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HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW) c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

J-3/729.3

18 March 1954

SUBJECT: Radiological Surveys of Several Marshall Island Atolls

TO: Distribution

410551

1. Attached herewith for your information and retention are copies of radiological surveys made on certain Marshall Island Atolls. The surveys were conducted as a result of contamination deposited on the affected atolls by BRAVO Shot, Operation CASTLE, fired from a reef approximately one and one half nautical miles southwest of Namu, Bikini Atoll. BRAVO Shot time was 1845 Zebra, 28 February 1954.

2. Water and soil samples were shipped to the Health and Safety Laboratory, New York Operations Office, Atomic Energy Commission (Attention: Mr. Merrill Eisenbud) for analysis.

FOR THE COMMANDER:

E. McGINLEY
Brigadier General, U.S. Army
Chief of Staff

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3 Incls:
1. Report on Soil and Water Sampling Mission by Maj R. D. Crea
2. Report on Soil and Water Sampling Mission by Dr. F. N. White, LASL
3. Rad. Survey of Downwind Atolls Contaminated by BRAVO by Dr. Herbert Seeville [redacted]

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HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW) c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

COMPT 8 March 1954

SUBJECT: Report on Soil and Water Sampling Mission

TO: Commander
Joint Task Force SEVEN
APO 187 (HOW)
c/o Postmaster
San Francisco, California

1. In compliance with your oral instructions, the undersigned visited LIKIEP and AILUK Atolls, JEMO Island and MEJIT Island in the Eastern Marshalls between the period 5-8 March 1954 for the purpose of collecting soil and water samples and measuring level of gamma radiation present at those places in connection with BRAVO. The mission, consisting of the undersigned and a Marshallese interpreter, Lan Lakapun, embarked on the USS BENSHAW (DDE499) at Kwajalein, visited the four sites and returned to Bikini, where the remainder of the trip to Eniwetok was performed by PBM. There follows a detailed discussion of the findings at each location:

a. LIKIEP ATOLL. The samples were taken on Likiep Island, which had the largest native population. Access to the lagoon was gained through South Pass. Poor light at the end of the day and numerous coral heads necessitated anchoring about 4 miles from Likiep Island. Trip in was made by whaleboat the following morning. A water sample was taken from a large cistern fed from the roof of the Catholic rectory, and earth samples were taken from random spots about the island which were unsheltered by trees or other growth at approximately 0800 M 6, March 1954. Radiation readings were taken with a MX-5 instrument between 0800 M and 0900 M and showed a maximum of 3 milliroentgens per hour. No variations from this reading were noted on clothing or bare feet of individuals. According to accounts received by Bishop Feeney, S.J., the population was greatly excited by the light and blast wave, the latter which reportedly arrived about 30 minutes subsequent to the light flare. According to Bishop Feeney, church attendance was greatly stimulated on the day of the test.

b. JEMO Island. This location was reached at 1100 M, 6 March 1954. It consists of a small heavily wooded island, surrounded by a line coral reef with heavy surf on three sides. There being no place for landing a whaleboat, personnel and equipment were transferred from the whaleboat to the reef by a one man rubber raft. The undersigned transferred himself by swimming. The island proved to be uninhabited, and reportedly is a sea turtle preserve. Turtle hunters erected several houses, a rain barrel of which provided a water sample. Earth samples were gathered at random from open areas, including one of beach sand above the high tide mark. The party was led straight across the island and back to the landing area via the beach, in order to verify its uninhabited state. Samples were

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SUBJECT: Report on Soil and Water Sampling Mission

collected at approximately 1200 M, 6 March 1954. Instrument readings with the MX-5 showed a maximum of 3 mr/hr, however this was not considered reliable, since a higher scale showed a lower reading.

c. AILUK ATOLL. The ship reached this atoll at approximately 1600 M, 6 March 1954, and slowly moved to an anchorage off Ailuk Island, the most heavily populated. The lagoon has not been swept, and numerous coral heads and pinnacles provided considerable hazard to ship movement. The landing party moved ashore by whaleboat without difficulty, and again obtained water samples from the most prominent cistern and soil samples from random unsheltered spots. Readings with the MX-5 showed approximately 3 mr/hr (off the 2 mr scale). An AN/PDR-27E showed a high reading of 7 mr/hr, however, on a different scale a reading of 12 or 15 mr/hr was obtained. The MX-5 reading is probably nearest correct. No significant variations were detected on bare feet or clothing of individuals. Samples and readings were taken at approximately 1700 M, 6 March 1954.

d. MEJIT Island. This single coral island is also surrounded by a reef, as is JEMO, but landing was possible with a whaleboat, due to an area protected fro the surf. The island was found to be heavily populated in view of its size, the total number of people being 327, according to the island magistrate. Soil and water samples were taken as in the previously described manner, at approximately 1300 M, 7 March 1954. Readings with the MX-5 showed maximum of approximately 3 mr/hr (off the 2 scale, but approximately 1.5 on the 20 scale); the maximum readin with a PDR 27 E was 10 mr/hr. The true figure was probably somewhere between the two.

2. CONCLUSIONS. Low level (less than 10 mr/hr) radiation measurements with field instruments of the type used are highly unsatisfactory. One MX-5 and three AN/PDR 27 E instruments all showed widely variant readings on different scales, and varied among each other when exposed to the same radiation. An AN/PDR T1-B proved completely useless not holding to zero even after an hours warm-up, and also showing widely variant readings on different scales.

3. RECOMMENDATIONS. Landing parties in islands such as JEMO and MEJIT should be provided with a rubber 6-man or 8-man pneumatic boat, to provide greater safety to personnel and equipment. This will permit landing directly on live coral reefs with less danger of the boat being stove in. Ships assigned to such missions should draw such equipment prior to departure.

4. The successful accomplishment of the mission was greatly facilitated by the interest and enthusiasm of the Commanding Officer of the USS RENSHAW, CDR L. H. Ilford, USN, and his officers and men. Their material contributions were necessary to the mission, however, the many valuable suggestions and assistance in solutions of problems proved invaluable.

/s/ R. D. Crea
R. D. CREA
MAJ, USA

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AFWL/WO

MEMORANDUM FOR: CJTF SEVEN [redacted] 10 March 1954

SUBJECT: Report on Soil and Water Sampling Mission

1. In compliance with your oral instructions, the undersigned visited Wotje, Erikub, Maloelap, Wotho, Majuro Atolls in the Marshall Islands 5 through 7 March 1954 for the purpose of obtaining earth and drinking water samples, and of measuring gamma ray dose rates, and also checked the radiological condition of the S.S. ROQUE on its arrival at Majuro 7 March 1954.

2. The first four atolls were visited by Marshallese interpreter Takushi and the writer by means of an UF-1 amphibious aircraft. Majuro was reached by C-47. Erikub might have been omitted since it was not inhabited, being property of the Wotje tribe which goes there only occasionally to gather copra. (This was unknown until after the visit.)

3. At each atoll, only the principal inhabited island was visited. At each visited island an effort was made to compose a representative soil average by collecting into a single container several samples, each approximately one square foot of area and one inch depth. Water samples were collected from the principal sources currently in use. The gamma dose rates are averages for the inhabited areas.

4. With regard to certain minor discrepancies between the survey methods used by Major R. D. Crea and the writer; it was originally planned to perform the survey jointly, and when it became advisable to separate and survey different atolls, no time remained for discussion of details of techniques.

5. Gamma-ray dose rates on Wotje and on Erikub are each the average of MX-5 and AN/PDR-39 average readings which agreed reasonably well. The MX-5 was rendered inoperative when the rubber life raft was swamped by surf on the first attempt to launch from the beach at Erikub. Following the Wotho survey, the PDR-39 developed a temperature-dependent reading of 0.4 - 2 mr/hr, so that later readings in this range are of very dubious reliability.

6. The following tabulation summarizes the atoll survey. S is Soil, W is Water Sample:

ATOLL	ISLAND	DATE	TIME	SAMPLE NO	MR/HR & SAMPLING
WOTJE	ORMED	5 Mar	1600	S5	3.5 mr/hr, 1-beach, 3-mid-village, 1-back village.
				W6	½ well plus ½ catch basin.
ERIKUB	ERIKUB	5 Mar	1715	S6	1.5 mr/hr. 1-mid-village, 1 on path to beach. No inhabitants, no water supply found.

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ATOLL	ISLAND	DATE	TIME	SAMPLE NO	MR/HR & SAMPLING
MALOELAP	KAVEN	6 Mar	1130	S7	1.8 mr/hr, 2-village, 2-path to beach.
				W12	Well water.
				W13	From catch basin.
WOTHO	WOTHO	6 Mar	1615	S8	0.8 mr/hr, 1 by well; 2-mid-village.
				W9	Well water (no rain in catch basin for 2 mo.)
MAJURO	ULIGA	7 Mar	1200	S9	0.5 mr/hr, 4 from near Admin Bldg.
				W10	Tap water.

7. Pacific Micronesian Line S.S. "ROQUE", Master: Lawrence Blanc, home port, Guam, left Eboye 0840 M on 1 March, entered channel to Utirik Lagoon about 1200 M on 2 March, and anchored in Lagoon at 1524 M on 2 March; docked at Majuro (Uliga Is.) 1630M on 7 March. Readings (mr/hr) after docking: 2-3 inside main deck structure, 10 on open deck, 5-8 in sleeping quarters on upper deck, 10-30 on rope and canvas. Prior radiation levels cannot be estimated because of rain squalls and uncertainty about when decks last washed. Master was advised to have decks washed down as soon as convenient. He was told that the activity would not hurt anyone, but that it was undesirable to have it around longer than necessary.

8. RECOMMENDATIONS: Future visits to Erikub and Maloelap should not be attempted by UF-1 except under conditions of greater urgency. The writer's prior experience in such operations is very limited, but from his own observations plus the remarks made by those better qualified to judge, it appears that a fair amount of risk is involved.

9. Especially notable was the very cooperative attitude of the Navy personnel at Kwajalein and the Marshall District Administrative Officials at Majuro in supporting this mission.

/s/ T. N. White
DR. T. N. WHITE
Health Division
LASL

1 Incl:
Marshall Islands Atoll
Samples collected by T. N.
White, 5-7 March 1954

[redacted]

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MARSHALL ISLANDS ATOLL SAMPLES COLLECTED BY T. N. WHITE, 5-7 MARCH 1954

Earth samples were collected as follows:

At each island visited several samples were dug and put into the same one-gallon "ice-cream carton". Each sample (i.e. each digging) approximated one square foot to a depth of one inch. The number and locations of the samples were selected to represent, as well as could be judged, an average of the areas used by the inhabitants, after the samples were mixed in the carton. Areas that were unusually shaded or unshaded by trees were avoided. The large "pebbles" in the composite represent coral gravel from "main street" through the village.

Water samples were selected according to the principal source in current use.

Inclosure 1

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HEADQUARTERS TASK UNIT 13
Task Group 7.1
APO 187 (HOW) P.O. Box 8
c/o Postmaster
San Francisco, California

TU-13-54-375 12 March 1954

SUBJECT: Radiological Survey of Downwind Atolls Contaminated by BRAVO

1. Acknowledgement

The members of the survey team wish to express their appreciation to the Captain, officers and members of the crew of the USS NICHOLAS (DDE 449) for their assistance and cooperation in conducting the survey herein reported. Captain Elliot turned over all possible facilities of his ship in order to assist in the survey. LT Frink, the Executive Officer, organized all the operations of the boat parties, and it was only through his personal direction and participation that it was possible to carry out the small boat surveys under extremely difficu conditions. Since most of the lagoon waters were not navigable by a DDE, it was necessary to make long boat trips in high seas and land on tricky coral reefs. That it was possible to make, without mishap, a detailed survey of five widely separated atolls in the course of three days with only two boats was largely due to his efforts.

2. Introduction

The BRAVO Shot contaminated a number of atolls in generally eastward direction from Bikini to such an extent that it became necessary to evacuate the native populations from Rongelap, Ailinginae and Utirik Atolls and the military personnel on Rongerik Atoll. Following this evacuation CJTF SEVEN organized the subject detailed radiological survey of the atolls to the eastward of Bikini (Ref. CJTF SEVEN Eniwetok 060400Z). The data from this survey were required for the following purposes:

a. The evaluation of the radiation effects on evacuees.

b. The estimation of the elapsed time before reoccupancy.

c. The estimation of the residual radiation effects of large yields surface detonations.

In connection with this survey, teams from various Task Groups and Mr. Wilds, Trust Territory Representative, returned to the atolls to secure the evacuated habitations, service military equipment, and obtain documentary photography.

3. Operational Schedule

8 March - 0800 Survey team rendezvous aboard USS NICHOLAS (DDE 449) in Rongelap Lagoon.

8 March - 1000 - 1800 Two parties in small boats surveyed living areas on Rongelap Island and eastern half of Rongelap Atoll.

9 March - 0700 - 1130 Two parties in small boats proceeded from the DDE which was stationed outside Utirik Atoll and surveyed Utirik and Aon Islands, the main islands of the Atoll.

9 March - 1500 - 1700 One party in a small boat landed on the outer reef of Bikar Island and surveyed the island, the only large island of Bikar Atoll.

10 March - 0700 - 1100 Two parties in small boats proceeded from the DDE which was stationed outside Rongerik Atoll and surveyed Eniwetak Island (where the Task Force's Units had been stationed) and the other important islands of the Atoll.

10 March - 1430 - 1900 Two parties in small boats proceeded from the DDE which was stationed outside Alinginae Atoll and surveyed the inhabited islands of the Atoll.

11 March - 0700 - 1400 One party in a small boat surveyed the northwestern islands of Rongelap Atoll and one party rechecked the living areas on Rongelap Island and established a reference location for future decay measurements.

12 March - 0800 Survey team arrived Eniwetok Atoll via DDE.

4. The following personnel from test projects in TG 7.1, TU 13, served as members of the survey team:

Herbert Scoville, Jr.	TU-13 Staff
Richard Rast	Project 2.1
Richard Soule	Project 2.5a
Walmer Strope	Project 6.4

The USS NICHOLAS (DDE 449) supplied boat crews under the direction of LT Clifford Frink, Executive Officer, for surveys.

5. Instrumentation

Radiac set AN/PDR-39 was selected as the instrument to be used in the conduct of the survey. Five (5) each of AN/PDR-39 were calibrated with an 80 Curie Co^{60} source twenty-four hours before departure. The calibration yielded a zero variation between instruments - any scale. Upon cross checking three of these instruments, (a point of actual survey) in a radiation field of 0.320 r/hr it was found that all three instruments gave the same reading.

These survey meters were subject to prolonged use under adverse conditions of dampness (to the point of sea water splashing over them), salt deposit and continual rough handling. With one exception, all instruments operated efficiently for the duration of the operation. On the final day it was found

that one survey meter could not be properly zero adjusted. The four remaining AN/PDR-39, still operated efficiently and seemed to be in good working order.

One (1) each Beckman MX-5, and one (1) each AN/PDR-27A was brought along for any low intensity checks necessary. Two (2) each calibrated AN/PDR-T1B, were on hand to serve as spares in the event of operational failure with the AN/PDR-39. None of these instruments were required.

6. The average and maximum gamma dose rates measured on the various islands of each atoll are plotted in Figures 1 through 5. All measurements were made at waist height unless otherwise indicated. The maximum readings do not include measurements made with the instrument next to a contaminated surface.

Detailed surveys were made of all the inhabited localities. Typical readings are given in Tables 1 and 2 for the native village of Rongelap Island, and the TG 7.4 camp on Eniwetak Island. In general, the villages and the camps appeared to have slightly lower average dose rates than the remainder of the island. This can perhaps be ascribed to different geometry of the contamination and to slightly greater penetration into the loose gravel in the native villages. The dose rates inside the native huts appeared to be almost the same as the dose rate outside. The dose rate in the middle of the military barracks, tents, and shacks was 1/3 to 1/2 that outside. This reduction is probably largely a geometr effect. The dose rate fell off rapidly on the beach below the high tide mark. There was no evidence of rain washing off the contaminated material. The foliag on the windward sides of the islands appeared to be slightly above average contamination.

TABLE 1

TYPICAL READINGS IN RONGELAP VILLAGE - 8 MARCH

Location	Dose Rate (mr/hr)
Rongelap Island (average)	375
Center of village	280
Near central cistern	300
Near southern cistern	220
Near northern cistern	350

TABLE 2

TYPICAL READINGS IN CAMP ON ENIWETAK IS. - 10 MARCH

Location	Outside Dose Rate (mr/hr)	Inside Dose Rate (mr/hr)
Eniwetak Island (average)	280	- -
Mess hall	220	110
Tent, edge of main camp	270	175
Latrine	260	160
Sleeping quarters	260	90
Dispensary	220	110

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Radio Station	290	160
Weather Station (N end of island)	280	110
Proj 6.6.Station (S end of island)	240	- -

In order to estimate the rate of decay between 8 and 11 March, the following radiation measurements were taken on three days on Rongelap Island:

	8 March	11 March
Central living area (village)	280 mr/hr	170 mr/hr
Southern most cistern	220 mr/hr	145 mr/hr
Roof of cistern (Southern most)	240 mr/hr	140 mr/hr
Ground (contact) cistern area	220 mr/hr	110 mr/hr

An area was selected 30 yards inland from the Rongelap cemetery as a measuring point for future decay measurements. This area is outlined with 2X4s placed on pails. The waist height reading was 210 mr/hr at 1000 hours, 11 March 1954.

7. Sample collections

Water samples were collected from the water supplies of all inhabited areas. About two quarts of water were transferred to a polyethlene bottle at each site. These will be turned over to the New York Operations Office, AEC for analysis.

Soil samples were collected at all inhabited areas and also at several uninhabited islands. In collecting the soil samples a one foot by one foot square was marked on the ground and soil to about one inch of depth was removed from the square and transferred to a cardboard container. The primary samples will be turned over to the New York Operation Office, AEC, for analysis, and some smaller samples will be analyzed by Program 2 of TU 13.

Listed in Table 3 are the samples taken with the dose rate measured at waist height at the location where they were taken.

TABLE 3 - SOIL

Sample No.	Atoll	Island	Date	Mr/Hr
1*	Rongelap	Rongelap (North end)	8 Mar	440
2	Rongelap	Rongelap (Center of village)	8 Mar	280
3	Rongelap	Rongelap (1 mile north of village)	8 Mar	340
4	Rongelap	Rongelap (near South cistern of village)	8 Mar	220
5*	Rongelap	Eriirippu	8 Mar	2200
6*	Rongelap	Eniaetok	8 Mar	900
7*	Rongelap	Kabelle	8 Mar	2000
8*	Utirik	Utirik	9 Mar	40
9	Bikar	Bikar	9 Mar	160
10	Rongerik	Eniwetak	10 Mar	280
11*	Ailinginae	Sifo	10 Mar	100

*Small additional sample taken for analysis by Program 2 of TU 13.

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TABLE 3 - WATER

Sample No.	Atoll	Island	Date	Mr/Hr
1	Rongelap	Rongelap (central cistern)	8 Mar	300
2	Rongelap	Rongelap (North part of village)	8 Mar	350
3	Rongelap	Rongelap (Northernmost cistern)	8 Mar	400
4	Rongelap	Rongelap (Southernmost cistern)	8 Mar	220
5	Utirik	Utirik (cistern near church)	9 Mar	40
6	Utirik	Utirik (cistern at south of village)	9 Mar	40
7	Rongerik	Eniwetak (Distillation water)	10 Mar	240

In addition to the above, a sample of foilage was taken at the windward side of Bikar Island. The radiation field was 180 mr/hr on 9 March 1954 at this point.

8. Conclusions and Recommendations

a. The radiological survey proved that a large yield surface detonation can produce extremely serious radiological contamination over a distance more than 120 miles downwind and important contamination about 250 miles downwind.

b. The center of the contamination pattern from the BRAVO Shot lies somewhat north of Rongelap and Rongerik Atolls and probably not far from a line between Bikini and Bikar.

c. Although the fall-out was serious on Rongelap Island located at the extreme southeast tip of the atoll, the contamination was about ten times greater at the north side of the atoll, twenty miles away.

d. The contamination decreased by a factor of about eight over the downwind distance of 50 miles between Rongelap and Rongerik.

e. Standard military field housing provides a significant degree of protection to personnel inside.

f. The AN/PDR-39 proved to be a very satisfactory instrument for field survey work under rigorous environmental conditions.

g. A single DDE with two (2) whale boats is not a completely satisfactory method of conducting a broad radiological survey of the type just completed. Future surveys should consider using vessels capable of entering more of the atolls and of handling a helicopter and several small boats.

6 Incls:
1. Rad. Survey Rongelap
2. Rad. Survey Utirik
3. Rad. Survey Bikar
4. Rad. Survey Rongerik
5. Rad. Survey Ailinginae
6. Summary of Rad. Survey

/s/ Herbert Scoville
DR. HERBERT SCOVILLE
Technical Director
AFSWP

[redacted]

[redacted]

AFWL/NO

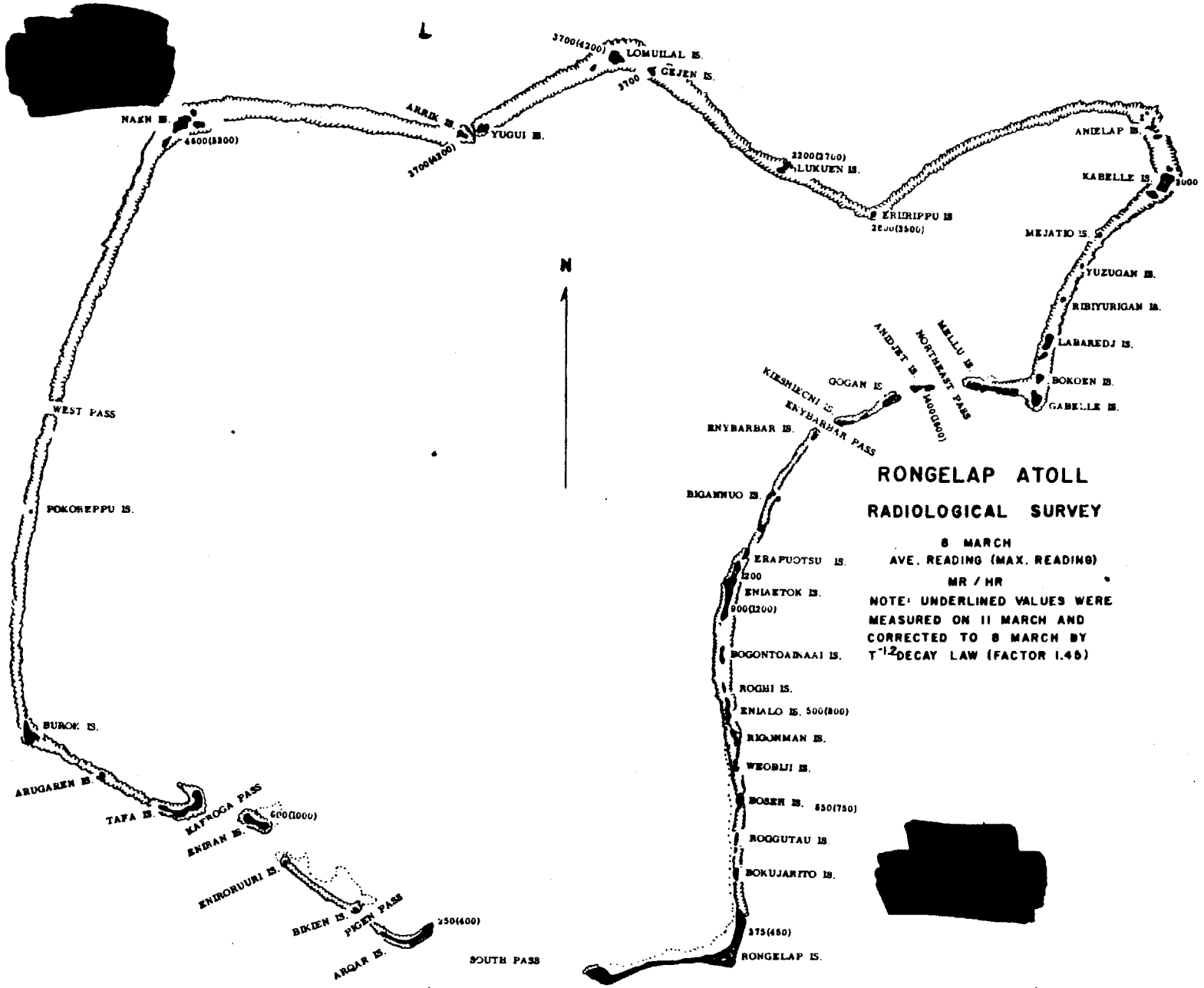


FIG. 1

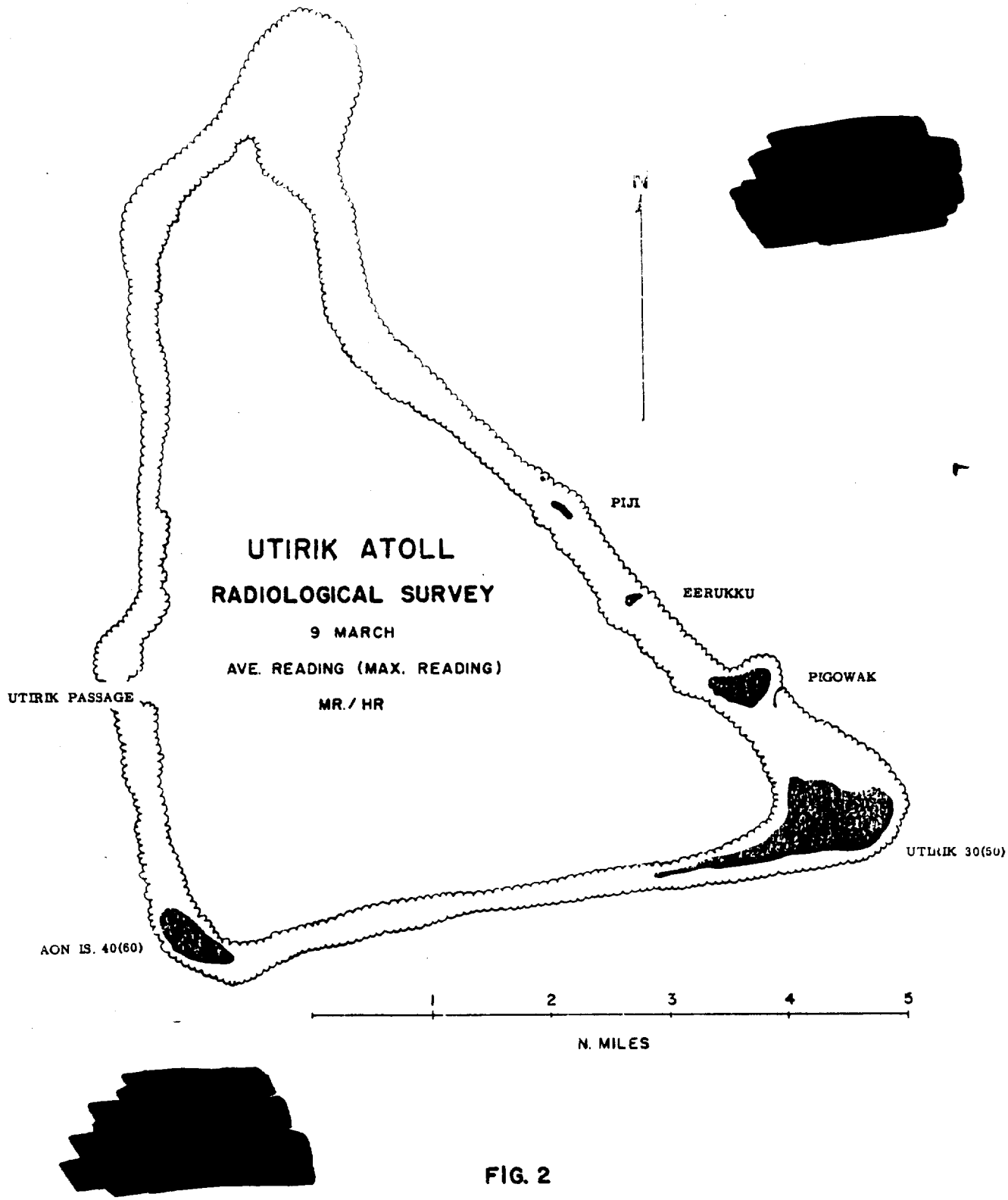
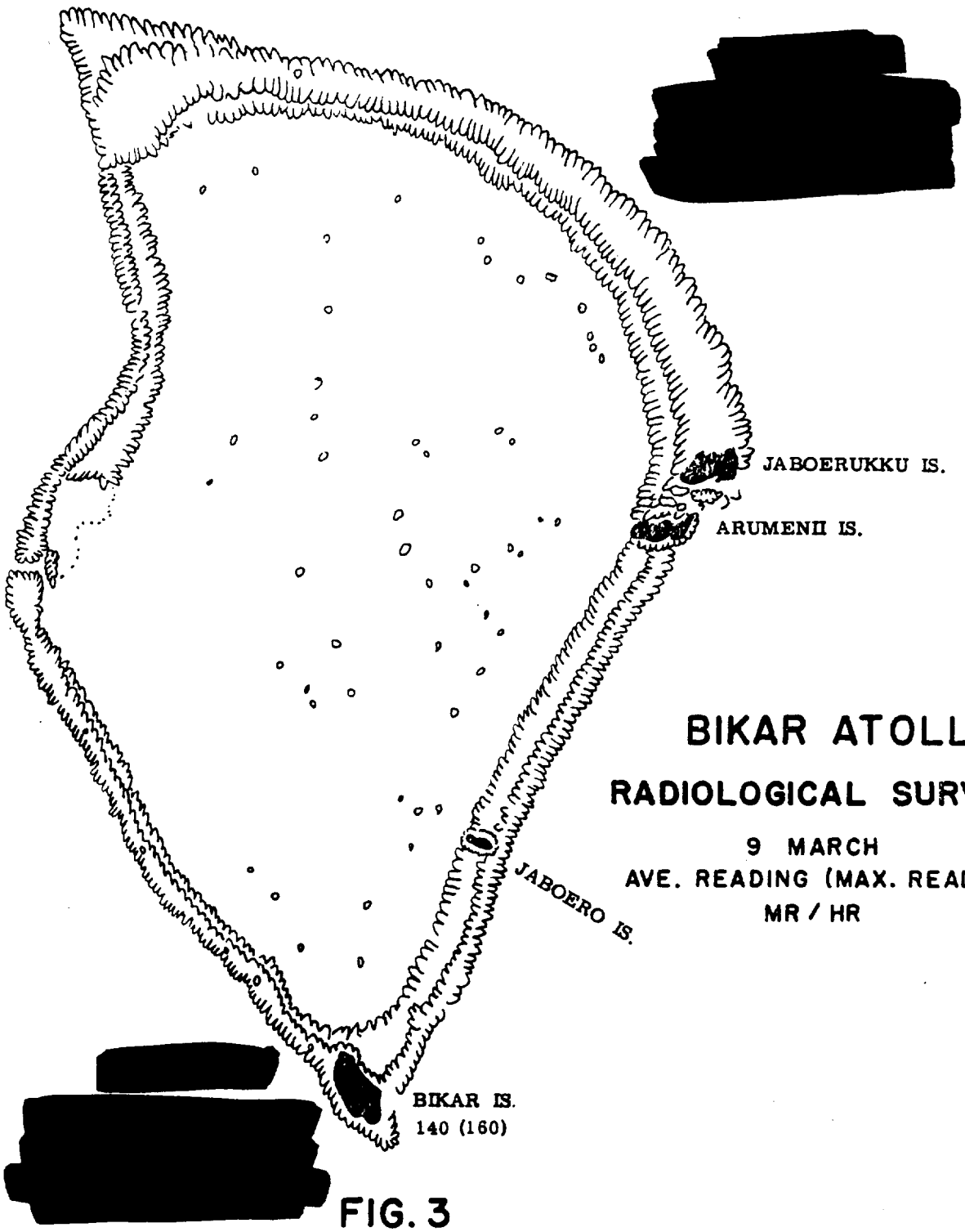


FIG. 2



BIKAR ATOLL

RADIOLOGICAL SURVEY

9 MARCH

AVE. READING (MAX. READING)

MR / HR

FIG. 3

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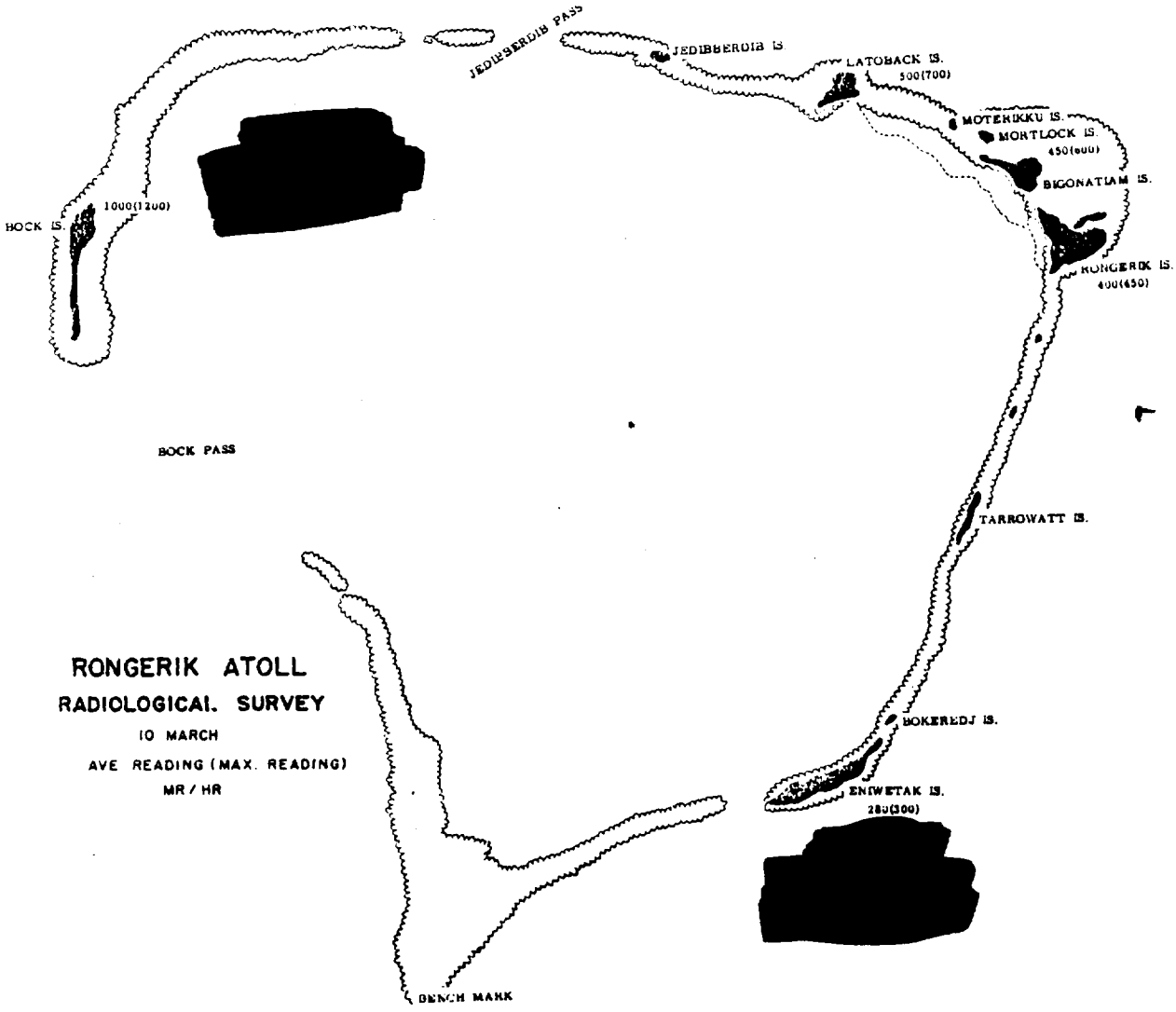

FIG. 4

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AILINGINAE ATOLL

RADIOLOGICAL SURVEY

10 MARCH

AVERAGE READING (MAX. READING)
MR/HR.

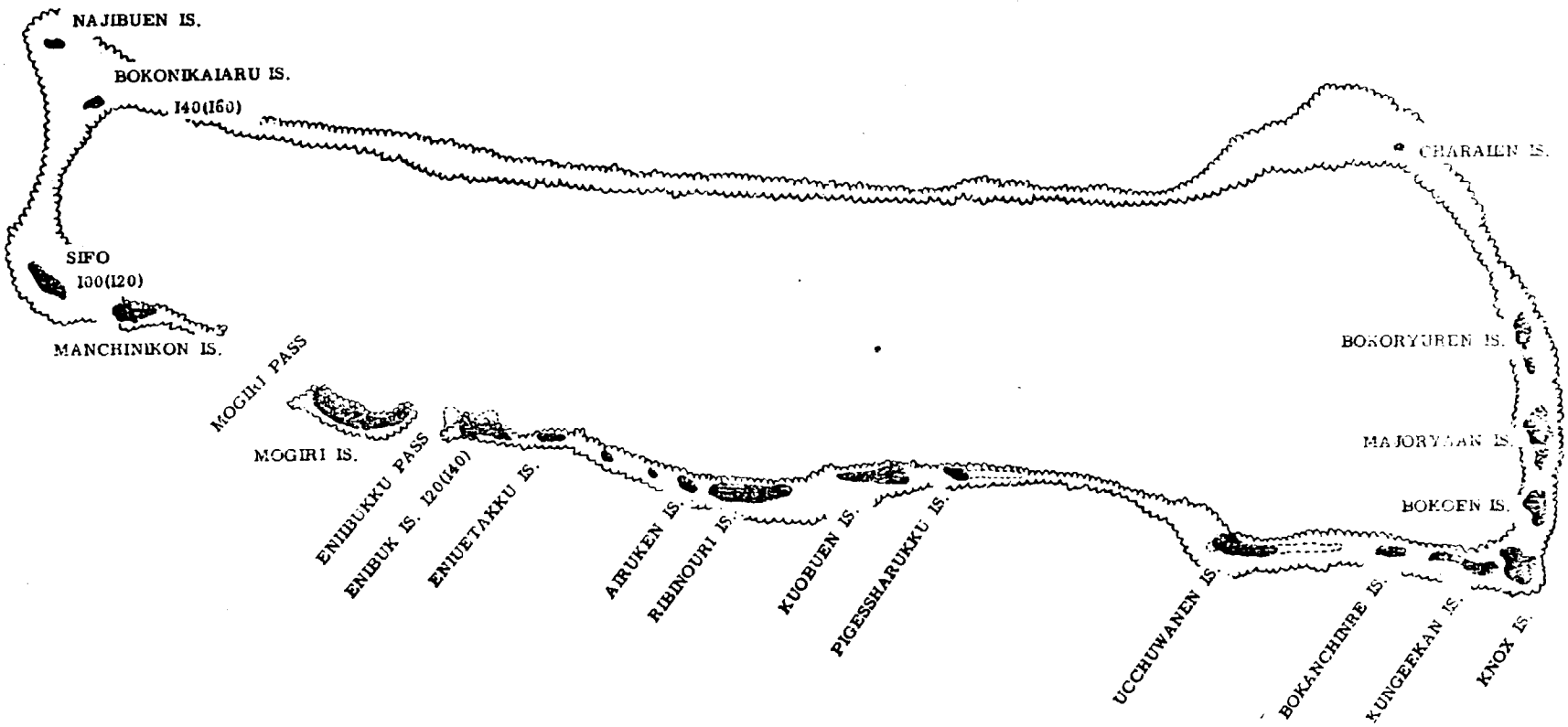

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FIG. 5

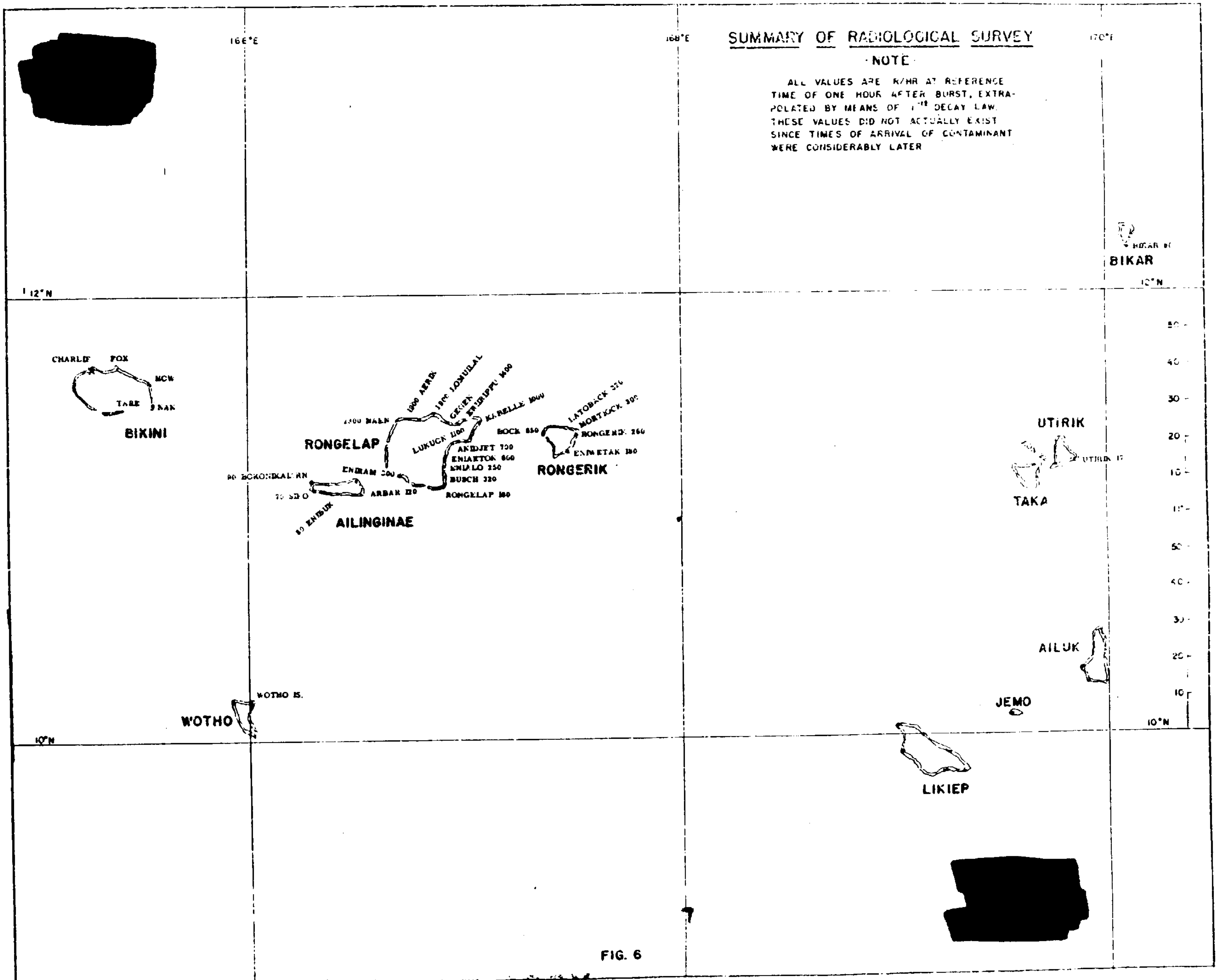

FIG. 6

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SELECTION OF A SYSTEM FOR DETERMINING AFTER-THE-FACT ACCURATE POSITIONING OF EFFECTS AIRCRAFT

PROBLEM:

1. To determine what system is available that would satisfy the requirements for after-the-fact accurate positioning (200 feet desired, 500 feet acceptable) of the B-36 and B-47 type aircraft participating in the effects program during Operation CASTLE (RESTRICTED, SI).

ASSUMPTIONS:

2. That a system has been developed which will satisfy this requirement.

3. That the system, if available, can be obtained on a loan, rental or purchase basis in the short time remaining.

4. That the funds required will be made available by AFSWP.

FACTORS BEARING ON THE PROBLEM:

5. Any system selected must satisfy requirements in the following areas of consideration:

a. Availability

b. Reliability

c. Accuracy

d. Real estate requirements

e. Vulnerability of equipment

f. Personnel requirement

g. Cost

h. Installation

i. Time required for and accuracies of data reduction

6. Any system selected must be in place and operational in the forward area by 15 February 1954.

DISCUSSION:

7. Radar O-15 Scope Photo: This equipment is available through the SAC who can provide trained operators and normal maintenance. The reliability of this equipment presents an index of probability of performance at any given time of ninety percent with normal calibration requirements. When this equipment is functioning properly it will give accuracies of 400 feet in altitude and 2000 feet in lateral position. As far as any other requirements concerning the above factors this equipment presents no problem. The fact that the accuracies are no better than 2000 feet in position rules the system out as a satisfactory solution.

8. Shoran, which appears to be the best equipment within the Air Force for this purpose, is available through the SAC on a loan basis and requires five people for each ground station. Highly qualified personnel are available within SAC. The airborne equipment consists of 290 pounds of electronics which can be operated by any rated individual after seven days of comprehensive training. It is 100 percent reliable, if two sets are at each location (ground and air), giving accuracies of fifty feet. These accuracies are dependent upon second order survey in locations of ground stations. The ground equipment must be installed on an island and housed in a tent with no effect on the equipment as far as weather is concerned. Shoran frequencies require 225 to 255 mc. for air and 290 to 330 mc. for ground installation. The installation presents no problem except for the installation required in the B-47. At present reading this appears to be a difficult problem. The ground equipment consists of $3\frac{1}{2}$ X $3\frac{1}{2}$ X $4\frac{1}{2}$ feet, weight 500 pounds, a power unit and a fifteen foot antenna. The data reduced consists of film development and interpretation. Although this equipment is available and satisfies the requirement, the problem of installation in the B-47 and the personnel errors inherent in the operation of the system makes it a poor selection.

9. The MPQ-2 is available through the SAC who have only one mobile set at the present time. It could be obtained on a loan basis. Personnel requirements consists of twelve individuals for both maintenance and operation. After a third order geodetic survey it could be reliable 100 percent of the time. This system is accurate only at ranges of less than twenty miles from aircraft, as an example, accuracies of 1000 feet in lateral position and 400 feet in altitude at thirty-five thousand feet altitude at a distance of fourteen miles can be expected. One objection to this equipment is that it can handle only one aircraft at a time. The equipment must be located on an island, is susceptible to weather and shock from the detonation. The ground installation requires three vans, one forty feet long, one twenty-eight feet long and another fifteen feet long. This equipment is not desirable because of its vulnerability to environment, its lack of flexibility and unacceptable accuracies.

10. The K-17 Visual Camera is owned by the SAC, can be obtained on a loan basis and can be operated by the crew. It requires two airmen for maintenance purposes. For good accuracies gyro stablized installation is required in the aircraft. This would give accuracies of approximately 200 feet depending on the ability of the photo interpreter. The use of this equipment would require certain ground light installations. An obvious objection to this system is its inability to function in the event of cloud coverage; however, it could be used as a back up for some other system.

11. Because of many informal discussions concerning the claims of Raydist which is manufactured by the Hastings Instrument Corporation it has been advisable to investigate this system thoroughly (See tab A). The Hastings people were briefed on a hypothetical problem and given full details of the requirement. After review of the complete problem, Hastings has stated that they can do the job with their equipment and their personnel within the time available guaranteeing us 100 percent reliability and accuracies of one in 5000. The installation problem appears to be non-existent and once completed it is also possible for the aircraft to be positioned through its use at the time of the shot as well as after the fact. All of the above areas of consideration are more than satisfied by the claims of the Hastings people. Therefore this system should be considered favorably as a primary method for determining effects aircraft positions.

CONCLUSIONS:

12. From the above it is concluded that:

a. Only one system, Raydist, exists which will completely satisfy the after-the-fact accurate positioning of aircraft.

b. K-17 Visual or O-15 Radar photography should be provided for back up purposes.

ACTION RECOMMENDED:

13. It is recommended that action be taken by this organization to request the AFSWP to contract with Hastings Corporation for the Raydist system.

TAB "A"

The Raydist navigational system is capable of providing a three dimensional determination of aircraft position with an accuracy of 0.02%, and it can determine speed with a possible 1.0% error. It can furnish recorded data, at these accuracies, of an aircraft's position, operation, and performance at speeds through Mach 1.

The system consists of several sources of signal and a measuring device, or one source of signal and several measuring stations. It gives an instantaneous hyperbolic position reference between the members of the system by means of instantaneous phase detection. The data is presented on dials and can be simultaneously recorded in three dimensional recorded data. Two hours are required to reduce this information.

Most suitable for Task Force use is a non-saturable configuration that employs three fixed ground stations with a small airborne unit which gathers information and telemeters it to a ground recording station independently positioned anywhere within the range of the telemetering signal, a radius of 150 miles. With some pilot training the equipment can also be used to accurately place him at the desired point as well as furnish after the fact data.

The three ground stations can be placed in small underground bunkers, about six feet square, sided and covered with sand bags with a thirty foot whip antenna protruding. These are duplicate units with automatic back up. They can be powered by batteries, small gasoline driven generators or commercial power. When on batteries, they can operate unattended for twenty-four hours without recharge. These transmitters can be placed on any available islands, but should have a minimum separation of three (3) miles for greatest ease and accuracy in data reduction.

The Hastings Instrument Corporation will install the equipment in the aircraft. No extensive modifications is required other than mounting equipment in available space and antenna installation. About ten cubic feet is required in several units with a weight of some 100 pounds. In the case of type B-47 aircraft a canopy antenna can be used, similar installation having been made in type F-86 aircraft and used with success. The Hasting's engineers estimate two weeks maximum for this installation.

One frequency is required for the system. The various transmitters differing only by an audio beat note well within allowable tolerances. The frequencies used can be in the range of 1.5 to 30 mcs. The recording device may be installed in the aircraft eliminating the telemetering feature, but if the telemetering system is desired an additional FM frequency in the vicinity of 40 mcs. is required.

The manufacturer makes the following claims for system performance:

1. Accuracy. Consistently better than one foot or one part in five thousand, which ever is greater.

2. Repeatability. Six inches or one part in ten thousand which ever is greater.

3. Stability. A test of a standard system over a base distance of 96,660.1 feet showed the stability to be within five parts in one hundred thousand for seventy-two hours.

4. Range. With small transmitters, radiating only three watts the system was successfully operated at ranges greater than 165 miles.

5. Reliability. No figures available since no failure has been experienced.

The equipment can be purchased or leased. The Raydist Navigation Corporation, a subsidiary of Hastings Instrument Corporation, can furnish a complete package consisting of equipment, operating crew of six, maintenance equipment and aircraft installations at a maximum cost of $200,000. Hastings states that, if furnished a contract by 1 December, they can have the equipment ready for overseas movement by 1 January.