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TASK GROUP 7.4
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OPERATION CASTLE
1 January 1953 - 26 June 1954

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HISTORY

of

TASK GROUP 7.4

participation in

OPERATION CASTLE

1 January 1953 - 26 June 1954

Prepared by the Historical Division
Office of Information Services
Air Force Special Weapons Center

(Air Research and Development Command)

Prepared under provisions of AF Regulation 210-3, 210-3A, and ARDC Regulation 210-1 as a part of the USAF Historical Program.

Kirtland Air Force Base, New Mexico
8 November 1954

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LIST OF ILLUSTRATIONS

[redacted] [redacted]

INTRODUCTION

This concise history of the Air Task Group in Operation CASTLE (the spring 1954 Pacific thermonuclear tests) was produced in the Historical Division, Office of Information Services, Air Force Special Weapons Center by A/1C Dudley F. Saunders. It is not intended to be a complete history of Task Group 7.4 in that operation, but is designed to record the major features of Task Group 7.4's participation.

For a full account of Task Group 7.4 in the operation, the reader is referred to the monthly histories of the Air Task Group for the period beginning July 1953 and ending in May 1954. These monthly reports contain all supporting documents and pictures of the operation. Copies are on file in the AFSWC Historical Archives, the Air Task Group's permanent records, and with the ARDC Historian. Size and bulk of these histories have made it impractical to distribute copies, since they occupy five linear feet.

One additional document completes the Air Task Group history. This is the Final Report of the Commander, Task Group 7.4, Operation CASTLE. Since copies are readily available, no attempt was made to include it in this history. For the same reason, to prevent duplication of effort, documents and photographs included in the monthly Task Group histories were not included in this document. For other reports of the operation, consult the appended bibliography.

Emphasis in this short account will be found to be on broad operational problems of the Air Task Group, and on information on the results and significance of the operation to the Air Force.

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Operation CASTLE also showed that the system of firing thermonuclear devices from anchored barges (no thermonuclear device or weapon has to date been detonated as an air drop) in Bikini and Eniwetok Atolls was practical. By firing from barges anchored in the craters of previous shots, the limited amount of available real estate was thus preserved for future tests. By leaving the reef intact, the lagoon was preserved, and lagoon operations were protected from strong ocean currents and roughness.

The high-yield thermonuclear devices detonated on the surface at CASTLE caused radiological contamination of personnel and natives in the atolls to the east of Bikini Atoll following BRAVO, and made it evident that the Pacific Proving Ground had outgrown its previously

established Danger Zone. The boundaries of the Danger Zone were extended considerably following BRAVO.

The Air Control System for aircraft used on CASTLE was of an advanced nature. It proved considerably superior to the systems used on previous operations.* Prior to CASTLE there had never been a positive Air Control System in the Pacific Proving Ground during a shot series. The Air Operations Center (AOC) and the USS ESTES exercised positive control of all aircraft in the Proving Ground and at all times knew the location of every participating aircraft. This was made possible by the installation of IFF scopes in the Air Operations Center and on the USS ESTES. This installation gave the control centers (the AOC and the Combat Information Center on the USS ESTES) the capability of directing the aircraft and of ascertaining their location in case of any emergency. This new system will be adapted for use on all future tests, both overseas and continental. (For additional information on this system see the Final Report of the Commander, Air Task Group 7.4, Operation CASTLE.)

Participation of the Air Force in Operation CASTLE was of great benefit, particularly in the field of increased knowledge of weapon effects on aircraft. Details of this knowledge will be found in the text.

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* Task Group 7.4 personnel affiliated with the Air Control System were generally in agreement that the only possible improvement to the System used on CASTLE would be the addition of a GCI (Ground Controlled Intercept).

ORGANIZATION OF JOINT TASK FORCE SEVEN

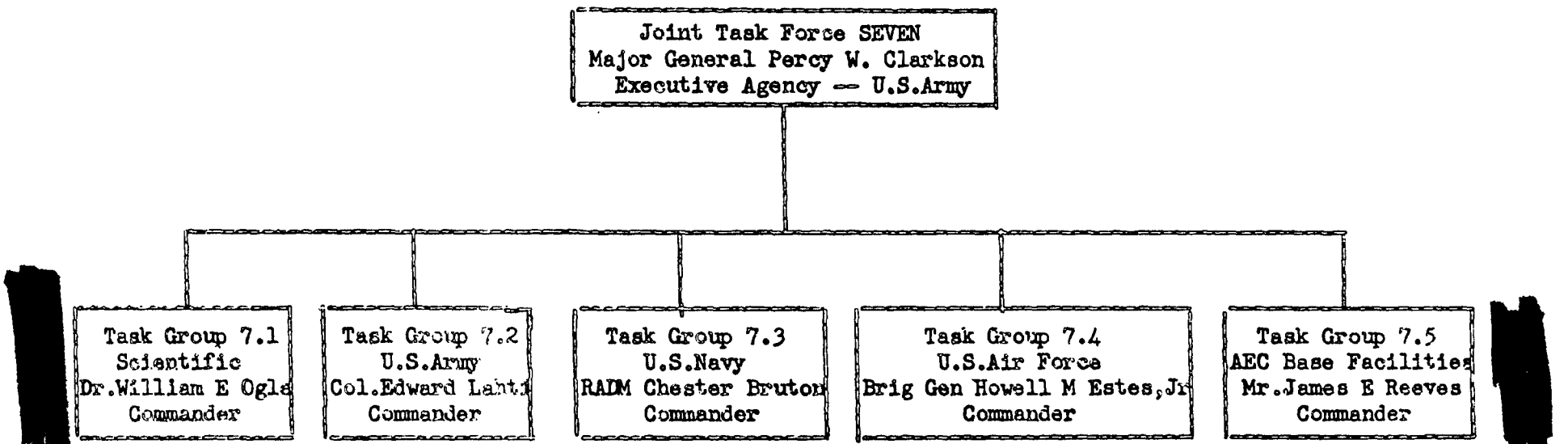


ILLUSTRATION 1

CHAPTER I

OPERATION CASTLE AND THE AIR TASK GROUP

Operation CASTLE, the fifth in the Atomic Energy Commission (AEC) series of overseas nuclear weapons tests, was conceived in April of 1952. Originally the operational phase was scheduled for about 1 September 1953, but this date was later set back to January of 1954. The tests were conducted in the Marshall Islands, at Eniwetok and Bikini Atolls in the AEC Pacific Proving Ground.

In May of 1953, the Joint Chiefs of Staff approved the revised CASTLE force requirements and directed the Chief of Staff, United States Air Force (USAF), to support Joint Task Force SEVEN (JTF SEVEN) by providing an Air Task Group (7.4) composed of units and detachments to conduct the Air Force's role, and allied functions, in the operation.[1] ILLUSTRATION 1, opposite page, shows the organization of Joint Task Force SEVEN.

The mission of this Air Task Group (ATG) was to:

1. Provide, operate and support the aircraft necessary to collect and record data as specified by the scientific program,

2. Operate adequate aircraft operations and maintain facilities,

3. Provide intra-atoll and inter-island air transportation,

4. Provide weather reconnaissance, analysis and forecasting services,

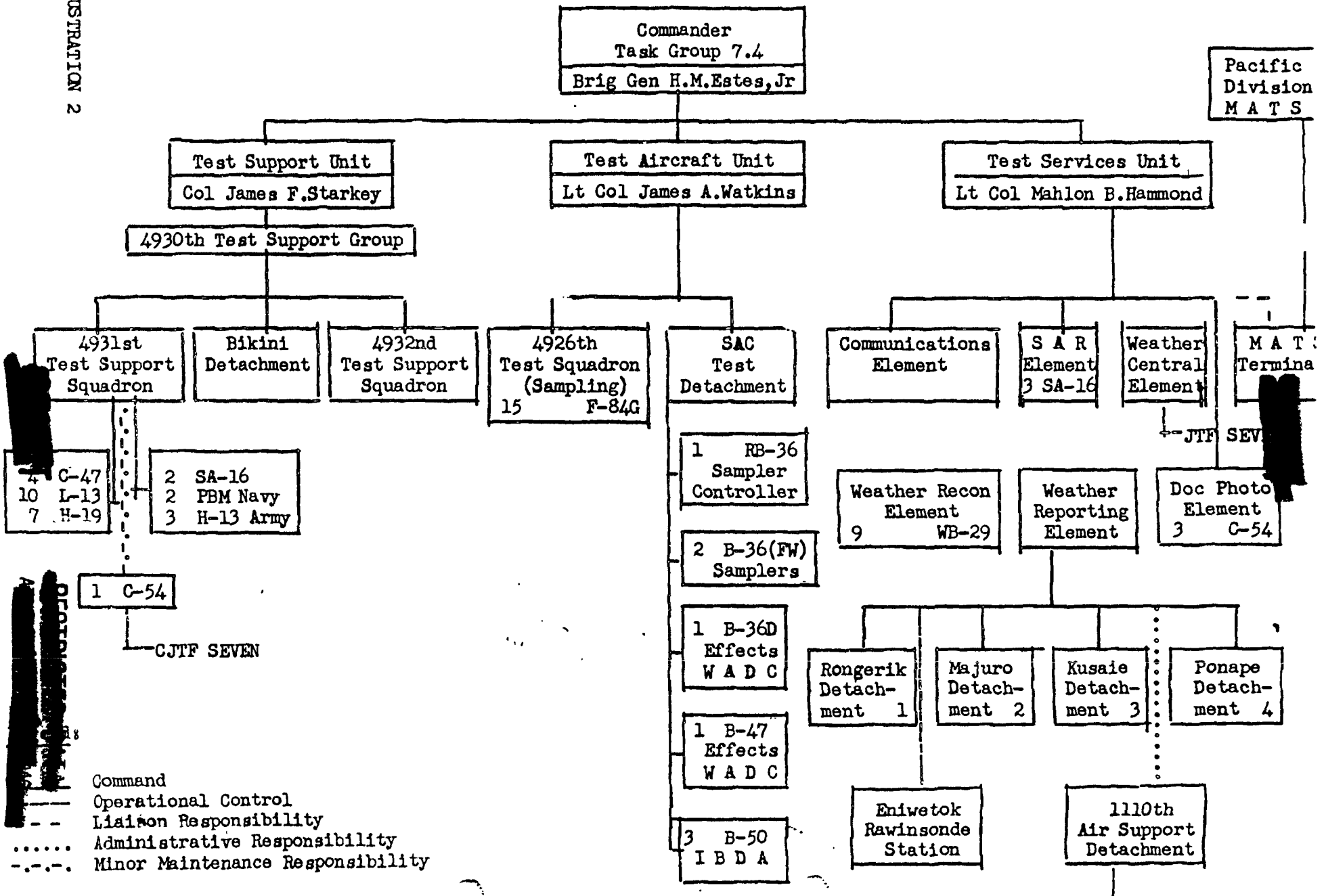
5. Augment existing search and rescue activities,

6. Augment logistical and administrative communications facilities, and

7. Provide and operate aircraft control facilities at Eniwetok.[2]

ILLUSTRATION 2

ORGANIZATION OF TASK GROUP 7.4



The Air Task Group was to be composed of Headquarters, Task Group 7.4, Provisional; the 4930th Test Support Group; the 4931st and 4932nd Test Support Squadrons; a cloud sampling and control detachment; an effects test detachment; a weather reconnaissance detachment; a documentary photo detachment; a weather detachment; and an aircraft control and warning detachment.[3] ILLUSTRATION 2, opposite page, shows the organization of TG 7.4.

A. FORMATION AND ORGANIZATION OF THE AIR TASK GROUP

The Commander, Air Research and Development Command (ARDC), was given the over-all responsibility of organizing Task Group 7.4 for participation in CASTLE. In turn, ARDC delegated this responsibility to the Air Force Special Weapons Center (AFSWC). In the Zone of the Interior (ZI) the AFSWC Commander was to exercise command over Headquarters, Task Group 7.4, except that the Commander, JTF SEVEN, would exercise operational control in the ZI for planning and coordination purposes. The Commander, AFSWC, was also to exercise operational control for planning and coordination, and administrative control -- for funding and reporting only -- in the ZI for units or detachments formed by other USAF commands.[4]

During its Zone of the Interior stay the Air Task Group was to be under the operational control of Air Force Special Weapons Center, but in the Pacific Proving Ground the executive head would be JTF SEVEN. For the most part the Air Task Group was organized, manned, trained and equipped at AFSWC, under the direction of Brigadier General Howell M. Estes, Jr., AFSWC Deputy Commander for Overseas Tests and Commander of TG 7.4. Three subordinate organizations — the Test Aircraft, Test Support (4930th Test Support Group), and Test Services Units — would be under the operational control of the Task Group. These units performed the functions described in the mission.

Brigadier General Howell M. Estes, Jr., of the Strategic Air Command (SAC), was named Commander of the Air Task Group in the book message

from the Chief of Staff, USAF. Colonel James F. Starkey, Commander of AFSWC's 4930th Test Support Group at Eniwetok, was later named to command that organization when it became the Test Support Unit during the operational phase of CASTLE. Personnel were to be assigned this unit for the direct support of CASTLE.

Lt Colonel James A. Watkins, Commander of the 4925th Test Group (Atomic)'s 4926th Test Squadron (Sampling) at Kirtland, was named Commander of the Test Aircraft Unit, which was to consist of elements from Air Force Special Weapons Center, Military Air Transport Service and Strategic Air Command, participating primarily for the direct support of the scientific mission. These elements were: F-84G sampling; B-36 sampling; RB-36 control; B-47 effects; B-36 effects and C-54 photography.

The Test Services Unit was to consist of those Military Air Transport Service (MATS) units furnishing services to Task Group 7.4, including Airways and Air Communications Service (AACS), Weather Central Element, Weather Reporting Stations, Weather Reconnaissance (Air) Element, the MATS Terminal at Eniwetok, and Search and Rescue Element. Headquarters, MATS, source of all aircraft and personnel of the Test Services Unit, designated Lt Colonel Mahlon B. Hammond as commander of that unit on 18 August 1953.

When General Estes assumed command of the Air Task Group on 1 August 1953, his staff included: Colonel Earl W. Kesling, Deputy Commander; Colonel Herschel D. Mahon, Chief of Staff; Colonel Ray M. Hawley, Director of Materiel; Lt Colonel Harry B. Allen, Director of Operations; Lt Colonel Birdene E. Forrest, Director of Personnel; Lt Colonel Arch C. Fleming, Comptroller; and Lt Colonel William R. Hanna, Personnel

HEADQUARTERS, TASK GROUP 7.4

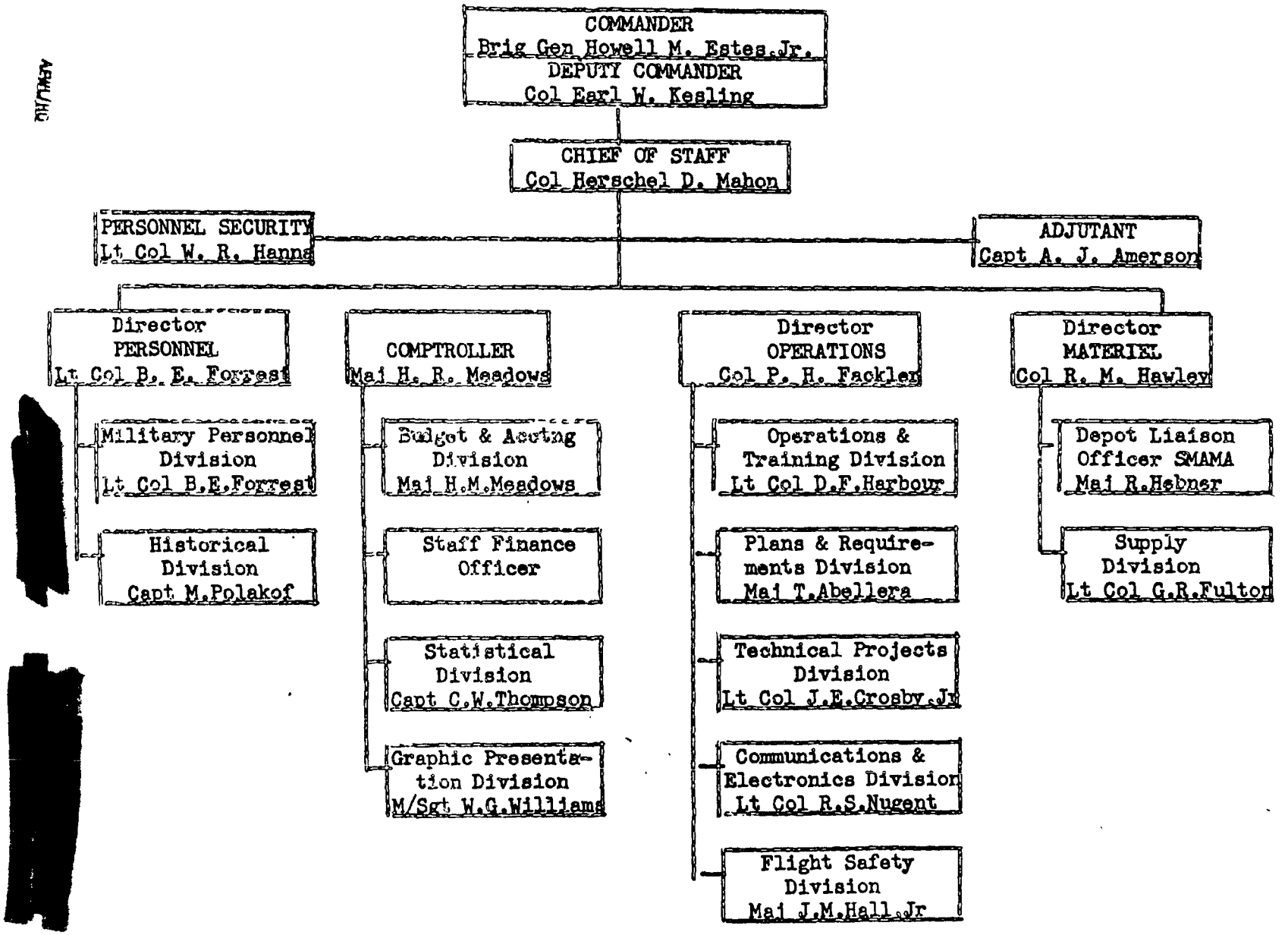


ILLUSTRATION 3

Security Officer. ILLUSTRATION 3, opposite page, shows the organization of Headquarters, Task Group 7.4.

In September, Lt Colonel Allen was requisitioned for duty at Headquarters, USAF. Lt Colonel Paul H. Fackler (promoted to full Colonel in May 1954) succeeded him as Director of Operations. Prior to overseas movement, Major Harold R. Meadows replaced Colonel Fleming as Comptroller.

B. ORGANIZATION OF TASK GROUP 7.4

In view of the relatively short time between IVY (the 1952 test) and CASTLE, Joint Task Force 132 desired that the Air Task Group from IVY be continued in an activated, but skeleton, status so that plans could readily be made for the coming operation. Early CASTLE planning, begun during the operational stages of IVY, was based upon the assumption that CASTLE would be a one-island operation based from Eniwetok. On 7 October Brigadier General Frederick E. Glantzberg, Commander of IVY's Task Group 132.4, forwarded CASTLE requirements to JTF 132 in order to further planning.[5] By October 1952, the concept of operations was changed by the AEC's desire to base the Air Task Group at Kwajalein. However, at a Kirtland conference on 25 November 1952, Dr. Alvin C. Graves of the Los Alamos Scientific Laboratory (LASL) stated that IVY results made a one-island operation more feasible and that the Air Task Group should be based at Eniwetok.

The selection of Colonel Howell M. Estes, Commander of SAC's 12th Air Division, as Commander of the Air Task Group for CASTLE, was made in October 1952.[6] Colonel Estes was a replacement for Colonel Charles M. Bondley, another SAC Commander, who originally had been earmarked as

the Air Task Group Commander. Colonel Estes was promoted to Brigadier General on 29 November 1952.

In November of 1952, Colonel Estes visited the Forward Area to witness MIKE, the thermonuclear shot of Operation IVY which ushered in the era of megaton devices, and to receive preliminary indoctrination.

Concurrently (28 October - 5 November 1952), a conference was held at Hickam AFB, Hawaii, by Manpower and Personnel representatives from USAF, ARDC, AFSWC, and the Air Task Group, to set up plans for the rotation of troops during the interim. However, in anticipation of the official concept of CASTLE being changed from a two-island operation to a one-island operation, these planners devoted most of their efforts to rearranging manning tables for the Air Task Group. Colonel Estes and Colonel Edward M. Gavin (then slated as the ATG Deputy Commander) attended this meeting.

The unusually short period between IVY and CASTLE, then anticipated to be about eleven months, necessitated certain changes in the IVY roll-up plan. Previously, the intervals between the overseas nuclear tests had ranged from nineteen to thirty-five months. It was therefore manifest that most of the planning for CASTLE be initiated prior to IVY roll-up. Roll-up for IVY and build-up for CASTLE were considered interdependent and were to be planned concurrently. Thus a situation existed where roll-up of IVY, and the inactivation of supplies and equipment, was to be followed immediately by supply and equipment build-up requirements for CASTLE. The same situation existed regarding personnel. In the light of this conflict of efforts, Task Group 132.4 requested that all retainable supplies and equipment remain in the Forward Area in

storage for subsequent use during CASTLE. Equipment and supplies not needed for CASTLE were to be disposed of.[7]

All these preliminary plans were partially changed by the scheduling of Operation UPSHOT/KNOTHOLE, the continental nuclear tests held in Nevada in March-June 1953. This operation required many personnel needed for CASTLE. In planning for the Nevada tests it was learned that much of the necessary construction and instrumentation for CASTLE could not be accomplished until the results of UPSHOT/KNOTHOLE were known. In view of this information, Major General John S. Mills, Commander, AFSWC, notified Major General Percy W. Clarkson, Commander, Joint Task Force SEVEN on 9 January 1953 that, since the operational phase of CASTLE would not take place until the spring of 1953, he would not maintain the Air Task Group at full strength. Instead, he planned to integrate the Air Task Group staff into the AFSWC staff, where some of them would participate in UPSHOT/KNOTHOLE.

Following UPSHOT/KNOTHOLE, the next earliest readiness date for CASTLE would have fallen during the typhoon season in November 1953 - January 1954. To avoid typhoon dangers and to insure the best possible weather conditions, all parties concerned had agreed that the spring of 1954 was the best possible period for CASTLE. The new overseas "in-place" date for the Air Task Group and its subordinate units was finally set for 15 January 1954.

Although activated in January 1953, the Air Task Group was not manned until 15 July of that year. On 13 February, ARDC General Order No. 19 redesignated the Air Task Group (Task Group 132.4) as Task Group 7.4.

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ARDC General Order No. 2, published on 6 January 1953, designated the provisional unit, Headquarters, Task Group 132.4, Provisional (CASTLE), and assigned it to Headquarters, AFSWC, effective 1 January 1953. The mission of the unit was "...to provide command and administrative control of personnel attached in connection with the activities of Joint Task Force 132." The latter general order also discontinued a table of distribution unit, that of the 4930th Test Support Group, and redesignated it to the Forward Area (Eniwetok Atoll). During IVY the 4930th had been the parent organization at Kirtland Air Force Base of Task Group 132.4 for the purpose of administration and assignment of personnel. It was what is commonly known as a "paper organization." When the 4930th was organized at Eniwetok, the 4931st and 4932nd Test Support Squadrons were organized and placed under its jurisdiction.

The Office of the Deputy Commander for Overseas Tests had been organized and established within AFSWC in October of 1952 as a planning section when Deputy Chief of Staff for Operations (DCS/Operations), USAF, notified ARDC that CASTLE was to be conducted in the Pacific Proving Ground as soon as conditions permitted. Colonel Edward M. Gavin assumed the position of Deputy Commander for Overseas Tests and Lt Colonel Richard S. Nugent was named as administrative coordinator.[8]

Colonel Gavin's office worked closely with AFSWC Operations personnel during the interim between IVY and CASTLE. One of Colonel Gavin's major projects was to make studies on the availability of aircraft in order to meet the requirements for extreme high altitude nuclear cloud sampling. The altitude requirements for these sampling aircraft were to be upwards of 55,000 feet, and the availability and capability of then-current aircraft posed difficult problems.

[redacted]

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PERSONNEL AUTH VS ASGD
Task Group 7.4

1953-54	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
HEADQUARTERS, TASK GROUP 7.4 — Authorized Officers 39 Airmen 65 (Includes AC&W Detachment)												
Officers Assigned	24	26	30	32	33	32	38	40	39	38	33	
Airmen Assigned	56	57	59	59	60	59	61	63	62	61	61	
TEST SUPPORT UNIT — Authorized Officers 60 Airmen 519												
Officers Assigned	19	23	33	40	44	47	49	61	66	63	58	
Airmen Assigned	267	341	370	454	484	505	532	540	544	538	510	
TEST AIRCRAFT UNIT — Authorized Officers 62 Airmen 233 (Includes WADC B-47 Crew)												
Officers Assigned	—	20	62	72	73	73	76	93	78	91	76	
Airmen Assigned		83	226	226	231	218	230	250	221	250	234	
TEST SERVICES UNIT — Authorized Officers 106 Airmen 646 (Includes Detachment of 1110th Air Base Gp)												
Officers Assigned	—	—	28	76	86	94	104	104	109	107	59	
Airmen Assigned	—	—	208	458	463	531	633	634	638	593	333	

Source: Unit Str. Repts

ILLUSTRATION 4

[redacted]

[redacted]

AEWL/HL

TASK GROUP 7.4 PERSONNEL
BY ACTUAL LOCATION

LOCATION		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ENIWETOK	OFF	16	20	28	33	44	97	248	277	276	288	212	
	AMN	210	285	339	423	484	681	1266	1294	1323	1339	994	
BIKINI	OFF	1	1	4	5	0	8	13	12	0	2	1	
	AMN	26	31	31	31	0	42	49	51	0	5	5	
WEATHER ISLANDS	OFF							1	1				
	AMN							86	87	63	59	60	
KWAJALEIN	OFF	2	2	20	15	15	15	0	0	1			
	AMN	31	25	198	177	177	179	34	31	55	20	11	
ZONE OF THE INTERIOR AND HICKAM AFB	OFF	24	46	101	167	177	126	5	8	15	9	13	
	AMN	56	140	291	566	577	411	21	24	24	19	68	
TOTAL	OFF	43	69	153	220	236	246	267	298	292	299	226	
	AMN	323	481	859	1197	1238	1313	1456	1487	1465	1442	1138	
GRAND TOTAL		366	550	1012	1417	1474	1559	1723	1785	1757	1741	1364	

Source: Daily Strength Reports

ILLUSTRATION 5

Air Task Group personnel visited the manufacturers and Wright Air Development Center (WADC) to study the capabilities of the B-36 featherweight, the B-47, B-57 and B-60, and the Canberra (English version of the B-57). The projected capabilities of the B-57 were the most impressive, but that aircraft was not expected to be available for many months to come. However, the possible availability of the B-57 during the latter stages of CASTLE brought about serious consideration of its use. (See pages 17 - 20 for more details on the B-57.) After careful study of the problem, two B-36 featherweights and F-84G's were finally selected as samplers.[9]

Colonel Earl W. Kesling relieved Colonel Gavin as Deputy Commander of Task Group 7.4 on 26 May 1953. In this capacity Colonel Kesling was acting commander of the Air Task Group and took part in the selection of personnel to man the organization.[10]

In late June 1953, Colonel Kesling notified AFSWC that the Air Task Group would start manning on 15 July 1953. Air Task Group personnel had been selected jointly by the Air Task Group Personnel Section and AFSWC DCS/Personnel.[11] ILLUSTRATIONS 4 and 5, opposite, show Task Group 7.4 personnel, authorized versus assigned, and by actual location.

During the interim test period the biggest problem faced by the prospective Air Task Group was in the supply field. With the completion of IVY, all Air Force supplies located at Kwajalein for use during nuclear tests had to be moved to the new base at Eniwetok. This task was accomplished after fifty men expended 45,000 man-hours. The burden included a total of 15,000 measurement tons, more than 37,000 line items, heavy equipment (cranes, tractors, trailers, tugs, trucks and special handling

equipment), office equipment and twenty prefabricated buildings. The LST's (Landing Ship, Tank) used in moving from Kwajalein to Eniwetok were not equipped with large booms, and drew too much water to unload at Eniwetok. Therefore, the cargo had to be unloaded at Parry Island, trucked to and loaded on LSM's (Landing Ship Medium), and then carried to Eniwetok, where once again it was loaded onto trucks for distribution to storage warehouses. The twenty prefabs were re-erected at Eniwetok. Although no exact dollar and cent cost could be estimated for the move, the consolidation of supplies resulted in a great saving during CASTLE operations.

In March 1953 representatives of the Headquarters, USAF Installations Office and JTF SEVEN had surveyed Eniwetok Island's rehabilitation needs for CASTLE.[12] It was believed that this rehabilitation program would cover all Air Force needs for CASTLE. However, it was later learned that the survey mainly covered getting the island in shape for general Air Force activities, and placed no emphasis on many of the requirements which would arise during the test operation. This survey was forwarded to JTF SEVEN where General Clarkson directed Task Group 7.5 (AEC Base Facilities) to begin working on only those rehabilitation programs which the report cited. However, since General Clarkson had not been advised of many of the Air Force requirements, a great deal of necessary rehabilitation was not accomplished prior to the start of the operation.

Lt Colonel Gordon R. Fulton, TG 7.4 Maintenance Officer, visited the Forward Area in April to study space requirements. His recommendations concerning parking areas, storage space (inside and out),

maintenance shops and hangar areas were forwarded to JTF SEVEN.[13]

In June 1953 General Clarkson and other Task Group commanders visited the Forward Area. All discrepancies in the Air Force's required construction program were pointed out to General Clarkson.

The requirements noted were those peculiar to the Air Task Group's activities, such as taxiway widening, surfacing the hangar floor, surfacing the aprons of taxiways, and construction of a parachute repacking facility. These requirements were approved by JTF SEVEN and funds amounting to $350,000 were forwarded to Task Group 7.5 to accomplish this construction.[14]

FOOTNOTES FOR CHAPTER I

1. Bk Msg, CS/USAF to CG/ARDC, 23 May 53, Cite AFODC 56991. (SECRET)
2. Ibid.
3. Ibid.
4. Ibid.
5. Ltr, Brig Gen F. E. Glantzberg to JTF 132, subj: "CASTLE Requirements -- Eniwetok," 7 Oct 52. (SECRET)
6. TWX, SAC to Col Estes, re: Replacement of Brig Gen Bondley by Col Estes, Cite VC 5895, 22 Oct 52. (SECRET)
7. Ltr, D/M, TG 7.4 to USAF, subj: "Authority to Retain IVY Supplies and Equipment for CASTLE," 29 Aug 52. (SECRET)
8. AFSWC General Order No. 1, 6 Jan 53.
9. Bk Msg, CS/USAF to TG 7.4, Cite AFODC 56991, 23 May 53. (SECRET)
10. AFSWC General Order No. 11, 26 May 53.
11. DF, Col Kesling to AFSWC, Jun 53.
12. Ltr, Dir/Inst, DCS/O, USAF to Cdr, JTF 7, subj: "Survey of Air Force Facilities, Eniwetok Atoll," 27 Mar 53. (SECRET)
13. Ltr, TG 7.4 to JTF 7, subj: "CASTLE Space Requirements -- Eniwetok," 6 May 53. (SECRET)
14. Ltr, JTF 7 to TG 7.4, subj: "Change in Airdrome Facilities," 9 Oct 53. (SECRET)

CHAPTER II

AIR TASK GROUP PLANNING FOR THE OPERATION

Concurrent with the build-up of men and materiel for CASTLE, Air Task Group staff officers were faced with numerous problems, some of them typical of any Air Force organization. Some of their problems, however, were peculiar to an organization assigned to such a mission.

A. THE HIGH ALTITUDE SAMPLING PROBLEM

The experimental use of a B-57 to determine its desirability for future operations and for long-range sampling and photography missions in event of an atomic war, was first discussed by General Estes and representatives of Task Groups 7.1 and 7.4 at Los Alamos on 13 August. The following day in Baltimore, Lt General Donald L. Putt, Commander of ARDC, stated that the availability of a B-57 for CASTLE would be announced at the earliest possible date. By October, the Air Task Group had decided that a B-57 would be used if at all possible. LASL had already forwarded requirements and specifications for B-57 sampling wing tanks (LAWT-7) to Tracerlab, Inc., of Berkeley, California. In early October 1953, however, production of these tanks was at a complete standstill because complete specifications requested from the Glenn L. Martin Company had not been received. In addition, all of the Tracerlab engineers were tied up on the B-36 sampling device (LABB-6) until the first of November. Tracerlab's chief engineer stated that their initial design for airflow was not compatible with the B-57 tank then in production.

One such tank had been cut apart to check on tie-in capability in fitting a new nose on the tank. To expedite matters it was requested that AFSWC appoint a project officer to work with Tracerlab, Martin and the Kaiser Metal Products Plant.

On 8 October at the Air Force Flight Test Center (AFFTC) at Edwards Air Force Base, California, General Estes learned that no B-57 had arrived at that Center for testing. The first B-57's had been scheduled for arrival in late September or early October, but slippages had postponed their arrival until November.[1]

Brigadier General Stanley J. Holtener, Commander of the Air Force Flight Test Center, believed at that time that Edwards was to receive eight B-57's between 15 November 1953 and 30 January 1954. Extensive testing was scheduled to get underway immediately upon arrival of the first aircraft. Altitude testing was not scheduled until late in the testing series, but it was believed that ARDC would, if requested, accomplish that phase of testing earlier.

Approximately two years earlier, the B-57 Phase II Project Officer had tested an aircraft of B-57 configuration, equipped with Avon engines instead of J-65's, and had found the aircraft extremely easy to maintain, a quality which made it well-suited for sparsely equipped forward bases like the Pacific Proving Ground. Although not a part of Phase II testing, the B-57 had been flown at 51,000 feet pressure altitude with a maneuver factor of 2.5G's. Although the pilot had made no effort to obtain altitude, he believed the aircraft could operate at 54,000 feet, if equipped with Avon engines. The Phase II Project Officer believed the aircraft admirably suited for sampling missions. Although he had not

flown a B-57 with J-65's, he stated that at a more recent test at the Martin factory, an aircraft had taken off with a maximum gross weight and flown immediately to altitude. At 48,000 feet the pilot had encountered difficulty with one of his engines and returned to the base. The indication was that a B-57 equipped with Avon engines would be as good as or better than a B-57 equipped with J-65 engines.

It was agreed at Edwards that the B-57 would be well-suited for the sampling mission and easily maintained in the Forward Area in its then-present state of development, and that a request should be made to ARDC, by AFSWC, for early altitude testing of this aircraft. If the B-57's were to be obtained for the early stages of CASTLE, the most likely source of procurement was from the eight to be assigned to Edwards for testing.

However, back at the Air Task Group Headquarters, General Estes had initiated a staff study of B-57 capabilities for CASTLE. By 16 October this study was completed and General Estes forwarded a memo to General Mills delineating reasons why the B-57 was no longer a logical CASTLE participant.[2] Test results from Martin indicated that the B-57 had developed an eight-cycle buffet appearing at .72 Mach, which Martin engineers had been unable to locate. Martin had lost several aircraft through disintegration due to this flaw and was justly concerned over finding the cause. The B-57 still wallowed considerably at altitude. Its ceiling was 48,600 feet, according to the USAF Characteristics Chart, which was well below the anticipated and desired maximum. Severe engine difficulties had been experienced with the J-65 engine, insofar as production and operation were concerned. Therefore, only sixteen B-57's

were expected to be off the assembly line by the end of 1953. Moreover, the limited range of the aircraft without bomb bay tanks made flight from the West Coast to Hawaii impossible. Range was limited also by excessive oil consumption and a small oil reservoir. Therefore, water-lift would be required to get the B-57 to the Proving Ground. Accessories for the aircraft were totally inadequate and mission-required modifications would be extremely difficult and costly. Flight and maintenance personnel for the aircraft were decidedly scarce. The Task Group 7.4 staff study clearly indicated that the B-57 had too many "bugs" to risk its use in CASTLE. Had later tests proven the B-57 a better aircraft, the Air Task Group would have recommended the use of one on a limited basis during the latter stages of the operation. On this basis the decision was made to use featherweight B-36's for high altitude cloud sampling.

B. SAMPLER CONTROL

Originally scheduled for CASTLE participation was one B-36 effects aircraft, two B-36 featherweight controller-samplers, possibly a B-47 effects aircraft, and an RB-50 for photography. The question arose as to how to control the F-84 samplers should one B-36 fail to get airborne. At Los Alamos on 13 August, General Estes, Colonel Kesling and Dr. Graves discussed the number of B-36's needed for the operation. LASL had written JTF SEVEN requesting an additional B-36 for control purposes, feeling that any substitute such as an RB-50 would be unsatisfactory. During Operation IVY this situation had arisen. At that time the RB-50 was already considered marginal due to its inability to attain

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AIRCRAFT INVENTORY
By Type

AIRCRAFT TYPE	1953						1954					
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
B-36			3	3	3	3	3	3	3	3	3	
RB-36			1	1	1	1	1	1	1	1	1	
B-47			1	1	1	1	1	1	1	1	1	
C-47	3	3	4	4	4	4	4	4	4	4	4	
C-54			4	4	4	4	4	4	4	4	4	
F-84G		13	15	15	15	15	15	15	15	15	15	
H-13	3	3	3	3	3	3	3	3	3	3	3	
H-19A	3	3	3	3	3	3	3	3	3	2	2	
H-19B			2	4	4	4	4	4	4	4	4	
L-13	11	11	11	13	13	11	11	10	9	9	9	
SA-16			2	2	2	2	2	3	5	5	5	
WB-29			8	8	9	9	9	9	9	9	8	
*FBM									2	2	2	
TOTAL	20	33	57	61	62	60	60	60	63	62	61	

*Costed to Navy

Source: AF Form 110

ILLUSTRATION c

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the proper altitude. Consequently, all parties preferred to use three B-36's, if at all possible. It was agreed that a second controller was needed in the event one of the featherweight sampler-controllers should abort. About the same time, SAC reported its inability to send an RB-50 because RB-50 crew members were attending RB-47 school. SAC then suggested the Air Task Group use an RB-36 instead of the already assigned RB-50, making a total of five B-36's. Task Groups 7.1 and 7.4 suggested that the RB-36 be rigged up for both control and photo purposes.

Finally, on 20 August it was agreed that the ATG would operate four B-36's. The RB-36 would be the primary controller and secondary photography aircraft, thereby eliminating the need for a separate controller B-36. One B-36 would be the primary sampler; one would have the primary mission of sampling and secondary mission of back-up controller; and one would operate solely for effects information. The sampler back-up controller was used on only one shot (KOON). LASL wanted samples at 55,000 feet true altitude, which was beyond the capability of F-84G's. Therefore, the two featherweight B-36's were scheduled to obtain samples at 55,000 feet. In addition to the B-36 controllers and samplers, fifteen F-84's were scheduled for particulate and gas sampling; three C-54's for photography; and seven H-19's for ground sample recovery. ILLUSTRATION 6, opposite, shows the aircraft inventory of the Air Task Group by type.

C. HIGH ALTITUDE SUIT REQUIREMENTS

Upon receipt of high altitude operating requirements for B-36 and F-84 aircraft, as outlined in JTF SEVEN Operations Order 1-53, the use of the T-1 High Altitude Suit for crew members was immediately investigated. Colonel Karl H. Houghton, Chief of the Human Factors Division

of DCS/Operations, AFSWC, stated that B-36 sampler personnel, flying above 45,000 feet, would require the T-1, but that F-84 personnel, scheduled to stay below 45,000 feet, would not need them. Maximum altitude for the B-36 was expected to be about 53,000 feet. Colonel Houghton and Major James M. Hall, Jr., Flight Safety Officer, were tentatively scheduled to study maintenance of the T-1 at the Aero-Medical Laboratory at Gunter Air Force Base, Alabama, where the suits were to be procured and fitted. The SAC Test Detachment was notified that all personnel flying above 45,000 feet would have to be equipped with T-1 suits. Gunter was requested to furnish enough suits for two crews for each B-36 featherweight.[3]

On 1 November Colonel Houghton and Major Hall conferred with Major J. I. Kendall of the 3882nd School Group at Gunter AFB, regarding the T-1 suits. The Commander of the Eighth Air Force had earlier notified ARDC that the T-1 pressure suits were inadequate for the mission requirement and that S-2 pressure suits were desired. ARDC replied that T-1 and S-2 suits afforded equal protection for descent to safe altitude, and had requested that SAC and Task Group 7.4 resolve this problem. The problem at Gunter was that Task Group 7. 4 requirements called for a descent from maximum obtainable altitude to 45,000 feet. Major Bachman, B-36 Featherweight Project Officer, stated that the B-36 would descend from maximum altitude to 45,000 feet at a rate of 1500 to 2000 feet per minute, with no damage to the aircraft. Major Kendall, Altitude Project Officer at the School of Aviation Medicine, assured the Task Group 7.4 representatives that either the T-1 or the S-2 would furnish ample protection for the CASTLE mission. Four extra helmet

bladders per suit and two extra helmets per crew were issued to the Test Aircraft Unit from Gunter because past results indicated these items often gave trouble. No special technician would be required for maintenance of these suits at the Proving Ground, but it was recommended that one airman in each crew become especially proficient in the nomenclature and repair of the suits. It was the opinion of SAC that a bail-out above 45,000 feet would be practically impossible, therefore only a normal H-2 bail-out bottle would be used.[4] It was also recommended that a "hot locker" be constructed at Eniwetok where the Test Aircraft Unit could handle and store the 48 pressure suits and that Colonel Houghton visit Nellis Air Force Base, Nevada, to study diets used and messing systems for an "altitude mess."

From 29 November through 3 December Colonel Houghton and Major Hall took part in the High Altitude Indoctrination Course at Gunter, becoming thoroughly indoctrinated in the nomenclature, fitting, maintenance and use of the T-1. A list of necessary repair tools was forwarded to the 4926th Test Squadron (Sampling), the responsible agency for the care and storage of the T-1 suits.

D. RADIATION PROTECTIVE DEVICES FOR PILOTS

During the same period, work was underway at Kirtland to develop a new lead vest to be worn by the F-84 sampler pilots to minimize radiation hazards. As designed by the 4926th Test Squadron (Sampling), the vest was composed of two parts: a nylon, sleeveless vest that buttoned at the neck in the front; and the lead impregnated fibreglass attachment. This latter part was a chest-size section of fibreglass with lead spun

into it in a quilted manner to make it conform to the body. This section was then attached to the nylon vest by four buttons.

A water escape test of this new lead vest was conducted at the Kirtland swimming pool on 27 August. The escape results were satisfactory, but Dr. Hal Plank from J-1 of Task Group 7.1 recommended that three inches of lead material be added to each side of the vest to afford more protection for the pilots' torsos. Dr. Plank's modifications were accomplished and tested on 18 September at the Sandia Base (Albuquerque, New Mexico) swimming pool. The modification was no hindrance to escape and the vests were declared satisfactory from both a flight safety and radiological safety standpoint. Total weight of the modified vest was six pounds. In addition to the vest, backs and bottoms of pilots' seats in the F-84 samplers were sheathed with sheet lead to provide additional protection.

The lead vest for WB-29 crew members was tested for emergency escape in mid-December and, although eight pounds heavier than the F-84 vest, was easily removed in the water.

E. PLANNING FOR AIR SHIPMENT IN CASE OF EMERGENCIES

In looking ahead to the possibility of shipment emergencies, in August 1953 General Estes had written Brigadier General Harold R. Maddux, Deputy Commander of the Pacific Division of the Military Air Transport Service, requesting information in case a "last minute emergency" arose for the rapid movement of large items to Bikini and a C-47 airlift or waterlift would be unable to handle it.

On 17 September, General Maddux contacted General Estes concerning the capability of C-54's and C-124's to operate in and out of Bikini. His letter stated that

> ... C-54 aircraft can operate into and out of Bikini from either Kwajalein or Eniwetok, and carry the structural strength allowable cabin load, which is approximately 14,000 pounds (zero fuel weight of C-54G, 67,700 pounds less the basic operating weight, 46,000). The C-124 aircraft load limitations on this short segment operation are based on the maximum permissible landing weight (160,000 pounds) which limits the allowable load into and out of Bikini to approximately 30,000 and 25,000 pounds, respectively. This holds true whether operating from Kwajalein or Eniwetok. The above allowable loads are based on refueling either at Kwajalein or Eniwetok. The flight plan and gas load computations based on MATS requirements which provide two hours of holding over Eniwetok or Kwajalein on their return from Bikini, plus 10 percent of en route fuel requirements.[5]

F. RUNWAY EXTENSION FOR F-84 EMERGENCY LANDINGS

After surveying emergency landing possibilities in all areas of F-84 operation, General Estes wrote Colonel Murray Bywater, Deputy Air Force Commander for JTF SEVEN, that any fighter landing on the 4,500 foot Bikini strip would have to perform a wheels-up landing, damaging the aircraft and possibly injuring the pilot. Unlike the B-47 which landed at Roi Island in Kwajalein Atoll during IVY, the F-84's had no drogue chutes to slow them down. General Estes' suggestion to grade and smooth a thousand feet at the east end of the runway was approved by higher headquarters and action gotten under way in October. Once completed, this grading lengthened the serviceable portion of the runway from 4,500 to 5,500 feet. The width was increased to 125 feet. The extension of the Bikini airstrip proved an excellent investment. Two sampler aircraft, forced to make emergency landings on the Bikini strip, were saved from possible destruction. (One had a rough engine and the other had trouble with a fuel feed.)

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G. AIRCRAFT LOCATION FOR POSITIONING

Another oft-studied problem during the pre-operational days of CASTLE concerned the selection of a device that would pinpoint the exact geographical location of the effects aircraft at burst time within extremely close tolerances. This information was needed to correlate the effects data with the yield of the shot. Task Group 7.1 had recommended that SHORAN be placed on several islands to obtain the fix, but General Estes felt that the information gained from SHORAN would not completely justify the expense of installation. In a letter to General William H. Blanchard, Headquarters, SAC, on 21 October, General Estes recommended that this problem be studied at a conference to be held at SAC Headquarters some time between 2 and 14 November. This conference was to be attended by highly qualified SHORAN people, a qualified SHORAN operator, a man skilled in ground station positioning and maintenance, and radar and photo interpretation personnel.

The conference was held at SAC Headquarters on 11 November and was attended by General Estes; Colonel Kesling; Colonel Ray M. Hawley, Director of Materiel, TG 7.4; Colonel Fackler; Lt Colonel Crosby and Mr. Martin Oberg, Western Electric Field Engineer. The R-17 and C-15 cameras were considered too inaccurate for this project and the MPQ was believed too delicate to withstand the shot jar.

It was found that SHORAN could be made available by SAC and would be reasonably accurate, although not necessarily as accurate as Task Unit 13 might desire. SHORAN was described as being reliable only when two complete stations were available at each location, and provided the survey of ground stations was of the second order.

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From this meeting Mr. Oberg proceeded to the Hastings Instrument Corporation near Langley Air Force Base, Virginia, to study the possible use of the Raydist navigational system. Hastings claimed that Raydist was the most accurate device known for such purposes, being capable of determining aircraft positions within 25 feet. Hastings could also provide all the equipment needed. During Raydist surveys in the Bahama Missile Range, the instrument performed accuracies of one part in 38,000, to no measurable error, at distances of 30 to 75 miles. Other results obtained from tracking aircraft at supersonic speeds indicated velocity accuracies within one percent and instantaneous position within 50 feet.

Raydist competitive marks revealed:

Raydist average error of fix . . . . . 6 feet

Loran average error of fix . . . . . 750 feet

SHORAN average error of fix . . . . . 2 3/4 miles

Following his study of the Air Task Group requirements, Mr. Oberg recommended the use of Type N Raydist as being most able to cope with after-the-fact instantaneous positioning of two aircraft. Hastings stated that they could meet our required 1 February deadline in the Forward Area, provided airlift was furnished. This equipment, including pre-overseas instrumentation and operating crews, could be leased to the Air Task Group for between $175,000 and $225,000. With the exception of development engineering for the B-47 antenna, the equipment was ready for operation.

Staff members of the Air Task Group agreed that Raydist was superior equipment, but that SHORAN was considerably less expensive. On 23 November the Directorate of Weapons Effects Tests of the Armed Forces Special

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Weapons Project was requested to review their requirement for accuracies within 500 feet because of the exorbitant cost of procuring Raydist and the problems involved in SHORAN installation.

On 13 November, Hastings offered to accomplish the mission for a flat $200,000 fee, which included rental of the equipment and maintenance and operational personnel. The Air Task Group felt that $200,000 was too expensive for the service rendered so Hastings was re-acquainted with our needs.

Dr. William Ogle, Commander of Task Group 7.1, felt that Raydist should be used and that pertinent installations be restricted to Enyu (NAN), Bikini (HOW) and Eniman (TARE) in Bikini Atoll.

Hastings replied that they had originally understood that our requirements were much greater and that in the light of re-investigation of our problem they offered the rental of the Raydist, as well as operational and maintenance personnel, for $100,000.

H. RUNWAY ARRESTING BARRIERS

On 16 December the Air Task Group had queried the Fourth Fighter Interceptor Squadron of the Far East Air Force (FEAF) for information pertaining to runway emergency arresting barriers, which the Air Task Group wanted installed at Eniwetok, Bikini and Roi Islands. This letter was forwarded through appropriate channels for necessary action. Headquarters, 6400th Air Depot Wing, APO 323, was to be responsible for procurement and modification of the aircraft arresting gear for these islands. Colonel James F. Starkey, Commander, Test Support Unit, borrowed a study on the barrier from FEAF to use as a guide in the installation of the barrier. It was determined by the Air Task Group that a

barrier would be installed at Bikini only. An officer from FEAF arrived on 12 February to direct the installation of the barrier at Bikini. The structure was operational in time for the first full-scale rehearsal on 23 February.[6] Although no occasion arose for its use during CASTLE, the mere presence of the runway arresting barrier was a great morale factor, especially for the fighter pilots.

I. EXERCISE TIGER/CAT

During the latter months of 1953, the Air Task Group completed the ZI phase of its training and found workable solutions for the problems incurred in the procurement of men and materiel. Of interest in the operational phase of training was Operation TIGER/CAT, the ZI rehearsal for CASTLE.

On 27 October 1953 Exercise TIGER/CAT was conducted from the San Diego Naval Air Station. This operation was held to check communication and operational procedures between the Navy and Air Force operating units. Most of the discrepancies, forty-five in all, were minor, such as the absence of wing-walkers, improper parking arrangement, minor communications failures and poor coordination. Corrective action in all cases was noted in the Task Group 7.4 secret document entitled TIGER/CAT Discrepancies, TG 7.4 Control No. 3-1053S.

Although several aircraft arrival and departure times varied slightly from the schedule, all times were considered operationally sound. Numerous problems arose that were the result of the work being performed by personnel who were complete strangers the day before the operation, but it was evident that a spirit of cooperation existed throughout the entire event.

TIGER/CAT brought together personnel and aircraft from different branches of the service and from different organizations within the Air

Force and Navy. Each group brought its own standing operating procedures (SOP's) and methods. Thus, within a matter of days, each group and individual had to conform to set patterns and procedures of the entire Task Force. That these procedural differences were corrected in such a short time was regarded as one of the most heartening aspects of the rehearsal.

Mechanical and equipment failures were located during TIGER/CAT, thus giving both the Air Force and Navy nearly three months to cope with such problems prior to moving to the Forward Area. The largest area of discrepancies brought out by TIGER/CAT involved communications and equipment aboard the Command Ship (USS ESTES) and the RB-36 control aircraft. These discrepancies concerned the antiquated and outmoded radar scope and very high frequency (VHF) equipment on the USS ESTES, and the lack of high frequency (HF) equipment and adequate identification, friend or foe (IFF) range on the RB-36. For instance, aboard the USS ESTES the use of one VHF channel would leak across to several other VHF channels rendering reception on those channels impossible. Several channels were thus inoperative. On one occasion during an emergency, D channel could not be remoted to the control room for fifteen minutes. It was also learned that three radar scopes were not slave-box equipped. These discrepancies necessitated the ESTES putting in at San Diego for corrective action.

After a thorough study of rehearsal results, General Estes notified Task Group 7.3 (Navy) that he would like to send six F-84's and their pilots back to San Diego Naval Air Station between 10 and 20 December for a retest of Command Ship communications, as well as to run the pilots through the ground control interception (GCI) again prior to overseas movement.

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Prior to TIGER/CAT, JTF SEVEN informed Task Group 7.4 that all travel, TDY and transportation costs for the rehearsal would be borne by the participating air commands. Any additional expenses incurred in connection with the rehearsal would also be borne by the corresponding air command.

J. MOVEMENT TO THE FORWARD AREA

The large-scale build-up of personnel in the Pacific Proving Ground started in December 1953. The advance echelon of Headquarters, Task Group 7.4, arrived at Eniwetok on 2 January 1954, and immediately set up the Headquarters and prepared for the arrival of the main party on 27 January 1954.

K. CONSTRUCTION DIFFICULTIES

Upon arrival of the main body of Air Task Group at Eniwetok, it was found that numerous programs were behind schedule. Supplies had not been properly stored, vehicular parking areas were not established, and old boards, wires, cable drums and assorted equipment, some dating back to GREENHOUSE, littered the Air Force end of the island. A clean-up program was initiated which consumed thousands of overtime man-hours. By mid-February, the Air Force end of the island had been cleaned up, outdoor storage areas designated, fences and parking areas installed and waste material scrapped.

In January and the first part of February, it appeared that Holmes and Narver, Inc., the AEC construction firm, had not started projects that should have been completed in November and December, such as the parachute building, wiring of the radiac and shop buildings, completion

of the aircraft decontamination pad, erection of pre-fab buildings and tents, and electrical wiring throughout the area. In an effort to speed up these projects, Air Force enlisted personnel were used to complete the erection of the pre-fabs and tents. The other unfinished projects were given priorities and completed.

This situation had arisen possibly because Holmes and Narver had accepted more projects than they could handle with available personnel; lack of clear delineation of the respective authorities of the Army and Air Force commanders of the interim force; and insufficient local "push" and drive from home.

L. FINAL REHEARSALS FOR THE OPERATION

Operationally, the Air Task Group's mission proceeded smoothly during the build-up phase at Eniwetok. In preparing for BRAVO Shot, the Air Task Group conducted six rehearsals to check communications and timing of aircraft arrival at their appointed positions. The first were partial rehearsals to work out individual mission deficiencies. Later, the individual missions were gradually combined so that on 16 February a complete Air Task Group rehearsal was conducted. The full scale dress rehearsal was conducted on 23 February with only minor discrepancies.

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FOOTNOTES FOR CHAPTER II

1. Slippage in B-57 production resulted from the fact that the aircraft was supposed to use engines constructed by Wright, but production difficulties had necessitated the use of Studebaker and Buick engines. These engines had been produced for other aircraft and required modification before they would fit the B-57's.

2. Memo, Gen Estes to Gen Mills, 16 Oct 53, subj: "B-57 Aircraft for CASTLE," TG 7.4, Control No. 3-777. (SECRET R/D)

3. It had been determined earlier that each crew would be allowed about 3.5 r per mission or about 12 r for the entire operation. Since there were six shots and each crew would probably receive their maximum dosage in three missions, a second crew was necessary for each featherweight. (SECRET R/D)

4. Hot lockers were specially constructed lockers with electric light bulbs burning to counteract the effects of high humidity on clothing and equipment.

5. Ltr, Brig Gen Maddux to Brig Gen Estes, 17 Sep 53, subj: "C-54's at Bikini." (CONFIDENTIAL)

6. The aircraft arresting barrier was designed by the Far East Air Logistic Force to halt damaged or runaway aircraft during landings, and aircraft that abort on take-off. Its component parts were nylon webbing, steel cable and extremely heavy anchor chain. The barrier, closely resembling a tennis net, stands four to five feet above the runway. When an aircraft strikes the net, the arresting cable rises and makes contact with the main landing gear, reducing the aircraft's speed. The cable then drags the heavy chains along the runway, further slowing the aircraft.

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STATUS OF EXTRA-MILITARY FUNDS -- OPERATION CASTLE
30 September 1954

Appropriation Symbol	Description	Allotment Received	Obligations
2142020 P1727			
421-4010	Travel	$120,200	$114,865.68
421-4020	Transportation of Things	200	26.19
421-4030	Communications	5,300	4,777.14
421-4041	Headquarters Overhead Expense	5,500	4,667.55
421-4043	Modification of Aircraft	153,930	40,413.90 *
421-4046	Radiological Safety	2,000	1,337.80
421-4047	Weather Service	4,400	4,400.00
421-4048	Operational and Logistic Support	20,000	19,010.17
Sub-Total		$311,530	$189,498.43
21X2040 P1410			
410-4107	AFOAT-1 A/C Modification	23,120	2,366.42 *
21-899/40101.002 421-4043 P400-99	AEC A/C Modification	18,720	-0- *
Grand Total		$353,370	$191,864.65

* AMC has informed JTF SEVEN that total AMC A/C Modification cost will amount to $160,866. This amount has not been obligated.

ILLUSTRATION 7

AFWL/HO

CHAPTER III

FUNDING FOR TASK GROUP 7.4[1]

Funding for Operation CASTLE was derived from two major sources:

1. Normal service operating expenses financed by the services; and

2. Extra expenses financed from funds available to the Task Force Commander. ILLUSTRATION 7, opposite page, shows Status of Extra-Military Expenses, Operation CASTLE.

The funding guides for the division of these expenses were originally based on the methods used in Operation IVY; however, directives issued from Headquarters, Joint Task Force SEVEN during the planning and build-up phase of Operation CASTLE were contrary to those issued for Operation IVY and caused confusion and misunderstandings. Examples of the inconsistencies are detailed in the following discussion.

A. INCONSISTENCIES IN FUNDING RESPONSIBILITY

Broad policies of funding and mission responsibilities for participating commands in Operation CASTLE were outlined by the Department of Defense in a memorandum from Mr. W. J. McNeil, Comptroller, subject: "Assumptions for Operating Expenses of Atomic Weapons Tests," dated 9 March 1953. Headquarters, USAF issued further instructions that each command required to participate in support of Task Group 7.4, at the call of the Commander, Air Research and Development Command would finance such support from its own financial resources within the scope of the McNeil memorandum. Joint Task Force SEVEN, in JTF SEVEN Operation Order 1-53, provided that Joint Task Force SEVEN operations during the period

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AIR FORCE COSTS

BY COMMAND PARTICIPATION

ARDC	
Task Group 7.4 and AFSWC	$10,503,580
WADC	803,030
AMC	236,944
MATS	7,636,040
SAC	291,350
TOTAL	$19,470,944

ILLUSTRATION 8

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covered by that operations order would be funded in the same manner as during Operation IVY. ILLUSTRATION 8, opposite page, shows Air Force Cost by Command Participation.

The McNeil memorandum was issued with the understanding that it was not all-inclusive but was an outline of the distinction between normal operating expenses, which were to be financed by the services, and the extra expenses, which were to be financed out of funds made available to the Joint Task Force Commander. Based on the McNeil memorandum, no difficulties were anticipated by Air Force Special Weapons Center in funding for Operation CASTLE as the AFSWC budget provided for the movement of personnel of Headquarters, Task Group 7.4 to and from the Forward Area in the same manner as during Operation IVY. It was assumed that this was the only expense to be borne by AFSWC. There were, however, three major reversals of policy which created confusion in funding responsibilities:

1. A requirement was placed on the Air Defense Command (ADC) and the Strategic Air Command for each to furnish eight F-84 pilots to train in sampling operations with the 4926th Test Squadron (Sampling) at Kirtland Air Force Base and for further temporary duty in the Forward Area for Operation CASTLE. Joint Task Force SEVEN stated that "expenses of training personnel to take part in atomic tests are the responsibility of the Services to which personnel belong." This meant that ADC and SAC would be required to fund for the TDY of their personnel. These commands requested funds for this TDY as they had not received specific assignment of responsibilities early enough to include the requirements in their Fiscal Year 1954 budget estimates. Task Group 7.4 requested funds

TASK GROUP [redacted]
By [redacted]

PURPOSE	**JUL	AUG	1953 SEP	OCT	NOV	DEC
TDY, TVL, PER DIEM	17,335	3,402	3,969	219	- 334	13,859
TRANSPORTATION						
COMMUNICATIONS	888	317	682	158	371	864
HQ OVERHEAD	171,230	46,411	73,440	32,977	81,145	57,672
SAMPLING PROGRAM				39,731	69,595	20,811
EFFECTS PROGRAM						
DOC PHOTO PROGRAM						
COMMON TO PROJECT***	1,693,783	175,800	280,505	676,512	358,558	799,383
MONTHLY TOTAL	1,883,236	225,930	358,596	749,597	509,335	892,589
CUMULATIVE TOTAL	1,883,236	2,109,166	2,467,762	3,217,359	3,726,694	4,619,283

PURPOSE	JAN	FEB	1954 MAR	APR	MAY	JUN
TDY, TVL, PER DIEM	63,185	21,269	2,164	2,440	- 2,090	2,952
TRANSPORTATION		5	22			60
COMMUNICATIONS	208	- 22	156	16	1,978	
HQ OVERHEAD	23,906	36,502	20,307	104,144	364	45,569
SAMPLING PROGRAM	244,046	234,657	349,183	247,063	****	
EFFECTS PROGRAM	98,865	52,455	61,373	87,115	****	
DOC PHOTO PROGRAM	13,261	119,718	22,176	33,654	****	
COMMON TO PROJECT***	1,042,832	815,841	808,732	1,240,021	97,228	- 7,058
MONTHLY TOTAL	1,490,303	1,276,425	1,264,113	1,714,453	97,480	41,523
CUMULATIVE TOTAL	6,109,586	7,386,011	8,650,124	10,364,577	10,462,057	10,503,580

* Includes cost to AFSWC.
** JUL includes all previous cost reported from 1 Jan 53 to 31 Jul 54 for planning phase of the operation.
*** Includes cost of personnel, aircraft modification, logistical expenses.
**** Costs to 15 May [redacted] PROTOTYPE [redacted] es.

AFWL/HQ ILLUSTRATION 9

from Joint Task Force SEVEN who in turn requested Headquarters, USAF to help resolve the question. Headquarters, USAF acknowledged that the funding for the TDY was the responsibility of the Air Force and directed Headquarters, ARDC to fund for the TDY. Later the TDY orders were changed by Headquarters, USAF to assign the pilots PCS (permanent change of station) to AFSWC. This settled the problem of funding for the TDY but brought up the question of the "first Task Force duty station" for these personnel. JTF SEVEN had previously stated that "first Task Force duty stations for the Air Task Group will be the overseas duty station, i.e., ENIWETOK, BIKINI, etc." The fighter pilots were assigned to the 4926th Test Squadron (Sampling), an organization of AFSWC, located at Kirtland AFB, the same location as Headquarters, Task Group 7.4. At a funding conference in Washington on 23 November 1953, JTF SEVEN decided that the first Task Force duty station of Headquarters, Task Group 7.4 was Kirtland, and that the first Task Force duty station of the 4926th was Eniwetok. This meant that JTF SEVEN funds would move the personnel of Headquarters, TG 7.4 to Eniwetok and return, and AFSWC would fund for the 4926th movement. This was the first reversal of the policies which had been followed in Operation IVY. ILLUSTRATION 9, opposite page, shows TG 7.4 Cost by Purpose.

2. The requirement placed on Task Group 7.4 to conduct a Zone of the Interior rehearsal during October 1953, brought about another reversal of policy. Since the funding responsibilities were not clear, a letter was sent to Joint Task Force SEVEN requesting information on the possibility of the charges being placed against ARDC (AFSWC). This information was needed as the ARDC (AFSWC) budget did not include funds for this purpose. Joint Task Force SEVEN advised that all travel, temporary duty and transportation in connection with the rehearsal must be

borne by the participating air commands. This determination was made by the Director of the Budget, USAF, and concurred in by the Office of the Secretary of Defense. A short time later, this decision was reversed by Headquarters, USAF and Joint Task Force SEVEN notified Task Group 7.4 that commands would not bear all the costs and that Headquarters, USAF was preparing a funding procedure for the rehearsal. The message from Headquarters, USAF establishing this funding procedure rescinded all previous instructions and stated that each command required to participate in support of Task Group 7.4, at the call of the Commander, ARDC would finance such support from its own financial resources within the scope of the McNeil memorandum in the same manner as in past years. Contrary to information contained in a previous communication from Headquarters, USAF no provision was made in the approved ARDC (AFSWC) annual financial plan for centralized funding. Accordingly, the Commander, ARDC was not required to provide funds in connection with total Air Force participation in the ZI rehearsal, but was required to fund for AFSWC participation.

3. During Operation IVY, supplies and equipment were issued by the Army and Navy units to the Air Task Group and reimbursement therefor was effected with funds made available by the Joint Task Force. For Operation CASTLE, Joint Task Force SEVEN issued Administrative Order No. 2-53, which stated briefly that housekeeping equipment and supplies, special purpose vehicle spare parts common to both Army and Air Force, and other items of common supply would be furnished by Task Group 7.2 to Task Group 7.4 on a reimbursable basis. Joint Task Force SEVEN ruled that funds from Joint Task Force SEVEN would not be used for such reimbursement. Reimbursement for this purpose had to be assumed by ARDC (AFSWC),

[redacted]

contrary to the policy followed in Operation IVY, which was to have served as a funding guide for Operation CASTLE.

These reversals of the policy which was established in the initial instructions for Operation CASTLE caused confusion and misunderstanding of the funding responsibilities on the part of personnel of Task Group 7.4 and AFSWC, and required many telephone calls, messages, and visits to resolve the problems as they arose. This procedure was not conducive to efficient operations and caused delays in procurement of services and materiel.

B. CONCLUSIONS

The following conclusions were arrived at by the Task Group 7.4 Comptroller at the end of Operation CASTLE:

1. The McNeil memorandum outlined, in broad terms, division of funding between the services and the Task Force.

2. Principles of funding were assumed to be on the same general basis as was followed during Operation IVY until the first reversal of policy was made by Joint Task Force SEVEN. USAF did not anticipate these changes and therefore explicit instructions were not issued to cover all funding problems. USAF was placed in the position of resolving each problem as it arose.

3. Major air commands participating in the operation did not receive specific funding information early enough to include fund requirements for CASTLE in their Fiscal Year 1954 budgets.

4. Decisions which had to be obtained, when a change was made in the funding concept, created serious delays in the procurement of important services and materiel for the support of Operation CASTLE.

[redacted]

[redacted]

[redacted]

C. RECOMMENDATIONS

The following recommendations were made by the Comptroller in the Task Group 7.4 Final Report:

1. To preclude inconsistencies, confusion or misunderstandings concerning the responsibility for funding future overseas atomic tests, Headquarters, USAF should provide funds directly to ARDC for all Air Force units participating in the operation. ARDC should then issue these funds to AFSWC.

2. If Headquarters, USAF does not make funds available to ARDC for all Air Force participants, then specific guidance should be furnished by Headquarters, USAF and Headquarters, Joint Task Force SEVEN early enough to permit participating commands to submit a supplemental budget to USAF to cover their requirements for the operation.

[redacted]

[redacted]

AFWL

[redacted]

FOOTNOTES FOR CHAPTER III

1. This Chapter is taken from the Final Report of the Commander, Task Group 7.4, Operation CASTLE, SWC 54-S-510. (SECRET, R/D)

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CHAPTER IV

TASK GROUP 7.4 AND THE SHOT SERIES*

Originally, Joint Task Force SEVEN had three primary scientific objectives in CASTLE: to fire seven experimental devices, six of which were in the megaton range, and three of which were to be proof tests of emergency capability weapons; to obtain diagnostic information on these devices necessary to evaluate properly their performance in case of success or failure; and to obtain effects information on megaton devices. The intention was to fire five devices developed by LASL and two devices developed by the University of California Radiation Laboratory at Livermore.

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Task Group 7.4's mission, as already stated, was to perform nuclear cloud sampling, aircraft effects measurement and technical photography as primary functions, and inter-island and intra-atoll airlift, weather reconnaissance and reporting, air rescue and communications as secondary functions.

A. NUCLEAR CLOUD SAMPLING

The sampling program consisted of collecting particulate and gaseous matter from the atomic cloud. Particulate samples were collected on a special type filter paper in specially designed wing tip tank filters. Gaseous samples were pumped by special devices into bags or bottles in the aircraft.

The Los Alamos Scientific Laboratory and the University of California Radiation Laboratory indicated the quantity of samples desired and allowed Task Group 7.4 to establish the aircraft requirements necessary to take this quantity. Two B-36's, fifteen F-84G's and one WB-29 were designated as samplers.

Nuclear cloud sampling was the task of locating and obtaining, for radiochemical analysis, the best possible representative samples of radioactive particles available throughout the nuclear cloud which ensued

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from each detonation. For this purpose, the aircraft were employed for sampling, in conjunction with an RB-36 aircraft from which a scientific team exercised control and direction of the sampling operation.

B. AIRCRAFT EFFECTS TESTING: PROJECTS 6.2a and 6.2b

The aircraft effects program was conducted to determine the relative safety with which current operational types of delivery aircraft could withstand hazards associated with detonation of weapons in the megaton range. A B-36D and a B-47 aircraft were used for this purpose. These aircraft were positioned in space at points for which the anticipated levels of thermal radiation, the shock wave overpressure and gust had previously been calculated. Special instrumentation on these aircraft measured the actual input levels and recorded the resultant skin temperature rises, together with structural stresses and deflections on various portions of the aircraft.

The same B-36D used in IVY and UPSHOT/KNOTHOLE was used in the Project 6.2a, to determine the blast and thermal effects on a B-36 in flight. SAC flew and maintained the aircraft and WADC was given the job of installation, maintenance and operation of the instrumentation, as well as selection of the position of the aircraft in relation to the shot at Time Zero.

To determine the thermal and blast inputs of the aircraft, measurements were made of peak overpressure, thermal intensity, and the total thermal energy. The B-36D was also instrumented for the measurement of wing, stabilizer and fuselage bending moments, stabilizer shear forces, fuselage and wing accelerations, skin temperature rise, and elevator position.

Limiting conditions of the aircraft were either one hundred percent of the design limit allowable bending moment on the horizontal stabilizer, or a 400° F temperature rise on the 0.020 magnesium skin on the elevators. For [redacted] the aircraft was positioned at Time Zero in a tail-to aspect for one of the two limiting conditions, whichever was critical for the maximum predicted yield of the device concerned. For NECTAR, the last shot, the aircraft was positioned in a head-on aspect to obtain figures on bending moments. This was the first time an aircraft had been in the "head-on" position at Time Zero.

The maximum useful incremental peak temperature measured was 250° F on the 0.020 magnesium skin on the undersurface of the elevator during YANKEE, the fifth shot. Although considerable damage was done to sheet metal, the theoretical overpressure criteria level of 0.80 was attained safely on BRAVO. An incremental bending moment on the horizontal stabilizer equalling approximately eighty percent of design load limit was the maximum gust load measured.

CASTLE data was sufficient to enable a more accurate determination of the delivery capabilities of the B-36.

Operational limitations of a manned B-36 in the vicinity of a nuclear detonation were:

1. Gamma radiation;
2. Thermal radiation (from the fireball);
3. Rise of the radioactive cloud;
4. Overpressure of the shock wave; and
5. Material velocities following the shock wave.

Project 6.2b was established to extend the work begun on Operation

IVY to determine the effects, principally thermal, of nuclear weapons on the structure of the B-47B. IVY and CASTLE results were to be used either to support or modify existing theories relating to the thermal output of nuclear explosions to their effect on the B-47B.

ELAINE TWO, code name of the B-47, was to be positioned on each shot so as to receive thermal inputs sufficient to raise the temperature of the critical skin panel to 370° F above ambient at 35,000 feet altitude. The skin panel considered critical was the 0.020 aluminum skin in the ailerons.

The safety of crew and aircraft made it necessary to position ELAINE TWO according to the maximum probable yield, rather than the most probable yield of the device. This system resulted in relatively low thermal inputs on IVY, but on CASTLE the difference between maximum probable and most probable yield was generally smaller, resulting in higher thermal inputs.

On BRAVO, Shot 1, the yield was higher than predicted and the aircraft received minor external damage.

Calorimeters and radiometers for these projects were supplied and maintained by the Naval Radiological Defense Laboratory. Statham pressure transducers of appropriate range and sensitivity were used to measure blast inputs. Thermal effects were measured on 0.020, 0.040 and 0.188 aluminum and 0.040 magnesium, using both thermocouples and strain gauges or thermocouples alone. Instrumentation necessary to correlate the primary data and to accurately ascertain the spatial position and attitude of the aircraft was also provided. This instrumentation was ninety-three percent effective on the five shots in which ELAINE TWO participated.

The Raydist navigational system was used to determine the spatial positions of the B-47 and B-36 to an accuracy of plus or minus 150 feet on Shots 1, 2 and 6. Raydist was not available at Bikini on the fourth shot. Data gained from Project 6.2b (B-47B) and 6.2a (B-36B) was to be extrapolated for use in aircraft of similar configuration, such as the B-52.

C. SAMPLING REQUIREMENTS

Sampling requirements outlined by LASL called for six radio-chemical samples for each shot, including high altitude samples from above 50,000 feet. A sample consisted of a predetermined amount of radioactive material collected on seven to eight square feet of special filter paper. Twelve F-84's on each shot were expected to bring back half a sample each. The high altitude samplers were required to bring back one sample each.

D. TECHNICAL PHOTOGRAPHY

The third major phase of the Air Task Group's mission was technical photography. The purpose of the nuclear cloud Photography Program (Project 9.1) was the photogrammetric determination of the various parameters of nuclear clouds as a function of time and the attempt to establish approximate yield relationships. The most important parameter was the rate of cloud rise and the areas of the cone swept out by the rising material. Of secondary importance was the dimension and drift of the cloud as functions of time after the cloud had reached its maximum altitude.

This project required three C-54's, an RB-36 and a B-50. The RB-36 was equipped with gyro-stabilized mounts holding a K-17 aerial camera and

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an Eclair 35 mm motion picture camera. The RB-36 was positioned sixty miles from Ground Zero for the purpose of photographing cloud phenomenology. For approximately ten minutes after the shot it orbited at 35,000 to 40,000 feet altitude. The C-54's, with a bank of cameras located in the cargo entrance, took fireball and cloud rise and growth photography from altitudes of 10,000, 12,000 and 14,000 feet and a distance of about eighty miles. The C-54's took pictures from Time Zero until the cloud lost its identity. These aircraft were on loan from MATS and were modified at Norton AFB, California, to accept camera racks and associated equipment from Air Force Lookout Mountain Photographic Laboratory. The B-50 took radar scope pictures from distances of fifteen to thirty miles at 30,000 feet for study of indirect bomb damage assessment and base surge characteristics. This information was then added to that gained from ground photography performed by Lookout Mountain Laboratory. On selected occasions, the SAC IBDA B-50's photographed the crater after completing their IBDA runs.

Approximately forty aircraft were airborne in the shot area for each detonation. Since each nuclear burst took place before daylight, careful aircraft control was necessary. Therefore two radar control centers were operated, one at Eniwetok and the other aboard the USS ESTES at Bikini. Under continuous radar control and surveillance, each aircraft was brought from Eniwetok to Bikini, positioned for its role in the shot, and then returned to Eniwetok. Throughout the mission all aircraft were in constant communication with the control centers and received their instructions through this system.

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E. THE INTER-ISLAND AND INTRA-ATOLL AIRLIFT

The final mission of the Air Task Group was inter-island and intra-atoll airlift. For the most part, the Bikini and Eniwetok intra-atoll airlifts were maintained by helicopters and L-13 liaison aircraft, which were used to carry scientists, construction workers and military personnel to and from the shot sites, work camps, military installations and measurement stations. The worn-out and outmoded L-13's used during the operation were salvaged and pushed into the lagoon at the end of CASTLE for reasons of economy, efficiency and safety.

For transportation of men and materiel between Eniwetok, Bikini and Kwajalein Atolls, C-47's were used. Their job was completed the day before each shot and commenced the day after each shot when the collection of scientific data from the last shot and preparation for the next shot started.

The Bikini intra-atoll airlift was activated in late 1953 when an Air Force detachment put seven H-19 helicopters into service. Until late January when the population and work load increased considerably, the Air Force had an average of ten daily scheduled flights. These flights originated at Eninman Island and alternately "flew the chain" clockwise and counter-clockwise. Regular stops were at Enyu, Romurikku and Namu. In late January, the Marine Helicopter Service assumed this responsibility and the Air Force helicopters were gradually phased out prior to the first shot. The Marines scheduled twelve flights per day and handled 3,000 passengers a week during the movement peak in February. With the loss,from blast and radiation, of the land base at Eninman after the first shot, all helicopter flights became special missions and were

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usually requested one day in advance. Frequently the Marine helicopters flew as many as forty missions a day.

The Eniwetok intra-atoll airlift operated five L-13's, four H-19's and two H-13's provided by Task Group 7.4. The number of available aircraft fluctuated, and there was an occasional shortage of H-19's.

Task Group 7.4 operated four round trips daily between Eniwetok and Bikini Atolls. Two PBM's were available for augmenting the C-47's.

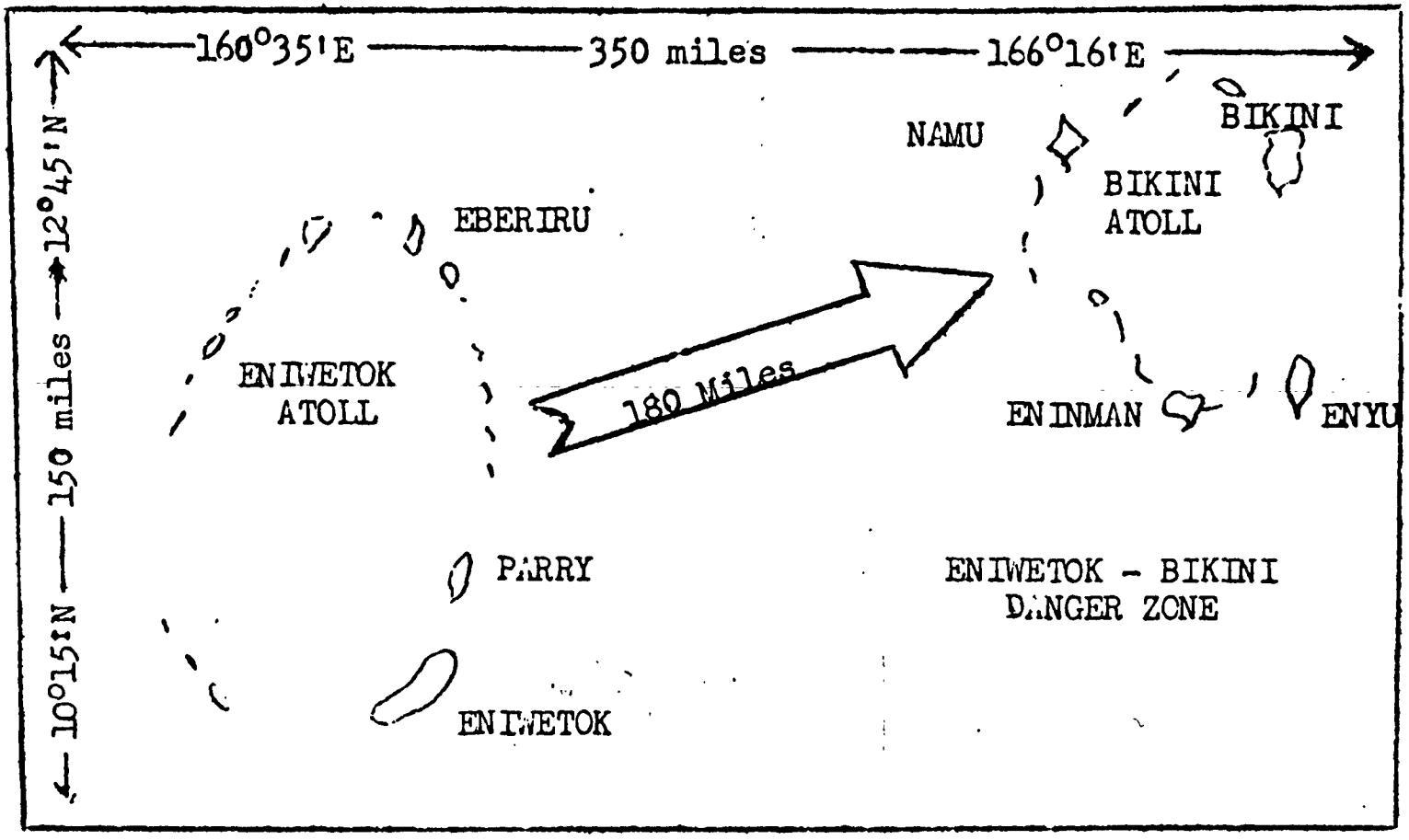
The Bikini airstrip was temporarily knocked out of commission by BRAVO. The Navy PBM's assigned to TG 7.4 were then saddled with the intra-atoll burden until the island's radiation level permitted re-entry and repair of the strip. This temporary use of PBM's proved unsatisfactory because of choppy waters and the difficulty of transferring passengers and cargo into small boats. Some of the C-47's were used for other flights, temporarily creating a shortage on the 180 nautical mile run from Eniwetok Island to Eninman Island.

F. WEATHER STATIONS

Weather stations were established on the inhabited islands of Majuro, Ponape and Kusaie, islands under the jurisdiction of the Trust Territories, Department of the Interior. However, during the IVY-CASTLE interval each weather facility was completely evacuated and the unoccupied buildings and structures deteriorated rapidly from the dampness and other adverse effects of the Pacific climate. Thus, extensive rehabilitation was necessary to reactivate these weather stations. Rongerik, the fourth weather station, was normally uninhabited, and also required renovation. Construction material for rehabilitation was limited, making such work difficult.

ILLUSTRATION 11

OPERATION CASTLE ([redacted])
DANGER ZONE



When these stations were originally constructed the layout of buildings and structures was haphazard at best. Prefabs were erected at any convenient open space, regardless of their distance from related activities. In many instances the buildings had been erected without first preparing any type of footing or foundation. Most of the buildings had plywood floors which would not support floor loads required for kitchen equipment and storage of supplies. Latrine facilities on all the islands were primitive. There were no shelters for critical equipment, such as walk-in type refrigerators, as well as no concrete pad foundations or shelter for gasoline-driven electrical generators. Nor was there any shelter or storage space of any kind for the large stocks of sensitive meteorological supplies and equipment required to sustain the operation of the weather island detachment for five months. On a morale level, there were neither day rooms nor recreational activities of any nature, other than outdoor movies.

Following BRAVO, the first shot, the twenty-eight personnel on Rongerik and approximately 236 natives from Rongelap and Utirik were evacuated to Kwajalein due to a high radioactive fall-out rate in those areas.[2] ILLUSTRATION 11, opposite page, shows Bikini-Eniwetok Danger Zone.

Not only did weather personnel receive information from such established Pacific stations as Tokyo, Hawaii, Guam, Wake and Kwajalein, but from twenty-man weather teams taking radiosonde observations on these four weather islands surrounding the Eniwetok-Bikini area. Finally, eight especially modified B-29's were dispatched, three daily, to fly ten and twelve hour missions in the areas of doubtful weather.

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G. RADIOLOGICAL CONTROL, MONITORING AND DECONTAMINATION

Radiological decontamination was of primary importance in all Joint Task Force and Air Task Group planning.

An allowable dosage of 3.9 r was set for all Joint Task Force SEVEN personnel other than those involved in special missions in which sampling was included. The Air Task Group planned to expose its pilots to 12 r during the entire operation and hoped to use them for three to four cloud sampling missions. Sampler pilots assigned to Task Group 7.4 who were expected to take part in future atomic tests were to be limited to 7.5 r for CASTLE. A maximum exposure of 20 r was to be allowed for the sampling effort. If necessary, B-36 maintenance personnel were to be permitted an increased allowable radiation dosage up to 7.8 r.

In its Final Report,[3] LASL stated that the then-current maximum permissible exposure of 3.9 r per thirteen-week period was not realistic in consideration of the heavy work loads in extensively contaminated areas. The use of waivers to cover exposures in excess of 3.9 r became a needless routine without much significance when operations were conducted in large contamination areas with short shot intervals. Many people exceeded the 3.9 r, but very few exceeded 6.0 r.

Three factors determined the aircrew dosage on each of the sampling missions: the time of penetration with relation to time of detonation; the time spent in or near the cloud; and the time spent in each contaminated aircraft in returning to the base. A sampler entering the cloud two to three hours after the detonation would be normally flying in a radiation field of approximately 60 to 120 roentgens per hour. Radiation of this intensity limited the aircraft's penetration of the cloud

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to ninety seconds or less. Later in the day the samplers would probably encounter intensities of five to twenty roentgens per hour, allowing them to remain in the cloud from thirty to forty minutes. In either case the crews received one or two roentgens. To protect the crews all sampler aircraft were pressurized, each carrying a special filter which prevented the entry of radioactive particles into the pressurization system. As a further safeguard should contamination escape this filter, all crew members were required to breathe one hundred percent oxygen during and after sampling. In effect, the crew members were wearing gas masks. Lead vests were furnished to crew members to decrease the amount of radiation reaching the body's vital organs. Finally, all aircraft were as clean as possible prior to take-off so that oily areas would not attract, or act as a collecting agent for radiation. To avoid picking up contamination, a platform was constructed and placed on a fork lift to serve as an elevator for pilots leaving the aircraft. On the B-36's, crews were given gloves and instructed to use extreme care in exiting through the crew hatches. The aircraft were then isolated to allow the radiation to decay for approximately 48 hours. Next, they were placed on either the decontamination pad or wash rack and thoroughly washed and scrubbed with a combination of detergent, kerosene and chemicals. Afterwards they were given a fresh water rinse. This process was continued until the cockpit reading was approximately 25 mr per hour. No flying was permitted until the cockpit level was reduced to this figure. Despite the above precautions, crew members frequently had small amounts of contamination on their clothing and the exposed portions of their body. These men were processed through the personnel decontamination center,

where they were showered and scrubbed until relatively radiation free, and then given clean clothing. These men were not released until their skin readings were down to seven milliroentgens and clothing readings down to twenty milliroentgens.

A highly experienced control team composed of a scientist from Los Alamos, Dr. Hal Plank; Colonel Paul Fackler, Director of Operations; Colonel Karl Houghton, Medical Adviser; Major Billy Burke, Deputy for Military Matters; and Major Finis Mitchell, Deputy for Scientific Matters, directed the nuclear cloud sampling operations. This team had observed and directed sampling on more than thirty-five nuclear detonations prior to CASTLE. On CASTLE, aboard the B-36 control aircraft, they observed the detonation and growth of the nuclear cloud and the areas from which representative samples should be obtained. Following the decrease of cloud intensities, the F-84, B-36 and B-29 samplers were then directed by the control team to enter the cloud at a specific point and altitude for a certain length of time. Prior to the operation these pilots were thoroughly schooled in methods of sample collection and radiation safety matters. This tended to minimize the amount of direction the sampling aircraft received from the control team.

Upon landing, the samples were removed by trained personnel using long-handled tools and placed in an especially designed lead container. These samples were then carried back to the Zone of the Interior by special long-range transport planes.

H. EFFECTS AIRCRAFT CONTROL AND POSITIONING

The B-36 controller aircraft's job was to place each aircraft at an

exact point in space at H-hour. This position was made good by the coordinated effort of the crew members responsible for flying and navigating the aircraft. An orbital flight pattern was flown by the crew several times just prior to H-hour, so timing adjustments could be made to take into account the existing winds over shot point. Thus the crew refined its timing to such an extent that they arrived at their assigned position with an error not in excess of plus or minus three seconds. On all CASTLE shots the B-36 and B-47 effects aircraft were positioned between 35,000 and 50,000 feet horizontal range and between 30,000 and 45,000 feet altitude. Their proximity to the detonation point necessitated protection against the heat and intense light. To increase reflectivity and prevent scorching of the metal, the B-36D was painted white on the underside. For crew protection, asbestos curtains were placed over all the windows and ports to intercept the thermal radiation. The aircraft received superficial damage from the blast on each of the shots, but not enough to endanger its flying characteristics or capabilities.

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The B-47 effects aircraft was 2985 feet from its planned location, possibly explaining why it received no superficial damage from the BRAVO yield.

The data gained from these two aircraft was to be used to design better aircraft and to develop techniques for safe delivery of nuclear weapons with aircraft now current.

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I. THE SHOT SERIES

1. BRAVO Shot

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The six shots fired were numbers forty-six through fifty-one in the United States atomic weapons test program.

Aircraft positioning was one of the most important phases of the shot series. Upon the correct positioning of aircraft depended the safety of crews and aircraft as well as the success of numerous scientific and photographic missions. In all cases it was agreed that aircraft would be positioned according to the maximum probable yield. ELAINE ONE and ELAINE TWO, the effects B-36 and B-47, were the most important aircraft in the positioning problem, because they were located nearest to Ground Zero on all shots.

On 20 February, the final positioning conference was held at Parry Island in Eniwetok Atoll (the site of JTF SEVEN and Task Groups 7.1 and 7.5). At that meeting, Dr. William Ogle, Commander of Task Group 7.1 (Scientific), stated that he had received the final yield

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possible yield, because of doubt as to the complete reactions. With this thought in mind, the Positioning Committee concurred and positioned the B-36 at 50,000 feet horizontal range and 33,000 feet altitude, and the B-47 at 48,000 feet horizontal range and 35,000 feet altitude. BRAVO was detonated at 0645 on 1 March. It was the only shot during the entire operation to be fired on schedule. Ground Zero was in a cab on the reef 2,950 feet from the southwest tip of Namu Island in Bikini Atoll. Early fireball and Bhangmeter results placed [redacted]

The take-off schedule for aircraft was closely adhered to and sample collecting by manned aircraft commenced. Fifteen F-84's and two FB-36's were used for sampling. It was considered that twelve operational F-84's would constitute the required number of samplers. In addition, one WB-29 with a "shoe box" type sampler was employed at H plus one hour for obtaining samples which the scientists hoped would contain heavy elements. The two FB-36's were used in an attempt to obtain samples at higher altitudes. Specifically, it was desired to obtain samples in the main cloud to determine whether they were more representative than the samples below the main portion. Sampling progressed as planned and the heavy nuclide samples from the WB-29 and several gas samples from the F-84's were transported from Eniwetok to Parry in minimum time by H-19's and L-13's. The other samples, destined for the United States, were removed from the aircraft, packaged and transported to the C-97 courier for shipment. A C-47 on stand-by at Eniwetok for recovery of samples at Bikini was not needed. The equipment in the control RB-36H operated

[redacted] [redacted]

satisfactorily with ranges in excess of seventy-five miles for both upper and lower radars. CASSIDY (B-36 control ship) radio beacon was held at 175 miles and used for homing. The control mission was a success from a radar standpoint. The Air Operations Center at Eniwetok operated without discrepancies.

However, the Raydist system monitoring the B-36D failed, possibly due to an error by one of the Hastings engineers. Therefore, no Raydist data was recorded by that aircraft. On BRAVO, the ELAINE ONE (B-36 effects) crew reported a bright red glow through the aluminized asbestos shields over the cabin windows during the peak of the thermal phase. In the aft cabin, a great deal of smoke was produced by the burning of the sponge rubber pads around the rims of both lower blisters. When the shock wave arrived, the controls were described as "free-floating" for a few seconds. A sharp bump similar to a thunderstorm was noted.

All equipment and instrumentation operated perfectly during the shot period. Jet engine tail-pipe temperatures, normally about 500° C, rose to 750° C shortly after shot time. It was believed that the peak temperature, however, was much higher. The reciprocating engines, set at 2080 rpm, decreased to 1600 rpm momentarily, then increased to 2500 rpm before returning to the normal 2080 rpm.

The greater than anticipated yield was noticeable in the damage sustained by ELAINE ONE (B-36 effects aircraft). Upon landing at Eniwetok the following damage was noted:

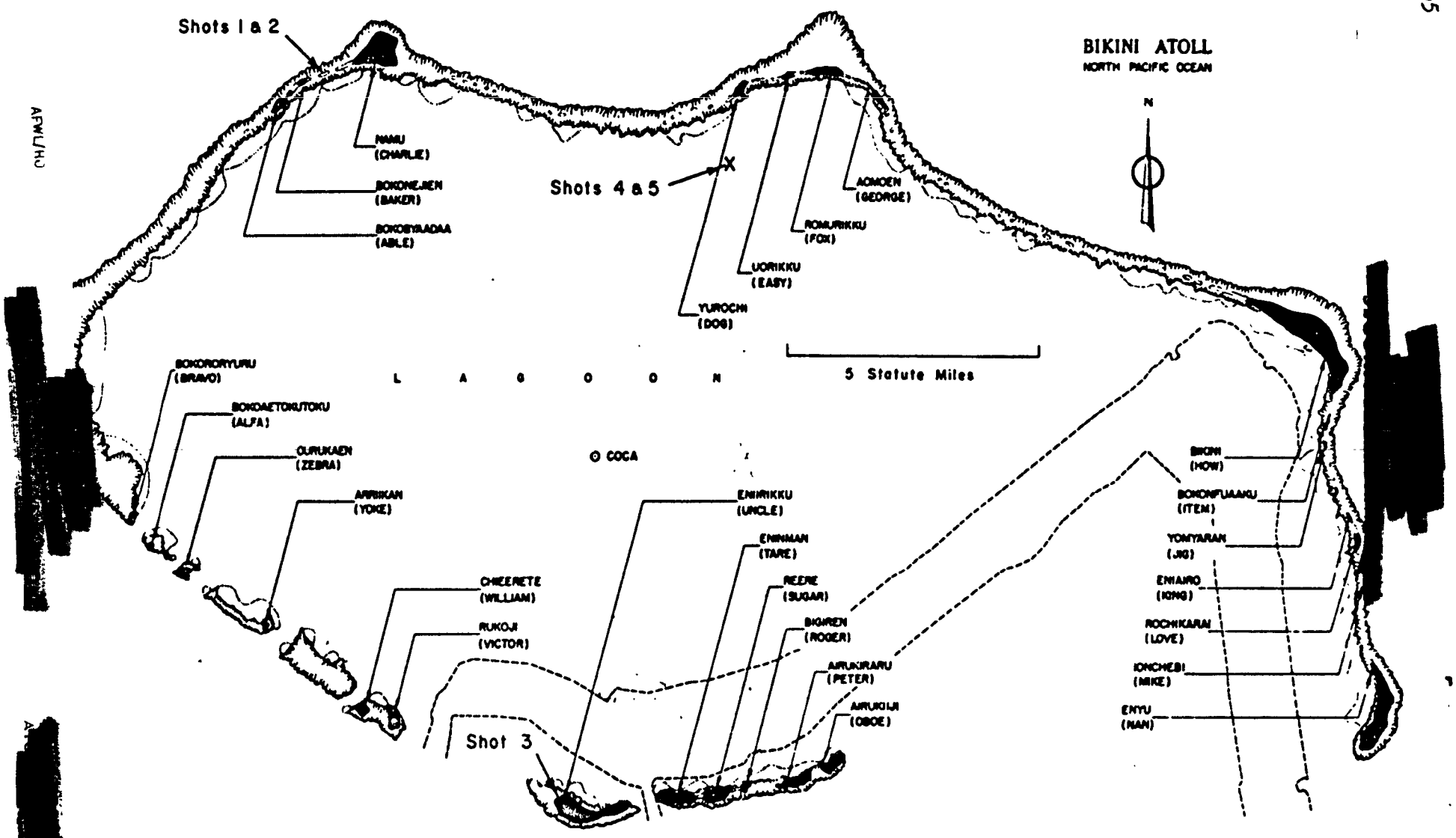
a. Radar dome crushed from rear;
b. Main gear wheel door flattened against wheel and panels dished;
c. Main column nacelle fairing blown in;
d. Nose door panels dished with some popped rivets and skin tears;

e. Lower forwarded nacelle cowling panels dished and buckled with some popped rivets and skin tears;
f. Lower aft turret door panels dished;
g. Slight distortions in light gauge skin of lower aft fuselage;
h. Combined blast and gust loads deflected forward and aft of bomb bay doors into bomb bay between hinge point and buckled door structure approximately four feet from front of each set;
i. Some distortion of bottom of Bulkhead No. 5;
j. Some torn rivets at right horizontal stabilizer tip;
k. Compression wrinkle pattern middle section of vertical stabilizer at leading edge;
l. Slight thermal damage in the form of minor paint blistering on elevators; elevator trim tabs, lower rounded portion of wing trailing edge between center and inboard engine, and inboard engine and fuselage;
m. Slight thermal damage on aft section of main gear wheel doors;
n. Slight warping of aluminum lacquered drog strut wing fairing and lacquer blistered and scorched;
o. Curtain on optics in periscope charred;
p. Black coating on ADF antenna fairing blistered;
q. Rear right upper and lower blisters cracked and rubber scorched;
r. Aluminum lacquered 24 ST .016 web of horizontal stabilizer trailing edge fairing scorched and buckled where exposed; some popped and loose rivets in spanwise rivet lines on top surface of horizontal stabilizer leading and trailing edge fairings.

Damages on ELAINE ONE were repaired prior to ROMEO, the second shot. Under normal maintenance conditions it was estimated that 750 to 800 man-hours would have been needed to complete the repairs.

The data for ELAINE TWO was usable, but ambiguities existed. The B-47 was 1,800 feet over according to its scope photography, but later reduction of Raydist data placed the figure at 2,985 feet. This was probably the reason the B-47 sustained no damage while the B-36 sustained fairly severe damages. The shock wave arrival time, 110.5 seconds after Time Zero, and the accompanying overpressure, 0.360 psi, agreed with the values calculated for the actual positioning of the aircraft. The crew felt neither heat nor extreme shock buffet in the cockpit. The aircraft received only minor external damage from thermal and blast effects. Two visible evidences of test effects were found: blistered

ILLUSTRATION 12



paint on several panels of the underside skin of the left horizontal stabilizer, and a burned rubber coupling on the in-flight refueling manifold in the bomb bay area.

Two discrepancies in the preliminary analysis of the data were still unexplained at this writing. At the attained position the recorded thermal energy received was [redacted] less than predicted. The maximum recorded skin temperature rises ranged from zero to forty-three percent lower than predicted for the recorded thermal input. A thorough analysis of films of ground zero were expected to substantiate the low thermal inputs confirming the presence of suspected clouds in the area between Ground Zero and the aircraft.

Because of the greater than expected yield and an adverse wind condition, a large amount of persistent fall-out occurred at various atolls east of Ground Zero; namely, at Rongerik, Rongelap, Utirik and Ailinginae. On previous shots the fall-out had been at sea where there were no instruments to record its location and intensity. Weather forecasts indicated that the BRAVO fall-out would barely miss these atolls, but a slight wind change, probably no more than ten percent, carried the fall-out directly over the eastern atolls of the Marshall Islands. A large amount of fall-out occurred in the Bikini area, which resulted in a revision of the shot schedule, both as to time and location. ILLUSTRATION 12, opposite page, shows Bikini Atoll and location of the five shots fired there. Since no one was able to work in the area, the next shot was postponed for two days and scheduled for the BRAVO crater. The Bikini airstrip was contaminated to

[redacted] [redacted]

such a degree that its immediate use was hazardous to personnel. Radiation prohibited the landing of aircraft. This situation imposed a serious problem because airlift between Eniwetok and Bikini was a necessity. The two PBM aircraft, operationally controlled by Task Group 7.4 at that time, were not considered sufficient to accommodate all the anticipated passengers and cargo. General Estes promptly requested USAF to furnish three SA-16 aircraft. Headquarters, USAF in turn directed the Air Rescue Service to dispatch three SA-16's from Hawaii to Eniwetok. However, only two SA-16's could be made available at Honolulu due to a lack of aircrews. These two aircraft arrived on 9 March and were immediately placed in operation in the inter-atoll airlift system.

Although contaminated, the existing radiological hazard at Rongerik did not preclude visits to that weather station, provided the period of occupation did not exceed radiological safety limits. It was decided that during the interim between evacuation and re-establishment of the station to normal operational status — about 1 May 1954 — that re-entry parties of five to seven men, including one radiological safety monitor provided by the 4926th, would be periodically transported from Eniwetok to Rongerik to service, maintain and operate, on a very limited scale, the equipment and facilities there. During the second week of March the first re-entry team arrived at Rongerik. Except for the radiological safety monitor, this team was provided by the Test Services Unit. Radiation intensities, samples of coral and other contaminated debris found in the vicinity of the working area were obtained and conveyed to Task Groups 7.1 and 7.4. Only personnel who had not been exposed to radiation intensities considered excessive would be assigned to man the weather reporting installation.

[redacted] [redacted]

True to forecast, BRAVO Day was poor for radio propagation. QRN and QRM bothered all voice and radio-teletype circuits, but on the whole, communications continuity was maintained. Within three hours after the blast, the Command Ship (USS ESTES) was washing down everything above decks. Since this included antennae, this raised havoc with voice and radio-teletype circuits on the ship. In addition, some indications, especially from Task Group 7.2's long-haul circuits, pointed to ionospheric disturbances due to the blast. However, aircraft control circuits, both voice point-to-point and air-to-ground, maintained continuity. Some improvisation was necessary; the VHF relay circuit remained active and the control destroyer acted as a voice relay for circuits J-407 and J-408.

The most significant observation of the Combat Information Center (CIC) during the BRAVO Shot was that the detonation did not seriously affect either radar or radio transmissions. This observation was in direct contrast to that made during MIKE Shot in Operation IVY, when both radar and radio seemed to be seriously affected by the explosion. Weather seemed to be the deciding factor. During MIKE Shot, the air was heavily saturated with visible moisture prior to the shot. During BRAVO it was not. MIKE Shot generated numerous cumulo-nimbus type clouds reaching to extremely high altitudes, but BRAVO did not. Radar scopes were cluttered for several hours with widespread cloud returns during MIKE, making sampling aircraft control extremely difficult. The scope was clear thirty minutes after BRAVO. IFF returns and radar blips disappeared for brief intervals during BRAVO, although no clouds were visible on the scope. This made for good control of all aircraft.

[redacted] [redacted]

BRAVO proved that extensive training of CIC personnel prior to the shot was a sound investment. The CIC Air Force and Navy team functioned smoothly and expertly throughout the operations. The check list monitor proved exceptionally valuable, in that he relieved the senior controller of many check list details so that his primary duty of supervising CIC operations coordinating with the Joint Operations Center (JOC) could be done in an orderly and efficient manner.

The Air Operations Center was successful in performing its mission during BRAVO. Detailed written procedures were made available to all operating positions and the Air Operations Center (AOC) was fully manned one hour prior to the take-off of the first aircraft, which was H minus six hours. Only minor discrepancies existed which affected the operation of the AOC. One incident was the arrival of three VIP aircraft at Eniwetok. Their IFF was not air or ground checked prior to BRAVO. The AOC dispatched these aircraft on the same heading climb-out with five minutes separation. IFF's of two of the three aircraft were inoperative and the radio procedure of point-to-point radio operators was not up to expected standards. This caused many repeats when communications reception was weak, resulting in the slow flow of important traffic. An on-the-job training program was re-emphasized to correct this deficiency.

Following BRAVO, J-11 of LASL reported that the Air Task Group's sampling mission was the best ever performed on an overseas test.

2. ROMEO Shot

The first delay of the CASTLE series began on the seventh of March when it became apparent that the upper winds over Bikini Atoll were

[redacted] It was believed that fall-out would be too severe to permit shooting when upper winds indicated possible contamination of any nearby populated areas. This was the lesson of BRAVO. While the delay was not serious, it led to situations of Project Participants (military and civilian personnel sent to the Pacific Proving Ground to witness shots) arriving at Eniwetok when no shot was imminent. To preclude this from happening, a TWX was forwarded on the seventh of March to SAC and AFSWC, informing them of the shot delays. Further information on the shot delays was dispatched to SAC and AFSWC on 30 March.

ROMEO was finally fired on 27 March from a barge in the center of the BRAVO crater in Bikini Atoll. The predicted yield, for the benefit of aircraft positioning, was

final LASL determination for

DELETED

The most significant aspect of ROMEO, from the Task Group 7.4 point of view, was not the overall success of the air mission, but the fact that success was achieved in spite of seventeen consecutive twenty-four to forty-eight hour postponements. These seemingly incessant postponements had a bad effect on both personnel and aircraft. The men were "peaked" for the shot's original firing date and each subsequent rescheduling and postponement resulted in a build-up and let-down of morale. It was also evident that the corrosive salt air would cause increased maintenance and abort rates

[redacted] [redacted]

[redacted]

unless frequent flights were made. These additional flights necessitated additional inspections and maintenance, thus possibly denying use of the aircraft for the operation. Since there was no assurance as to when a shot would be fired, the Air Task Group was in the position of assuming a calculated risk by withdrawing aircraft from operation for these inspections. Critical aircraft, such as the RB-36, required special maintenance. Therefore, a maintenance priority was set up giving top priority to the RB-36 sampler-controller and the two B-36 samplers. Second priority was given to the F-84 samplers, WB-29 weather aircraft, rescue planes, one C-54 photography aircraft, and the inter-atoll airlift aircraft. All other aircraft were considered as third priority jobs.

This extended BRAVO-ROMEO interim gave rise to the possibility of firing two or more shots at minimum time intervals to permit a possible make-up in schedule. A thorough study was prepared by the Air Task Group considering this possibility. Information from this study was forwarded to General Clarkson on 23 March, indicating actions which could be taken by JTF SEVEN to improve Task Group 7.4 capability on turn-around. Such things were suggested as elimination of CASSIDY's (B-36 control aircraft) requirement to take crater photos, thus reducing the possibility of contamination; increasing the allowable radiation dosage limits on B-36 maintenance personnel; elimination, when feasible, of the B-36 effects aircraft to free those maintenance personnel for other B-36 work; authorization of one B-36 sampler instead of two; and provision for additional decontamination units. General Clarkson agreed with most of these proposals, stressing that two B-36

[redacted] [redacted]

[redacted]

samplers should participate whenever possible, but that one would be acceptable should the shot interval be less than seven days. He also stated that if necessary the B-36 effects aircraft could be eliminated on all shots except YANKEE and NECTAR.* During this, the BRAVO-ROMEO interim, planning got underway on the roll-up, the final report and the Eniwetok Five-Year Plan.

The successful air operation was due partly to a calculated risk taken by General Estes. Basing his decision upon a thorough study of radiological and weather forecast analysis, General Estes decided that an announced postponement would in reality be longer than the twenty-four to forty-eight hour period officially announced. This theory involved a certain amount of calculated, but obviously necessary, risk. Each day, Weather Central at Eniwetok gave the same weather briefing to General Clarkson and General Estes. However, General Estes looked at the projected weather one day ahead. While General Clarkson was considering the next day as D-day, General Estes was considering the next day as D-day and D plus 1. If the trend looked unfavorable for D and D plus 1, General Estes then considered that he was in D minus 3 and directed his commanders to fly their aircraft and still have two days for inspection and maintenance. If D and D plus 1 looked favorable, he cautioned his commanders not to fly their aircraft. While this procedure permitted the line and flight crews to do the best possible maintenance job of keeping aircraft in a quality maintenance condition, it placed the Air Task Group in an awkward position should a rapid unforecasted change in the weather suddenly place everyone in D minus 1.

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*The B-36 effects aircraft was flown on all missions.

[redacted] [redacted]

However, most parties felt this risk was worth taking in order to insure against mission and ground aborts.

No formal meeting was held for the positioning of effects aircraft for ROMEO. Aircraft were positioned on a [redacted] This wide spread of probability was an outgrowth of BRAVO results, which indicated that thermonuclear fuel reactions concerning device components were too uncertain at that time for attempting a high probability yield prediction. Therefore, it was informally decided to position the B-36D at 37,000 feet altitude and at 50,000 feet horizontal range, and the B-47 at 35,000 feet altitude and a horizontal range of 50,000 feet. Since the shape of BRAVO's radioactive cloud had persisted for some time, sampling for ROMEO was extended for a longer period.

Radar scope jamming prevented accurate positioning of the B-47 effects aircraft on ROMEO. This jamming was caused by two or more aircraft operating on the same radar frequency in a small area around Ground Zero. The actual position at Time Zero, as determined by the Raydist tracking system, was 28,500 feet beyond the assigned horizontal range of 50,000 feet from Ground Zero. The radar-data-repeater indicator induced an error in headings and as a result the burst was ten degrees to the right of a tail-on aspect to the aircraft. Therefore, the aircrew felt heat in the cockpit, although they had felt no heat during BRAVO.

Five of the six GSAP cameras failed because heater thermostats broke and the brittle film jammed in the magazine. About ninety percent of the seventy-six recording functions performed their missions.

[redacted]

The recorded thermal energy received at the aircraft was [redacted] about ten percent greater than predicted. There has been no explanation for this discrepancy to date. The arrival of the shock-wave at 159.1 seconds after burst and the accompanying overpressure of 0.237 psi, agreed very closely with the predictions. The recorded maximum skin temperature rises ranged from zero to forty-two percent lower than predicted for the total thermal energy recorded. The fuse-lage pressure gauges sensed the unsymmetrical loading received from the shock wave by registering higher overpressures on the side of the shock wave arrival. The effects B-47 received no appreciable damage. A very small patch of paint on the right elevator trim tabs was blis-tered and the gelatin filters on the GSAP cameras were burned.

On ROMEO, the effects B-36 was one second early and a little to the left. Raydist malfunctioned on this aircraft and no results were obtained. The B-36 received damages similar, but less extensive, to those on BRAVO. Repair was estimated at 100 man-hours. Flight crew reactions and observations during ROMEO were the same as on BRAVO, with the exception that two distinct light pulses were seen through the asbestos window shields. It is possible that there were two light pulses on BRAVO, since it is characteristic of this type detonation. The jet tail-pipe temperatures reached the gauge limit (1000° C) and probably exceeded the figure. No notable thermal damage was observed, however.

There were several minor aborts, all considered primarily due to the length of time the aircraft had sat on the ground in preparation

[redacted]

for the operation. Back-up aircraft were quickly airborne in all cases and the mission successfully executed.

Although there was minor damage to the landing strip at Bikini and considerable debris had to be removed, it was reopened to air traffic at 1700 M Time on Shot Day. The fall-out on inhabited islands during and after ROMEO was minor, and re-entry of Bikini Atoll was accomplished on the evening of ROMEO Day, thereby allowing early sample recovery. Most of the heavy fall-out went to the northwest as predicted. However, a secondary fall-out was noted on the morning of D plus 2 days.

In preparation for ROMEO, the Communications Element had to send men to Rongerik on D minus 1 to service and turn on the homer, and to NAN to inspect, service check and turn on the homer, Racon and VHF transmitters. A PBM or SA-16 run into Rongerik on D minus 1 was set up for three Communications personnel, a Rawinsonde team and a radiological safety monitor. This trip was just as faithfully postponed each night, as a direct result of the twenty-four and forty-eight hour shot delays.

One phenomenon observed on BRAVO Day was also evident on ROMEO Day: the Kwajalein multiplex circuit went out immediately after the shot and remained out for several hours. In addition, two CW circuits to Kwajalein were out for an hour after the shot. Indications were that perhaps some electromagnetic aspect of the detonation was interfering with long-haul circuits. Task Group 7.2 (Army) had the same trouble on their Honolulu circuits. Both were out for at least an hour.

The Command Ship was again successful in performing its mission during ROMEO. Positive control of all aircraft was continuously maintained throughout the mission. No radar, IFF or communication failures occurred.

[redacted] [redacted]

[redacted]

The radar video return from the ROMEO cloud was ten to fifteen miles in diameter. It was persistent for about thirty minutes and then began to dissipate. By H plus forty-five minutes the cloud had completely faded from the radar scopes. The cloud formation on the scopes did not hamper air control to any degree during ROMEO.

3. KOON Shot

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Eniwetok and Parry Islands, approximately 175 nautical miles from Ground Zero, were bathed in brighter-than-daylight brilliance for several seconds after each of the other five CASTLE shots. KOON, in comparison, was likened to the explosion of a flash bulb.

No usable data was obtained from the effects B-47 on this shot because of the low yield of the device and heavy cloud cover which reduced thermal inputs below the minimum sensitivity of the calorimeters and radiometers. No temperature rises were observed in the aircraft skin. The shock wave reached the aircraft 110.7 seconds after Time Zero. The peak overpressure reading was 0.035 psi.

In spite of poor weather conditions, including turbulent air in the flight orbit and several mechanical difficulties, the B-36 effects aircraft managed to attain its Time Zero position. No instrumentation data of value was obtained because of the low yield. There was no thermal

[redacted] [redacted]

damage of note and very minor blast damage similar to that incurred on ROMEO. The shock time arrival was at 81.04 seconds after Time Zero. This was the only shot the back-up controller-sampler participated in. The primary sampler had landing gear trouble and a fracture in one of the plexiglass bubbles which made it lose pressure.

None of the PEWTER photography aircraft was able to get pictures because of extensive cloud cover below. Although the photography aircraft climbed to 15,500 feet and were in the clear at H-hour, they were unable to see the blast. On this shot it was found that a 120° angle between PEWTER ONE and PEWTER THREE was too great for triangulation purposes used in Project 9.1.

In February, it had been believed that a four-day maintenance period was required between shots, provided a shot was postponed after H-5 hours. As the delays continued, however, it became more and more apparent that the four-day period had to be reduced. In March there seemed to be minimum flexibility in the Task Group 7.1 shot plans. Nothing could be done except sit and wait for the proper firing winds. Following ROMEO, Task Group 7.1 decided to have one shot ready for firing at Bikini and Eniwetok, respectively, so that either could be fired on a short notice whenever the proper firing winds occurred at either shot site.

This added flexibility in the shot schedule placed additional burdens upon the Air Task Group. Their first project was to find out how fast they could accomplish aircraft "turn-around" for two missions within possibly three days. Two things were required: a revised decontamination procedure and a maintenance system capable of giving priority maintenance to the RB-36 controller, a B-36 sampler and eight F-84 samplers, in order to assure their readiness within a three-day turn-around period.

Following ROMEO, the Air Task Group found it could, without undue effort, pursue a three-day turn-around between shots and be assured of

[redacted]

the above-mentioned "half-effort" * for each shot as far as decontamination was concerned. Due to the number of aircraft taking part in ROMEO, the maintenance system was not tried. It was intended to test this system following KOON, the third shot.

General Estes committed the Air Task Group to support firing on a three-day interval with all required sampling aircraft, but stated that this was the maximum Task Group 7.4 capability. To shorten the three-day interval, the sampling effort would have to be cut in half: one B-36 sampler, one B-36 controller and six F-84's would be available. Due to the possible need for reducing the shot interval, General Clarkson and Doctors Ogle and Graves decided to keep the half sampling effort in mind, because with it a one-day turn-around was not entirely impossible. The Air Task Group had stated that a one-day turn-around was possible, providing there were no B-36 aborts or maintenance requirements.

Following KOON, the new decontamination procedure worked very well, but the Air Task Group still did not test the maintenance system, due to the less than full-scale number of aircraft in operation. It was again planned to check the short interval maintenance system subsequent to UNION, the fourth shot. This very simple maintenance system entailed certain priorities which called for putting the effects B-36 crew and the other crews from the contaminated B-36's to work on the control B-36 immediately upon its return from the mission.

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*So-called because approximately one-half of the Air Task Group aircraft would be available for a shot.

[redacted]

[redacted]

4. ECHO Shot

ECHO Shot [redacted] no weapon prototype designation), scheduled for Eniwetok Atoll, was cancelled on 12 April when it was ascertained that KOON data had eliminated the scientific requirement [redacted] This change had no great effect upon Task Group 7.4, other than the natural lessening of requirements. On the same date UNION was rescheduled for 16 April. However, a series of postponements followed in which D-day was the 20th, 21st, 23rd, 24th and 25th. UNION was finally detonated on the 26th.

5. UNION Shot

UNION Shot [redacted] was detonated at 0610 hours on 26 April, nineteen days after KOON, on a barge in Bikini Atoll. The exact location was at an intersection of arcs with radii of 6900 feet from Yurochi and three nautical miles from Aomen. The

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The TARE-OBOE airstrip, approximately thirteen nautical miles from Ground Zero, was closed for two days afterwards while debris was removed from the runway.

There were only two aborts: an IBDA B-50, with inoperative radar and VHF; and an F-84 with a wing tank that would not feed. A spare F-84 was airborne and returned successfully with the required samples. As usual, there was minor damage to ELAINE ONE, the effects B-36, and no damage to ELAINE TWO, the effects B-47.

[redacted]

On UNION, no unfamiliar reactions were noted by the B-36 flight crew. The pressure altimeter was observed more closely on this shot and, after the effects of the shock wave had subsided, the altitude was more than 200 feet higher than before the shock arrival. There was no thermal damage worth noting, but blast damage was similar, but less in degree, to that of ROMEO. The measured overpressure was between 0.41 and 0.45 psi, and the shock time arrival was 69.49 seconds after Time Zero. The total thermal intensity was between [redacted]ETED

[redacted]

The assigned position of the B-47 at Time Zero was at an altitude of 35,000 feet, on a 180° heading, and at a horizontal range of 48,240 feet from Ground Zero. The six GSAP cameras produced excellent motion pictures of the burst. Ninety-three percent of the ninety-one distinct instrumentation functions operated satisfactorily. Total thermal energy received amounted to [redacted] This thermal energy induced skin temperature rises in the range of 10° F to 180° F throughout the aircraft. The shock wave reached the aircraft 117 seconds after the blast. The accompanying overpressure was 0.261 psi. The B-47 crew reported no heat in the cockpit and only a moderate shock wave jolt. The aircraft suffered no apparent damage.

Immediately after UNION the decontamination and minimum turn-around principle was practiced. It was found that within twenty-four hours after one shot, the Task Group could have supported another shot in the same manner as it did on UNION. This included decontaminating seven F-84's and one B-36 for sampling. On this particular mission all critical aircraft landed after the shot with only very minor maintenance required for turn-around.

[redacted]

6. YANKEE Shot

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Aircraft positioning for YANKEE and NECTAR, the final shot, was confirmed during an 18 April meeting at Parry Island. The YANKEE sampling effort consisted of one-half the normal capability, in order that the Air Task Group might be in a position to participate in another detonation within twenty-four to forty-eight hours. Nine F-84's, one FB-36 and one WB-29 were used. Each aircraft obtained a double sample. ELAINE TWO, the B-47 effects aircraft, aborted with a fuel leak, but the B-36, ELAINE ONE, accomplished its mission.

The B-36 instrumentation system received the highest values of thermal and blast response measured by that aircraft in the entire operation on YANKEE, partly because estimated and actual yield were closely compatible.

According to the crew, the red glow seen through the asbestos curtains during the thermal phase was more intense than on any previous shot and was observed to have two distinct pulses. Considerable smoke was observed in the aft crew compartment. The fire warning lights on

four of the reciprocating engines were lit for four seconds. When the shock wave arrived, the aircraft was described as "free-floating" and flexible. It was believed that considerable bending resulted from the passage of the shock wave. The reciprocating engines varied plus or minus 300 rpm from the cruise setting of 2100 rpm. A maximum reading of twenty milliroentgens for 10 to 15 seconds was recorded. Visual thermal damage was similar but more severe than that received on BRAVO. The entire elevator and tab areas were covered with paint blisters ranging from one quarter to two inches in diameter, most of which were torn or blown away from the airstream. Where the paint was missing the color of the elevator surface was dark gray. At four places on the elevator the paint was completely missing over areas of fifteen square inches. Permanent skin buckling was noticed at three places, the most severe occurring on the right elevator, where two places were about 3/64ths of an inch deep. No buckling was observed in areas where the white paint was more or less intact. Blast damage was similar to BRAVO, but of the same degree as ROMEO.

On 10 May, General Estes, Colonel Fackler and Colonel Hawley visited Bikini to inspect the operational capability of the TARE strip. It was found that waves caused by the YANKEE detonation had washed in from the lagoon and made the runway unsafe for heavy use. Ditches and holes had been washed in the shoulders and there were numerous holes in the runway itself. The runway could have been used by C-47 type aircraft in an emergency but not for day-to-day operation. However, since YANKEE was the last shot scheduled for the Bikini area, no action was taken to repair the runway.

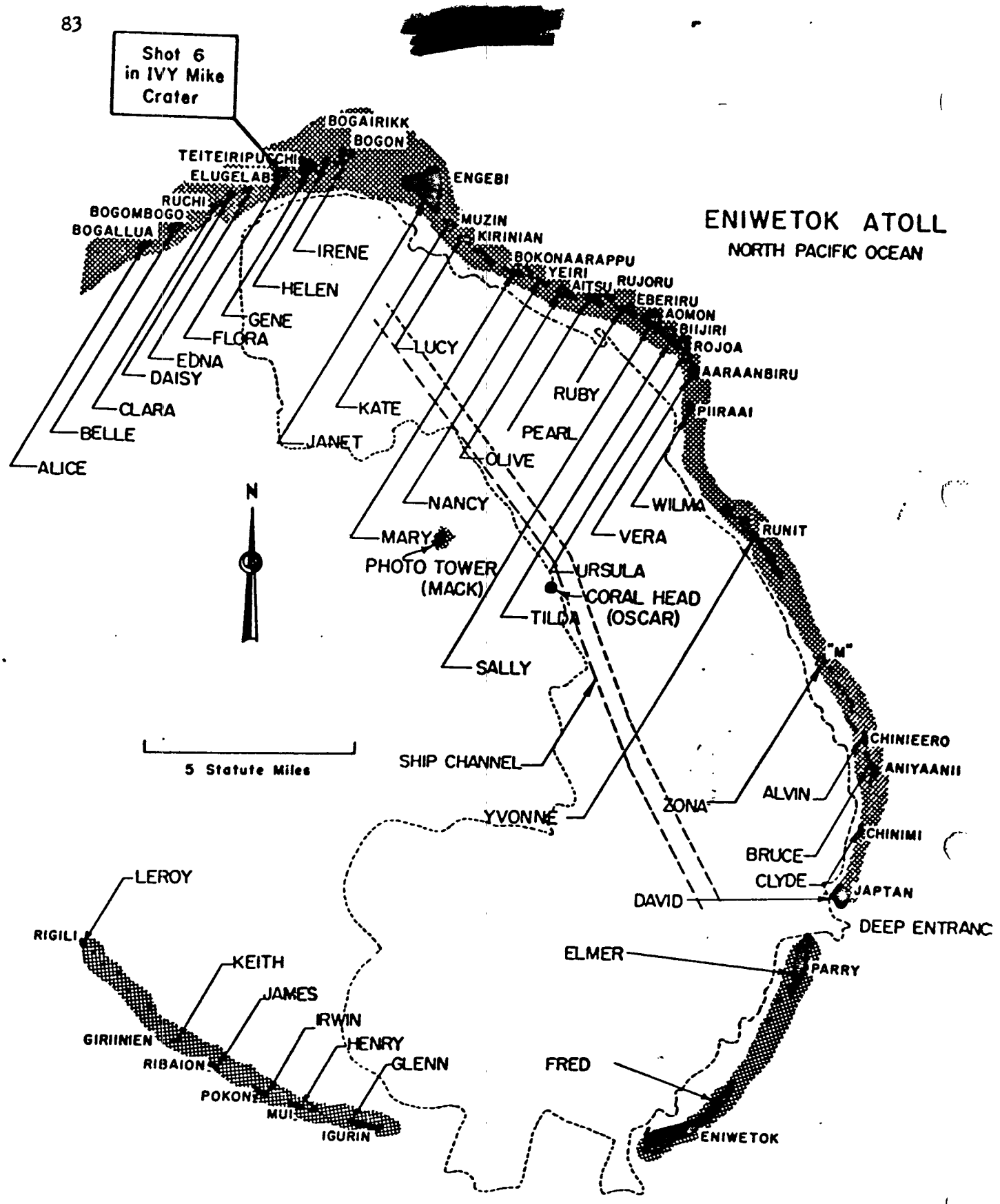

ILLUSTRATION 13

APWL/HO

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[redacted]

7. NECTAR Shot

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Unfavorable weather caused several postponements of this shot, once after many aircraft were already airborne.

All normal mission aircraft were scheduled for NECTAR. Only the samplers failed to accomplish their complete mission. Due to heavy rain at Eniwetok, electrical difficulties were experienced with the F-84's. Sixteen sorties were flown by the 12 available aircraft, but samples were not obtained by all aircraft that reached the sampling areas. A concentration of cirrus clouds caused by typhoon conditions prevented the B-36 controller from providing adequate directions to the samplers. Several aircraft were thus forced by a lack of fuel to return to Eniwetok Island before completing their mission.

The B-36 effects aircraft participation in NECTAR was normal and routine. No unusual observations were made, except that the shock wave was very sharp and of shorter duration than on previous shots. No radiation was detected. The only visual damage consisted of slight bomb bay dishing, and crushing of the sheet metal strip that seals the gap between the doors and the fuselage. Failure of some of the rivets to hold this strip to the fuselage was noted.

[redacted] [redacted]

[redacted]

According to data obtained from the K/A Navigation and Bombing System, the horizontal range of the B-47B at shot time was 28,300 feet, or 3520 feet short and 4.7 seconds late of the assigned position of 31,820 feet. The heading was 120 degrees true, in a tail-on aspect to Ground Zero. Raydist figures were not available at this writing. Incident thermal energy was [redacted] and the weapon's yield was 1.6 megatons. Using these figures as a basis of comparison, the thermal rises in 0.020 aluminum skin were twenty-five percent higher than predicted. The temperature rises ranged from a 21° F peak value in 0.188 to 205° F in 0.020 aluminum skin. At shock time, the horizontal range of the aircraft was 81,000 feet and the measured peak overpressure was 0.25 psi plus ten percent at all stations. The shock wave reached the aircraft in 74.5 seconds.

All of the instrumentation equipment was operative prior to take-off. Records indicated that ninety-six percent of the ninety-one instrumentation functions were operative in flight.

DELETED

[redacted]

[redacted]

AFWL/HO

[redacted]

DELETED

The technique of using barges as shot sites was practical and essential to the CASTLE tests and allowed greater flexibility in the operation. [redacted]

Neither change would have been possible with land shots. However, an attempt to fire from a barge on the high seas was deemed unwise until the problems of tsumanis (great sea waves produced by submarine earth movements or volcanic eruptions) are settled and other operational problems carefully studied.

[redacted]

[redacted]

FOOTNOTES FOR CHAPTER IV

1. Dr. Edward Teller, University of California Radiation Laboratory, was convinced that [redacted] Dr. Graves conceded that there was a slight possibility of such a high yield, but LASL personnel were willing to stand by their figures. Dr. Teller's theory caused concern within the Air Task Group because 7.4 could not easily overlook a possibility that could result in severe damage or loss of aircraft and crews. The effects aircraft were positioned according to the maximum probable yield on all shots. Dr. Teller had made the same prediction on MIKE Shot in 1952, but LASL's estimate had been borne out in the long run.

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2. Unpredictable weather was the main reason for this unforeseen fallout. In fact, the greatest single difficult factor throughout the operation was weather. It affected the ability of the scientists to collect data, the Air Task Group's ability to take photographs and collect samples and, above all, it determined the areas of radioactive fall-out. (CONFIDENTIAL)

3. Report of the Commander, Task Group 7.1, Los Alamos Scientific Laboratory, June 1954. LASL, JO-11. (SECRET, R/D)

4. Before and during the Operation there were many shifts of time and location schedules for detonation. The tables listed in the following pages show some of the different time scheduling, and the arrival and assembly times of the devices.

[redacted] [redacted]

DELETED

DELETED

DELETED

DELETED

[redacted]

FOOTNOTES FOR CHAPTER IV (Contd)

B. ARRIVAL AND ASSEMBLY TIMES OF THE DEVICES

BRAVO [redacted]

25 January - Unit arrived at Eniwetok
17 February - Final assembly completed
18 February - Shipped to Bikini and trans-shipped to cab on 20 February
22 February - Installation in cab completed

[redacted]

ROMEO [redacted]

25 January - Unit arrived at Eniwetok
4 March - Final assembly completed
5 March - Unit installed on barge
7 March - Barge departed for Bikini in LSD
9 March - Anchoring completed in [redacted] crater and cables checked out
11 March - Exchanged booster cylinders (used small one)

[redacted]

UNION [redacted]

25 January - Unit arrived at Eniwetok
2 March - Assembly completed
8 April - Reassembled after postponement and loaded on barge
9 April - Barge departed for Bikini in LSD
10 April - Anchoring completed and cables checked out

[redacted]

NECTAR [redacted]

5 March - Unit arrived at Eniwetok by air

[redacted]

14 April - Final assembly completed after postponements and loaded on barge
16 April - Barge towed to MIKE crater at north end of Eniwetok lagoon, anchored, and cables checked out
17 April - Support jacket removed and dummy lugs attached to the case

[redacted]

14 May -

[redacted]

[redacted]

AFWL/HC

[redacted]

FOOTNOTES FOR CHAPTER IV (Contd)

YANKEE [redacted]

16 April - Unit arrived at Eniwetok by air
26 April - Final assembly completed
27 April - Loaded on barge
30 April - Barge departed for Bikini in LSD

[redacted]

5. Conclusions taken from Report of the Commander, Task Group 7.1, Los Alamos Scientific Laboratory, June 1954. OCA-WT-940. (SECRET, R/D) This document is on file in the AFSWC Technical Library.

[redacted]

[redacted]

CHAPTER V

RADIOLOGICAL CONTAMINATION OF PERSONNEL ON BRAVO SHOT[1]

Several hours after BRAVO was detonated on 1 March, high intensity radioactive fall-out began to appear on the atolls to the east of Bikini. It started at approximately H plus five hours on Rongelap and Ailinginae, at H plus eight hours on Rongerik and several hours later at Utirik. All four atolls were inhabited. Rongelap was populated by sixty-four natives; Rongerik by twenty-five airmen at the weather station and three Project 6.6 personnel from the Army; Utirik by 154 natives; and Ailinginae by eighteen natives. Because of communication and logistic problems, evacuation of Rongelap did not start until H plus fifty hours, followed by Ailinginae at H plus sixty hours, Rongerik at H plus twenty-eight hours, and Utirik at approximately H plus eighty hours.

Rongerik, approximately 130 nautical miles from Ground Zero, was the only atoll in the group that had any radiation detection devices or dosimeters. Twelve film badges had been assigned to the U. S. personnel at the weather station, along with a recording rate meter being operated for the New York Operations Office of the Atomic Energy Commission. The rate meter went off-scale at 100 mr/hr at approximately H plus eight hours. The film badge readings were only regarded as approximate because of confusion as to the locations of the badges during the fall-out period. Six badges were in the refrigerator and registered 37 to 37.5 r. The badges carried, or in possession of USAF personnel, measured 40 r.[2]

The one badge in the possession of Army personnel (working on the other end of the island) registered 98 r.

[redacted]

At 0100 hours on 2 March, Task Group 7.4 at Eniwetok ordered all Air Force personnel to remain indoors until the arrival of the evacuation party. Concurrent with each evacuation, Colonel Clinton S. Maupin, Surgeon, JTF SEVEN, calculated the following dosages at the different islands: 110 to 125 r at Rongelap; 10 r at Utirik; 60 r at Ailinginae; and the abovementioned readings at Rongerik. These calculations were based on the $T^{-1.2}$ decay law and were subject to change if further study disclosed a change in the exponent.

The typical radiation rate meter readings were: Rongerik at H plus twenty-four hours, 1.2 r/hr gamma at approximately thirty inches from the ground by T1B ion chamber; Rongelap at H plus eight hours, 374 mr/hr and at H plus fifty-four hours, approximately 1.4 r/hr of gamma; Ailinginae at H plus fifty-nine hours, 412 mr/hr of gamma; and Utirik at H plus eighty hours, 100 mr/hr of gamma.

All contaminated personnel and natives were evacuated to the Kwajalein Naval Station for observation, treatment and housing. On H plus eight days, JTF SEVEN started operation of Program 4.0 under Task Unit 13 of Task Group 7.1, to study and document the acute effects, if any, of the over-exposed inhabitants of the atolls. The medical group was headed by Commander Eugene Cronkite and his party from the Naval Medical Research Institute, Bethesda, Maryland. Colonel Karl Houghton, AFSWC's Human Factors Chief, visited Kwajalein twice to ovserve the progress of their studies and to obtain any information of interest to USAF.

The dosage spread of the different groups of personnel covered the range of estimated operational tolerances being considered by the

[redacted] [redacted]

Department of Defense. Typical readings were approximately 10, 40, 75, 98 and 125 r. The Rongelap group absorbed the 125 r and exhibited the most symptoms of radiation effects.

At Rongelap, approximately six hours after BRAVO a visible fall-out of white to yellowish-white ashes started, which was likened to snow seen by one individual on a trip to Japan. This ash was visible on clothing, water cisterns and the ground. Later on, the particles became sandy, but most of the people were unconcerned. Contaminated food and water were freely consumed. Approximately fourteen hours after the BRAVO detonation, some individuals at Rongelap complained of a slight loss of appetite, mild diarrhea and slight malaise. Some vomited. These symptoms apparently lasted no more than forty-eight hours, when the people were removed by a United States Navy destroyer. From that time they were free of symptoms other than skin disorders. The children must have received the heaviest dosages while playing on the ground, but they "...remained bright-eyed, alert and as mischievous as any other children." Skin itching on exposed areas of skin followed the fall-out in about twenty-four hours, but was not severe enough to cause traumatic injury from scratching. Itching was still noticeable on the seventeenth day after the shot, but to a far milder extent.

About three days following the exposure, there was evidence of dermatitis encircling the base of the neck, similar to heat rash. There were small macular-papular spots that were discreet and highly pigmented. These lesions continued to appear on new individuals for a period of about three or four weeks. They also spread to the chest, scalp, axilla, anticubital fossa, knees and feet. All lesions, except the feet, were

dry. Cases of secondary infection were all probably results of scratching, and were easily cleared up by antibiotics. Several weeks following the appearance of the lesions, the affected areas became slightly indurated, very deeply pigmented and with some fissuring of the areas but no frank ulceration. About twenty-five to thirty days after exposure the areas presented a superficial slough that resembled the peeling of a second degree sunburn. Under the slough the skin was parchment-like in appearance and was depigmented.

The foot lesions came last and displayed the most severe symptoms. The lesions developed blebs from the original papules which were filled with a serous fluid. After the blebs had drained, the lesions healed with sloughing and depigmentation, as described above. All of these lesions were on the dorsum of the feet and between the toes. Weight bearing on the feet was painful and the individuals characteristically walked on their heels.

Epilation of the scalp first appeared on about the thirteenth or fourteenth day and was patchy in distribution. In most cases it appeared in the same areas as the scalp lesions. Epilation appeared earlier and more severely in children. A few cases developed into practically complete epilation of the head. This tendency continued for three to four weeks. No regrowth of hair was noticed in the first two months after the exposure. There was no evidence of hair loss except on the head.

Statistics based on Rongelap group incidence figures -- H plus thirty days -- were:

Epilation 46%

Skin Lesions:

Scalp	39%
Neck	64%
Axilla	15%
Anticubital fossa	25%
Hands	4.5%
Anus	8%
Knees	1 case
Feet	34%
Forehead	8%

Statistics based on Ailinginae group incidence figures -- H plus thirty days — were:

Epilation	16%

Skin Lesions:

Scalp	28%
Neck	50%
Axilla	16%
Anticubital fossa	11%
Hands	2 cases
Arms	2 cases
Forehead	11%

Epilation and skin lesions occurred only in the Rongelap and Ailinginae groups. The Ailinginae group developed lesions approximately ten days after the Rongelap group and to a less severe extent. As mentioned above, Rongelap absorbed a 125 r dosage and Ailinginae absorbed approximately 75 r.

By H plus one month only two Task Force personnel had developed clearly defined lesions. They were similar to the ones developed by the natives, but pigmentation was less marked. One person had been bending over scrubbing pots on KP the day of the shot. As the perspiration gathered on his back, it trapped the fall-out material and held it long enough to produce a superficial burn following the pattern of the sweat rivulets. The United States group had no other signs or symptoms other

than those attributed to psychoneurosis. Some personnel were frankly alarmed and apprehensive and several complained of chronic headache and malaise. Repeated discussions on the effects and aspects of radiation were necessary before these people began to relax, indicating that the psychological aspects of radiation exposure might well be a problem in spite of all the training done by the Department of Defense. There were no apparent differences in symptoms between those who received forty and those who received ninety roentgens. An unsubstantiated possibility existed that the film badges might have been in error, but such a chance was remote.

The white blood counts of the Rongelap personnel dropped from a mean of approximately 8337 to a low mean of 5488 for adults and 4488 for children at H plus seventeen days. By H plus thirty-nine days the counts were on the upgrade, having risen to a mean 5900. The U. S. counts followed the same pattern, dropping to a low of approximately 5500 to 6000 white cells and on H plus thirty-nine days were on the increase. The platelet counts dropped to a low of 150,000 (mean) for U. S. personnel and 100,000 (mean) for natives about H plus twenty to H plus twenty-five days. Young, large platelets were much in evidence. The count on one native reached a low of 25,000.

There was no evidence of bleeding, throat lesions or fever in any of the personnel studied. Biopsies of the skin lesions were studied at the Naval Radiological Defense Laboratory and reported as degenerative lesions that might possibly break down. Urine studies for internal fission product contamination were made by the Los Alamos Scientific Laboratory. Fission products were present in the 24-hour urines, but

were below the acceptable tolerances. The plutonium measurement was approximately 1/100th the permissible amount.

Earth samples were taken from all the involved islands for decay studies by NRDL on the uptake of fission products by plants and animals left on the island after the evacuation. Since the Trust Territories Government planned to return the natives to their own islands, they would continue to study the problem of plant and animal uptake. Surveys of the fish in the atoll were made by AEC contractor personnel to determine their future edibility.

In summary, it did not appear that the operational dosages estimated by the Nuclear Energy Power for Aircraft Medical Committee were in error as far as acute effects were concerned. The 40 and 75 r people suffered a modest reduction in white count but no other signs or symptoms (disregarding the local skin lesions). This group was capable of carrying on work without any apparent loss of efficiency. The 125 r group had very mild general symptoms occurring between fourteen and eighteen hours after the exposure started and lasting forty-eight hours or more. Any loss of efficiency by this group was short-lived and not observed to any marked degree. One medical observer on the evacuation destroyer was unable to detect any trace of symptomatology during the evacuation.

Observations indicated that the external hazard continued to overshadow the internal hazard for short-time exposures to fission products. However, continued exposures of these groups to gross ingestion of the fall-out material would have been undesirable. Radioaudigraphs of chicken bones from animals left on the islands revealed a marked uptake of radioactive material on x-ray film after a three-hour exposure.

The desirability of aircraft pressurization filters seemed somewhat enhanced when considering the penetration of atomic clouds of this type and magnitude, especially if the cloud was generated from a surface detonation. From observing the personnel burns occurring on the downwind islands and on board naval vessels of the Task Force, it was apparent that superficial burns due to beta radiation could be produced from unconcentrated fission products in the fall-out. The concentration of fission products in an unfiltered aircraft following a cloud penetration was not measured under the BRAVO conditions, but was considered worth including in future test planning. The skin burns as seen were not disabling but were certainly undesirable.

It was reported by Program 4.0 that as of H plus thirty-nine days there was no factor present in the blood pictures to indicate any evidence of chronic or internal radiation effects.

Finally, there was still a psychological factor to be considered when dealing with Department of Defense personnel. The natives were unconcerned and carefree about the whole affair, but U. S. personnel were shaken by their experiences. Apparently, they were well educated to the dangers of contamination, but not to the actual effects.

FOOTNOTES FOR CHAPTER V

1. Memo for Record by Colonel Karl H. Houghton, Technical Advisor to Comdr, TG 7.4, 28 Apr 54, subj: "Personnel Overexposures Post-BRAVO." (SECRET, R/D) On File in TG 7.4 Classified Document Section.

2. Some confusion existed in the evacuation of Task Force personnel from Rongerik. An account of this, gleaned from official reports, was this:

   Twenty-four airmen and one warrant officer of the Weather Reporting Element (Provisional) of Task Group 7.4 had been assigned to operate a weather station for JTF SEVEN and a recording radiation rate meter for the New York Operations Office of the AEC on Rongerik. This radiac station was one of several situated in the Pacific as part of a general fall-out study. This instrument was capable of detecting a maximum activity of 100 mr/hr. Three Army enlisted men assigned to Task Group 7.1 were stationed at Rongerik to operate the ionosphere measurement station for Project 6.6.

   At 1500 hours on BRAVO Day (1 March 1954), the following message was dispatched to Mr. Breslin of the NYOO at JTF SEVEN on Parry:

   > "...GR MIKE over 100 CHARLIES — over 100."

   Another message to JTF SEVEN at 2015 hours on BRAVO Day stated that:

   > "...auto monitor present reading is 100 plus repeat 100 plus, pen off chart and has been in this position since 0250Z. Request acknowledgement of receipt by Mr. Breslin."

   However, Mr. Breslin was not on the island. Colonel David Miller, Task Group 7.1, stated that the top range of the instrument was 100 mr. Therefore, at 0015 hours on 2 March (B plus 1), the Rongerik station was notified to keep all personnel inside metal buildings until further notice. At 0830 the same morning, Captain Chrestenson departed for Rongerik in an SA-16 to act as a rad monitor. At Rongerik, the aircraft did not land immediately but made passes over the island at 500 feet altitude. The average reading on the AT-1B radiac instruments were 200 mr/hr. Another pass at 250 feet resulted in a reading of 340 mr/hr. Captain Chrestenson then contacted JTF SEVEN and asked if Rongerik should be evacuated immediately. The message reached JTF SEVEN garbled and Lt Colonel Richard House, JTF SEVEN Rad-Safety Officer, advised them not to evacuate, since Rongerik was in the same contamination level as the USS ESTES and the USS BAIROKO and reading about 300 mr/hr. He stated that this effect should be transient and disappear in a few hours. Captain

FOOTNOTES FOR CHAPTER V (Contd)

Chrestenson was asked to transmit more information. He immediately sent his only reading, "340 at 250 feet altitude," but this message arrived as "340 mr/hr at 250." Following a hasty conference between Colonel Houghton and Lt Colonel Crosby, Task Group 7.4 Tech Projects Officer, Captain Chrestenson was notified to disregard the "no evacuation" message and report the radiological situation at Rongerik. Captain Chrestenson finally landed at Rongerik at 1130 hours and quickly took the following readings:

Inside buildings	0.6 r/hr
Outside buildings	1.8 r/hr (waist height)
Outside buildings	2.4 r/hr (sand surface)
Surface of one bed in tent	1.2 r/hr
One inch from ground surface	3.2 r/hr

Captain Chrestenson immediately decided to evacuate. He loaded eight of the twenty-eight men aboard the Navy plane and started for Kwajalein. He then sent a reading of 3.2 r/hr at one inch to TG 7.4, but this message was never received. The other twenty people were evacuated by PBM and arrived at Kwajalein about 1900 on 2 March.

Shortly after arriving at Kwajalein, Captain Chrestenson sent the following message to TG 7.4: "Suggest immediate survey of inhabited islands of Rongerik. High possibility exists that immediate steps must be taken to evacuate natives." Survey and evacuation of these islands followed shortly. (SECRET, R/D)

Above material was taken from Memo for Record by Colonel Karl H. Houghton, Technical Advisor to the Comdr, TG 7.4, 14 April 1954, subj: "Evacuation of Rongerik after Shot BRAVO, Operation CASTLE." On file in TG 7.4 Classified Document Section.

CHAPTER VI

FLYING SAFETY, ROLL-UP AND PLANNING

A. THE AIR TASK GROUP AND FLYING SAFETY

A review of Operation CASTLE reveals that all Air Task Group missions were successfully accomplished, many of them through skillful improvisation and the experience of veterans of previous overseas test operations. Among the accomplishments noteworthy of mention was the flight safety record. Only one aircraft, an H-19A helicopter, was lost during the entire operation. More heartening yet was the fact that no lives were lost due to aircraft accidents.

On 3 March the Air Task Group had its first aircraft accident, when a newly-arrived helicopter pilot from Bikini taxied his aircraft between a parked helicopter and an SA-16. The narrow passage was approximately twelve feet wider than the helicopter rotor blade circle. The rotor blade struck the SA-16's left elevator. Although this accident did not affect the Air Task Group's accident rate, it awakened many people to stricter enforcement of the Task Group's regulations. One day prior to the accident the Bikini Detachment arrived at Eniwetok and had begun operations without any formal briefing on airfield regulations.

The first major aircraft accident occurred at 0808 on 15 April when a Parry-to-Eniwetok bound H-19A helicopter lost engine power and crash-landed on an exposed reef between the two islands. The H-19A had been directed by the Eniwetok tower to stay clear of traffic due to an impending

B-29 emergency. The pilot circled back to Parry and en route to Eniwetok started losing power too rapidly to make it to either island. Auto-rotation would have forced him to land in the water, so the pilot elected to crash-land on an exposed portion of the reef between Parry and Sand Islands. Flying downwind and lack of power and altitude were contributing factors to a harder-than-normal landing. The gear collapsed and the aircraft skidded across the reef, stopping at a forty-five degree angle, supported by the rotor blade. The aircraft was destroyed except for the tail boom and rotor. Fire started on impact. Personnel aboard the helicopter were unhurt except for two first-aid injuries.

An F-84 was involved in the second major aircraft accident just one hour prior to completion of the entire mission. On the last shot day the weather had lowered to a precipitation ceiling of 500 feet and one-half mile, obscured with heavy rain. Four F-84's had to make ground controlled approaches (GCA's). The rain was very heavy and GCA was unable to establish proper contact with the fighters. The AOC aligned them with the runway and brought them down on the final approach until the GCA could control them. The first two fighters landed safely and the second pair made a very good touchdown, but approximately 2,000 feet after touchdown the lead aircraft ran through a heavy pool of water on the runway, veered to the left out-of-control, and went off the runway, hitting a sand embankment at a slow speed. The nose gear collapsed on impact, resulting in major damage to the aircraft but no injury to the pilot.

A serious B-36 accident was narrowly averted on 7 April when the left landing gear of the control RB-36 jammed in the canoe door and would

neither continue retraction nor be extended. The aircraft had sixteen hours of fuel remaining and a tentative decision was made to send it to Guam for a crash-landing. However, the landing gear was finally extended and secured in a locked down position and the aircraft landed safely at Eniwetok.

Until the end of April the major accident rate was ten per 100,000 flying hours, the H-19A mishap on 15 April the only blemish on the record. The F-84 accident on 14 May virtually skyrocketed the rate to eighteen accidents per 100,000 hours, thus nearly doubling the rate in the last hour of a four and a half month operation. A total of 11,207 hours were flown by Task Group 7.4 aircraft during this period. On IVY, a shorter, less complex operation, a B-50, an F-84 and an L-13 were destroyed and two lives were lost. Therefore, CASTLE could well be regarded as a flight safety success. It was doubtful whether so many aircraft had ever operated from such cramped quarters and under such unusual circumstances as the eighty-odd aircraft stationed at Eniwetok during CASTLE. During shot periods more than ninety aircraft were frequently stationed at Eniwetok.

B. ROLL-UP

Due to the numerous shot delays most roll-up plans were made long before the end of Operation CASTLE. The pre-roll-up planning had been so thorough that the usually monumental task of redeployment of hundreds of men, approximately eighty aircraft and thousands of pounds of equipment and supplies, turned into a strictly routine, but back-breaking job. Every piece of equipment and materiel had been earmarked for its new home and method of transportation weeks before the last shot was detonated. Therefore, when NECTAR, the last shot, was fired on 14 May, Eniwetok was

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like a circus on closing night — every man had a job, knew what it was, and quickly did it. The few minor problems that arose were quickly solved. Turn-in of supplies and rehabilitation of equipment had started as early as mid-April, due to the available time resulting from the shot delays. Had all shots been fired as originally scheduled, it was estimated that it would have taken fifteen days to accomplish what was actually done in the first five days after the last shot. Following his inspection of the Air Task Group on 19 May, General Estes stated that the only remaining work was roll-up of the weather islands. There was nothing to be gained by General Estes and his staff remaining on the island any longer. A rear headquarters had already been set up to handle Air Task Group affairs during the early post-CASTLE months. General Estes and his staff returned to the ZI shortly thereafter.

By the day of the last shot a few small shipments of men and materiel were already en route to the ZI, but the mass exodus took on epic proportions within hours after NECTAR was fired. Approximately 1300 of the 1700 Task Group 7.4 personnel were returned to the ZI during May, most of them leaving the Pacific Proving Ground within a week after NECTAR. Approximately 250 men remained on the island with the 4930th Test Support Group to perform normal housekeeping functions during the CASTLE-REDWING interim.

Concurrent with the redeployment of Task Group 7.4 was the departure of men and materiel assigned to Joint Task Force SEVEN and the other four task groups. Almost overnight Eniwetok changed from a noisy, round-the-clock beehive of activity to a quiet, routine operation.

On 26 June 1954, Task Group 7.4 was inactivated by USAF.[1] Until

such time as the Air Task Group was reactivated for REDWING, ARDC was requested to assist in the planning for any future overseas tests. This planning was to be conducted under the direction of, and in conjunction with, Headquarters, JTF SEVEN. All personnel previously assigned to Task Group 7.4 were reassigned to various staff sections within the Air Force Special Weapons Center or to its subordinates. The various staff sections of AFSWC were made responsible for planning or other actions regarding the Air Task Group in the next overseas tests.

C. A COMPARISON BETWEEN IVY AND CASTLE

CASTLE was a vastly more complex and difficult operation than IVY.

Operation IVY, the 1952 test series, had been a two-shot affair, covering a two-month operational period. The Air Task Group was based on Kwajalein, approximately 290 nautical miles from the shot areas in the northern reaches of Eniwetok Atoll. KING Shot on IVY was an air drop from a modified B-36 of a [redacted] MIKE Shot, for which all personnel in Eniwetok Atoll had been evacuated, was the world's first megaton device.

In contrast, CASTLE was a six-shot operation, involving no air drops, but five of the devices detonated were in the megaton range, making extremely careful preparation necessary. The operational period covered nearly five months and was lengthened by almost daily postponements of five of the shots because high winds in the upper atmosphere would have placed several Pacific areas in danger of almost certain radioactive fall-out. Five shots were fired in Bikini Atoll and one shot, a megaton device, was detonated in Eniwetok Atoll, location of Task Group 7.4.

[redacted] [redacted]

Seven shots were originally scheduled for CASTLE, but one, ECHO Shot [redacted] was cancelled on 12 April, partly because of numerous weather delays, but mainly because a scientific requirement no longer existed for the shot.

High winds in the upper atmosphere necessitated numerous shot delays, seventeen straight one-day postponements of ROMEO alone, which served to lengthen the operation considerably and increase the maintenance work load on all aircraft, as well as to tax the patience and fortitude of everyone in the Pacific Proving Ground. Ever since GREENHOUSE, weather experts had pointed out that high winds in the upper atmosphere and general weather conditions made the Pacific Proving Ground a highly undesirable location for atomic tests. Other sites throughout the world were studied, but since remoteness from civilization was considered an equally important factor, it was doubtful that the searchers would find a more remote region on this planet outside the polar regions.

D. PLANNING FOR FUTURE OVERSEAS NUCLEAR OPERATIONS

During the numerous shot delays in March, April and May, the Air Task Group, as well as Joint Task Force SEVEN and the other four task groups, devoted effort to other pressing matters, such as the five-year plan and the roll-up plan.

The Eniwetok Five Year Construction Plan, initiated on 19 February, was submitted to JTF SEVEN in late April. This document was to be integrated into the JTF SEVEN Five Year Plan. Major General E. McGinley, Deputy Commander of JTF SEVEN, had requested the Air Task Group to study

Eniwetok's needs for subsequent operations and to enumerate the minimum requirements prior to the conclusion of CASTLE.

Task Group 7.4's study revealed seven major requirements during the next two years which would take top priority in the Five Year Plan. They were:

1. Airfield improvements;
2. POL tank farm;
3. Construction of buildings to replace Bldg 135 (location of headquarters for the three test units);
4. Construction of 50' x 100' buildings for the buildup and storage of aircraft engines;
5. Erection of an additional prefab building 20' x 48' to provide additional space for electronics maintenance;
6. Re-routing and paving of the perimeter road on south side of the airfield; and
7. Construction of 22,000 square feet of additional combined aircraft decontamination pad and wash rack.

During the latter stages of CASTLE, announcement was made of Operation REDWING, the proposed 1956 overseas tests.

On 15 April 1954, General Mills apprised General Estes that information at AFSWC indicated that the next test in the Pacific Proving Ground, Operation REDWING, was scheduled for the spring of 1956. Since a period of nearly two years would exist between CASTLE and REDWING during which the 4930th Test Support Group would be operating at minimum strength as a garrison force, General Mills stated that he was contemplating sending a junior officer to command the 4930th in place of Lt Colonel Donnell Massey (promoted to full colonel on 14 May 1954), who was originally mentioned for the job.[2]

In the days that followed, General Estes talked with Dr. Graves,

who indicated that the spring 1956 date was a poor assumption in that it was mentioned as the earliest possible date that LASL would request tests, but that the Department of Defense might bring pressure for an earlier date. University of California Radiation Laboratory (UCRL) was extremely desirous of running REDWING at the earliest possible date. The cancellation of [redacted] and the results of [redacted] were expected to increase UCRL's desire. The fall of 1954 was considered to be out of the question, but the spring of 1955 would probably be the date requested by the AEC should an earlier test be ordained.[3]

On 21 April General Estes forwarded this information to General Mills and renewed his request that a senior officer of Colonel Massey's caliber be sent to Eniwetok for indoctrination on CASTLE and eventually to command the 4930th.

General Mills saw little likelihood of an overseas test prior to the spring of 1956, and no reason to send a full colonel to Eniwetok for indoctrination. Therefore, he notified General Estes that a competent officer, not in the rank of colonel, would arrive at Eniwetok prior to Colonel Kesling's departure on or about 25 July 1954. However, a competent full colonel would be sent to Eniwetok in July of 1955.[4]

FOOTNOTES FOR CHAPTER VI

1. USAF msg 58775, 26 June 1954, to AFSWC. SWC 54-S-11059. (SECRET)

2. TWX Gen Mills, Comdr AFSWC, to Gen Estes, CTG 7.4, 15 April 1954, Cite SWG 4-2. (SECRET)

3. TWX Gen Estes, CTG 7.4, to Gen Mills, Comdr AFSWC, 21 April 1954, Cite TG 7.4 TGG 4-218. (SECRET)

4. TWX Gen Mills, Comdr AFSWC, to Gen Estes, CTG 7.4, 26 April 1954, Cite SWA 4-6. (SECRET, R/D)

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Material in this history of Task Group 7.4 in Operation CASTLE was obtained from the following monthly histories of the Task Group:

1. History of Task Group 7.4 for 15 July through 31 August 1953. SWC 54-S-1660. (SECRET R/D)
2. History of Task Group 7.4 for September 1953. SWC 54-S-1661. (SECRET R/D)
3. History of Task Group 7.4 for October 1953. SWC 54-S-2890. (SECRET R/D)
4. History of Task Group 7.4 for November 1953. SWC 54-S-3815. (SECRET R/D)
5. History of Task Group 7.4 for December 1953. SWC 54-S-2892. (SECRET R/D)
6. History of Task Group 7.4 for January 1954. SWC 54-S-4053. (SECRET R/D)
7. History of Task Group 7.4 for February 1954. SWC 54-S-4262. (SECRET R/D)
8. History of Task Group 7.4 for March 1954. SWC 54-S-4263. (SECRET R/D)
9. History of Task Group 7.4 for April 1954. SWC 54-S-4527. (SECRET R/D)
10. History of Task Group 7.4 for May 1954. SWC 54-S-10,326. (SECRET R/D)

In addition the following Reports, Final Reports, and Operations Orders and Plans listed below were utilized to obtain additional information:

1. Summary Report of the Commander, Task Unit 13, Programs 1 - 9, Operation CASTLE. SWC Tech Library No. OCA ITR-934, June 1954. (SECRET R/D)

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2. AFSWP report on "Study of response of human beings accidentally exposed to significant fall-out radiation." Operation CASTLE Project 4.1. SWC Tech Library No. OCA ITR-923, May 1954. (SECRET R/D)

3. Final Report of the Commander, Task Group 7.4 on Operation CASTLE, June 1954. SWC 54-S-510. (SECRET R/D)

4. Final Report of the Commander, Scientific Task Group 7.1 (Los Alamos Scientific Laboratory) on Operation CASTLE, June 1954. SWC Tech Library No. LASL JO-11. (SECRET R/D)

5. Report of the Commander, Scientific Task Group 7.1 (Los Alamos Scientific Laboratory) on Operation CASTLE, June 1954. SWC Tech Library No. OCA WT-940. (SECRET, R/D)

6. Final Report of the Weather Reporting Element, Provisional, on Operation CASTLE, July 1954. SWC 54-S-11,592. (SECRET)

7. Task Group 7.4 Operations Order 2-54, 26 February 1954. TG 7.4 No. 3-2709S. (SECRET)

8. Task Group 7.4 Operations Plan 4-54 (Interim Phase Operation Plan), 15 June 1954. TG 7.4 No. 3-3614S. (SECRET)

CHRONOLOGY

1952	
April	CASTLE first conceived
September	IVY operational phase commenced at Eniwetok-Bikini Atolls
October	Office of Deputy Commander for Overseas Tests established at AFSWC
22 October	Brigadier General Howell M. Estes, Jr., (then Colonel) appointed Commander, Task Group 132.4 for CASTLE
28 October - 5 November	Manpower Conference at Hickam AFB, T. H.
November	General Estes visited Forward Area to witness IVY's MIKE Shot and to receive preliminary indoctrination
1 November	MIKE Shot detonated at Elugelab Island in Eniwetok Atoll
16 November	KING Shot detonated
November - December	Roll-up and redeployment of men and materiel at the conclusion of IVY
1953	
6 January	Task Group 132.4 activated for CASTLE, effective 1 January 1953
13 February	Task Group 132.4 redesignated Task Group 7.4
March - June	Operation UPSHOT/KNOTHOLE, Nevada Proving Ground
9 March	CASTLE funding policies outlined in McNeil Memorandum
March	Eniwetok Island surveyed by USAF Installation Office personnel for CASTLE needs

[redacted] [redacted]

CHRONOLOGY (Contd)

1953

May - September	Consolidation of Eniwetok and Kwajalein supply accounts at Eniwetok
May	The Joint Chiefs of Staff approved revised CASTLE force requirements
June	Major General Percy W. Clarkson, Commander, JTF SEVEN, and Task Group Commander, visited Forward Area
15 July	Task Group 7.4 manned at Kirtland
1 September	Original date for beginning of CASTLE operational phase
27 October	Exercise TIGER/CAT, ZI rehearsal for CASTLE, conducted at San Diego Naval Air Station, California
December	Large-scale build-up of men and materiel began at Eniwetok and Bikini Atolls

1954

2 January	ADVON (Advance Echelon of Hq TG 7.4) arrived at Eniwetok and operational phase commenced
27 January	Main body of Hq TG 7.4 arrived at Eniwetok
23 February	First full-scale Joint Task Force rehearsal conducted at Eniwetok and Bikini Atolls
1 March	BRAVO [redacted] fired at Bikini Atoll (0645 ~~M Time~~)
1 March	Personnel contaminated by BRAVO fall-out on Rongelap, Ailinginae, Rongerik and Utirik
27 March	ROMEO [redacted] fired at Bikini Atoll (0630 ~~M Time~~)
7 April	KOON [redacted] fired at Bikini Atoll (0620 M Time)
12 April	ECHO [redacted] Cancelled

[redacted]

[redacted]

CHRONOLOGY (Contd)

1954

26 April	UNION [redacted] fired at Bikini Atoll (0610 M Time)
5 May	YANKEE [redacted] fired at Bikini Atoll (0610 M Time)
14 May	NECTAR [redacted] fired in Elugelab Crater, Eniwetok Atoll (0620 M Time). Final Shot of CASTLE series
May	(After NECTAR) Roll-up and redeployment of men and materiel
26 June	Task Group 7.4 inactivated by USAF

[redacted]

GLOSSARY OF TERMS

AACS	Airways and Air Communications Service
ADC	Air Defense Command
AEC	Atomic Energy Commission
AFFTC	Air Force Flight Test Center
AFSWC	Air Force Special Weapons Center
AOC	Air Operations Center
ARDC	Air Research and Development Command
ATG	Air Task Group
CASTLE	Spring 1954 overseas nuclear and thermonuclear tests at the Pacific Proving Ground
CIC	Combat Information Center
DCS	Deputy Chief of Staff
FEAF	Far East Air Force
GCA	Ground Controlled Approach
GCI	Ground Control Interception
GREENHOUSE	Spring 1951 overseas nuclear tests in the Pacific
HF	High Frequency
IBDA	Indirect Bomb Damage Assessment
IFF	Identification Friend or Foe
IVY	Fall 1952 overseas nuclear tests in the Pacific
JTF	Joint Task Force
kt	Kilotons
LABB-6	(Los Alamos bomb bay sampling device for B-36) A device for cloud sampling by which particles of the cloud are taken through a filter so that they adhere to a type of paper and let the gasses escape

GLOSSARY OF TERMS (Contd)

LASL	Los Alamos Scientific Laboratory
LAWT-7	B-57 wing sampling tank
LiD	Lithium Deuteride
Li^6D	Enriched Lithium Deuteride
LORAN	Long Range Navigation
LSM	Landing Ship Medium
LST	Landing Ship Tank
MATS	Military Air Transport Service
mt	Megatons
NRDL	Naval Radiological Defense Laboratory
NYOO	New York Operations Office (Atomic Energy Commission)
PCS	Permanent Change of Station
REDWING	Proposed spring 1956 overseas nuclear and thermonuclear tests in the Pacific
SAC	Strategic Air Command
SFOO	Santa Fe Operations Office (Atomic Energy Commission)
SHORAN	Short Range Navigation
SOP	Standing Operating Procedure
TDY	Temporary Duty
TG 7.4	Task Group 7.4
TIGER/CAT	Zone of the Interior rehearsal for CASTLE
UCRL	University of California Radiation Laboratory
UPSHOT/KNOTHOLE	Spring 1953 continental nuclear tests at Nevada Proving Ground
USAF	United States Air Force

GLOSSARY OF TERMS (Contd)

VHF	Very High Frequency
WADC	Wright Air Development Center
ZI	Zone of the Interior

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