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A Preliminary Report of [redacted] (Navajo)
ROP-90 26 July 1956
Issued as 5715-JFE

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July 28, 1956

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[redacted]

OPERATION REDWING

A PRELIMINARY REPORT

OF

DE[redacted] (NAVAJO)

Submitted by Task Group 7.1

5715JFK

26 JULY 1956

9

[redacted]

CONTENTS

PAGE NO.

INTRODUCTION

This is a preliminary report, and therefore, does not give either complete or final results of the work of the various projects. No information on the construction of the device is included, in order that the classification may be kept to Secret Restricted Data.

DELETED

PART I

GENERAL INFORMATION

Observed Weather at Shot Time

Fig. O-1 - Bikini Atoll Map

Fig. O-2 - Bikini Atoll North Reef with Scientific Stations

Fig. O-3 - RadSafe Survey, D + 1

Fig. O-4 - RadSafe Survey, D + 2

Fig. O-5 - RadSafe Survey, D + 3

[redacted] (NAVAJO)

BIKINI OBSERVED WEATHER FOR 11 JULY 1956
AT DETONATION TIME 0556M

Sea Level Pressure	1010.2 mbs
Free Air Surface Temperature	81.2°F
Wet Bulb Temperature	76.2°F
Dew Point Temperature	74.0°F
Relative Humidity	80.0%
Surface Wind	090° - 8 knots
Visibility	10 miles

CLOUDS

2/10 cumulus bases estimated at 1800 feet
6/10 cumulus bases estimated at 2000 feet
7/10 cirrostratus, bases estimated at 30,000 feet (transparent)

AREA WEATHER SUMMARY FROM AIRCRAFT

0600M - (Aircraft at 45,000 feet) Scattered to broken cloud layer based at 30,000 feet, tops at 35,000 feet. Few cumulus (widely scattered) with tops to 35,000 feet. Could not see surface or Bikini Atoll.

0619M - (Aircraft at 44,000 feet just above broken to overcast cirrus cloud layer to the west of Bikini) Scattered cirrus clouds 50 miles south of Bikini. Few scattered cirrus to north and east of Bikini with approximately 2/10 small cumulus at low levels. Few cumulus tops to 25,000 feet.

STATE OF SEA

Ocean Side: Wave height 5 ft., period 5 seconds, direction 080 degrees. Sea water temperature - 83.0°F.

Lagoon Side: Wave height less than 1 foot.

[redacted]

14

[redacted]

WINDS ALOFT (Release time 0630M)

Height (Feet)	Direction (Degrees)	Speed (Knots)	Height (Feet)	Direction (Degrees)	Speed (Knots)
1,000	080	21	24,000	170	4
2,000	080	23	26,000	180	10
3,000	080	22	28,000	200	14
4,000	080	22	30,000	210	15
5,000	080	20	32,000	180	14
6,000	080	18	34,000	210	19
7,000	080	19	36,000	230	22
8,000	080	20	38,000	260	15
9,000	080	19	40,000	270	16
10,000	080	18	45,000	240	30
12,000	070	13	50,000	240	29
14,000	060	12	52,000	230	32
16,000	100	9	55,000	120	12
18,000	100	9	60,000	080	23
20,000	130	8	65,000	090	35
22,000	130	8	70,000	080	45

UPPER AIR SOUNDING (Release time 0630M)

Pressure (Millibars)	Height (Feet)	Temperature (°C)	Dew Point (°C)
1000	210	27.2	23.5
850	4,940	15.5	12.2
700	10,290	8.3	1.2
624	13,353	Missing	Missing
500	19,160	-7.5	-14.3
400	24,730	-18.5	-26.5
300	31,570	-34.2	-46.8
270	33,957	-40.3	Missing
250	35,660	-44.1	Missing
200	40,430	-56.2	Missing
150	46,220	-70.5	Missing
120	50,492	-79.0	Missing
100	52,900	-77.6	Missing
94	55,151	-79.0	Missing
81	57,344	-76.0	Missing

[redacted]

[redacted]

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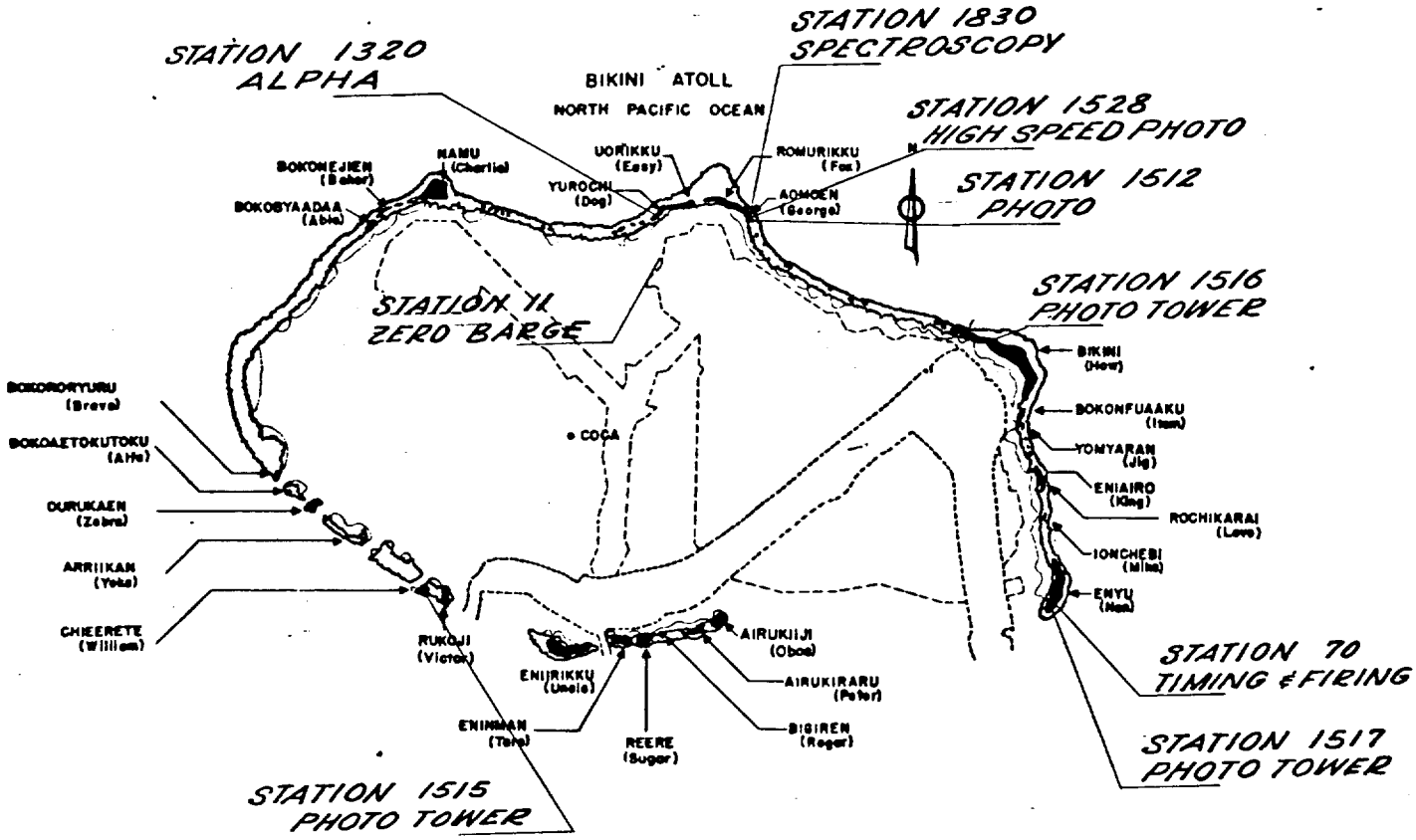


Fig. O-1 - Bikini Atoll Map

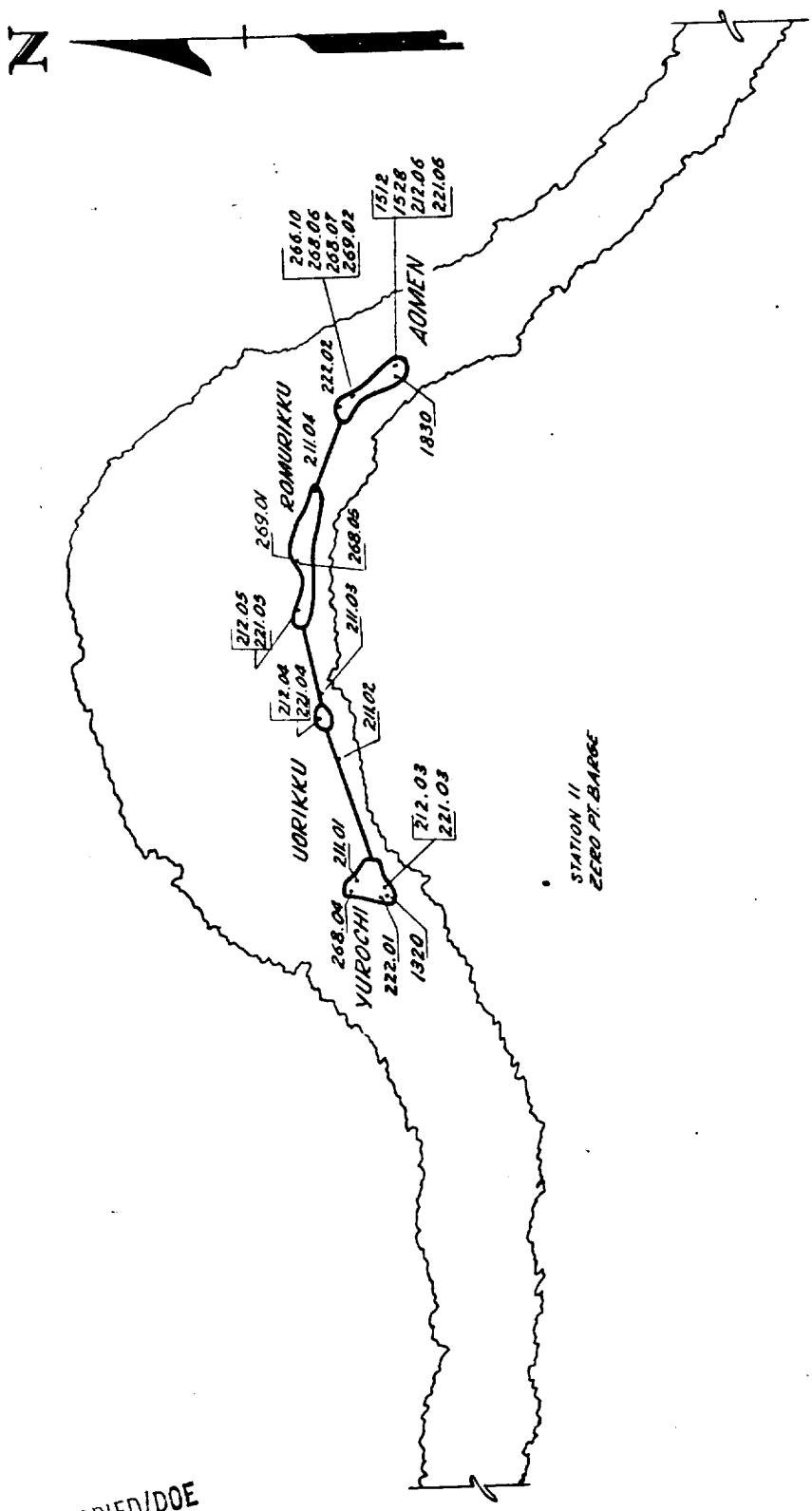
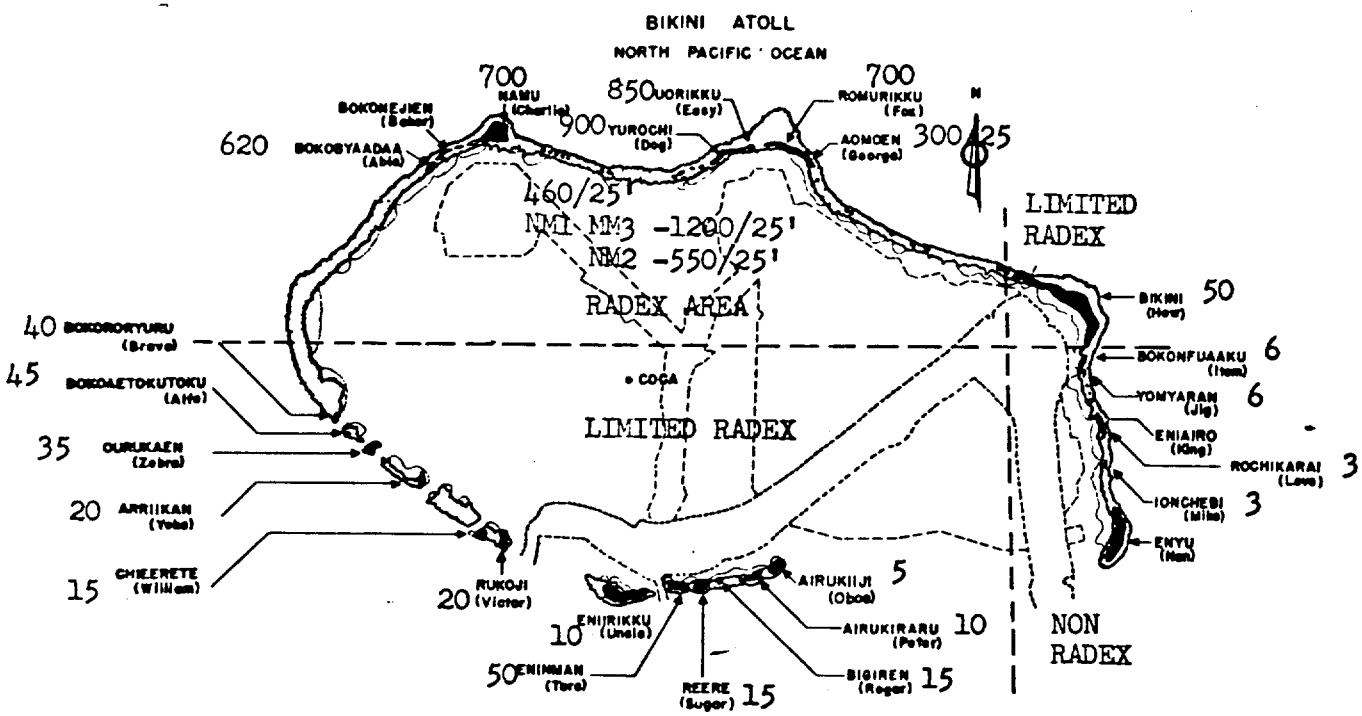


Fig. O-2 - Bikini Atoll North Reef with Scientific Stations

[redacted]

12 July 1956
All readings in mr/hr
Int./Alt./ at 0800 hrs

[redacted]



[redacted]

Fig. D-3 RadSafe Survey, D + 1

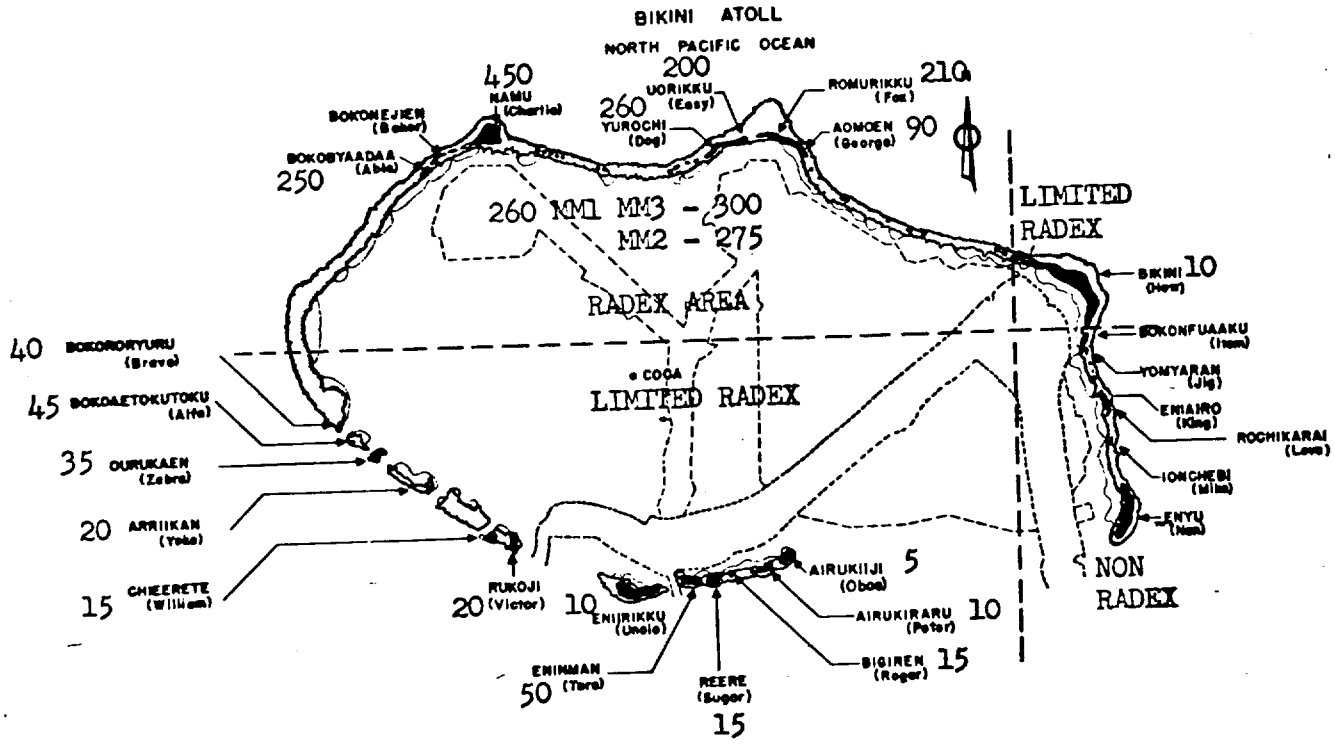
18

[redacted]

13 July 56

All readings in mr/hr
on ground at 0800 hrs

[redacted]



[redacted]

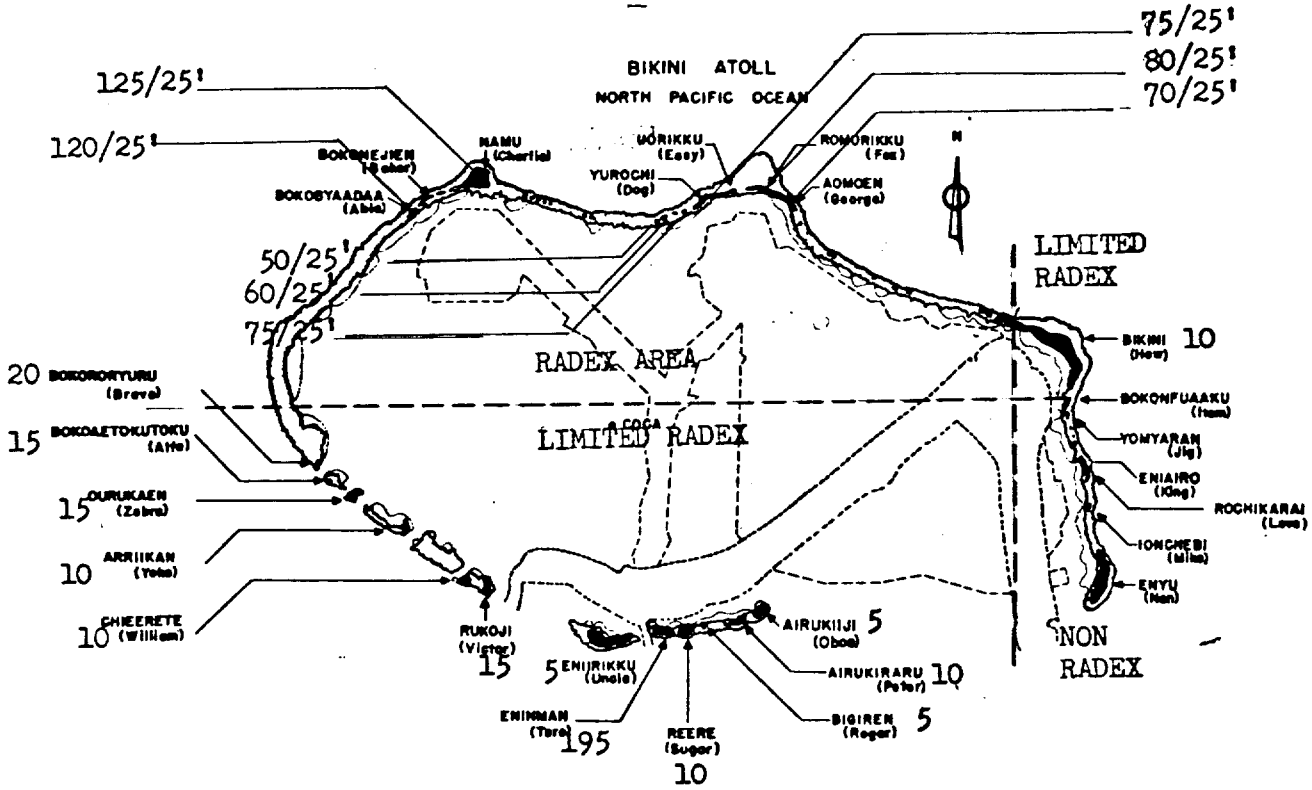
Fig 0-4 - RadSafe Survey, D # 2

[redacted]

[redacted]

14 July 56
All readings in mr/hr
converted to 0800 hrs

[redacted]



[redacted]

Fig. O-5 - Rad Safe Survey, D + 3

[redacted]

[redacted]

PART II

TASK UNIT 3

DOD PROGRAMS

K. D. Coleman

Col. K. D. Coleman
CTU-3

Program 1 - Blast and Shock Measurements	Maj. H. T. Bingham
Program 2 - Nuclear Radiation and Effects	CDR D. C. Campbell
Program 4 - Biomedical Effects	Lt Col C. W. Bankes
Program 5 - Aircraft Structures	CDR M. R. Dahl
Program 6 - Tests of Service Equipment and Materials	Lt Col C. W. Bankes
Program 9 - General Support	Lt Col J. G. James

[redacted]

DELETED (NAVAJO)

Project 1.9 - Water Wave Studies - W. Kidd

OBJECTIVE

To obtain data on water waves induced by nuclear detonations.

INSTRUMENTATION

Project 1.9 had eight Bikini Lagoon wave stations active that produced useful data for the [redacted] (Navajo). In addition the lagoon wave station was active at Eniwetok. The two long period wave recorders located on the outside reefs at Eniwetok and Allinginae Atolls were also operating for Navajo.

RESULTS

The four shore recording lagoon wave stations at Bikini yielded excellent data. Preliminary analysis shows the following approximate maximum crest, troughs and periods to exist at the indicated locations. These values were recorded in 60 foot depth lagoon water. Up-rush and inundation as a result of these, depending upon topography, can easily exceed these values.

All values about tide stage at shot time (≠ 6 ft)

Enyu (Nan)	Maximum crest	≠ 5 feet
	Maximum trough	- 4 3/4 feet
	Maximum period (first series)	- 164 seconds
Bikini (How)	Maximum crest	≠ 3½ feet
	Maximum trough	- 3½ feet
	Maximum period (first series)	- 160 seconds
Airukiraru (Oboe)	Maximum crest	≠ 8 feet
	Maximum trough	- 7 feet
	Maximum period (first series)	- 150 seconds

[redacted]

Chiecrete (William)	Maximum crest	+ 4 3/4 feet
	Maximum trough	- 5½ feet
	Maximum period (first series)	- 164 seconds

Two skiff stations in the lagoon at ranges of 8 - 10 miles recorded Navajo waves. Three turtle stations (self-contained and resting on the lagoon floor) were set in the one to 1½ mile range. Two of these have been recovered and contained data. One unit shows a maximum crest to trough height of 40 feet. The third unit has not been located as yet. It should contain valuable close-in data.

The lagoon wave recorder at Eniwetok may eventually show the presence of lagoon wave action for Navajo but if it is present, it is too close to background wave action to be discernible on cursory examination. It should be detectable because of its different period.

The long period wave recorder at Parry produced excellent data. The Ailinginae station should have a good record as it was armed and functioning satisfactorily on N-2. Both Wake and Johnston Island stations were successful.

An inundation survey was completed on N + 4. Pictures were taken of wave damage at Enyu on D day but inclement weather prevented the aerial photographic run until N + 2. Water wave damage was amplified by the fact that shot time coincided with high tide. Wave heights and innundation lines of Navajo correspond very closely with those predicted. The pattern and extent of inundation follows very closely that observed for CASTLE [redacted] (Union).

It is interesting to note that the single [redacted] (Navajo) wave responsible for the greatest extent of inundation damage at Enyu

occurred 6 3/4 minutes after the arrival of the first (and maximum) crest. Immediately preceeding this wave, the mean water level receded to its maximum low of -4 3/4 feet over a period of 3 minutes and then increased to a crest height near maximum in a relatively short time to give a total "head" change of approximately 9 feet. The near shoreline obstruction having been reduced by the first crests of the wave train, this later wave increased considerably the intensity and extent of the inland rush and damage of the first waves of the train.

[redacted] (NAVAJO)

Project 2.1 - Gamma Exposure Versus Distance - P. Brown

Objective

The object was to measure initial and residual radiation using NBS type film badges, quartz fiber, chemical, and phosphate glass dosimeters.

Instrumentation

Twelve stations on the Yurochi (Dog) Complex were instrumented to measure initial gamma radiation. Twenty other stations throughout Bikini atoll were instrumented to measure the residual gamma exposure.

Results

Table 2.1-1 lists the uncorrected initial gamma exposure versus distance data. These values should be increased about 30% to correct for the shielding of the steel pipe stations.

Conclusions

This data is in agreement with other data obtained during REDWING.

[redacted]

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Table 2.1-1

Distance (feet)	Exposure (roentgens)
7,922	7,200
8,580	2,900
8,960	1,350
9,810	380
10,680	270
11,880	43
13,170	11

[redacted] (NAVAJO)

Project 2.2 - Gamma Dose Rate vs Time - P. Brown

OBJECTIVE

The object was to measure initial gamma dose rate and gamma dose rate and residual gamma exposure using Conrad, Gustave, and Long John detectors along with their appropriate recording devices.

INSTRUMENTATION

The accompanying Table 2.2-1 lists the pertinent information as regards instrumentation for the event.

RESULTS

Satisfactory results were obtained. Evaluation of the data is now in progress.

[redacted]

[redacted]

TABLE 2.2-1

Navajo Instrumentation

Island	Station #	Coordinates	Type of Instrumentation
Bokobyaadaa (Able)	221.01	N 169,900 E 71,350	1 ea Conrad w/E/A Recorder
Yurochi (Dog)	221.03	N 168,520 E 116,850	1 ea Conrad 2 ea Long John w/Sanborn recorder 1 ea Gustave w/Cook recorder
Uorikku (Easy)	221.04	N 170,200 E 121,500	1 ea Conrad 1 ea Long John w/Sanborn recorder
Romurikku (Fox)	221.05	N 170,700 E 125,260	2 ea Long John w/Sanborn recorder 1 ea Conrad 1 ea Gustave w/Cook recorder
Aomoen (George)	221.06	N 168,100 E 131,150	1 ea Conrad 1 ea Gustave w/Drum recorder
Bikini (How)	Portable		1 ea Conrad
Rochikarai (Love)	Portable		1 ea Conrad
Airukiiji (Oboe)	0220.03	N 103,475 E 126,245	1 ea Conrad
Enidrikku (Uncle)	0220.01	N 99,938 E 99,994	1 ea Conrad
Chicorete (William)	0221.01	N 109,009 E 116,550	1 ea Conrad
Arriikan (Yoke)	221.02	N 116,550 E 70,091	1 ea Conrad
Bokoaetokutoku (Alfa)	221.04	N 124,113 E 58,974	1 ea Conrad
Enyu (Nan)	Portable		1 ea Conrad

[redacted] (NAVAJO)

Project 2.61 - Rocket Determination of the Activity Distribution Within the Stabilized Cloud - R. Soule

OBJECTIVES

Rockets were fired into the [redacted] (NAVAJO) cloud in order to develop the capability of measuring and to explore the spatial distribution of gamma activity within the stem and cloud produced by the detonation of nuclear weapons of megaton yield. It was desired to make measurements of activity distribution in clouds resulting from an air detonation, a land surface detonation and a water surface detonation. Besides the [redacted] (NAVAJO), the water surface detonation, the project has participated in the [redacted] (CHEROKEE) and the [redacted] (ZUNI).

INSTRUMENTATION

A six inch diameter ground launched rocket capable of attaining 130,000 feet altitude, bearing a radiation detector and telemetering equipment was used to obtain information on the radiation field in the cloud and stem. Twelve of these units were fired, six at the stem at H + 7 minutes and six at the cloud at H + 15 minutes. Radiation intensity information (in the form of F.M. pulses) was telemetered to two receiving stations where the information was recorded on magnetic tape.

RESULTS

All rockets fired and good signal strength was apparently received on ten of the twelve channels. The radiation fields that were measured were lower than those previously encountered. Data on channels corresponding to rockets shot at the stem indicate that at least one rocket

[redacted]

passed through the stem. There were data on five of the six channels corresponding to rockets passing through the cloud. Failure of automatic readout equipment prior to the first test will necessitate manual readout of the tapes.

[redacted]

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Project 2.62 - Fallout Studies by Oceanography Methods - F. D. Jennings

OBJECTIVES

To measure the fallout radioactivity and its chemical nature in water from a surface water burst. To calculate the equivalent land fallout pattern.

To understand the nature of the transport and dilution of radioactive fallout material in the ocean to permit future surveys to acquire a complete fallout picture.

DESCRIPTION AND EXPERIMENTAL PROCEDURE

SIO installed and maintained thriteen deep-moored skiff stations in the fallout area between 10 and 30 miles from ground zero. Recording instruments were installed on two of these skiffs to measure radioactivity as a function of time at depth intervals of 20 meters down to 100 meters. The recorder was started on arrival of fallout by a trigger which was pre-set to start when radiation levels reached 30 mr/hr.

Two high speed vessels, USS SILVERSTEIN (DE 534) and USS MC GINTY (DE 365), were outfitted with devices for measuring radioactivity as a function of depth and in air, and drogue floats for marking areas of particular interest. These two vessels were stationed outside the fallout area during the shot and then proceeded to survey the fallout area, making measurements out to about 180 miles from ground zero and across a pattern about 120 miles wide. These two ships, together with the M/V HORIZON, collected about 85 water samples from the surface and from depths for Project 2.63 and an equal number for Project 2.64.

The two project 2.63 YAG's were supplied with detectors for measuring and recording radioactivity as a function of depth and in addition the YAG 39 was supplied with a similar detector for use in her decay tank for

measurement of effective radioactive decay.

The research vessel M/V HORIZON was completely equipped with equipment for depth sampling and for measuring radioactivity and oceanographic values. After the shot it proceeded into the fallout area and performed its functions, particularly in the areas of interest marked by the DE's and YAG's.

RESULTS

The only preliminary results available at this time is that concerning the rate of penetration meters which were installed on the deep moored skiffs. Although the triggers functioned properly and started both recorders, leakage in both underwater cables negated measurements of penetration rate. All other results await further data reduction.

[redacted] (NAVAJO)

Project 2.63 - Collection and Characterization of Fallout with Time -

T. Triffet

OBJECTIVES

To collect samples of fallout and measure radiation field intensities with time at various distances from high yield land, water, and air thermonuclear detonations. To study these samples from early times with respect to gamma and beta activity, to analyze them for chemical and radiochemical composition and to determine certain of their physical properties, including distributions of particle sizes.

DESCRIPTION AND EXPERIMENTAL PROCEDURES

Instrumentation was similar to past major shots. Minor and major arrays were again mounted on various platforms including YAG-40 and YAG-39, LST-611, YFNB-29, YFNB-13, rafts and skiffs. Location of the major elements were:

Station Type	Latitude N	Longitude E
YAG-40	12° 12.0'	165° 05'
YAG-39	12° 00'	165° 20'
LST-611	11° 35'	164° 40'

RESULTS

Approximately 94 percent of all project instrumentation functioned properly. No significant damage to any station, other than the one located on Aomoen (George) Island was reported; and even this which was left in place primarily in order to assess the powers of resistance of the Standard Station, survived and collected a useful sample. All island, barge and raft stations received fallout, as well as nearly every skiff station. In general, however, activity levels were low, the highest

being observed on the YFNB-13, Namu (Charlie) Island and the skiffs lying in the northwest quadrant. Surface readings of samples collected on island, raft and barge stations averaged 50 mr/hr at 1400 on N ≠ 1 day, with some as high as 200 mr/hr at the same time. The time of arrival of fallout at the YFNB-29 was about 17 minutes and 15 minutes at the YFNB-13.

Each project ship received fallout, the approximate time of arrival being H ≠ 2.0 hours for the YAG-39, H ≠ 3.2 hours for the LST-611 and H ≠ 6.5 hours for the YAG-40. The highest activity level observed was approximately 1.8 r/hr at about H ≠ 4.6 hours on the deck of the YAG-39, while the maximum deck intensity observed on the YAG-40 was 115 mr/hr at H ≠ 12.1 hours. Extrapolated to a deck condition without washdown the maximum intensity observed on the LST-611 was approximately 200 mr/hr at H ≠ 5.6 hours. Activity measurements, decay and gamma spectra measurements, and physical observations of fallout material were performed at early times in the shielded laboratory aboard the YAG-40. The great majority of these data are being reduced at the present time. It appears however, that the primary fallout arrived in slurry droplet similar to that observed for event Flathead. Once again the droplets averaged 100 to 200 microns in diameter, ordinarily possessed an NaCl content greather than 80 percent, and appeared to contain smaller particulate with which nearly all of the activity was associated.

The data obtained are being examined further and additional analyses are being performed at NRDL; these results will be included in the preliminary report.

[redacted] (NAVAJO)

Project 2.64 - Fallout Location and Delineation by Aerial Survey -

R. Graveson

OBJECTIVES

To survey the gamma radiation from fallout contaminated ocean areas using an airborne detector.

To survey the areas of the sea, off Bikini Atoll, which are contaminated prior to the shot. The information to provide both background radiation data, and oceanographic studies of the mixing of the lagoon water into the open sea.

DESCRIPTION AND EXPERIMENTAL PROCEDURES

Three P2V-5 aircraft were equipped with gamma radiation detectors to record the dose rate arriving through the thin aircraft skin from a water surface below.

One aircraft was flown over the Bikini Atoll area, and the contaminated area, which was expected to be downwind of the atoll, was to be delineated. Surveys were scheduled for minus three, and minus two. The pre-shot surveys were requested by Program II on Navajo —3.

RESULTS

The D-day survey was started late on the afternoon of D-day. It was confined to an area 60 miles west to 30 miles east and from the south to 10 miles north of ground zero. The southern boundary of the contaminated area was delineated. The aircraft encountered no airborne contamination.

The D plus 1 survey utilized two aircraft simultaneously. Total elapsed flight time totaled approximately 16 hours for the two. No aircraft contamination was encountered throughout the area of contaminated ocean. The contaminated area extended approximately 150 miles from GZ.

Heavy rain throughout the day made flight operations difficult. Both aircraft were IFR at 300 feet during most of the surveys.

On D plus 2, one aircraft was used on a wide search pattern to confirm the position of the outer boundary plotted on the previous day. While the first examination of the results indicate this confirmation was achieved, a close examination of the results will be required before a positive conclusion can be reported.

In summary, two preshot surveys outlined an area of light contamination, down wind from the atoll. The levels were low, but the possibility of incomplete mixing of fallout in that area must be examined. Surveys on D, D + 1, and D + 2 were used to delineate the contaminated area, and to verify its boundaries.

[redacted] NAVAJO)

Project 2.65 - Analysis of Fall-Out and of Base Surge - M. Morgenthau

Objectives

To obtain fallout samples on land and to perform radiophysical and radiochemical measurements on the samples.

To prepare dose rate contours of the atoll area from information gathered by this project, other projects, and Rad-safe.

To evaluate the role of the base surge in transport of radioactive material.

Description and Experimental Procedures

Intermittent fallout collectors (IFC) and gross fallout collectors (GFC) were installed on islands in the Bikini Atoll and on the YAG's and LST in the expected fallout zone. The IFC timing intervals were 1 minute, 5 minutes, or 30 minutes, depending on location of the collector. The equipment was installed prior to the shot and was activated by E.G.&G. Blue Boxes. Samples to be used for early decay measurements were recovered on D-day and the balance of the samples were recovered on D/1. All of the recovery was made by helicopter. Wire signals were used to activate the base surge detectors as a warm-up period was required before shot time. Some of the stations also incorporated a tape fallout monitor (TFM).

On D-day, D/1 an aerial survey of residual radiation was made over the respective atolls by helicopter. The measurements were taken by means of a probe on a long cable suspended below the hovering helicopter. The positions of the probe were determined by comparison with maps and aerial

[redacted]

[redacted]

3

photographs. Two project personnel were stationed in the Program 2 Control Center to consolidate data from the various projects and to assist the Program Director in maintaining a situation plot.

RESULTS

Aerial survey of Bikini Atoll following the [redacted] (Navajo) covered islands between Bikini and Bokororyuru. Negligible levels of contamination resulting from this shot were observed on other sections of the Atoll. The result of the D-day and D + 1 day survey is shown in Table 2.65-1. Extremely heavy and steady rains occurred between the D-day survey and the D + 1 day survey. The table shows that the D + 1 day readings are very low compared to the D-day readings. A gamma decay factor of -1.025 determined from laboratory gamma decay measurements for early times was used in converting the D-day reading to H + 1 hour values.

The sampling stations on Romuriku, Yurochi, Bokororyuru, Arriikan and Airukiiji were damaged by the water wave. Samples were obtained on Namu and Bokobyaadaa. The time of arrival of significant fallout activity at Namu was between 30 and 35 minutes. The time period during which fallout occurred at its maximum rate was between 45 and 50 minutes. Significant fallout ended between 1 1/2 and 2 hours after detonation at the Namu station.

Radiochemical analysis on the samples collected is in progress.

TABLE 2.65-1

CORRECTED AERIAL SURVEY READINGS - NAVAJO
(Laboratory Gamma Decay Factor: -1.025)

Island	Day	Time After Shot (hrs)	Corrected Reading (mr/hr)	r/hr at H + 1 hr.
Bikini (How)	N	6.97	110	0.8
	N+1	34.6	10	
Aomoen (George)	N	7.12	4500	33.6
	N+1	34.7	170	
Romurikku (Fox)	N	7.17	6000	45.0
	N+1	34.8	520	
Yurochi (Dog)	N	7.32	8000	61.6
	N+1	34.8	125	
Namu (Charlie)	N	7.43	6000	46.9
	N+1	34.9	130	
Bokobyaadaa (Able)	N	7.53	6200	49.1
	N+1	35.0	280	
Bokororyuru - (Bravo)	N	7.72	230	1.9
	N+1	35.2	52	

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[redacted]

[redacted] (NAVAJO)

Project 2.71 - Ship Shielding Studies - Heinz R. Rinnert

OBJECTIVE AND INSTRUMENTATION

Objectives, instrumentation, and techniques are as stated in the Project Detail in section 2 of the Program 2 Consolidated Book.

GENERAL

The radiation levels on the YAG-40 were too low to supply data adequate for the satisfaction of project objectives.

The radiation levels on the YAG-39 were high enough to yield useful data; however, the rains encountered by the YAG-39 caused some apparent anomalies in the data and may prevent the satisfaction of some project objectives.

The instrumentation performed satisfactorily with one or two exceptions.

RESULTS

Interaction of Gamma Radiation with Steel

Gamma radiation fields inside steel cylinders of various thicknesses were compared as a function of cylinder thickness and time. The results appeared to be anomalous and will require further study to determine their validity, therefore the combined absorption and multiple scattering coefficients will not be presented or used at this time.

Relative Gamma Radiation Fields Contributed by Various Radiation Sources

Figures 2.71-1 and 2.71-2 show the gamma dose and dose rates contributed by contaminants both in the air and on the weather surfaces of YAG-39.

Figures 2.71-3 and 2.71-4 show the gamma dose rates in several

[redacted]

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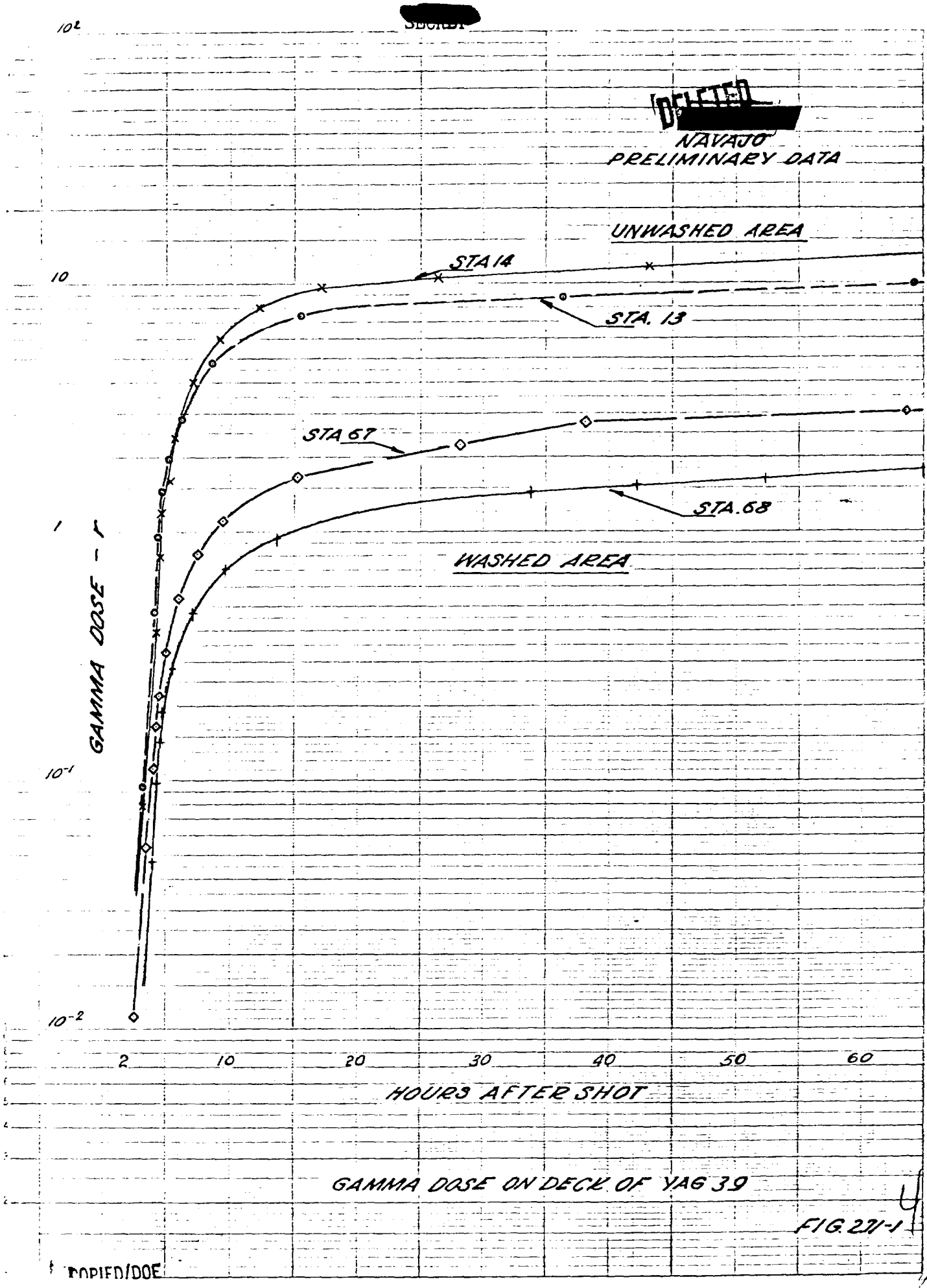
interior locations on YAG 39.

Figures 2.71-5 and 2.71-6 show the ratios of gamma dose rates in several interior locations relative to the gamma dose rates on deck for the YAG-39.

Estimation of radiation contributions by contaminated air and water will require further evaluation and are not presented at this time.

CONCLUSIONS

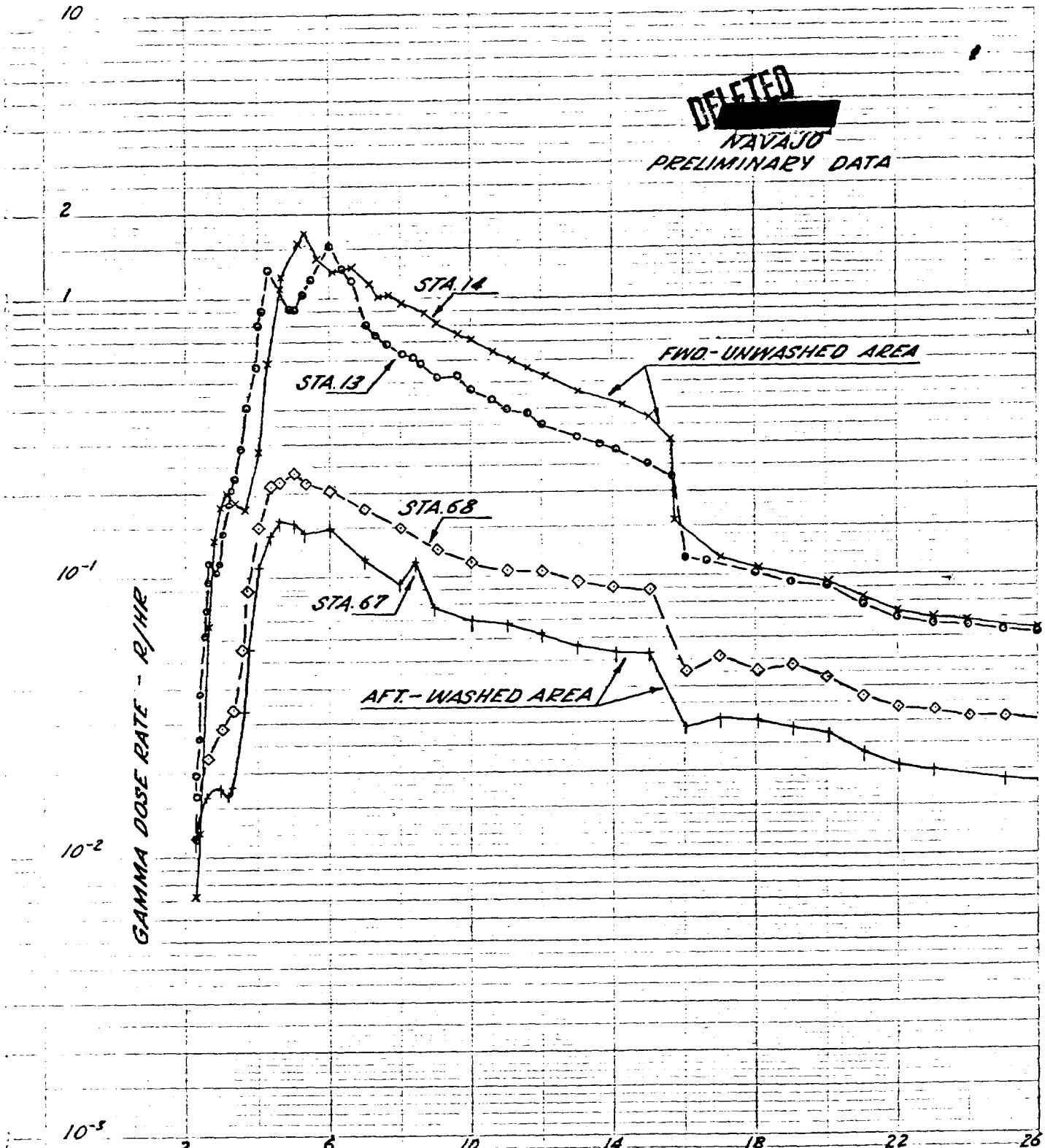
Participation in the [redacted] (Navajo) supplied limited data and may not permit adequate satisfaction of project objectives.



GAMMA DOSE ON DECK OF YAG 39

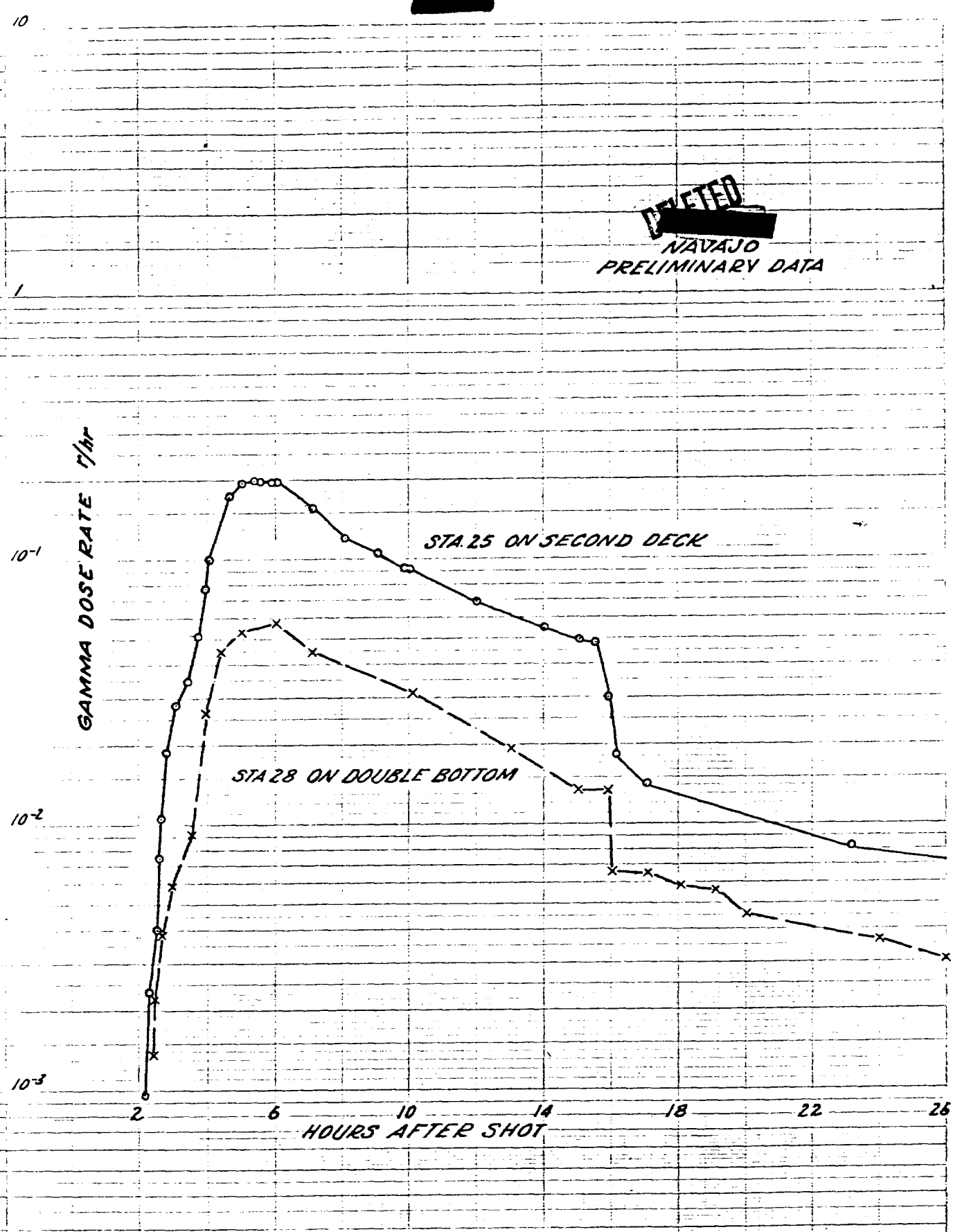
FIG 27-1

COPIED/DOE



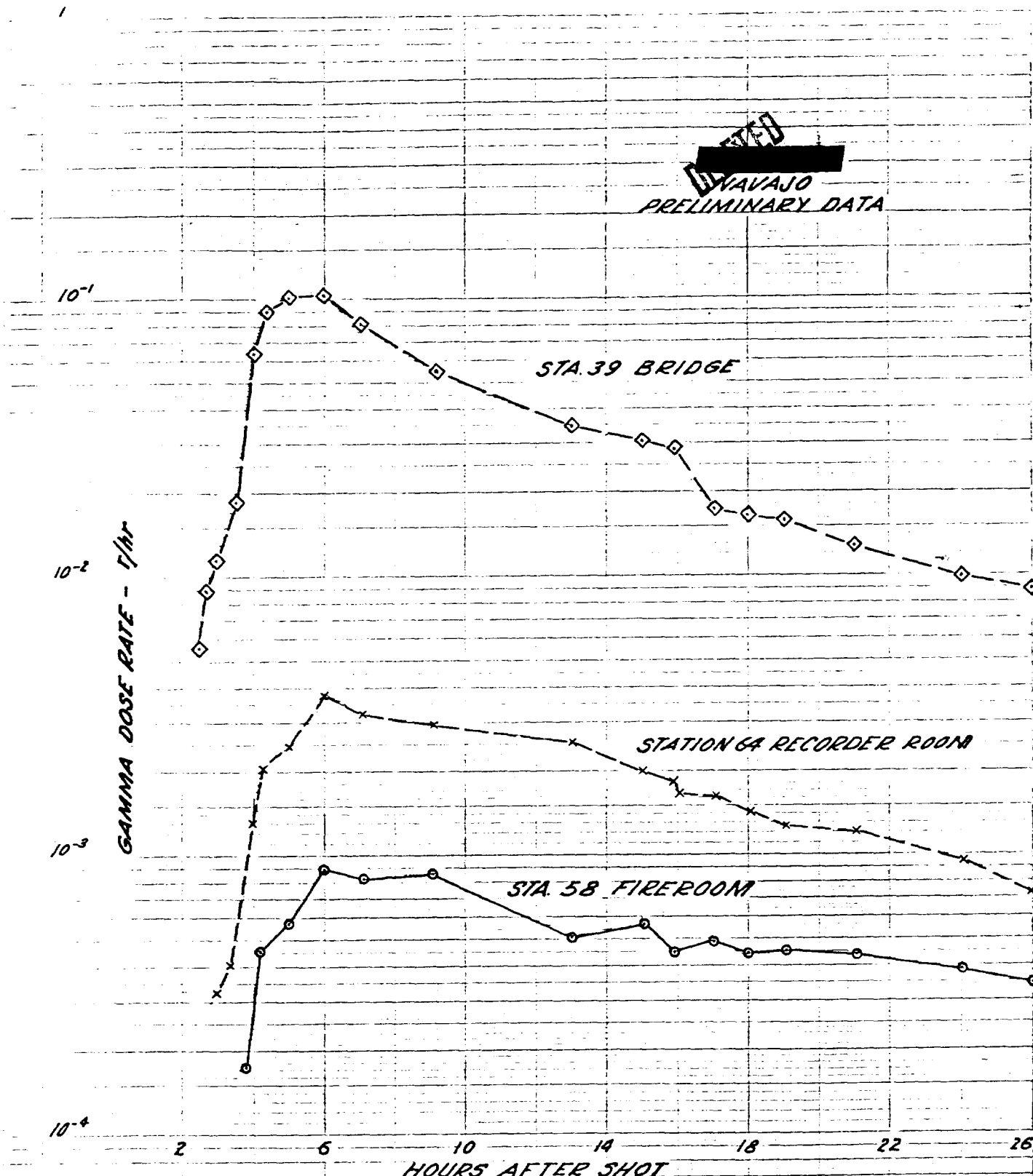
GAMMA DOSE RATE ON DECK OF YAG 39

FIG. 2.71-2



GAMMA DOSE RATE IN NO. 2 HOLD OF YAG 39

FIG. 2.71-3



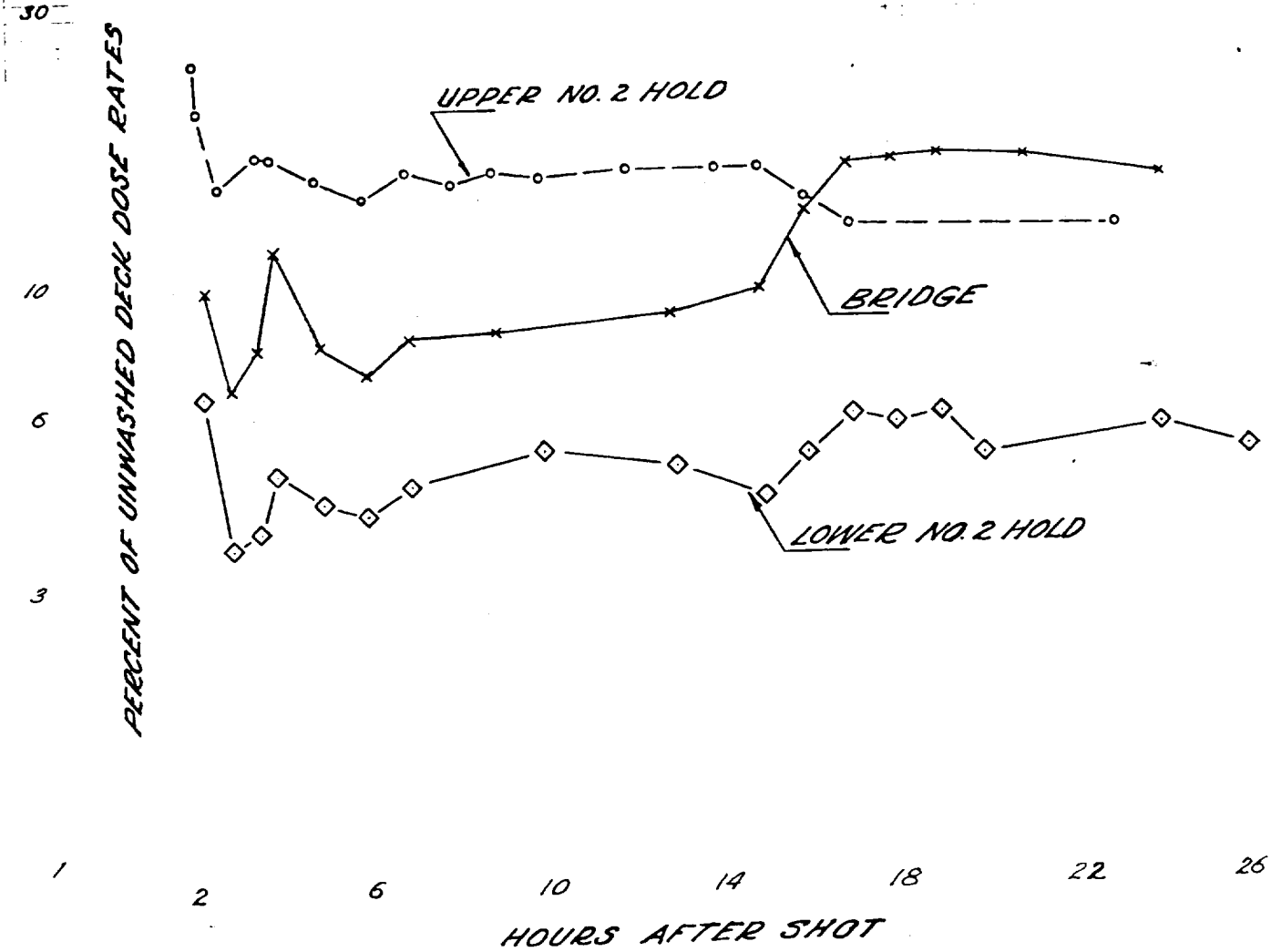
GAMMA DOSE RATE IN OTHER INTERIOR LOCATIONS ON YAG 39

FIG. 2.71-4

[redacted]

DELETED [redacted]

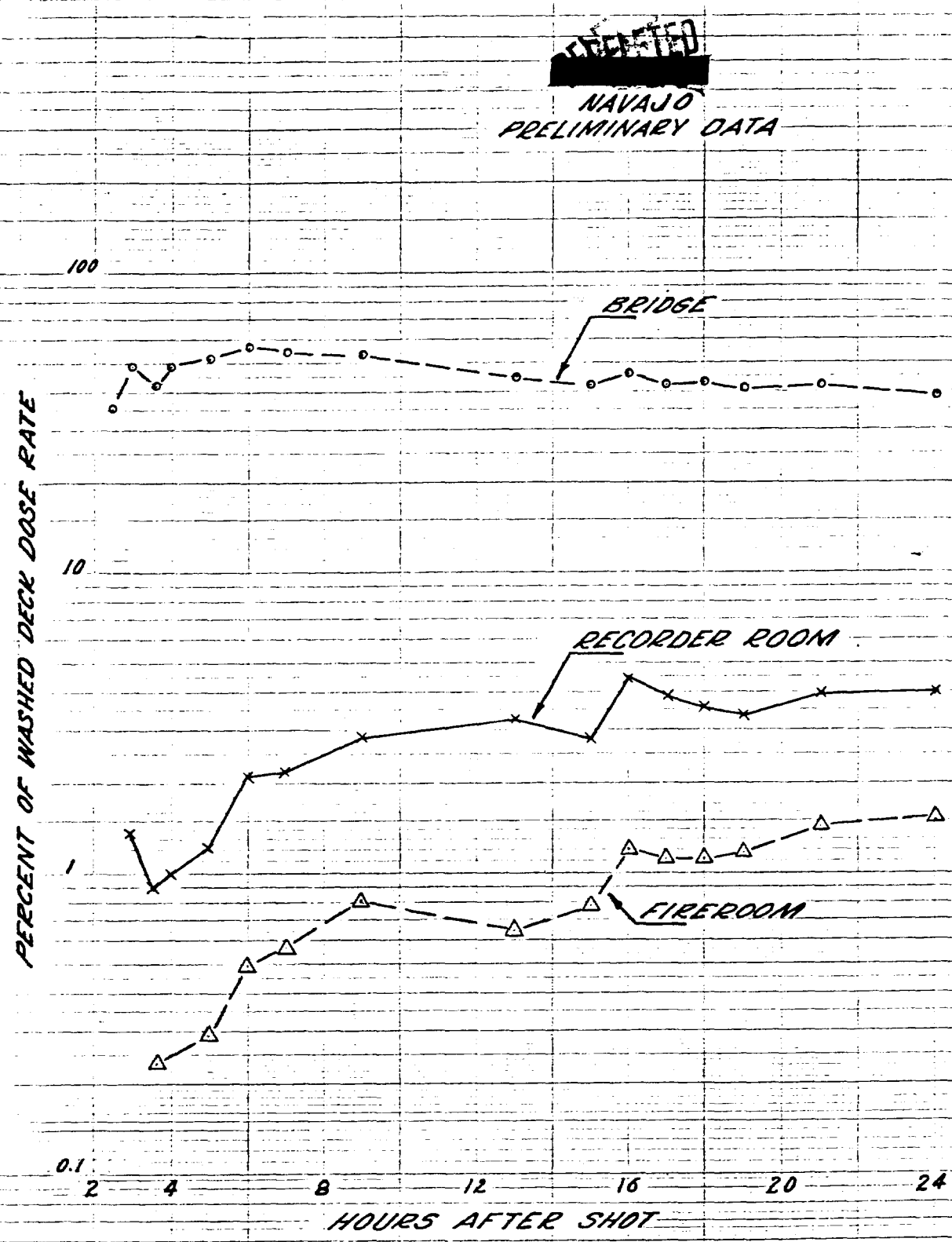
NAVAJO
PRELIMINARY DATA



GAMMA DOSE RATE IN INTERIOR LOCATION
RELATIVE TO UNWASHED DECK ON YAG 39

FIG 2.71-5

[redacted]



GAMMA DOSE RATE IN INTERIOR LOCATIONS
RELATIVE TO WASHED DECK ON YAG 39

FIG 2.71-6

[redacted] (NAVAJO)

Project 2.8 - Shipboard Countermeasures Methods Studies - W. S. Kehrer

OBJECTIVE

To determine the relative effectiveness of various proposed ship and personnel protection and reclamation methods.

DESCRIPTION AND EXPERIMENTAL PROCEDURES

The shipboard countermeasures methods studies were divided into eight problems to be carried out on the YAG-39 and YAG-40 and at the Rad Safe Center on Parry Island. These involved the study of the effectiveness of various shipboard protective methods, decontamination methods, hazard assessment methods, personnel protection and decontamination methods, and basic contaminability - decontaminability studies. Monitoring service was provided by Problem g for Projects 2.7, 2.9, and 2.10.

Experimental problems follow:

a. Removable Radiological Protective Coating - did not participate in this shot.

b. Chemical Paint Stripping - did not participate in this shot.

c. Mechanical Scrubbing Methods - did not participate in this shot.

d. Protection of Miscellaneous Shipboard Materials - no results because low levels of activity gave insufficient contamination.

e. Methods of Reducing Radiation from Contaminated Wood Decks - no results because low levels of activity gave insufficient contamination.

f. Skin Decon & Protection Methods - the hands of the ships crews' aboard the YAG-39 and YAG-40 when they returned to Parry Island, the decontamination crews, and technical personnel who went aboard the ships before and during the decontamination period were monitored when they arrived at the decon tent. "Hot" hands were divided into two groups

to be decontaminated with waterless cleaner or with soap and water. No barrier cream was used.

g. Monitoring and Hazard Assessment Methods - Gamma surveys at 3 feet and 1 inch were made on the YAG-39 before and after decontamination and on the YAG-40 after decontamination. No beta measurements were taken.

h. Basic Contamination-Decontamination Studies - did not participate in this shot.

RESULTS AND CONCLUSIONS

The only results obtained were from (f) and (g) above. Preliminary results from problem (f) on a limited number of cases indicates that the waterless cleaner, and soap and water have about the same overall average effectiveness in removing contaminant from the hands. The data from problem (g) (monitoring the ships) is being processed.

[redacted] (NAVAJO)

Project 2.9 - Standard Recovery Procedure for the Tactical Decontamination of Ships - F. S. Vine

OBJECTIVE

To evaluate recovery procedures for ship decontamination.

PROCEDURE

Because of the two-day availability of the YAGs 39 and 40, and the Task Force personnel assigned to the decontamination work party, ship decontamination procedures were limited to firehosing, handscrubbing and firehosing in the non-washdown areas and the superstructure, and to firehosing alone in the washdown area aft of the superstructure.

The YAG 40 was decontaminated at the Parry Island deep water pier on N / 2. Similar operations were conducted aboard the YAG 39 while at anchor in the stream on N / 3.

Decontamination of the LST 611 was not required because of the low radiation levels and the absence of removable contamination.

RESULTS

Due to the low radiation levels aboard all ships no technical data were obtained.

The average initial levels aboard YAG 40 were 7.8 mr/hr in the non-washdown area forward of the superstructure and 4.1 mr/hr in the washdown area aft. The decontamination procedures reduced these levels to 6.1 mr/hr and 3.7 mr/hr (corrected for decay according to $t^{-1.2}$ from H / 54 to H / 56.5) with resultant decontamination effectivenesses of 18 percent and 5 percent, respectively.

The corresponding initial levels aboard the YAG 39 were 23.2 mr/hr and 4.8 mr/hr. After decontamination these were 10.4 mr/hr and 3.7 mr/hr

[redacted]

[redacted]

(corrected for decay according to $t^{-1.2}$ from H + 75 to H + 80). The indicated decontamination effectiveness was 51 percent and 3 percent, respectively.

Prior to decontamination the indicated peak radiation levels in the non-washdown areas of both the YAG 39 and the YAG 40 were reduced approximately 65 percent by a series of heavy rain squalls and the effects of natural decay.

[redacted]

[redacted] (NAVAJO)

Project 2.10 - Verification of Washdown Effectiveness as a Shipboard Radiological Countermeasure - M. M. Biggers

OBJECTIVES

Operation of YAG's and LST to be stationed in fallout area.

Rad Safe for NRDL Projects.

Washdown effectiveness evaluation.

PROCEDURE AND RESULTS -SHIP OPERATIONS

The Project ships, YAG-39, YAG-40 and LST-611, successfully completed their mission on the [redacted] (Navajo). Complete information regarding all phases of ship and instrumentation operations has been given to Project 2.63 for inclusion in their reports.

YAG-39 Operations

During fallout, the YAG-39 operated within 5 miles of 12°00'N, 165°20'E, approximately 21 miles NW of the shot location.

Fallout arrived at 0755, N + 2 hours, and the washdown started at 0815. The maximum radiation level recorded on the unwashed fore decks was 1.86 R/hr with a second peak of 1.71 R/hr at 1215. The maximum radiation level aft under the washdown was 242 mr/hr at 11, N + 5 hours.

On arrival at Eniwetok at about 1430 on 13 July, the combination of rain and decay had reduced radiation levels to 60 mr/hr on the flight deck, 45 mr/hr in the unwashed No. 2 Hatch area and 20 mr/hr on the main deck aft. One day's decontamination by Project 2.9 further reduced the radiation levels and removed most of the loose contamination so that an operational clearance was given with the condition that gloves and booties be worn on the forward portion of the ship. Unrestricted access was

57
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granted for the aft portion of the ship which had been washed down during fallout. Radiation levels were 6.1 mr/hr forward and 3.7 mr/hr aft.

YAG-40 Operations

The YAG-40 operated during fallout in the vicinity of 12°12'N Lat. and 165°07'E Long., approximately 36 miles at 330° from the Navajo detonation point.

Fallout arrived at 1051 as indicated by a survey meter on deck and air samples. The fallout was light and at 1133 rain reduced the radiation levels to near the previous background. At 1300, the principal fallout began, reaching a peak intensity during the period 1800 to 1830 of 115 mr/hr.

At 0730 on N + 2, the ship entered Eniwetok Lagoon. A cursory decontamination of the ship was accomplished this same day to remove loose contamination from the weather surfaces. Final radiation levels were 10.4 mr/hr forward and 3.7 mr/hr aft.

LST-611 Operations

The LST-611 operated during fallout at approximately 11°35'N and 164°40'E, about 42 miles West of the shot point.

The first indication of fallout occurred at 0900 (1 mr/hr above background on an MX-5 survey meter on deck). At 0950, when the level of activity on the deck as measured by the TIR had reached 20 mr/hr, the ship was closed and the washdown was activated.

Peak activity both on deck and in the sampling platform was reached at 1130. The level in the platform was 50 mr/hr and on deck was 43 mr/hr.

At 1530, the washdown was secured, the platform level being approximately 22 mr/hr and the level on deck about 8.5 mr/hr.

The ship arrived at Eniwetok at 1130 on 12 July with approximately 4 mr/hr body dose rate top side. Very little of the contaminant was "loose", as shoes, hands, etc., stayed well within tolerance.

The levels on board the ship were lower than they might have been due to frequent rain squalls encountered both on D day and D + 1.

WASHDOWN EFFECTIVENESS

YAG-39 and YAG-40 received modest amounts of fallout during Shot NAVAJO and were required to operate their washdown systems. Preliminary examination of records from gamma-time instrument stations indicated that, although the peak activity was less than two R on the YAG-39, its records appeared adequate for making a washdown evaluation. The YAG-40's peak activity, slightly over 100 milliroentgens, was considered too low to allow significant comparison between the washed and unwashed areas.

The washdown was turned on twenty minutes after arrival of initial fallout, when the level of activity had reached approximately 50 mr/hr. It was kept on about two hours after cessation of the primary fallout, for a total period of operation of seven hours. Peak activity occurred at about 5½ hours. The activity under the washdown at this time was 180 mr/hr. The accumulated dose recorded by the washed stations was about 340 mr. This, compared with a rate of 1.35 R/hr and dose of 2.15 R from the unwashed area gives an efficiency of 87% for contaminant removed and an effectiveness of 83% for total dose reduction at time of peak activity.

DISCUSSION - WASHDOWN

The nature of the Navajo fallout material is quite similar to that from Flathead, i.e., small radioactive coral particles (30-40 microns) associated with 100-200 micron salt slurries that are soluable in sea water. The washdown system appears to operate more efficiently and

[redacted]

rapidly against this type of contaminant than the higher mass, insoluable material encountered during the [redacted] (Zuni)

The washdown removal efficiency obtained for the [redacted] (Navajo) is 87 percent at the time of peak activity. For the [redacted] (Flathead) where similar fallout material was encountered and the ship was maneuvered in the same way, an efficiency of 92% was obtained on YAG-39. The distribution of fallout material from port to starboard both forward and aft is noticeably different. Analysis of later survey data and the relative wind recorder may help to rationalize the 6% difference in removal efficiencies noted above. On the other hand, final calibration of the gamma-time stations may indicate this 6% to be due to instrument error.

[redacted]

[redacted] (NAVAJO)

Project 4.1 - Biomedical Effects - Chorioretinal Burns -

Colonel R. S. Fixott

OBJECTIVES

The primary objective of this project is to obtain information on the requirements for protection of the eyes against chorioretinal burns from atomic detonations of various yields; in this case, an [redacted]

Corollary technical objectives at the same yield are to:

Determine whether blink reflexes will prevent chorioretinal burns.

Ascertain which portions of the time-intensity pulse can produce thermal injury to the retina and choroid of the eye.

Determine the time required for blink reflex (BRT) in rabbits and monkeys exposed to the extreme light intensity of the atomic detonation.

Explore the feasibility of ocular protection by means of fixed density optical filters and/or combinations of filters.

Test, under field conditions, protective shutter devices which are in the developmental stage and which are designed to close much more rapidly than the BRT.

INSTRUMENTATION

The instrumentation employed during this event is identical to that used on the [redacted] (ZUNI) with the exception of some changes in shutter timing. Calorimetric instrumentation, identical to that used on the [redacted] (MOHAWK), was also utilized. The main exposure facility was located on Bikini (How) (site 411.02) at 10.6 statue miles from the detonation. Ten additional rabbits without filter or shutter protection

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were exposed at the 60 foot level of a photographic tower about 150 feet from the main exposure site. On Enyu (Nan) (site 411.01), 10 rabbits were also exposed without filter or shutter protection at the 200 foot level of a photographic tower.

RESULTS

No burns were sustained in the 103 rabbits and 4 monkeys exposed to this shot. It was estimated that 7-10 cal/cm^2 would be received at the exposure sites on Bikini (How) and 2-3 cal/cm^2 on Enyu (Nan). Actual measurements, however, showed that less than 1 cal/cm^2 was received at Bikini (How). The actual dose at Enyu (Nan) is not known, but is presumed to be correspondingly low. The extremely low radiation doses are ascribed to rainstorms between the shot and the exposure sites. Eyewitness accounts of personnel on Enyu (Nan) just prior to shot time confirmed the presence of heavy rainfall over Bikini (How) at shot time.

CONCLUSIONS

The results of this study are inconclusive, apparently because of extremely high atmospheric attenuation due to rainstorms at shot time.

DELETED (NAVAJO)

Project 5.1 - In-Flight Participation of a B-47 Aircraft -

Lt Robert C. Laumann

OBJECTIVE

The objective of this project is to measure the blast, gust, and thermal effects of a nuclear detonation on an in-flight B-47 aircraft. With the recorded data, the criteria and method used in the B-47 Weapon Delivery Handbook may be verified or corrected. In addition, the project will provide basic research data for the design criteria of future USAF aircraft.

INSTRUMENTATION

Two hundred seventy three data channels were available on this shot to record bending shear and torsion in the wing and horizontal stabilizer, thermal inputs to the aircraft, thermally induced strain, temperature measurements, and overpressure. Prior to shot participation 97.0% of these channels were operating satisfactorily. There has been no newly added instrumentation since the last participation.

AIRCRAFT POSITION IN SPACE

The B-47 was flying at an absolute altitude of 34,000 feet, a speed of Mach 0.77, and on a heading of 270° at both T_o and shock arrival. The aircraft was oriented tail to the shot; at T_c the horizontal range beyond GZ was 33,000 feet, and at shock arrival it was approximately 86,000 feet.

DELETED

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[redacted]

DELETED

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DELETED (NAVAJO)

Project 5.2 - In-Flight Participation of a B-52 - Lt F. L. Williams

OBJECTIVE

The objective of this test was to determine the delivery capability of the B-52 aircraft.

INSTRUMENTATION

Instrumentation of the B-52 for the DELETED (Navajo) Shot consisted of 300 oscillograph channels which recorded measurements from strain-gage bridges, accelerometers, roll and pitch gyros, radiometers, control position transducers, thermocouples, pressure transducers, and calorimeters. In addition, 14 cameras recorded photorecorder instruments (14 channels), wing and tail deflection, cloud coverage, and fireball rise and growth.

AIRCRAFT POSITION IN SPACE

The following chart shows the airplane's position at Time Zero and Time of Shock Arrival:

	Altitude (Abs. ft)	Offset (ft)	Heading (True-deg)	Slant Distances	Velocity (Fps) TAS	Ground
Condition at Time Zero	38,000	700	283	42,100	770	752
Condition at Shock Arrival	38,000	0	283	DELETED	770	749

DELETED

60

[redacted]

DELETED

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[redacted]

[redacted] (NAVAJO)

Project 5.3 - In-Flight Participation of a B-66B Aircraft- R. W. Bachman

OBJECTIVE

The primary objective of this test was to measure the gust, thermal and high thermal energy field effects of a high yield megaton device on a B-66B aircraft in flight.

INSTRUMENTATION

Instrumentation on the B-66B for the [redacted] (NAVAJO) consisted of the following: 67 strain gages @ 5 stations and 26 thermocouples @ 7 stations on the L.H. wing, 16 strain gages @ 1 station and 6 thermocouples @ 2 stations on the R. H. wing, 25 strain gages @ 4 stations and 12 thermocouples @ 2 stations on the L. H. horizontal stabilizer, 9 strain gages @ 1 station and 2 thermocouples @ 1 station on the R. H. horizontal stabilizer, 3 strain gages @ 1 station and 9 thermocouples @ 3 stations on the L. H. elevator, 2 strain gages @ 1 station and 6 thermocouples @ 1 station on the R. H. elevator, 56 thermocouples @ 11 stations on the fuselage, 17 accelerometers on the fuselage, empenage, and nacelle, 13 calorimeters and 1 radiometer together with 6 cameras in the fuselage belly, 5 calorimeters and 1 radiometer together with 6 cameras in the tail, wing and tail deflection cameras, 32 basic flight instruments on a photo recorder panel, and 8 correlation channels.

AIRCRAFT POSITION IN SPACE

Using the K-5 Radar system, the B-66B was being positioned at an altitude of 21,000 feet, on a heading of 124° and for a horizontal range of 24,500 feet at time zero. During both race track patterns and the wind box, the navigator had difficulty in clearly defining

the target island due to the existing cloud masses. At H-4 minutes on the final inbound run to ground zero, the A/C was approximately 28 seconds late and since the time could not be made up, the crew elected to reposition according to a preflight plan to a new heading. They continued on course, accelerating until the selected time of H-1:10, at which time a turn was executed to the new heading of 241 degrees. On rolling out of the turn, the A/C was traveling approximately 60 knots faster than the desired speed, and as a result, the horizontal range at time was estimated by the navigator to be 71,000 feet. The horizontal range at time of shock arrival was 180,000 feet with the A/C at the same altitude as before and on the new 241 degree heading.

DELETED

63

[redacted]

[redacted] (NAVAJO)

Project 5.5 - In-Flight Participation of F-84F Aircraft -

1st Lt R. F. Mitchell

Lt J. A. Sabatella

OBJECTIVE

Waiter (Capabilities F- 84F)

This participation was an attempt to determine the capability of the F-84F aircraft by subjecting it to both thermal and symmetric blast loads.

Barley (Sideloads F-84F)

The object of this participation was to study the dynamic response of fighter structures to anti-symmetric blast loads.

INSTRUMENTATION

Waiter

100 data channels were available to record moment, shear, and torsion loads; accelerations; overpressure; temperature; thermal strain; and aircraft attitude. Three of these channels were unsuccessfully recorded, and in addition, a flap camera failed to operate.

Barley

Out of 100 data channels available to record essentially the same information as above, there were no channel failures.

AIRCRAFT POSITION IN SPACE

Waiter

At time zero, the aircraft was flying at an altitude of 17,000

[redacted]

64

feet on a heading of 122°. The horizontal range was 2[redacted]00 feet with zero offset. The shock arrival position at [redacted] was 17,000 feet altitude, 50,800 feet horizontal range, and zero offset. The true air speed was 800 fps.

Barley

At time zero, the aircraft was flying at an altitude of 32,000 feet on a heading of 032°. The horizontal range and offset were -43,000 feet and 71,900 feet respectively. At shock arrival (at [redacted] the aircraft was at 32,000 feet altitude; zero horizontal range; and 71,900 feet offset to the right. The true air speed was 775 fps.

RESULTS

DELETED

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[redacted] (NAVAJO)

Project 5.6 - In-Flight Participation of an F-101A Aircraft -

Capt M. H. Lewin

OBJECTIVE

The objective of Project 5.6 is to determine the responses of an in-flight F-101A aircraft to the thermal, blast and gust effects of a nuclear detonation. A correlation of the responses, combined with known characteristics of any weapon, will be used to define the maximum safe delivery capability of the aircraft.

INSTRUMENTATION

The aircraft was instrumented with radiometers, calorimeters and pressure transducers to measure the thermal and blast inputs and with strain gages, thermocouples and various other instruments to measure the aircraft response to the inputs. For the [redacted] (Navajo) Shot, the aircraft was again positioned to receive a high caloric input, 126 cal/sq cm, at a low angle of incidence. At this position the aircraft would theoretically receive a ΔT of 310° F on the .020 inch skin covered honeycomb surface based on positioning yield and on time position. At this position the aircraft would receive 60% design limit load on the stabilator.

AIRCRAFT POSITION IN SPACE

The aircraft was to fly at 15,000 feet absolute altitude on an inbound heading of 122° at a ground speed of 800 fps. It was planned that the aircraft would be 25,400 feet beyond ground zero at time zero with shock arriving 32.5 seconds later at a horizontal range of 51,500 feet. Actual shot position was 1,000 feet short and 1500 feet to the

[redacted]

[redacted]

left of planned position at time zero, with shock arriving [redacted] later at a horizontal range of 54,900 feet.

RESULTS

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[redacted]

67

[redacted] (NAVAJO)

Project 5.7 - Thermal Flux and Albedo Measurements from Aircraft -

Capt R. L. Dresser

OBJECTIVE

The objective of Project 5.7 participation on this shot was to obtain thermal flux and albedo information of a nuclear detonation with airborne calorimeters, radiometers, and sixteen millimeter motion picture cameras.

INSTRUMENTATION

Instrumentation within the purview of Project 5.7 which was installed in the B-47 included nineteen NRDL calorimeters and two NRDL radiometers for measuring the direct and surface reflected thermal radiation. Six calorimeters were utilized to measure thermal radiation which was back-scattered toward the cockpit. Seven GSAP N-9 cameras were utilized to obtain photographic coverage of the fireball, the earth's surface, and of clouds beneath the aircraft, and also of any reflecting surface such as a cloud which could contribute to the back-scattered radiation.

Project 5.7 instrumentation on the B-52 included the twenty-one basic instruments for thermal radiation measurements, but only an additional two instruments were utilized for back-scatter measurements. Eight GSAP cameras were installed for photographic coverage.

Project 5.7 instrumentation on the B-57 consisted of the basic twenty one instruments and six cameras.

Project 5.7 instrumentation on the B-66 consisted of the basic

twenty one instruments and twelve cameras.

Neither tactical bomber (B-66, B-57) was instrumented for measuring back-scattered thermal radiation. The twenty one basic thermal instruments used various fields of view and were suitably filtered to obtain qualitative spectral distribution information. The cameras were equipped with red and blue filters to obtain information at each end of the visible region of the spectrum. Several cameras were equipped with spectroscopic attachments to obtain continuous spectra in the visible region. Two of these spectrographs were operated at the Chieerete (William) photo tower.

AIRCRAFT POSITION IN SPACE

Information of the position in space of each aircraft is contained in the postshot reports of the following projects:

Project 5.1 - B-47

Project 5.2 - B-52

Project 5.3 - B-66

Project 5.4 - B-57

RESULTS

DELETED

[redacted]

DELETED

[redacted] (NAVAJO)

Project 5.8 - In-Flight Participation of the A3D-1 Aircraft -

LCDR P. F. Harward

OBJECTIVE

The objective of this test was to investigate the A3D-1 aircraft capability for the delivery of high yield nuclear weapons by the measurement and correlation of the In-flight effects of a nuclear detonation.

INSTRUMENTATION

Instrumentation of the A3D-1 aircraft consisted of 96 oscillograph recording channels, one photo recorder, four GSAP cameras, and three dosimeters. The data recorded included temperature rise, thermal input, rate of thermal input, overpressure, gust loading, aircraft response, engine response, and gamma radiation.

AIRCRAFT POSITION IN SPACE

The A3D-1 aircraft was flying at an absolute altitude of 36,100 feet, heading 124°T in a tail-on position at H / 0. Slant range to ground zero at H / 0 was 45,200 feet, (aircraft TAS 722 ft/sec) aircraft position at time of shock arrival [redacted] was 88,000 feet slant range on a heading of 124°T at 36,000 feet absolute altitude.

RESULTS

DELETED

[redacted] (NAVAJO)

Project 6.1 - Accurate Location of Electromagnetic Pulse Source -

E. A. Lewis

OBJECTIVE

To utilize the electromagnetic signal originating from nuclear weapon detonations to determine ground zero of detonation. Secondarily to obtain the yield data that is available in the bomb pulse.

PROCEDURE

Location of ground zero is made by use of an inverse Loran principle. The exact time the bomb pulse is received at various stations is recorded. The exact time difference in receipt of the electromagnetic pulse between two stations will be used to determine a hyperbolic curve which runs through ground zero. The point of intersection of two or more curves determines ground zero.

There are two systems. One of the systems is known as the long base line system and the other, the short base line system. Each system has two sets of stations. The long base line has one set of stations located in the Hawaiian Islands (Midway, Palmyra and Maui) with synchronizing antenna station at Haiku, Maui, and the other set of stations in the States (Harlingen, Texas; Blytheville, Arkansas; Kinross, Michigan, and Rome, New York) with synchronizing antenna station at Cape Fear, North Carolina. The short base lines have one set of stations located in the Hawaiian area (Kona, Hawaii; Papa, Hawaii; and Red Hill, Maui) the other set in California (Pittsburg, Woodland, and Maryville).

RESULTS

All stations in both the long and short base lines successfully

[redacted]

received and recorded the wave form of the electromagnetic pulse emanating from the bomb detonation. Line of position and fix errors will be reported later.

Project 6.3 - Effects of Atomic Explosions on the Ionosphere - M. Hawn

Objective

The objective of Project 6.3 is to obtain data on the effects of high yield nuclear explosions on the Ionosphere. Principally, to investigate the area of absorption, probably due to the high altitude radioactive particles, and to study the effect of orientation relative to the earth's magnetic field on F2 layer effects.

Instrumentation

The system comprises:

Two Ionosphere recorders, type C-2, operating on pulse transmission, installed in 6 ton trailer vans, one located at Rongerik Atoll and one locate at Kusaie in the Caroline Islands.

One Ionosphere recorder, type C-3, operating on pulse transmission, installed in a C-97 plane based at Eniwetok Island.

Detailed Description:

Ionosphere recorder site (Rongerik Atoll)

site (Kusaie)

An/CPQ-7, type C-2 Ionosphere recorder with a power output of 10 KW peak pulse alternately transmitting and receiving automatically over the range of frequencies from 1 to 25 megacycles. This equipment measures and records at vertical incidence the virtual height and critical frequencies of ionized regions of the upper atmosphere.

A 600 ohm multiple wire antenna designed and erected, so that the direction of maximum intensity of radiation will be at the desired vertical angle over all of the operating frequency range from 1 to 23 megacycles. The transmitting and receiving antennas and the ground plane were in mutual perpendicular planes with the plane of the transmitting antenna oriented 53 degrees to the East of Magnetic North.

Ionosphere recorder site (C-97 airplane)

Same as for Rongerik and Kusaie, except that a C-3 Ionosphere recorde: was used. This recorder is the same as the C-2, except for a few modifica- tions and improvements.

The transmitting antenna in the C-97 was a single wire delta fastened to the lateral extremities of the tail assembly.

Method of Operation

Kusaie: Routine until H - 15 minutes; thence once per minute until H ∕ 17 minutes; thence twice per minute, alternating the receiving and transmitting antennas at the end of each 15 second sweep, until approximat H ∕ 44 minutes; thence once per minute until H ∕ 8 hours; thence routine.

Rongerik: Routine until H - 15 minutes; thence once per minute until H ∕ 8 hours; thence routine.

C-97 Airborne Station: Routine operation until H - 15 minutes using 30 second sweep time; thence continuous until approximately H ∕ 5 hours.

Results

All stations operated successfully for this shot.

DELETED

[redacted] (NAVAJO)

Project 6.4 - Determination of Characteristics of Airborne Flush Mounted Antennas and Photo Tubes for Yield Determination at Extended Ground-to-Air Ranges - A. J. Waters

OBJECTIVES

To determine the effectiveness of flush mounted airborne antennas and phototubes at various ground-to-air ranges in detecting characteristic low frequency electromagnetic radiation and visible radiation, respectively.

To determine the temporal and amplitude characteristics of the low frequency electromagnetic radiation at various ground-to-air ranges.

To determine the temporal and intensity characteristics of visible radiation at various ground-to-air ranges.

To determine the effects of ambient conditions upon the satisfactory measurement of the parameters specified in items 1 and 2 above.

INSTRUMENTATION

2 fiducial antennas	2 scope cameras
1 whip antenna	1 sequence camera
1 synchronizer	1 recorder
2 photoheads	

2 DuMont Scopes (1 a dual beam, 1 a single beam)

TECHNIQUE

Signal is received by antenna fed through an amplifier and then to the scope. The signal is then photographed. Photohead output is let directly to the recorder. The sequence camera photographs the blast directly for use in correlation of previous data. Distance was approximately 62 miles.

RESULTS

Signal was received and recorded on both antennas. No photohead data was obtained because there was a restrictive filter (1%) placed over the photohead and there also was a rain storm between the burst and the instrument.

[redacted] (NAVAJO)

Project 6.5 - Analysis of Electromagnetic Pulse Produced by Nuclear Explosions - Charles J. Ong

OBJECTIVE

The objective of Project 6.5 is to obtain waveforms of the electromagnetic radiation for all the detonations during Operation REDWING. This data is to be used in connection with a continuing study relating the waveform parameters to the height and yield of the detonation.

INSTRUMENTATION

Two identical stations are used to record data, one at Eniwetok and one at Kwajalein.

The instrumentation consists of a wide-band receiver with separate outputs connected to each of the three oscilloscopes. Mounted on each oscilloscope is a Polaroid Land Camera for recording the transient display.

The wide-band receiver consists of one primary and four secondary cathode follower amplifiers. An antenna, frequency insensitive in the range of interest is fed directly into the primary cathode follower. The primary cathode follower is then connected to four individual cathode followers by a 50-ohm coaxial cable. Only three secondary cathode followers are utilized, the fourth serving as a spare.

The number one and two cathode followers feed oscilloscopes with sweep speeds of approximately 30 microseconds per centimeter and 10 microseconds/centimeter respectively. The number three cathode follower is connected to the third oscilloscope through a 2 microsecond delay line. The third oscilloscope has a sweep speed of 1.0 microseconds/centimeter. All oscilloscopes were triggered simultaneously by the DC trigger device located in the primary cathode follower and connected directly to the

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receiving antenna. The 2 microsecond delay line was added to permit the leading edge of the waveform to be recorded.

In order to establish a definite time relationship between the reception of the signal and the triggering of a given device such as a counter or transmitter, a time marker pip, generated by the delay trigger from one of the oscilloscopes, is fed through the 2 microsecond delay line and superimposed on the initial portion of the received waveform.

PROCEDURE

All oscilloscopes are calibrated against a known frequency standard for sweep linearity.

The cathode follower triggering system is set to trigger approximately 6db. above the noise level. The vertical deflector of the oscilloscopes are set to receive the predicted field strength.

RESULTS

Station A - Parry Island

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Station B - Kwajalein

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[redacted] (NAVAJO)

Project 9.1 - Technical Photography - Lt Col Jack G. James

Three 9.1 RB-50 aircraft participated on this event. This was the first shot of the series where all three photo planes had an unrestricted view of the detonation and resulting cloud from H Hour to Plus One Hour. Conditions for cloud photography were considered excellent by all three photo navigators.

Carter 1, positioned at 110 Nautical Miles East of Ground Zero entered his photo orbit at 20,000 feet and had three successful 15 minute runs without change of altitude.

Carter 2, positioned at 110 Nautical Miles South of Ground Zero had an identical successful mission as Carter 1.

Carter 3, positioned 130 Nautical Miles West of Ground Zero encountered light cirrus at 20,000 feet at approximately Minus 30 Minutes. The aircraft climbed out to 30,000 feet and were properly repositioned at Zero Time. Two good 15 minute photo runs were made, and a probable third accomplished.

No camera malfunctions were reported on any of the three aircraft.

It is anticipated that the cloud data resolved from this mission will qualitatively and quantitatively exceed any previous missions on either CASTLE or REDWING Operations.

At H plus 2 1/2 hours the Program Director contacted Carter 1 through AOC and directed the aircraft to return to Bikini Area and make two level photo mapping runs over Enyu (Nan) Island to photograph wave penetration area and any subsequent damage to camp area

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and runway. This mission was accomplished at H plus three hours and fifteen minutes. On return to Eniwetok, contamination on the aircraft did not exceed 150 mr.

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PART III

TASK UNIT 1

LASL PROGRAMS

Keith Boyer
Advisory Group

Program 10 - Thermal Radiation and Hydrodynamics	H. Hoerlin
Program 11 - Radiochemistry	G. Cowan
Program 13 - Fission Reaction Measurements	J. S. Malik
Program 15 - Photo-Physics	G. L. Felt
Program 16 - Physics & Electronics & Reaction History	B. E. Watt
Program 18 - Thermal Radiation	H. Hoerlin

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[redacted] (NAVAJO)

Project 10.1 - Fireball Hydrodynamics - J. F. Mullaney

L. N. Blumberg & J. F. Mullaney

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TABLE 10.2-1

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[redacted] (NAVAJO)

Project 10.2 - Time of Arrival - J. F. Mullaney

L. N. Blumberg

Atmospheric conditions of interest, provided by U.S.S. CURTISS at shot time, are:

Pressure:	1010.5 mb
Temperature:	79.6°F
Wind:	11 Knots from 089°
Dew Point:	75.3°F

From these data, a sound speed of 1144.4 fps was calculated.

Position of the ship, relative to Station 70 (ENYU), as determined by radar, was:

Range:	78,300 ft
Bearing:	290°T

The results of the time-of-arrival calculation are presented in Table 10.2-1.

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[redacted] (NAVAJO)

Project 11.1 - Radiochemical Analysis - G. Cowan

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[redacted] (NAVAJO)

Project 11.2 - Sampling - H. Plank

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TABLE 11.2-1

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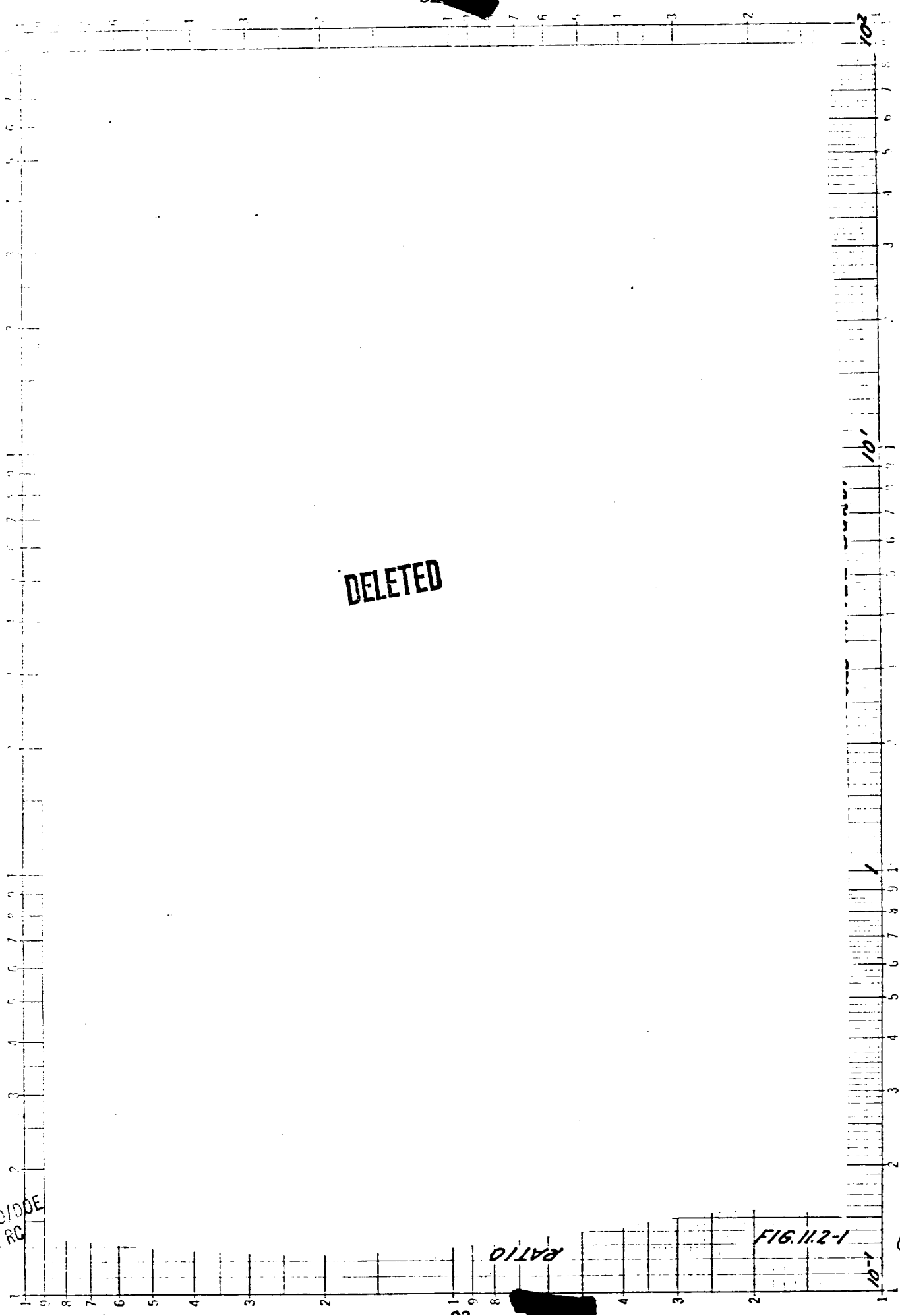

FIG. 11.2-1

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[redacted] (NAVAJO)

Project 13.2 - Measurement of Alpha and Time Interval - J. Malik

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[redacted] (NAVAJO)

Project 13.3 Measurement of Transit Time - D. Henry

J. Malik

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[redacted] (NAVAJO)

Project 15.1 - EG&G Photography (Cloud, Fireball and Bhangmeter) H. Grier D. Berkowitz & D. Barnes

CLOUD DIMENSIONS

Approximate measurements on 70 mm Cloud Camera film indicate the following cloud dimensions at stabilization, roughly 6.5 minutes after zero time.

Height above cloud horizon	73,000 feet
Top of clouds	30,000 feet
Total height of cloud	103,000 feet
Diameter	140,000 feet

Measurements were made on film #36865, exposed in Cloud Camera #4 in plane #7120.

FIREBALL

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BHANGMETERS

Two Bhangmeters at the control point failed to trigger, while the

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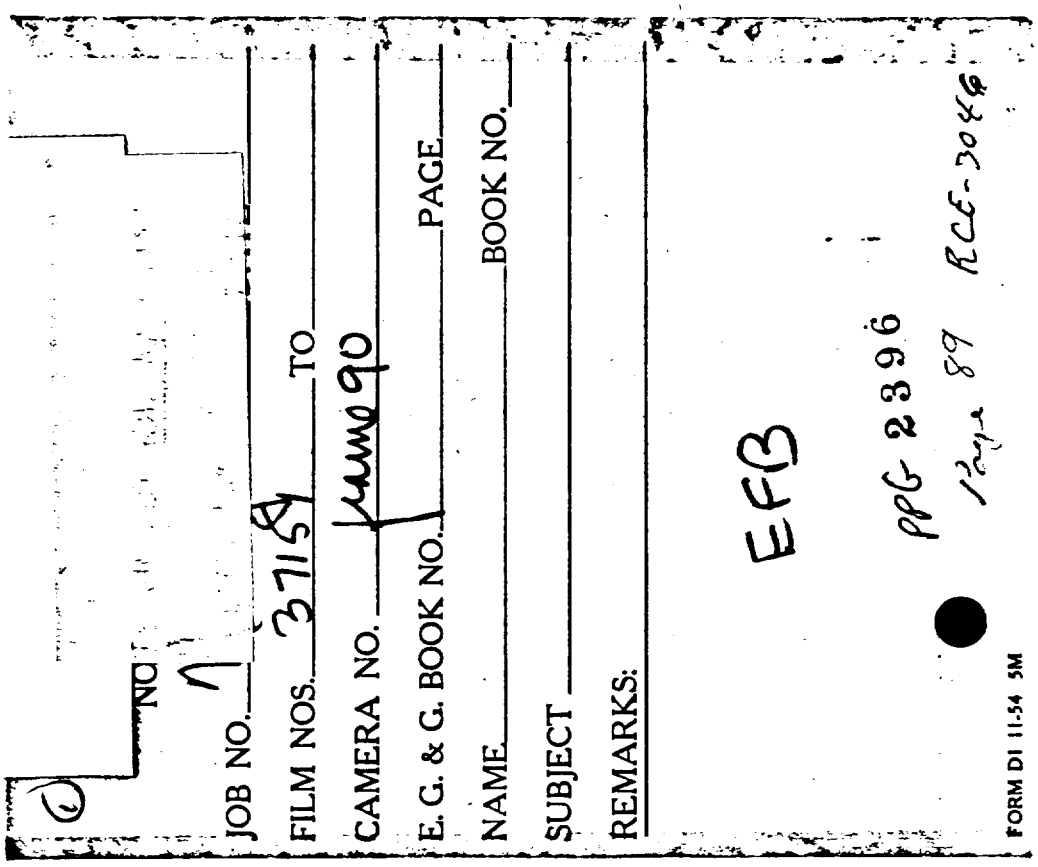
To reproduce this page use JDO Log # RCE-3046, which is a Navajo fireball negative, together with a photo mat layout showing classification top and bottom, Figure # and page #. From this material Graphic Arts can make a composite neg. and produce glassy prints.



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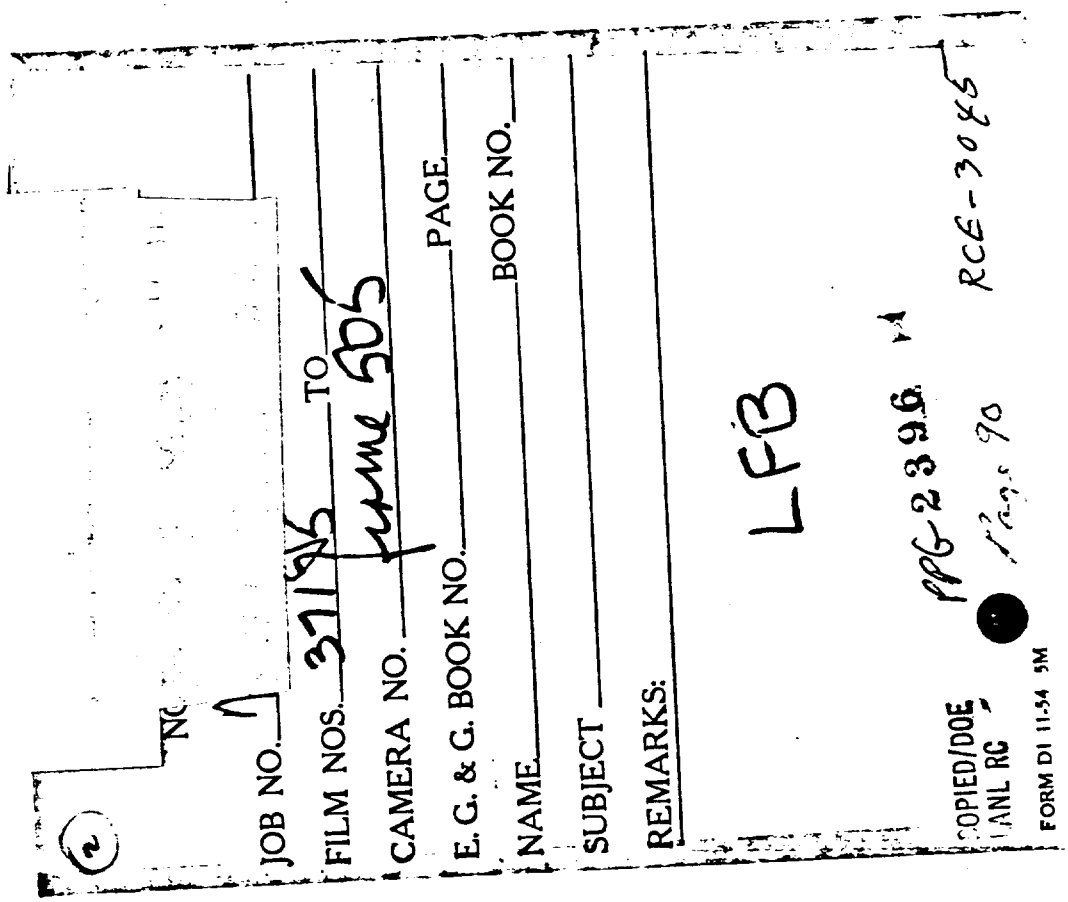
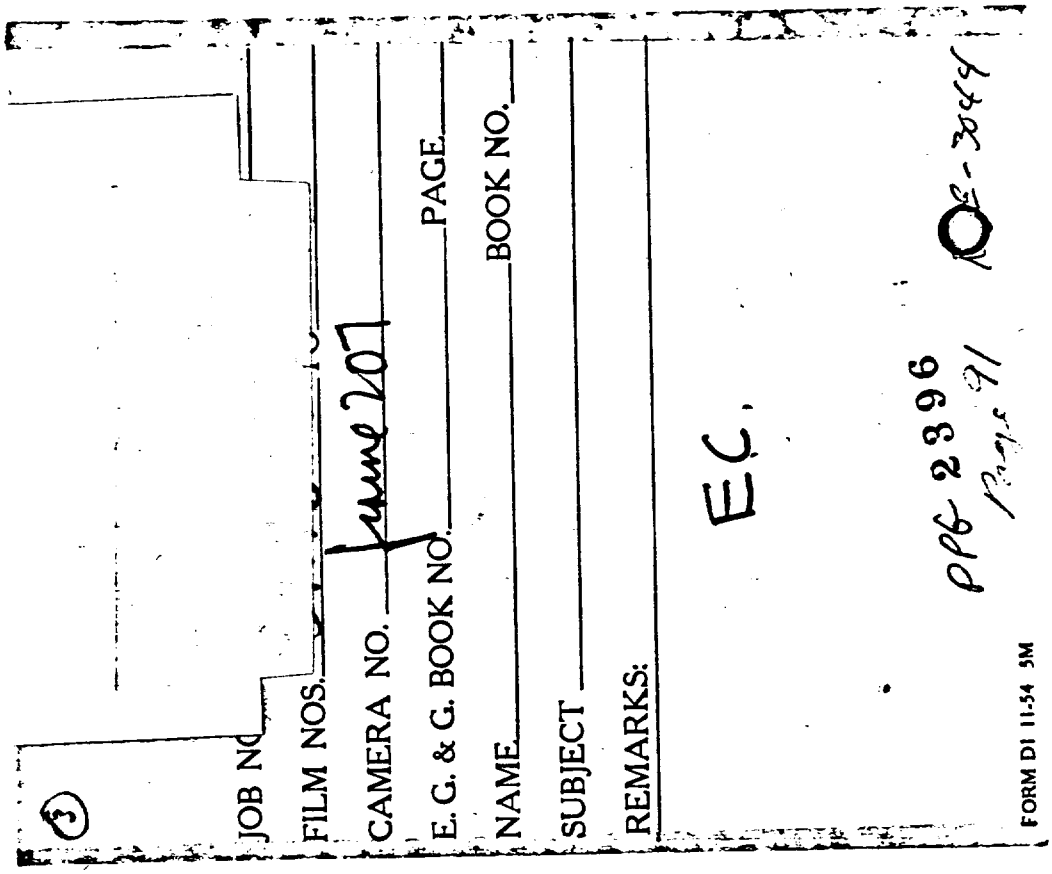
To reproduce this page see instruction for page 89, using JDO Log # RCE-3045, Navajo fireball negative.

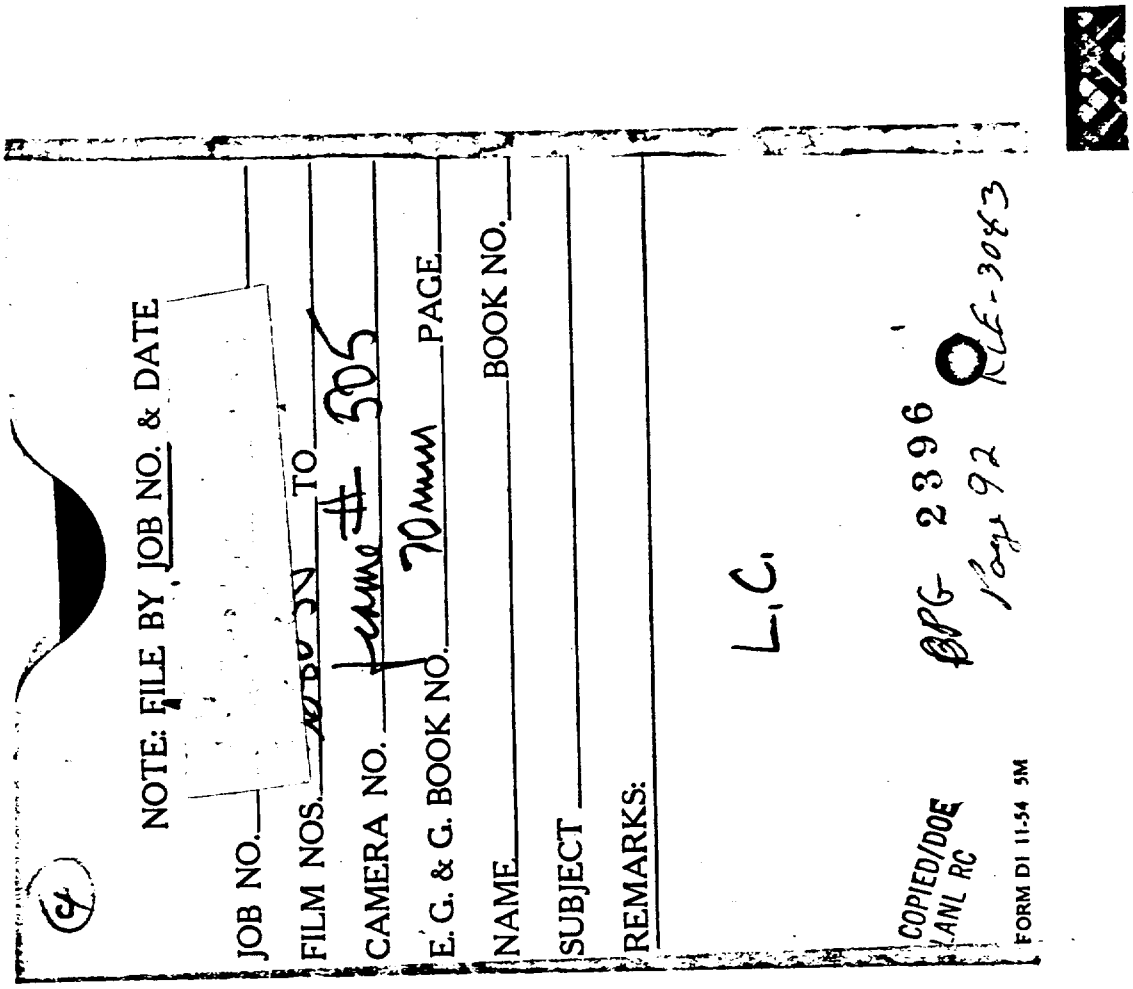


98

To reproduce this page see instruction for page 89, using JDO Log # RCE-3044, Navajo cloud negative.



To reproduce this page see instruction for page 89, using JDO Log # RCE-3043, Navajo cloud negative.



[redacted] (NAVAJO)

Project 15.2 - High Speed Photograph - G. L. Felt

Time Interval, Chord Experiment, Color Studies - L. Allen

The [redacted] (Navajo) was observed with high speed cameras from Station 1528 on Aomoen. The details of the instrumentation were somewhat different than described in the J-15 Pre-operational Report and are given below in the discussion of the records obtained.

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[redacted] (NAVAJO)

Project 16.3 - Electromagnetic Measurements - R. Partridge

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[redacted] (NAVAJO)

Project 18.3 - Spectroscopy - H. Stewart

F. Harrington H. Stewart

OBJECTIVE

The N.R.L. phase of the Redwing chord experiments was planned as a continuation of the spectrographic studies of the absorbing agents formed around a nuclear detonation by excitations, disassociations and recombinations of the air molecules exposed to the high energy particles generated by the explosion. A particular purpose of the experiments was to carry out such investigations with better time and spectral resolution than had been achieved in the past.

In addition to the chord work it was planned to study the spectrum of the bomb light at minimum time with good wavelength resolution and to investigate the spectrum of Teller light with improved time and wavelength resolution.

INTRODUCTION

A chord experiment is one in which the spectral characteristics of a light source as a function of time are observed under conditions such that the gamma rays and neutrons from an exploding weapon cross the line of sight from the observing station to the light source.

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Absorption Observed along the Chord

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ACKNOWLEDGEMENTS

The work reported here is a continuation of the chord investigations started at Tumbler-Snapper. The planning and execution of the Redwing experiments described here has involved H. Hoerlin, Bill Deal, and John McQueen of LASL; F. Harrington, H. Stewart, O. Westfall, J. Meeks, W. Fussell, R. Scott, H. Judy, D. O'Conner and J. Yandle of NRL and G. Milne, J. Eyre, and T. Putman of the University of Rochester.

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[redacted] (NAVAJO)

Project 18.4 - Chord Experiment and Time-Interval - H. Hoerlin

Westervelt, Bennet, Day, Hoerlin

CHORD EXPERIMENT

Objectives:

All optical observations of an expanding fireball at early times are affected by the characteristics of the strongly disturbed air ahead of the radiating front. The brightness temperatures observed during this phase of expansion are in the range of 2000° to 10000° K which is several hundred times lower than the true temperatures of the expanding radiation or shockfronts. This obscuration is partially due to effects of the gamma-rays and neutrons on a large volume of the surrounding air and more locally due to the disturbance of the air immediately ahead of the radiating surface by soft x-rays and ultraviolet radiation.

Past studies, mainly conducted by the Optics Division of the NRL (Stewart) under LASL sponsorship, have resulted in qualitative identification and semi-quantitative time histories of the absorbing reaction products of the disturbed air. More specifically the presence of these main specimens has been established in spectroscopic work: O_3, absorbing in the ultraviolet; excited OH and O_2, also in the ultraviolet; HNO_2 and NO_2, in the ultraviolet and blue; N_2^+ in the blue. Whereas these molecules have well known absorption structures the analysis of past data indicates that their presence alone does not fully account for the strength of the observed fireball obscuration. It is reasonable to assume that additional strong absorption must be caused by transitions from bound into free states and that negative ions like O_2^- and O^- contrib-

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ute also to the opacity of the air. Identification of continuous absorption and of the absorbing structure of negative ions (so far only postulated by theory) is made difficult by the experimental limitations and particularly by the fact that one looks at the fireball through a non-equilibrium, continuously changing gamma-ray, neutron and x-ray field. The gases in this field have in addition to their absorbing characteristics also emissive properties, the emission originating from excited states and from recombination processes. The latter ones are probably quite strong in the space close to the bomb where, for a short time, ion densities of the order of 10^{15} to 10^{19} ions, per cc occur (normal air has appr. 5×10^{19} molecules per cc). Furthermore the actual temperature profile at the edge of the fireball is probably not very sharp nor well defined.

One looks therefore into a rather uneasy atmosphere and the existence of such non-equilibrium conditions and inhomogeneities present difficult problems in optical studies. In spite of this it seemed, however, well worth the effort to enhance our knowledge of the physics of the expanding fireball and to study in particular the characteristics of the plasma located at the edge of the fireball.

In order to simplify the problem it is desirable to separate the effects of gamma-rays and neutrons from those of black body type radiation including soft x-rays. The first steps in this direction were taken by the optics teams during operations Tumbler - Snapper, Upshot-Knothole and to a minor extent during Castle in so called chord experiments. In order to become independent of the bomb as a light source, auxiliary light sources of known characteristics were set up and fired in the vicinity of the bomb. Observation of such sources through the

[redacted]

gamma and neutron field of the bomb was expected to permit determination of the effect of the gamma-ray and neutron bombardment on the optical opacity of the air. The preceeding experiments provided a series of good qualitative data with evidence of formation of ultraviolet absorbing substances, their absorption coefficients gradually decreasing towards the longer wavelengths and becoming rather weak in the red part of the spectrum

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ACKNOWLEDGMENT

Besides the staff members shown on the title pages the following persons participated in one or the other phase of the experiment: Ralph Speece, John Gallegos, Jim Hyde, and William Clark of J-10; Ralph Dorsey of J-12, David Steinhaus of CMR-1; Frank Berry of Graphic Arts and Edward Shaw of J-7. The Argon Flashlights were competently handled during numerous runs on the Hill and at Bikini and on the actual shots by GMX-teams with the following participants at one time or another: William Deal, John McQueen, Charles Hoskins, Andrew Koonce, Robert Reithel, James Johnson, Douglas Evans and others. Sandia Corporation's Don Shuster and Ed Jenkins assisted also by providing timing and signal transmitting equipment. Carl Lyon and Paul Hegler of J-6 did their best to provide field engineering support. Al Peaslee and Dave Leberman assisted in gamma and neutron calculation, and last but not least Keith Boyers active and vigorous interest helped greatly to overcome critical hurdles.

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PART IV

TASK UNIT II

UCRL PROGRAMS

W. D. Gibbins
Dep for UCRL

PROGRAM 21 - RADIOCHEMICAL ANALYSIS R. Goeckerman

[redacted] (NAVAJO)

Project 21.3 - Gas Analysis - F. Momyer

OBJECTIVE

Project 21.3 was engaged in finding total tritium in the cloud.

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RESULTS

Results are shown in the attached Table 21.3-1.

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Table 21.3-1

TIME - 05:56 11 July 1956

(All other samples too low to count)

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