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Operation CASTLE

PACIFIC PROVING GROUNDS

March — May 1954

[redacted]

REPORT OF COMMANDER, TASK GROUP 7.1

[redacted]

[redacted]

JOINT TASK FORCE SEVEN

[redacted]

WT-940

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Operation

CASTLE

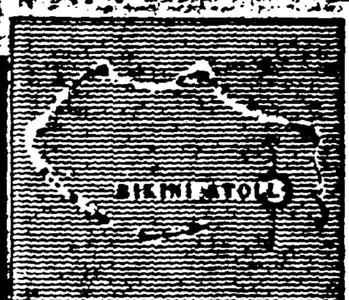
PACIFIC PROVING GROUNDS

March — May 1954

[redacted]

REPORT OF COMMANDER, TASK GROUP 7.1

[redacted]



[redacted]

JOINT TASK FORCE SEVEN

[redacted]

3.10 RECOVERY OPERATIONS

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

A certain amount of study of the recovery problem had preceded the overseas phase of the operation. Recovery methods were discussed, and the various support items were laid on. In the field further discussions of recovery methods resulted in a firm operating plan which was then given a full rehearsal with such vehicles, helicopters, or boats as the mission required. [redacted] recovery plan was issued on February 22 as a result of these discussions. It detailed the movements of each project for the period from shot time through [redacted] when it was felt that the majority of the recoveries would have been accomplished. The results [redacted] caused this plan to be abandoned, and recovery of data went at a much slower rate than planned due to the extensive fall-out in the islands. This experience led to the conclusion that detailed plans based on assumptions of yield and fall-out patterns were of little value except as they served to acquaint the operations people with the problems involved. Subsequent plans were far less elaborate, allowing leeway for conditions which could not be predicted. Essentially these were lists of the participating projects, the locations of the instrument stations, and the types of vehicles and other support most likely required.

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

Of the total of 63 projects participating in Operation Castle, approximately 75 per cent took part [redacted] 80 per cent participated [redacted] 69 per cent in [redacted] and 65 [redacted] Of these, about 30 per cent were able to make at least limited recovery on shot day, using helicopters to get into the hot areas for short visits. Generally, the recovery time depended on the distance of the station from Ground Zero, but the majority of the recovery missions went out on the day following the shots when the radiation levels had fallen somewhat. The exceptions to this [redacted] all recoveries were delayed due to extensive fall-out, [redacted] reentry into the islands.

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

3.11 POSTSHOT REENTRY

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

[redacted]

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

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

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

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

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

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

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

3.12 SAMPLE RETURNS

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

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

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

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

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

[redacted]

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

4.5 TASK UNIT 6, FIRING PARTY

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

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

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

4.6 TASK UNIT 7, RADIOLOGICAL SAFETY

4.6.1 Introduction

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

4.6.2 Task Group Organization for Radiation Safety

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

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

[redacted]

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

(a) Bikini Rad-Safe (Afloat)

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

This organization resulted from [redacted] wherein the field Rad-Safe center at Eninman was destroyed [redacted] shore-based operations became radiologically unsafe.

(b) Parry Rad-Safe

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

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

4.6.3 Training

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

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

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

4.6.4 Control Element

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

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

[redacted]

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

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

4.6.5 Laboratory Element

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

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

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

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

4.6.6 Decontamination Element

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

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

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

[redacted]

4.6.7 Supply Element

Supply stations were originally set up on both atolls, Parry station on Eniwetok and Eninman on Bikini Atoll. In addition to its normal functions, Parry supply was responsible for shipping, receiving, and recording all supplies and keeping supplies moving to Forward Areas as required. Eninman station was a base supply, and its function was to maintain sufficient stocks on hand in case additional substations were required to cope with the operational situation.

After [redacted] the Eninman supply station was contaminated and was therefore eliminated as a supply point. A sea-going barge was procured and set up as a Rad-Safe Control and Supply Station. The construction aboard the barge consisted of two squad tents and portable salt-water showers. One tent was jointly utilized by control and supply elements; the other was a dressing and change station. Two transportainers were procured for storage purposes, and a wooden hot locker was constructed for radiac instruments. The barge was tied up alongside the USNS Ainsworth during recovery and salvage operations.

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

Facilities for laundering contaminated clothing at Parry were adequate.

4.6.8 Radiological Situation Data Summary

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

Table 4.1 - [redacted]UMMARY IN ROENTGENS [redacted]R*

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

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

[redacted] The first complete survey was conducted o[redacted] As a result of wind conditions [redacted] areas had become spotty in nature; therefore the extrapolated [redacted] hr readings can only be considered approximate. These extrapolated values are based on a $t^{-1.2}$ decay, whereas laboratory analyses indicate a $t^{-1.3}$ decay during this period, thus indicating values in excess of those noted in the table.

[redacted]

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

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

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

Table 4.2 — [redacted] SUMMARY IN ROENTGENS PER HOUR

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

*Contamination by Runt I shot.
†200-ft altitude.
‡Radiation shine from water in southwest passage.
§At 300 ft.

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

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

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

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

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

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

[redacted]

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

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

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

Table 4.3—[redacted] SUMMARY IN ROENTGENS PER HOUR

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

*Contaminated by [redacted]
†Reading at 100 ft.
‡Reading at 200 ft.

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

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

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

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

[redacted]

Table 4.4—[redacted] SUMMARY IN ROENTGENS PER HOUR

Island	Extrapolated H+4 hr	[redacted] +1 day	[redacted] +4 days	[redacted] background for [redacted]
Enyu*	0.75	0.10	0.03	0.01
Bikini*	70	8.5	0.80	0.03
Aomoen*	140	15.0	2.0	0.40
Romurikku*	140	15.0	2.4	0.40
Uorikku*	85	10.0	1.0	0.36
Namu			1.0	2.5
Yurochi*	85	10.0	1.0	0.40
Bokobyaadaa		1.2	2.2	4.0
Ourukaen		0.01	0.50‡	0.01
Arriikan		0.01	0.60‡	0.01
Eniirikku		0.06	0.10‡	0.90
Eninman Crater		6.5	4.0	100
Airukiiji		0.01	0.01	0.01
Crater*	4.2†		0.01	0.00

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

Table 4.5—[redacted] SUMMARY IN ROENTGENS PER HOUR

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

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

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

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

Table 4.[redacted] SUMMARY IN ROENTGENS PER HOUR

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

*Period preceded by heavy rainfall.

4.6.9 Laboratory Data Summary

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

[redacted]

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

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

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

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

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

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

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

4.6.10 Conclusions and Recommendations

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

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

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

[redacted]

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

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

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

4.7 TASK UNIT 8, TECHNICAL PHOTOGRAPHY

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

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

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

Statistics are as follows:

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

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

4.8 TASK UNIT 9, DOCUMENTARY PHOTOGRAPHY

4.8.1 Mission

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

4.8.2 *Organization and Command Relation*

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

4.8.3 Requirements

(a) Preliminary Requirements

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

[redacted]