	UCRL	13 July 58	13 July 1958	B-1835	17 July 1958	NA	NA
SCAEVOLA	LASL	14 July 58	15 July 1958	NA	NA	NA	NA
PISONIA	LASL	18 July 58	19 July 1958	B-1837	22 July 1958	NA	NA
JUNIPER	UCRL	22 July 58	23 July 1958	B-1838	25 July 1958	NA	NA
OLIVE	UCRL	23 July 58	24 July 1958	B-1839	25 July 1958	B-1841	26 July 1958
PINE	UCRL	27 July 58	28 July 1958	B-1842	29 July 1958	B-1843	2 Aug 1958

TABLE 7 - HARDTACK ALPHA INSTRUMENTATION

SHOT NAME	AGENCY	DATE	ALPHA STATION	NO. OF DETECTORS	NO. OF INDICATORS
Cactus	[illegible]	[illegible] May 1958	1310	10	21
Butternut	LASL	[illegible] May 1958	[illegible]	8	17
Koa	LASL	1[illegible] May 1958	1311 & 1520	11	19
Holly	LASL	[illegible] May 1958	1310	10	21
Yellowwood	LASL	[illegible] May [illegible]	1312	7	14
Magnolia	LASL	[illegible] May 1958	1310	6	14
Tobacco	LASL	[illegible] 1958	1312	7	14
Rose	LASL	[illegible] June 1958	1310	9	21
Walnut	LASL	[illegible] June 1958	1312	4	11
Linden	LASL	[illegible] June 1958	1310	10	22
[illegible]der	LASL	[illegible] June 1958	1312	7	15
Sequoia	LASL	2 July 1958	1310	10	21
Dogwood	UCRL	6 July 1958	1312	7	19
Scaevola	LASL	1[illegible] Jul 1958	1310	7	18
Olive	UCRL	[illegible] Jul 1958	1312	[illegible]	19
Pine	UCRL	27 Jul 1958	1312	[illegible]	11
Quince	UCRL	Aug 1958	1310	6	17
Fig	UCRL	Aug 1958	1310	6	17

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4.6 TASK UNIT 6, RADIOLOGICAL SAFETY

4.6.1 Mission. The mission of TU-6 was as follows:

1. Perform all ground and aerial monitoring services associated with the scientific mission except those in conjunction with aircraft and airborne collection of scientific data; assume responsibility for rad-safe for TG 7.5 during the operational phase.

2. Provide laboratory and technical assistance to all task groups.

3. Provide all official dosimetry services for JTF 7.

4. Maintenance and issuing of monitoring instruments and protective clothing as required.

5. Decontamination facilities for personnel, vehicles, and equipment

4.6.2 Organization. The necessity of maintaining a capability for firing at both Bikini and Eniwetok Atolls at the same time required that TU-6 provide two complete and independent rad-safe organizations. Over-all control over the two organizations was maintained by CTU-6. In addition, full rad-safe support was provided for the operations conducted at Johnston Island. Each organization contained the following sections:

1. Monitoring section for providing all monitoring services and manning check points.

2. Plotting and briefing section for conducting all aerial surveys and briefing all personnel going into radiological exclusion areas.

3. Supply section for maintenance of rad-safe supplies, including laundry. (Facilities furnished by TG 7.5)

4. Instrument repair section for maintenance of rad-safe instruments.

5. Laboratory section for determining the amount of activity contained in soil, water and urine samples.

6. Decontamination section for operating facilities for personnel and equipment decontamination.

Control over the official dosimetry and records was maintained directly by CTU-6. The single badge system was used during the operation. Badges were exchanged after missions in radex areas. All badges were called in at sixty-day intervals. Badges were processed by photodosimetry sections located on both Bikini and Eniwetok atolls. Complete current dosage

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record files were maintained on a daily basis at both atolls. A master record file for personnel in JTF 7 was maintained on IBM tape at Eniwetok.

Personnel for manning TU-6 were obtained from the Army, Navy and Air Force. The majority of the personnel were obtained from the Army's First Radiological Safety Support Unit, a Chemical Corps unit stationed at Ft. McClellan, Alabama. The following is a breakdown of personnel attached to TU-6:

1. Army - 95 Officers and Enlisted.
2. Navy - 8 Officers and Enlisted.
3. Air Force - 12 Officers and Enlisted.
4. Contract civilians (TG 7.5)- 14
5. Contract advisors (TG 7.5)- 3

Scientific project personnel in TG 7.1 and contractor personnel in TG 7.5 were requested to provide their own monitors for recovery and construction missions. A three day school was held at EPG specifically to train such monitors. The schooling was found to be a very satisfactory arrangement.

4.6.3 <u>Operations</u>. In support of TG 7.1 and 7.5 at both Bikini and Eniwetok, check points were established as required. Main check points utilized at all times at both atolls were located at the air dispatcher's office and the marine landing. All personnel entering or returning from a radex area were processed through the check points. An area was considered a full-radex area if the gamma radiation field exceeded 100 mr/hr. Full protective clothing was required for entry into a full radex area. Limited radex areas were established when the gamma radiation field exceeded 10 mr/hr, but was less than 100 mr/hr. Clothing requirements varied with the situation in the limited radex areas. An area in which the gamma radiation field was less than 10 mr/hr was considered non-radex. The following is a summary of rad-safe processing:

1. A total of 2,658 parties containing 6,124 persons were processed through the Eniwetok check points from 1 May 1958 to 1 August 1958;

753 parties containing 2,747 persons being processed at Bikini from 13 May 1958 to 1 August 1958.

2. The personnel decontamination station at Eniwetok handled a total of 852 individuals while the facility at Bikini processed 1227.

3. The following equipment was decontaminated:

	Eniwetok	Bikini
Vehicles	50	28
Pieces of equipment	591	193
Helicopters	5	3*
Hot park (equipment)	100	70
Aircraft	0	1

* Processed by parent organization with rad-safe advise.

The majority of the rad-safe surveys of both atolls were conducted by helicopters. Normal operations included a pre-entry survey with CTG 7.1 at H/6 to 8 hours, and detailed surveys on the mornings of D/1 and 2 days. Additional surveys were made as required. Instruments used in the surveys included AN/PDR-39's converted to read to 500 r/hr. Ground surveys of islands in the atolls were conducted when required.

Fallout occurred at both atolls from the Fir device commencing two days after the event on Bikini with the highest background being 12 mr/hr and one day after detonation at Eniwetok, the background being 30,000 counts for a two day period. At Eniwetok fallout occurred from the Olive device on 18 July for a period of three hours, the maximum intensity being 60,000 counts per minute. The Poplar device caused a two day increase in background at Eniwetok. It has been estimated that personnel at Eniwetok received a 1500 mr dose and Bikini personnel received a 300 mr dose from fallout. This dose in no way interfered with the mission of TU-6. Fallout was not sufficiently high to hamper operations during the entire period.

A total of approximately 850 soil, water, and food samples were taken by laboratory personnel. An arbitrary limit of 500,000 disintegrations per minute per liter of water was established as the tolerance level for swimming. Swimming areas at both atolls remained open during the entire operation except for one day at Bikini following the Fir shot.

4.6.4 Official Dosimetry. A single film badge system was used during the operation with exchanges being made every eight weeks and when personnel returned from full radex areas. Total dosage records were kept current daily through the use of the following equipment: IBM 704 Computer, IBM 526 Summary Punch, IBM 082 Sorter, IBM 026 Key Punch, IBM 056 Verifier, IBM 519 Reproducer, IBM 552 Interpreter, IBM 066 Data Transceiver, and the Eberline FD-11 Film Badge Evaluation System configured to feed the IBM 526 Summary Punch.

The first film badge was issued on 1 April 1958, there being 7,500 badges issued at Bikini and 40,000 badges issued at Eniwetok out of a total for 50,000 badges processed during the operation. Remaining badges were used for calibration purposes and by project personnel as special programs required their use. As of 1 August, a total of 19,000 persons had been issued film badges.

Twenty persons were utilized in dosimetry, nine at Bikini and eleven at Eniwetok. Only film processing and filing was done manually.

The maximum permissible dosage was established as 3.75 r for any 13 week period with 5 r being the upper limit for the entire operation. The one exception to this decision was that sampler aircraft pilots were allowed 10 r for the operation. As of 1 August 1958, only four persons had exceeded the 5 r maximum permissible dose.

4.6.5 Conclusions. The Eberline FD-11 Film Badge Evaluation System, in conjunction with the IBM installation, enabled the dosimetry section to operate efficiently on less than half the personnel required for previous operations.

The rigid acetate encased film badges were highly successful because they were not affected by heat, moisture, or humidity. The type film badge used were DuPont type 559, and consisted of the 502 and 834 dental type films for low and high range dosage exposures respectively.

4.6.6 Recommendations. It is strongly recommended that the method of maintaining daily dosage records employed during Operation HARDTACK be used in future operations of this type.