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THE ONO BOOK

OPERATION CASTLE

DELETED VERSION ONLY

APPENDIX I, ANNEX C
OPERATION PLAN 1-53
Task Group 7.1
Joint Task Force SEVEN

Compiled by

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of Group J-3

and

Commander Waldron M. McLellon, CEC, USN
DOD Liason Officer to Task Group 7.1

Headquarters
Task Group 7.1
Los Alamos Scientific Laboratory
1 October 1953

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FOREWORD

This publication is intended to fill the need for an explanation of the various experimental aims of Operations CASTLE for those people, of various professions, who require an understanding of the scope and purposes of the operation. Most of the descriptions of experimental methods to be used have been treated in a general manner, some detail being added where it was felt necessary for better understanding. The figures on personnel and special support items are intended again only to give the reader some idea of the size of the operation, being neither firm nor complete enough to be used for accounting purposes.

The LASL or UCRL "shots" mentioned frequently in the discussions of the experiments refer to the firing of devices developed by the Los Alamos Scientific Laboratory or the University of California Radiation Laboratory respectively. A list of these devices is given below.

	Laboratory		Code Name	Shot Locations
1.	LASL	DELETED	Bravo	Bikini Atoll
2.	LASL		Union	Bikini Atoll
3.	LASL		Nectar	Bikini Atoll
4.	LASL		Romeo	Bikini Atoll
5.	UCRL		Koon	Bikini Atoll
6.	UCRL		Echo	Eniwetok Atoll
7.	LASL		Yankee	Eniwetok Atoll

This list has been adopted as a shot schedule, only for the purposes of this book, in order to describe the activities of each project more clearly. It must be emphasized at this point that there is no firm schedule of firing order or location at present, nor is one likely until the beginning of the operation. The number of shots, the large expected yields, and other equally important considerations require a high degree of flexibility in planning not allowed in a rigid schedule. For this reason the shot participation mentioned in the discussion of each experiment, and given in tabular form at the rear of the book along with project locations, should be viewed only as indications of intent on the part of each project. Changes in the firing order and shot locations may make such participation unlikely, or may eliminate some projects completely. This is the appearance of things five months before the first shot of Operation CASTLE.

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CASTLE EXPERIMENTAL PROGRAM

Proj. No.	Title	Organization
	TASK UNIT 13 - DOD PROGRAMS (Col. H. K. Gilbert, Capt. N. E. Kingsley)	
	PROGRAM 1 - BLAST AND SHOCK MEASUREMENTS (LCDR W. L. Carlson)	
1.1	Blast Measurements by Photography	
	a. Free Air Pressure (Rocket Trails)	NOL
	b. Precursor Phenomena (Rocket Trails)	NOL
	c. Base Surge Phenomena	NOL
	d. Peak Pressure by Aerial Photography	NOL
1.2	P vs. T on the Surface	
	a. Pressures Less Than 40 psi	Sandia
	b. Pressures Greater Than 40 psi	BRL
1.3	Shock Winds	Sandia
1.4	Underwater P vs. T.	ONR-NOL-DTMB
1.5	Acoustic Pressure Signals in Water (SOFAR)	ONR
1.6	Water Wave Studies	ONR-Scripps
1.7	Close-in Ground Accelerations	Sandia
1.8	Dynamic Pressure Investigations	BRL
	PROGRAM 2 - NUCLEAR EFFECTS (Lt. Col. E. A. Martell)	
2.1	Gamma Film Dosage Measurements	ESL
2.2	Gamma Dose Rate vs. Time	ESL
2.3	Neutron Flux & Spectrum Measurements	NRL
2.5a	Fall-Out Distribution Studies	NRDL
2.5b	Fall-Out Distribution Studies	CRL
2.6a	RC Analysis of Ground Contamination	NRDL
2.6b	RC Analysis of Ground Contamination	CRL
	PROGRAM 3 - STRUCTURES (Capt N. E. Kingsley)	
3.1	Loading of Structures	ONR-SRI
3.2	Crater Survey and Evaluation	ONR-SRI
3.3	Tree Stand Studies	ONR-BRL-Forest Service
3.4	MINES	
	PROGRAM 6 - TEST OF SERVICE EQUIPMENT AND OPERATION (Lt. Col. D. I. Prickett)	
6.1	IBDA	
6.2 a b	Effects of Blast, Gust and Thermal on AC in Flight	WADC
6.4	Proof Testing of AW Countermeasures	BuShips
6.5	Decontamination and Protection	CRL
6.6	Ionospheric Effects	ESL
	PROGRAM 7 - LONG RANGE DETECTION (Col. P. R. Wignall)	
7.1	Electromagnetic Radiation Calibration	AFOAT-1
7.2	Detection of Airborne Low Frequency Sound	AFOAT-1
7.4	Calibration Analysis of A-Bomb Debris	AFOAT-1
	PROGRAM 9 - SUPPORTING MEASUREMENTS (Lt. Col. Jack G. James)	
9.1	Cloud Photography	AFSWP

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TASK UNIT 1 - LASL PROGRAMS (R. L. Aamodt)

PROGRAM 11 - RADIOCHEMISTRY (R. Spence)

11.1	Analysis for Fission and Fusion Energy Yields	LASL
11.2	Sample Collection	LASL
11.3	Heavy Element Investigations	LASL & UCRL

PROGRAM 12 - REACTION HISTORY (B. Watt)

12.1	DELETED Reaction History	UCRL
12.3	Reaction History	LASL

PROGRAM 13 - PHOTOGRAPHY (G. Felt)

13.1	Ball of Fire Photography	EG&G
13.2	Cloud Photography	EG&G
13.3	Bhangmeters	EG&G
13.4	High-Speed Photography	LASL
13.5	Time Interval Measurement with Bowen Cameras	LASL

PROGRAM 14 - EXTERNAL NEUTRON MEASUREMENTS (C. Cowan)

14.1	Threshold Detectors	LASL

PROGRAM 15 - ALPHA MEASUREMENTS (N. H. Smith)

15.1	Teller and Scintillation Alpha	LASL
15.2	Electromagnetic Alpha	LASL

PROGRAM 16 - GAMMAS AND RESIDUAL CONTAMINATION (B. Watt)

16.1	Gamma Intensity at Late Times	LASL

PROGRAM 17 - MICROBAROGRAPHY (J. M. Harding)

17.1	Microbarography	Sandia

PROGRAM 18 - THERMAL RADIATION (H. Hoerlin)

18.1	Time Interval Between Reactions	NRL
18.2	Power vs Time	NRL
18.3	Spectroscopy	NRL
18.4	Air Transmission	NRL
18.5	Total Thermal Radiation	NRL

PROGRAM 19 - MARINE SURVEY (L. R. Donaldson)

19.1	Marine Survey	U of W

TASK UNIT 12 - UCRL - LIVERMORE PROGRAMS (A. J. Hudgins)

PROGRAM 21 - RADIOCHEMISTRY (K. Street)

21.1	Analysis for Fission & Fusion Energy Yields	UCRL
21.2	Sample Collection	UCRL
21.3	Heavy Element Investigation	UCRL
21.4	Gas Analysis	UCRL

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PROGRAM 22 - HISTORY OF THE REACTION (S. Colgate)

22.1	Ganex	UCRL
22.2	Tenex	UCRL
22.3	Alpha	UCRL

PROGRAM 23 - SCIENTIFIC PHOTOGRAPHY (W. Ball)

23.1	Hot Spot Time Interval Measurement	UCRL
23.2	Ball of Fire Photography	EG&G

PROGRAM 24 - EXTERNAL NEUTRON MEASUREMENTS (S. White)

24.1	Phonex	UCRL

Addresses and channels for classified communications may be found in document J-20656 dated 12 October 1953.

Key to abbreviations used above:

AFOAT-1	Air Force Office for Atomic Energy
AFSWP	Armed Forces Special Weapons Project
BRL	Ballistics Research Laboratory
BuShips	Bureau of Ships, U. S. Navy
CRL	Chemical and Radiological Laboratory
DTMB	David Taylor Model Basin
Forest Service	Calif. Forest & Range Exp. Sta., Berkeley, Calif.
EG&G	Edgerton, Germeshausen & Grier, Inc
ESL	Evans Signal Laboratory
LASL	Los Alamos Scientific Laboratory
NRDL	Naval Radiological Defense Labor.tory
NRL	Naval Research Laboratory
NOL	Naval Ordnance Laboratory
ONR	Office of Naval Research
SANDIA	Sandia Corporation
SCRIPPS	Scripps Institution of Oceanography
SRI	Stanford Research Institute
UCRL	University of California Radiation Laboratory
UofW	University of Washington
WADC	Wright Air Development Center

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PROJECT 1.1a

BLAST PRESSURES BY ROCKET-TRAIL PHOTOGRAPHY

The object of this experiment is to obtain peak air overpressure as a function of distance from an atomic burst by means of rocket trail photography. Because all shots will be on the surface, true free air pressures cannot be obtained.

Method

A series of light reflecting rocket smoke trails in a fan type grid will be established a few thousand feet from ground zero approximately 8 seconds prior to zero time. A camera placed in such a position as to photograph the smoke trails through the expanding shock wave will obtain a photographic record of the propagation of the blast wave related to time. The photographs can give only time and distance measurements, but by applying the shock velocity method, which relates pressure to the velocity of the shock wave, a pressure versus distance curve can be determined.

The rocket launchers and cameras will be set up as shown in the accompanying diagram. 35mm Mitchell cameras will be used, operating at the rate of 100 frames per second. All shots will be photographed, but rockets are to be employed only [redacted] The pictures obtained will also be used by 1.1b. All photography will be by EG&G.

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Support Requirements

The main laboratory space for all of 1.1 will be on Parry (Elmer) with additional space on Eninman (Tare) and at the rocket sites. All rocket launcher installations at Bikini will be essentially completed [redacted] Installation at Eniwetok will commence about [redacted] minus 15 days. Rocket launchers will be checked out for an event at minus four days, or as Rad-Safe conditions permit; final checking and loading will be accomplished on minus one day or as late as is permitted. Helicopter lifts will be necessary for up to four personnel. Transportation of rocket motors will be necessary from storage sites on Aomon (Sally) and Bigiren (Roger). The project will require full meteorological data up to 10,000 feet altitude for the period just before shot time. No recovery of launchers will be effected. Film recovery will be as specified by EG&G. Project 1.1 film return to the ZI will require courier service. Total number of people for Projects 1.1a, b, c and d: 7

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Project Officer: Mr. C. J. Aronson
Naval Ordnance Laboratory
White Oak
Silver Spring, Md.

Sponsor : DOD

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W. Tench
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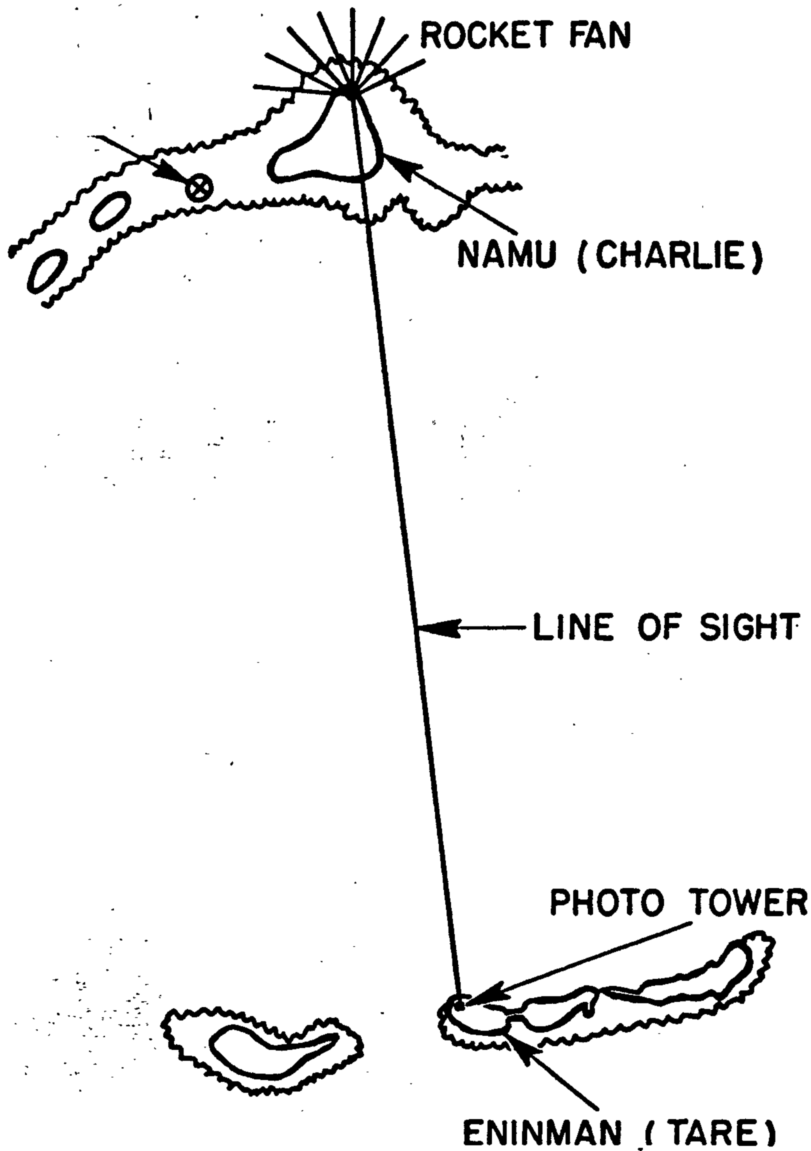
PROJECT 1.1a [redacted]

ROCKET TRAIL PHOTOGRAPHY



OTHER LOCATIONS

ROCKET LAUNCHERS	PHOTOTOWERS
Yurochi (Dog)	Bikini (How)
-	Bikini (How)
-	Bikini (How)
Eniirikku (Uncle)	Bikini (How)
Rujoru (Pearl)	Runit (Yvonne)
-	Runit (Yvonne)

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PROJECT 1.1b
BLAST PHENOMENA BY SURFACE PHOTOGRAPHY

It is desired in this experiment to measure, by photographic means, the motion of the shock wave over land and water as a function of time. Peak overpressures near the earth's surface will be computed and a study made of the propagation of any precursor waves formed.

Method

Direct photography of the shock wave travel will be used and is coordinated with that under 1.1a. As in Project 1.1a, pressures will be computed after determining velocities from time and distance measurements of the travel of the shock wave. NOL participation will consist of an analysis of film taken by EG&G.

Support Requirements

Support and personnel requirements are combined with Project 1.1a.

Project Officer: Mr. C. J. Aronson
Naval Ordnance Laboratory
White Oak
Silver Spring, Md.

Sponsor : DOD

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PROJECT 1.1c
BASE SURGE PHENOMENA [redacted]

When a bomb is detonated under or near the surface, a great quantity of water is taken up in the column of rising air. Some of this soon loses its energy and falls back into the water, forming what is called a "base surge". It was observed at CROSSROADS that this phenomenon expanded with a high initial radial velocity, gradually assuming the rounded profile of a fog bank which was growing in volume, until the top had reached a height of about 1800 feet. As the radial expansion ceased, the base of the cloud lifted from the surface and the entire mass thickened until the top was about 6000 feet high. The surge cloud then drifted with the wind, dropping rain for nearly an hour.

Although this description applies only to the one underwater burst to date, it is felt that a sufficient body of water will be taken up in a near surface burst of much larger proportions to produce a somewhat similar phenomenon. The study of the formation, growth and dissipation of the base surge by photographic means is the purpose of this experiment.

Method

Photographic coverage of the base surge will be made independently of Projects 1.1a and 1.1b. Cameras will be located on Bikini (How) and Enyu (Nan) at Bikini Atoll and on Parry (Elmer) and Engebi (Janet) at Eniwetok Atoll. Five cameras will be located at each of the first three sites and two will be placed on Engebi. There will be enough [redacted] light for base surge photography only [redacted] since the other devices are to be fired at an earlier hour. All photography will be performed by EG&G.

Support Requirements

Major support will be as required by EG&G in accomplishing its mission. NOL will have one man on site to coordinate photographic requirements and to collect meteorological data as a part-time duty. The project will require meteorological data from observations made in the Bikini and Eniwetok areas on the day of each shot. Results of the use of radar on the surface cloud phenomena produced by each barge shot are also desired. Personnel are included under Project 1.1a.

Project Officer: Mr. C. J. Aronson
Naval Ordnance Laboratory
White Oak
Silver Spring, Maryland

Sponsor : DOD

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PROJECT 1.1d
AERIAL PHOTOGRAPHIC STUDIES OF BASE SURGE AND BLAST

The object of this experiment is to study the motion of the base surge and shock wave over the surface of the water by means of aerial photography.

Method

The C-54 aircraft scheduled to participate in Project 9.1 will have additional cameras for 1.1d photographs. Participation will be on all shots. The light from the bomb will be of sufficient intensity and duration to permit the photographing of the motion of the shock wave along the water. It is estimated that the photographs will be obtained from a range of approximately 50 miles.

Support Requirements

Major support will be as required in operating and maintaining the aircraft and cameras under other projects. No separate support for NOL is required. Personnel are included under Project 1.1a.

Project Officer: Mr. C. J. Aronson
Naval Ordnance Laboratory
White Oak
Silver Spring, Md.

Sponsor : DOD

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PROJECT 1.2a
PRESSURE VS TIME ON THE SURFACE (PRESSURES LESS THAN 40 PSI)

The exact nature of the shock wave initiated by a bomb depends on many factors. Of these, perhaps the most important for weapons effects purposes are the type of surface over which it is fired, the presence of contours and obstructions, the height of burst and the yield. Since an exact theoretical treatment of these factors for actual targets is manifestly impossible, it becomes important to document blast wave phenomena over a wide variety of conditions so that general rules may be established for planning purposes.

The object of this experiment is to measure the pressures involved in the shock wave as a function of time at a series of stations, so that the variation of pressure with distance will also be obtained. These data will be used to investigate the validity of the static pressure scaling laws for large yield surface bursts.

Method

In general, pressure gauges will be restricted to the regions in which pressures are calculated to be below 40 psi. The pressure sensing elements, Wiancko gauges, generate signals which can be recorded on magnetic tape. A time base is provided by the moving tape, zero time being the first light from the bomb detected by a 'Blue Box'. The gauges will be installed in ground baffles and their signals transmitted on buried cables to concrete shelters, where they will be recorded. Backup recording will be done on photographic paper. The project will participate in shots [redacted]

Support Requirements

The instrumentation will be completed prior to beginning of the operation, but will have to be visited between shots for data recovery and resetting. Helicopter service for three men will be needed for this. The personnel of Projects 1.2a, 1.3, 1.7 and 17.1 are consolidated in the figure given below, since a breakdown by project is not feasible. Total number of people: 35

Project Officer: Dr. J. M. Harding
Sandia Corporation
Sandia Base
Albuquerque, New Mexico

Sponsor : DOD

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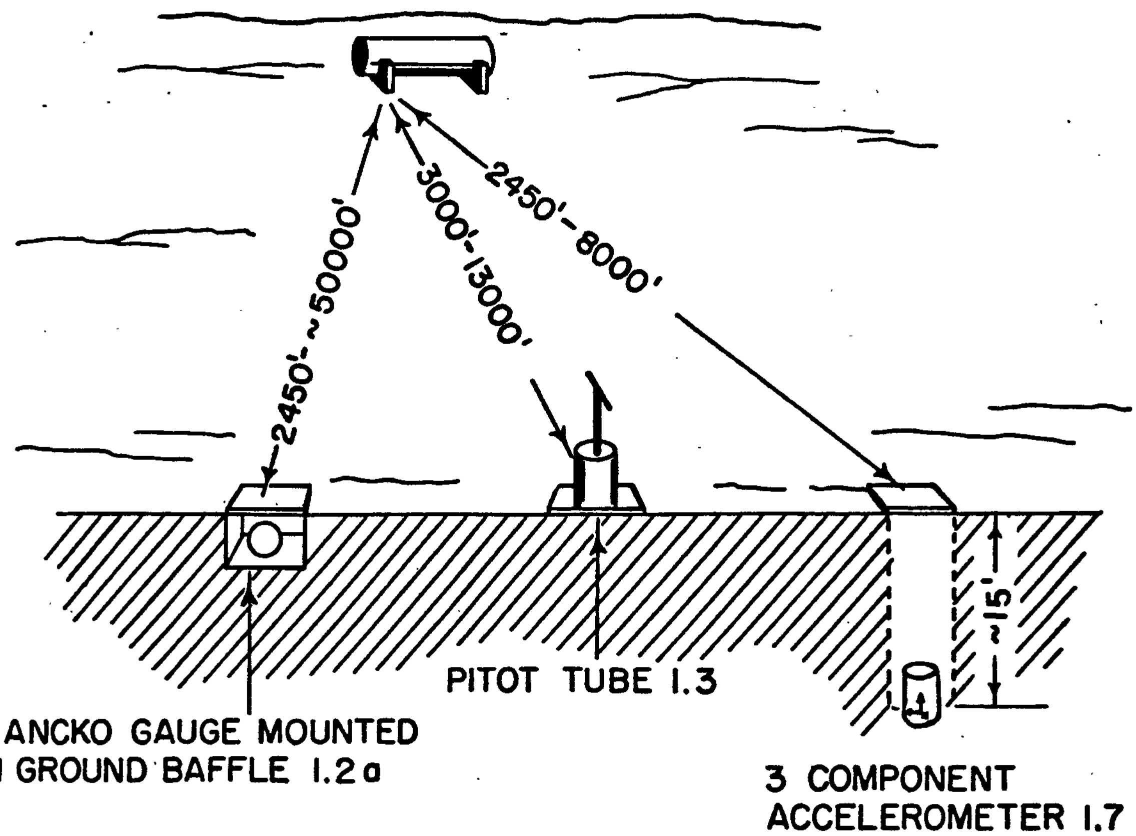
PROJECTS 1.2a, 1.3, 1.7 SE[redacted]T

1.2a - P vs T on the Surface (< 40 psi)
1.3 - Shock Winds
1.7 - Ground Accelerations



LOCATIONS

Island	Ground Baffle	Pitot Tube	Accelerometer
Romurikku (Fox)	4		
Aomoen (George)	2	1	
Airukiiji (Oboe)	1		
Airukiraru (Peter)	3	1	
Bigiren (Roger)	3	2	1
Reere (Sugar)	1		2
Aitsu (Olive)	3		
Rujoru (Pearl)	6	3	2

Note: Force plate, drag gauge, temperature and density gauges to be exposed on George adjacent to pitot tube. Gauges on Fox and George to be used [redacted] Others on one shot only.

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PROJECT 1.2b

PRESSURE VS TIME ON THE SURFACE (PRESSURES GREATER THAN 40 PSI)

The measurements in this experiment will be similar to those in Project 1.2a except that the majority of the instruments will be closer to ground zero, where the greater pressures are found. Pressure-time versus distance measurements will be made. These data will be used to investigate the validity of the static pressure scaling laws for large yield surface bursts. In addition some supporting measurements will be made for the tree stand study, Project 3.3.

Method

Self contained, flash initiated pressure-time recording gauges in ground baffles will be installed at various distances from ground zero. The gauge consists of a pressure sensing element which causes a stylus to scratch a record of pressure changes on a revolving drum. The drum is driven by a clock mechanism which provides a time base. The project will participate on all shots with a number of the gauge mounts being reused. Some overlap into lower pressure regions will be effected for correlation with other data. A sketch and summary are included below.

Support Requirements

A DUKW will be required to reach the reef stations to the east of Namu (Charlie) for installation, data recovery and resetting of the gauges between shots. Some of this work will also involve both helicopter and boat service. Total number of people: 21

Project Officer:	Mr. J. J. Meszaros Ballistics Research Laboratory Aberdeen Proving Ground Maryland
Sponsor :	DOD

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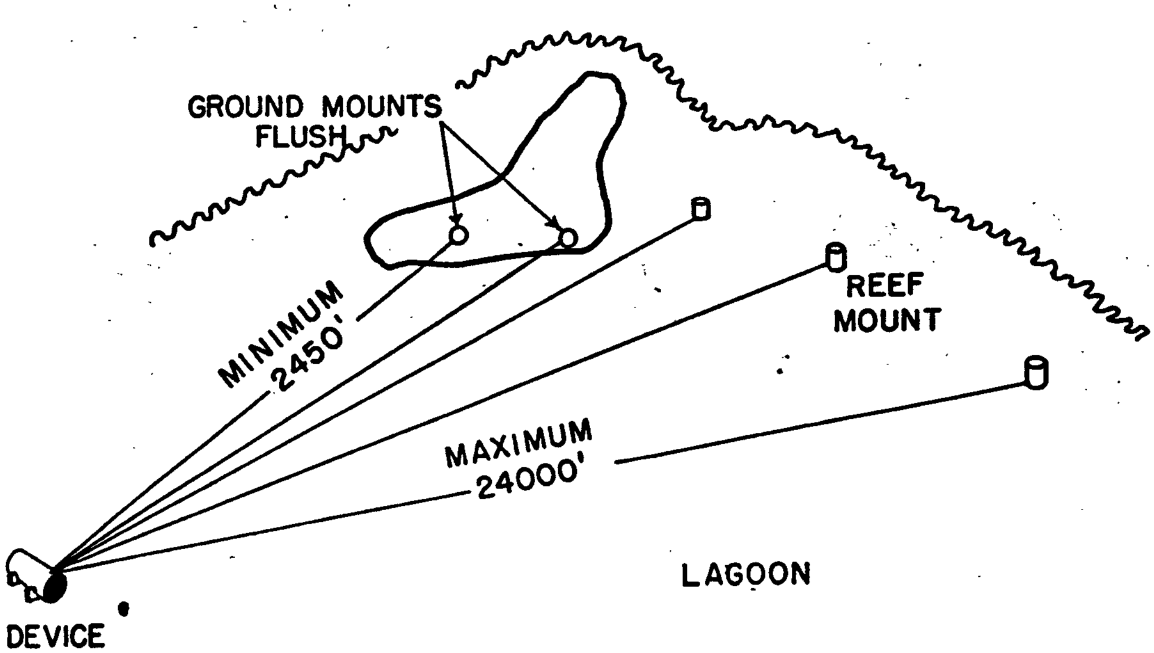
PROJECT 1.2b

P VS T ON THE SURFACE (> 40 PSI)



LOCATIONS

Islands	Gauges
NAMU (Charlie)	4
East of NAMU	5
YUROCHI (Dog)	3
UORIKKU (Easy)	1
ROMURIKKU (Fox)	2
ENINMAN (Tare)	2
ENIIRIKKU (Uncle)	6*
RUJORU (Pearl)	5
BOGALLUA (Alice)	2
BOGOMBOGO (Belle)	2
RUCHI (Clara)	2
COCHITI (Daisy)	2

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* Additional gauges will be located at sites in the tree stand for project 3.3 These will be selected on site.

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PROJECT 1.3
SHOCK WINDS

At a fixed point in space the passage of a shock wave is characterized by an abrupt rise in pressure to some peak value followed by a drop in pressure to a point below ambient. The pressure then slowly comes back to ambient. The positive phase is marked by higher pressure values than the negative phase but is of shorter duration. Associated with the positive phase is a wind flowing radially outward; in the negative phase the wind is reversed. These winds, in both directions, are shock winds and may last as long as several seconds in each phase. It is the purpose of this experiment to document this phenomenon by determining the dynamic pressure-time characteristics of the shock wave produced by large yield surface bursts.

Method

Double-ended-pitot tubes oriented toward ground zero will be installed on islands at different ground ranges corresponding approximately to a pressure range of from 10 to 50 psi. The pitot tube does not measure wind velocity directly but rather the difference between two pressures; that which the open end of the tube sees, called the "dynamic" pressure, and the "static" pressure which the tube would see if it were traveling along with the wave. This is measured at side-on pressure openings. The difference between these two pressures is the pressure due to the material velocity, or $\Delta P = 1/2 \rho u^2$, where ρ is the air density and u the material velocity to be determined. Recording will be accomplished in the same fashion as Project 1.2a at the DELETED same recording shelters. The Project will participate [redacted] if radiological conditions permit. A sketch and summary are included under Project 1.2a.

Support Requirements

Requirements and personnel are included under Project 1.2a.

Project Officer: Dr. J. M. Harding
Sandia Corporation
Sandia Base
Albuquerque, New Mexico

Sponsor : DOD

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[redacted]

PROJECT 1.4
UNDERWATER PRESSURE VS TIME MEASUREMENTS

USS Gypsy

A question of considerable importance to the military is concerned with the behavior of a shock wave in water. The barge shots on CASTLE will offer an opportunity to study the pressures due to a nuclear explosion near the surface. Pressure-time fields and peak pressures will be determined and an estimate made of the amount of blast energy transmitted into the water.

Method

Instrument stations will be located in the lagoon at various distances from ground zero ranging approximately from 3,000 to 24,000 feet. These stations will be positioned along a line of buoys running toward Enirikku (Uncle) from ground zero. Twelve stations of pressure-time instrumentation are planned along with spreads of ball crusher gauges to measure peak pressures. Data will be telemetered from instrument cans along the line of buoys to recorders in a P4Y aircraft. In addition, data from a station in the lagoon will be recorded at a buried shelter on Aomoen (George). Primary participation will be on the Bikini barge shots, however some gauge installations may be operated [redacted] to check out equipment. In addition, participation [redacted] under consideration. A sketch of the layout is included below.

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Support Requirements

All instrument cans will be processed on Parry (Elmer) and transhipped through Eninman (Tare). Since large buoys, cables, anchors and other gear are also involved, cranes, lo-boys and T-Boats will be necessary in moving equipment. An ATF and ARSD have been requested to accomodate personnel, lay the moors and handle equipment. Work on the moors will commence about January 1 and should require about 30 days. Assembled instrument cans will be positioned along the buoy string after February 1 and gauges installed. A modified LCM will be required on a full time basis to provide small boat support. A DUKW will also be required. These vessels will be required for reprocessing cans between shots. The P4Y aircraft will be on site after January 15 and will require maintenance and logistics services. Total number of people: 34

Project Officer: Dr. W. J. Thaler
Office of Naval Research
2515/T3 Building
Navy Department
Washington 25, D. C.

Sponsor : DOD

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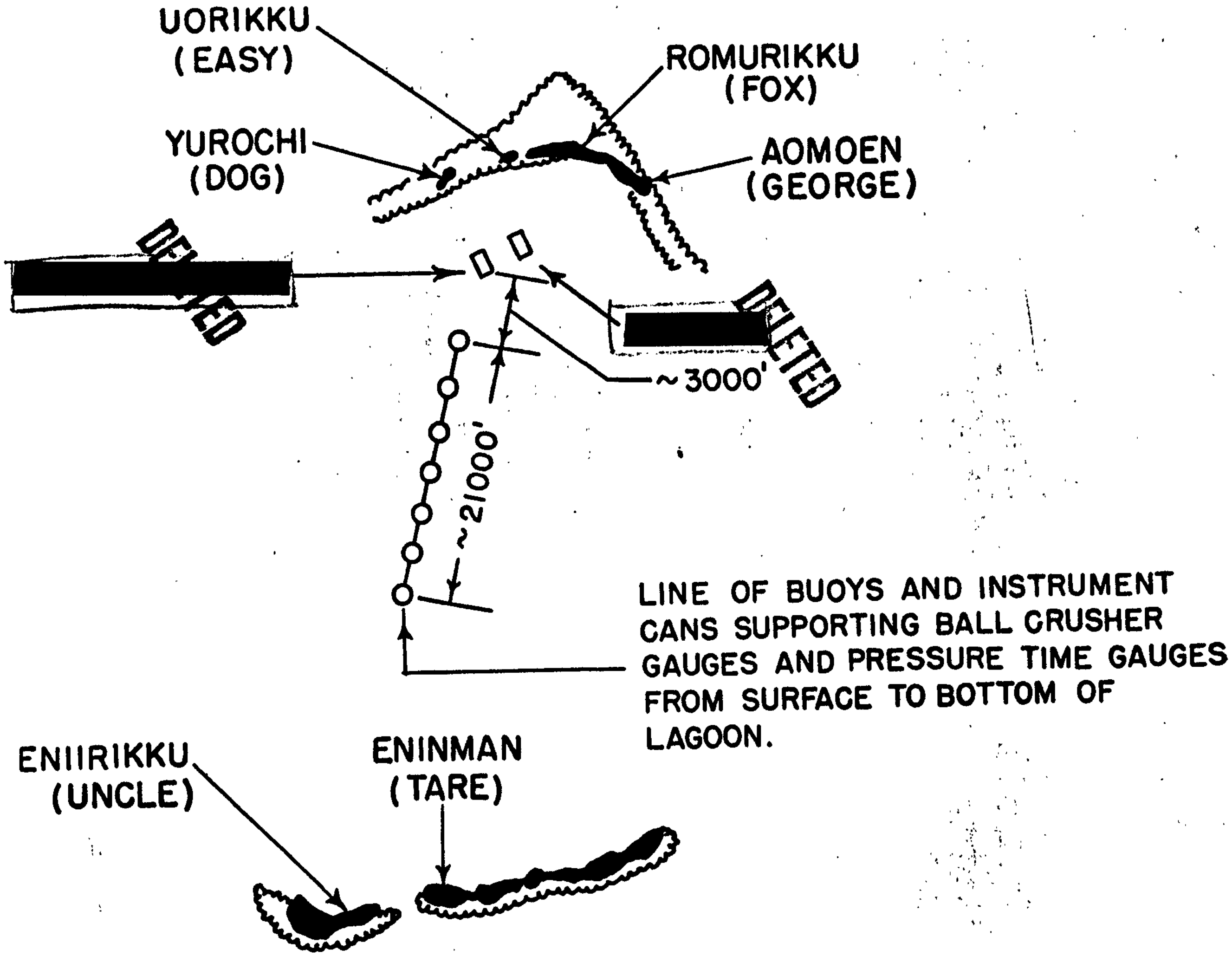
PROJECT 1.4

UNDERWATER PRESSURE VS TIME MEASUREMENTS



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PROJECT 1.5
ACOUSTIC PRESSURE SIGNALS IN WATER (SOFAR)

The object of this experiment is to determine the relative intensity of the long range acoustic signals produced by surface bursts. There occurs in deep water an isothermal layer in which low frequency sound waves are transmitted great distances. It is found at a depth of somewhere around 3,000 feet, depending upon the temperature gradient of the water above it. Since the velocity of sound in water, as in air, is temperature dependent, a portion of the energy of the explosion will arrive at and travel in this layer as a sound wave, losing little of its energy until it strikes a land mass. An effort will be made to determine device yields relative to the GREENHOUSE and IVY shots, acoustic velocity, shot location and time.

Method

SOFAR stations in regular operation will be used to detect signals originating from the devices. The Naval Electronics Laboratory will be requested to continue observation and analysis of data at Pacific SOFAR stations. Similarly, groups from Columbia University will undertake observations at Atlantic SOFAR research stations. The project will participate on all shots.

Support

All operations will be conducted off site and no support is necessary.

Project Officer: Mr. J. W. Smith
Office of Naval Research
Washington, D. C.

Sponsor : DOD

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PROJECT 1.6
WATER WAVE STUDIES

A nuclear detonation close to a water surface transfers a portion of its energy to the water by means of the shock wave, causing a disturbance which forms surface waves. The object of the experiment is the study of the mechanism by which these waves are generated by measuring wave height, period and velocity as a function of time and distance.

Method

The wave characteristics mentioned above can be determined by measuring the variation in subsurface pressure as the 'head' of water above a pressure gauge changes with time due to a passing wave. Four of these pressure-time gauges will be located on submerged coral heads within Bikini Lagoon, with the recorders carried in skiffs anchored above them. The distance of the stations from ground zero will change for each shot, but the closest will be about 2 1/2 nautical miles and the farthest about 17. One shore recorder will be installed on the lagoon side of both Enyu (Nan) and Eninman (Tare). Distant wave recorders will be located at La Jolla and Ocean Side, California, and at Midway, Wake, Guam and Parry Islands. In addition, maximum inundation will be measured on three islands in Bikini Atoll by use of 'Beer Can' gauges, open cans attached to trees or poles at several levels to indicate the height of exceptional waves. A feasiblity test will also be conducted on a type of underwater pressure gauge designed to measure shock pressures in the region close to the detonation.

The local instrumentation will be used only on the Bikini shots, but the distant recorders will operate during all shots.

Support Requirements

A modified LCM will be permanently assigned to handle the lagoon installations. Recovery of data and reprocessing of instruments will be necessary between shots, with final recovery being made [redacted] Services and transportation to and from remote stations such as Guam will be required for the operating personnel. Total number of persons: 12, with 9 on site and one each at Midway, Wake and Guam.

Project Officer: Dr. R. R. Revelle
Scripps Institution of Oceanography
La Jolla, California

Sponsor : DOD

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[redacted]

SECRET

PROJECT 1.7
CLOSE-IN GROUND ACCELERATIONS

The object of this experiment is to determine the amount of blast energy transmitted radially outward through the earths surface from a large yield surface burst.

Method

Bull plugs containing Wiancko accelerometers for detecting the magnitudes of the vertical, radial and tangential components of earth acceleration will be installed about 15 feet below grade level. The three components of acceleration-time will be recorded on Ampex Tape recorders at the concrete shelters used by Project 1.2a. Five stations will be installed. Three will be used [redacted]
A sketch and summary are included with Project 1.2a. DEL

Support Requirements

Requirements and personnel are included under Project 1.2a.

Project Officer: Dr. J. M. Harding
Sandia Corporation
Sandia Base
Albuquerque, N.M.

Sponsor : DOD

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[redacted]

PROJECT 1.8
DYNAMIC PRESSURE INVESTIGATIONS

This is a tentative project in which it is proposed to investigate some of the causes of damage to vehicles subjected to the blast from a nuclear detonation. This damage was observed at UPSHOT/KNOTHOLE but the causative mechanism is uncertain.

It is proposed to expose a group of jeeps on each of two CASTLE shots to obtain additional data. The details of the experiment, the instrumentation, locations and shot participation have not been established as of this writing.

Project Officer: Mr. E. Bryant
Ballistics Research Laboratories
Aberdeen, Maryland

Sponsor : DOD

PROJECT 2.1 and 2.2
GAMMA FILM DOSAGE MEASUREMENT

The limited total gamma dose data available from the IVY tests indicate considerably higher values of gamma dosage for high yield devices than would be expected by direct scaling from lower yield weapons. One reason for this is the basic difference in neutron production rates in thermonuclear devices, the 'large' bombs, and the generally lower yield fission weapons. Another important reason can be found in the greatly reduced attenuation of gamma rays in the region behind the shock wave. For a fairly close-in detector, the shock from a large bomb would remove a greater volume of air than would that of a smaller weapon, thus allowing the detector to see more of the total gamma radiation from the larger device.

The purpose of this experiment is to measure, as a function of distance, the gamma film dosage due to both prompt and fall-out radiation. The yield ranges of the various devices to be tested will provide a spread of information which can be used as a basis for predicting gamma radiation for effects purposes.

Method

The film packets to be used are made up of a number of dental films of overlapping sensitivities in National Bureau of Standard Type holders. The graduated sensitivity of each packet gives it a dynamic range of from 1 to 40,000 roentgens, simplifying the distribution of the packets among the stations, as well as allowing for uncertainties in the calculated gamma ray intensities. The degree of blackening of a film as read on a densitometer will determine the total gamma dosage at that station; a series of stations will give the dosage as a function of distance. The film will be calibrated in the field with a standard cobalt-60 source, and recalibrated in the ZI with a betatron source.

In general, the film badges will be placed on stakes about 500 yards apart, covering the range from 2000 to 7000 yards from ground zero. A number of the Bikini stations will be activated for more than one shot, producing from 10 to 25 readings for each shot. Some of the film badges will be at Project 2.2 stations ashore, measuring both prompt and fall-out radiation, but the majority will be located in tidal wash areas where the fall-out contribution will be reduced. In addition, film packets will be placed at all Project 2.3 stations, [redacted] A summary of station locations is included below.

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Support Requirements

A DUKW will be required for servicing the reef stations; it and the necessary supporing boat will be needed, along with a helicopter, to replace the film badges between shots. Similar requirements will exist at both Bikini and Eniwetok.

Photodosimetry support is being provided by Rad-Safe in its space afloat and ashore; Project 2.2 will also share its assigned space. Total number of people: 5

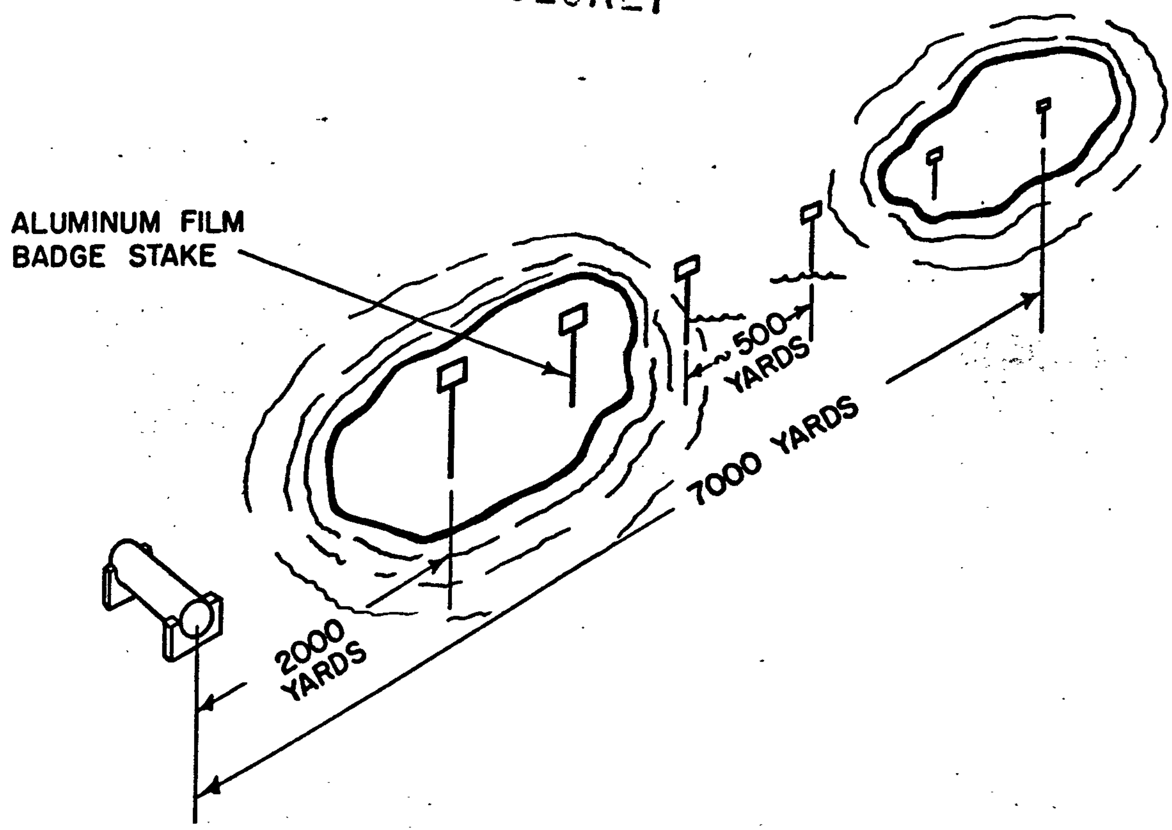
Project Officer: Capt. R. Dempsey, USA
Evans Signal Laboratory
Belmar, New Jersey

Sponsor : DOD

[redacted]

GAMMA FILM DOSAGE MEASUREMENT

S[redacted]T



LOCATIONS

Island	Number	Island	Number
BOKOBYAADAA (Able)	3	CHIEERETE (William)	1
NAMU (Charlie)	2	ARRIIKAN (Yoke)	1
East of NAMU	6	OURUKAEN (Zebra)	1
YUROCHI (Dog)	3	BOKOAETOKUTOKU (Alpha)	1
UORIKKU (Easy)	2	BOKORORYURU (Bravo)	1
ROMURIKKU (Fox)	3	Reef (LUCY-MARY)	1
AOMOEN (George)	2	BOKONAARAPPU (Mary)	2
AIRUKIIJI (Oboe)	3	YAIRI (Nancy)	2
AIRUKIRARU (Peter)	4	AITSU (Olive)	2
BIGIREN (Roger)	3	AARAANBIRU (Vera)	3
ENIIRIKKU (Uncle)	5	PIIRAAI (Wilma)	1

Note: Stakes will be reused for several shots where associated with project 2.2 stations and at suitable ranges.

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[redacted]

[redacted]

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[redacted]

[redacted]

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Support Requirements

Project laboratory space will be provided on Parry (Elmer) and all electronics will be processed there and transhipped to Eninman (Tare). An 88 curie and 4 and 5 curie sources will be on hand at Parry for calibration required by Projects 2.1 and 2.2. The large source will be stored in the Rad-Safe area. Access for instrument installation [redacted] will be by boat. Recovery of records and reactivation of stations between shots will require helicopter flights. Recovery of equipment will be necessary [redacted] Total number of people: 9

DELETED

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Project Officer: Mr. Peter Brown
Evans Signal Laboratory
Belmar, New Jersey

Sponsor : DOD

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[redacted]

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PROJECT 2.3
NEUTRON FLUX AND SPECTRUM MEASUREMENTS

The purpose of this experiment is to measure the number of neutrons and their energy distribution at various distances from a nuclear detonation. Available data indicate that the dangers of neutron radiation in the distances to be used are far overshadowed by other effects of a bomb. However, the neutron flux from a device does not scale simply with the yield, being highly dependent upon the mechanical design of a particular device, and therefore neutron measurements are important for a thorough analysis of weapons effects.

Method

One method used to obtain an estimate of the neutron energy spectrum involves the use of 'threshold detectors'. These elements react when bombarded with neutrons having energies greater than some limiting values, known as the thresholds. The neutron induced reactions produce radioactive nuclei which can be detected and counted, the number produced in each detector being proportional to the number of bombarding neutrons in the particular energy range of that detector. Measurements on a number of detectors with different thresholds give the integrated neutron fluxes in the various energy ranges.

Gold and tantalum foils will be used for the slow neutron measurements by means of the cadmium difference technique. Cadmium has a high cross section for neutrons with energies from thermal* to .25 ev, being 'transparent' to higher energy neutrons. By coating one of a pair of gold foils with cadmium, and counting the activity after bombardment, the number of neutrons with energies greater than the cadmium 'cut-off' can be calculated from the known cross section curve for gold. The other foil, not coated, would give the total number of neutrons of all energies at which reactions in gold occur. The difference is the number of neutrons in the range desired. A similar technique is used with tantalum foils.

Sulphur, with a 3 Mev threshold, will be used to detect the fast neutron flux. The region below the sulphur threshold will be covered by using nuclear emulsions to detect the fission fragments from neptunium, uranium 238, and thorium, which have fission thresholds in the region of 1 Mev.

A limited number of measurements will be made on all shots at distances ranging from 2500 yards to 5000 yards from ground zero. Stations will be spaced at approximately 500 yard intervals, with several

* Thermal energy $\cong$ .025 ev.

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stations in a given direction and one or two separated in azimuth for some shots. Total gamma dosage measurements will also be made at each station. A total of 23 stations will be used. A sketch and summary are given below.

Support Requirements

Space will be available on both Parry (Elmer) and Eninman (Tare) to prepare samples. Since some sample containers will weigh several hundred pounds, it has been proposed to use a DUKW with monorail and chain fall to handle containers. This will provide [illegible] elevation and also allow processing of reef stations. [redacted] it will be necessary to use this DUKW for installations at Bikini. Boat travel to various islands will also be required. Similar requirements will exist at Eniwetok also. Recovery of detectors and reactivation of some stations will involve the same procedure and entry into contaminated areas. Hot sample return by aircraft from Bikini to Eniwetok will be necessary. Samples will be sorted and one group forwarded by courier to NRL, Washington, D. C., for counting. Short lived activities will be counted in a laboratory trailer on Parry (Elmer). Total number of people: 9

Project Officer: Mr. T. D. Hanscome
Naval Research Laboratory
Code 3132
Washington 25, D. C.

Sponsor : DOD

P/U recovery - see Status Report.

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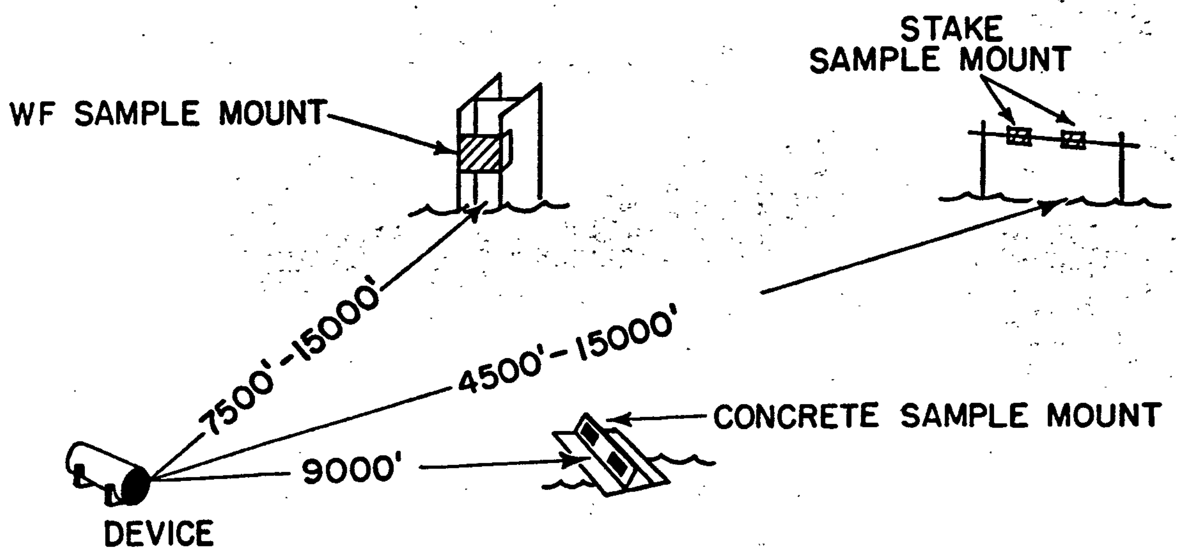
[redacted]

PROJECT 2.3 SECRET

NEUTRON FLUX AND SPECTRUM MEASUREMENTS



TYPE	NUMBER	LOCATION
Concrete	1	Ruchi (Clara)
Wide Flange	3	East of Namu (Charlie)
Wide Flange	4	West of Yurochi (Dog)
Wide Flange	1	Romurikku (Fox)
Wide Flange	1	Aomoen (George)
Wide Flange	1	Bigiren (Roger)
Wide Flange	4	Bogombogo (Belle)
Stake	3	East of Namu (Charlie)
Stake	1	Airukiraru (Peter)
Stake	1	Aomon (Sally)
Stake	2	Biijiri (Tilda)
Stake	1	Rojoa (Ursula)

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PROJECTS 2.5a & b
FALL-OUT DISTRIBUTION STUDIES

SECRET

As the fireball rises from a nuclear detonation, it carries with it particles of various sizes to form the atomic cloud. These particles, most of which are radioactive, are then distributed over the earth's surface, in what is known as "fall-out", in a manner depending up on their sizes, the wind directions and velocities, and other variables. Some particles of very small size may be deposited in precipitation thousands of miles away from the shot location.

The object in these experiments is to study the time-intensity and total distribution of radioactive fall-out resulting from high yield detonations. Samples will be collected for physical and radiochemical analyses which will provide a basis for evaluation of the residual contamination hazards resulting from such bursts. The main effort will be concentrated on the distribution of close-in fall-out (less than 50 miles).

Method

A broad pattern of fall-out stations will be established to cover land and water areas. Twenty-six rafts will be placed in Bikini Lagoon and thirty-two in Eniwetok Lagoon, located in a grid system so as to cover lagoon fall-out. In addition, land stations will be established on many islands in the Bikini Group to give general land coverage in this area. Gum paper collectors will be placed on other atolls, including those at which the weather stations are located. Free floating stations will also be used off both atolls. These will consist of collectors on Dan Buoys, placed in a pattern extending to 50 miles from ground zero. Associated with this will be the instrumentation on the drone ships of Project 6.4.

Several types of collectors will be used. These include a gross fall-out type, intermittent collectors, filter samplers and total particle collectors. In addition, gamma time-intensity recorders and film badges will be used. Several types may be located at a single station. Stations [redacted] be used in various combinations with the main emphasis being [redacted] to aid in the evaluation of Pr[redacted]ct 6.4 experiment. The project will also participate on the other shots.

Support Requirements

The different station types pose individual handling problems. Raft stations will probably be used on all shots though only limited spreads will be activated in some cases. Handling of the rafts involve an LCU with a crane in the well. Instrumentation will commence about shot day minus seven and continue until evacuation. Rafts used are standard Navy balsa life rafts with instruments on a built-in platform.

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Rafts will be put out by the crane and shackled to an existing buoy. At Bikini, processing will be done through Eninman with the LCU handling all rafts. The project plans to furnish two 26-foot motor whaleboats for small boat support. Rehandling of all stations between shots will be necessary to recover data and to set up for the next shot. The same equipment support is necessary for this operation. Further, it is planned to pick up and move some rafts from Bikini to Eniwetok Lagoon [redacted] This will involve LST transportation of contaminated equipment. Rafts will then be put out in the Eniwetok Lagoon in the same fashion as at Bikini.

Dan buoys will be used [redacted] These buoys will serve as fall-out collector stations out to a 50 mile radius down wind. Two destroyers or vessels of comparable speed (about 12-15 knots), equipped with a ½ ton boom, will be necessary to put out the spread, [redacted]. Recovery of buoys will be made by the same or similar vessels and will continue until about D + 4. Buoys will be reused on later shots.

The land stations are at Bikini Atoll only. Where several types of collectors are on one island, these are grouped in the same area for ease of access. Stations will be instrumented [redacted] Initial placement of the instruments will occur well before [redacted] Recovery of data and reworking of instruments will be necessary between shots, requiring the use of a helicopter.

Samples will be sent by air to Eniwetok Atoll, where they will be separated, a part being sent to the Parry laboratory for analysis, the remainder going back to the ZI for analysis at NRDL and CRL. NRDL is interested in obtaining at least two samples at a very early time (about H + 2 hours) for early analysis of short half-lives. Analysis will be done in a Rad-Safe trailer on the carrier. Total number of people: 50

Project Officers:

2.5a Dr. E. R. Tompkins
U.S. Naval Radiological
Defense Laboratory
San Francisco 24, California

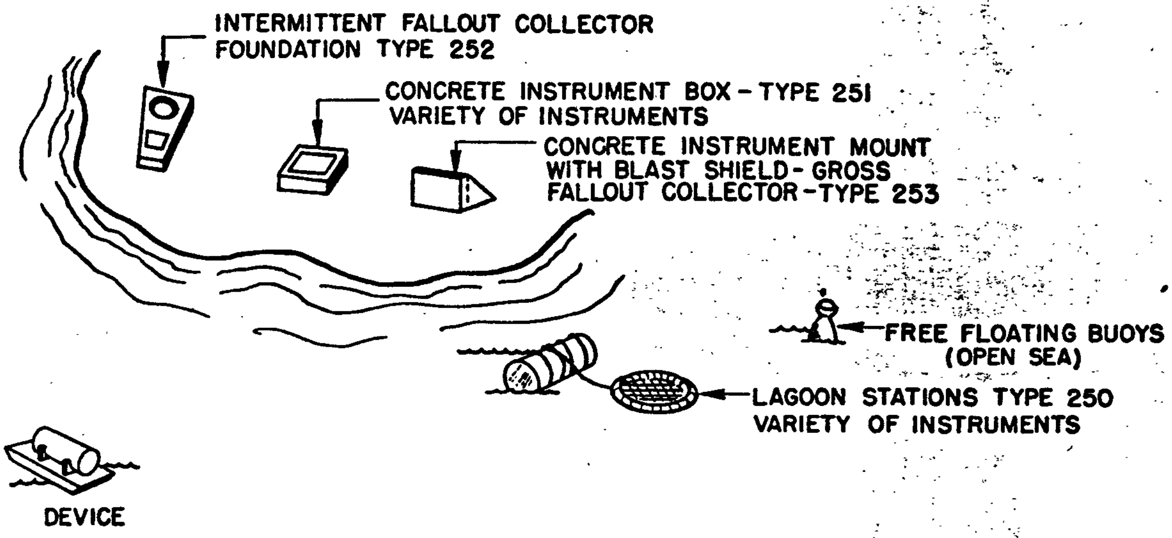
2.5b Mr. E. F. Wilsey
Chemical and Radiological
Laboratories
Army Chemical Center
Maryland

B will be on Parry

Sponsor : DOD

PROJECTS 2.5a and 2.5b

FALL-OUT DISTRIBUTION STUDIES



LOCATION	STATION TYPE 250	251	252	253
Bikini Lagoon	26			
Eniwetok Lagoon	32			
Bokobyaadaa (Able)		1	1	
Namu (Charlie)			1	
Yurochi (Dog)			1	
Romurikku (Fox)		1	1	
Aomoen (George)			1	
Bikini (How)		1	1	
Rochikarai (Love)		1	1	
Enyu (Nan)		1	1	
Airukiiji (Oboe)		1	1	
Eniirikku (Uncle)		1	1	
Rukoji (Victor)			1	1
Chieerete (William)		1		1
Arriikan (Yoke)		1	1	1
Ourukaen (Zebra)		1	1	
Bokororyuru (Bravo)			1	

[redacted]

PROJECTS 2.6a & b
CHEMICAL, PHYSICAL AND RADIOCHEMICAL ANALYSIS OF GROUND CONTAMINATION

The objective of these projects is to determine the physical, chemical and radiochemical nature of the fall-out samples collected by Projects 2.5a and b. This information will afford a better understandin of the mechanism of distribution of bomb debris on which predictions of fall-out hazards may be based. It will further provide basic information essential to the study of decontamination and protection techniques.

Method

NRDL plans radiochemical analysis for short-lived radioactive constituents of fall-out debris, early gross decay measurements, and chemical analysis to determine the presence and nature of transitory chemical states. Some of this work will be done in the forward area in the Rad-Safe trailer aboard the carrier and on Parry (Elmer). Size distribution studies and most of the chemistry and radiochemistry will be done in the ZI.

CRL also will do some early time work at Parry with the remainder to be done at the Army Chemical Center upon receipt of the Project 2.5 samples. Analysis procedures include the size grading of samples by standard sieves down to approximately 40 microns and by roller analysis below this size. Radiochemical analysis will include determinations of Na^{24}, Zr^{97}, Mo^{99}, Cd^{115}, and Ba^{140}.

Support Requirements

Rapid return of the 2.5 samples by aircraft will be necessary from the Bikini area to Eniwetok (Fred) to allow analysis for short-life activities. This, with recovery, has been covered under Project 2.5, along with sample return to the ZI. Total number of people: 13

Project Officers:

2.6a Dr. E. R. Tompkins
U.S. Naval Radiological Defense Laboratory
San Francisco, California

2.6b Mr. R. C. Tompkins
Chemical and Radiological Laboratories
Army Chemical Center
Maryland

Sponsor : DOD

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[redacted]

PROJECT 3.1
LOADING OF STRUCTURES

The objective of this project is to investigate the loading pattern as a function of time imposed on a parallelepiped exposed to the shock wave from an atomic burst. Further, it is planned to obtain limited information on structural response.

The plan for location of gauges on the test structure for study of loading was developed by the Weapons Effects Department, Sandia Corporation in coordination with other interested agencies. It is designed, within the limitations of the geometry of the test structure, to serve the following purposes:

a. Extend the data obtained by Project 3.1 at UPSHOT/KNOTHOLE.

b. Correlate with data obtained at the Coyote Canyon project of the Sandia Corporation in subjecting a 1:15 scale model of the test structure to blast loading from high explosives.

c. Extend loading data obtained at the test structure at Operation GREENHOUSE. The blast wave at GREENHOUSE had a slow rise time, not all pressure gauge records were consistent, and a need for additional information on loading patterns near edges of structures was indicated.

d. Provide an "ad hoc" comparison of loading imposed by a high yield device with that of the low yield device of operation GREENHOUSE.

Method

DELETED

The project will participate only on the [redacted] shot. The GREENHOUSE 3.1.1 structure on Engebi (Janet) to be used in this test is 36 feet high, 52 feet deep and 196 feet long, and is composed of seven individual buildings of different types. The orientation of the normal to the front face is about 16° from the line of sight to ground zero. Because of this approximate symmetry, only the north end of the structure will be instrumented. Forty-eight Wiancko pressure gauges will be mounted in the faces of buildings one, two and three. In addition, twelve displacement gauges will be located in buildings two and three to measure response. Further, free field phenomena around the structure will be measured using one pitot tube and pressure gauges both in ground baffles and on towers up to 40 feet in elevation. The predicted overpressure that will be imposed is 14 psi.

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Support Requirements

All operations will be restricted to Engebi (Janet). Equipment will be transported to the shelter by routine means commencing about February 10. Normal support during the preparatory period will be required in handling personnel and material. Two small trailers and a portable calibration shelter will be lifted to Engebi during this period and subsequently removed prior to shot time. Access to the instrumentation and shelter will be necessary [redacted] to make final adjustments. This reentry, and reentry for recovery of data [redacted] will be dependent on radiological conditions and may be by boat or helicopter. Post operational recovery of equipment will be necessary. Total number of people: 9

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Project Officer: Mr. L. M. Swift
Stanford Research Institute
Stanford, California

Sponsor : DOD

[redacted]

PROJECT 3.1

LOADING OF STRUCTURES

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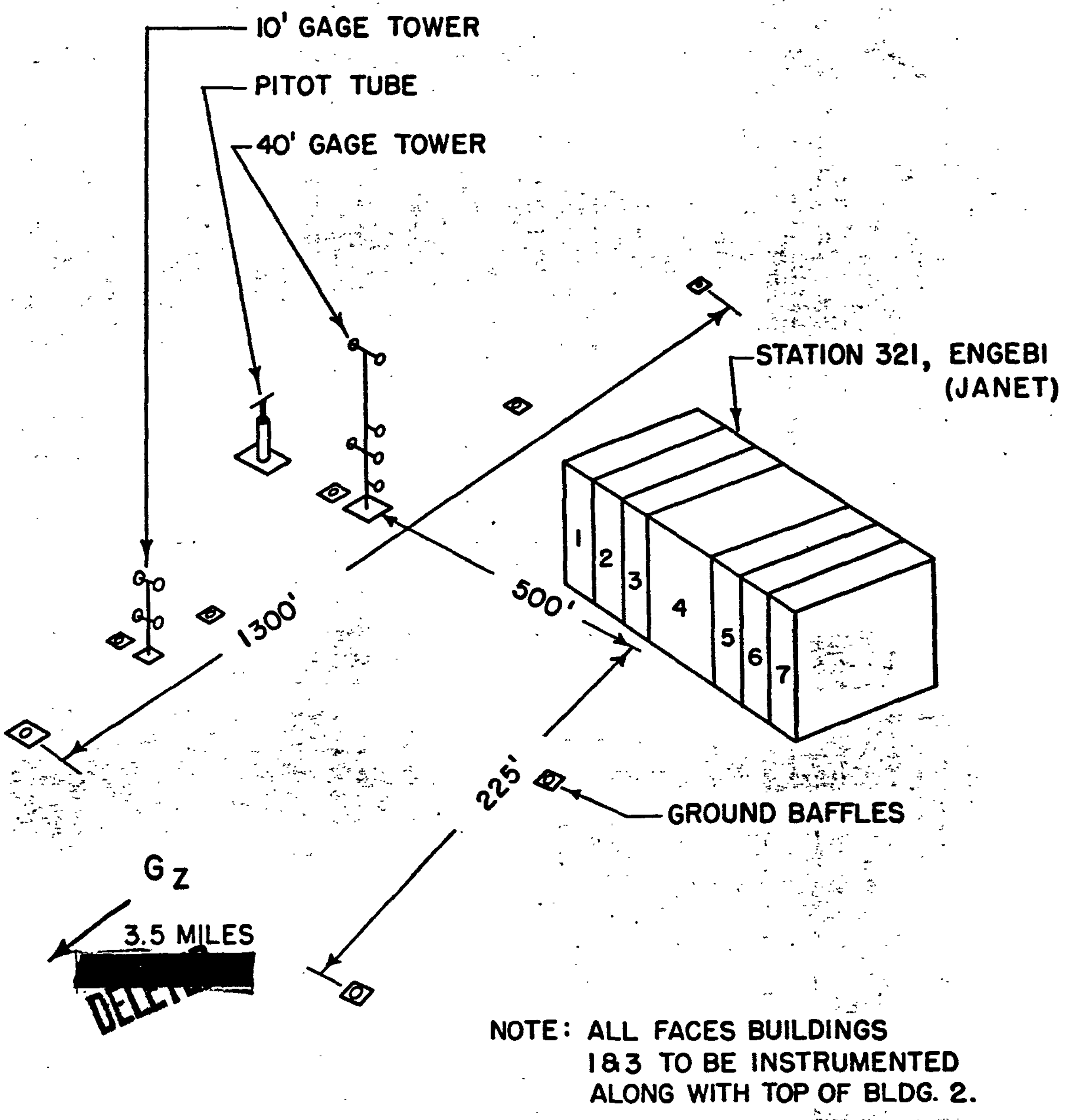

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PROJECT 3.2
CRATER SURVEY AND EVALUATION

The explosion of a nuclear device on a reef or over shallow water will form a crater, the size of which is dependent upon the yield of the device, the height of the burst, and the nature of the surface at that point. The true crater created by the explosion is obscured to some extent by the filling process caused by inrushing water and collapsing walls. The object of this experiment is to obtain dimensional data on the apparent craters formed by nuclear detonations under the two surface conditions above.

Method

Two measuring techniques will be used in this project:

a. Photo interpretation. The Army Map Service will employ stereoscopic photogrammetry to map the craters. By this technique it is expected to obtain the diameters of the craters for all shots and some detail of crater lips [redacted] DELETED

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b. Fathometer traverse of craters. A standard fathometer will be mounted on an LCU for traversing [redacted] craters. In addition, traverses will be made in the IVY-MIKE crater for test purposes. Traverses will be made on three lines spaced about 60° apart to secure bottom profiles.

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Support Requirements

Lookout Mountain Laboratory will accomplish the photography required using regularly assigned aircraft. The fathometer surveys of crater depth will be done by the project, using a modified LCU. An early survey (January) of the IVY-MIKE crater will be made to check out the equipment. It is desired to measure the other craters as soon after a shot as radiological conditions permit. The procedure used will be to establish three ranges through ground zero with Dan buoys and shore reference points. The buoys will be laid by the LCU. The LCU will then make passes through the crater on these lines taking readings at intervals along each line. The actual survey is expected to require 1 to 2 days and will be done about D + 4 days. Personnel will live on the vessel for these short periods. Total number of people: 7

Project Officer: Dr. R. B. Vaile
Stanford Research Institute
Stanford, California

Sponsor : DOD

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PROJECT 3.3
TREE STAND STUDIES

The objective of this project is to determine the attenuation of a shock wave due to a natural forest stand. Supplementing this, it is desired to determine blast damage to trees where effects are influenced by their location in a stand. Individual tree breakage data is also desired in a region of long positive phase duration in order to provide a basis for breakage and blow-down predictions.

This will be the first observation of the effects of a nuclear detonation on a natural tree stand. From previous experimental work, culminated by observation and instrumentation on an artifical tree stand in Operation UPSHOT/KNOTHOLE, a tree breakage prediction system is in preparation by the U. S. Forest Service presenting 90 per cent (severe damage) and 10 per cent (light damage) levels of probability. Project 3.3 will serve as a test of this prediction theory.

Method

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This project will participate in [redacted] only, making its measurements in a tree stand on Eniirikku (Uncle). The pressures within this stand will be measured with eight self recording gauges placed by Project 1.2b. The 'Q' force, or force exerted by the shock winds, will be calculated from theory and from measurements made by Project 1.3 on other shots. Snubbers, wires which run from the center of pressure on the tree stem to a friction grip on a ground stake, will be used to measure the maximum deflection. A few isolated trees outside the stand will be instrumented for comparison with those in the stand. 'Before and after' photographs of the tree stand will be used to document the damage.

Support Requirements

Laboratory space is required on Eninman (Tare). Total number of people: 2

Project Officer: Mr. W. L. Fons
c/o California Forest & Range
Experiment Station
Box 245
Berkeley 1, California

Sponsor : DOD

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[redacted]ON

PROJECT 6.2
BLAST, GUST AND THERMAL EFFECTS ON MANNED AIRCRAFT

The object of this experiment is to develop a theory whereby the blast, gust and thermal effects on aircraft in flight can be predicted with acceptable accuracy. To this end, a manned B-36 participated in IVY and UPSHOT/KNOTHOLE. The same B-36 will participate in CASTLE to proof-test the theory and obtain additional data to eliminate areas of uncertainty. An additional test aircraft, a B-47, is presently being proposed to provide further coverage.

Method

The present instrumentation in the B-36 will be reconditioned and augmented in areas of uncertainty, i.e., the empennage and fuselage. The aircraft will be instrumented and positioned by WADC, but will be maintained and flown by SAC, with flight planning to be coordinated with TG 7.4. A straight flyover pattern is desired but safety requirements may dictate a pattern similar to that used in IVY, in which a known position was reached at time zero. In any case, the aircraft will be on an outbound radial heading at time zero. Participation in shots [redacted] is planned.

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Support Requirements

The B-36 will be based at Eniwetok Island and will require the necessary maintenance and logistics services, to be supplied by TG 7.4. Laboratory space has been assigned in the scientific compound near the flight line in addition to supporting space requested from TG 7.4. Total number of people: 17

Project Officer: Mr. G. C. Miller
Wright Patterson AFB
Ohio

Sponsor : DOD

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PROJECT 6.4
PROOF TESTING OF ATOMIC WARFARE COUNTERMEASURES

A serious problem in naval operations would be presented by the radiological contamination of vessels as a result of fall-out from a nuclear detonation. This project proposes to study this problem as it relates to vessels and aircraft not in flight, and to proof-test existing and proposed countermeasures. A limited study of protective measures for harbor targets will also be made.

Method

Two drone liberty ships will be directed through the most likely fall-out area. One of these, TRANSIT ABLE, will carry protective measures, such as sprays to wash down the exposed surfaces of the ship while it is in the area of high activity, and monitoring systems which will telemeter the information on the activity levels to the control aircraft. The second ship, TRANSIT BAKER, will be similarly instrumented, but will have no protective devices. The relative contamination of the two ships during and after the run will afford a direct check on the merits of the protective measures employed.

The ships, with skeleton crews, will steam from the base at Eniwetok to a predesignated spot off Bikini Atoll, where the crews will be removed at about H-3 hours. The radio control aircraft, a P2V, will take over and direct the drones to a point 10 to 20 miles, depending upon the wind velocity, downwind from ground zero. After H hour, the ships will steam directly toward the zero point, presumably being subjected to fall-out a good portion of the time while on that path. A few miles from the atoll they will be directed to a rendevous with the recovery tugs, and will then be taken to Eniwetok. Here a detailed radiological survey of each vessel will be made to determine the effectiveness of the protective measures. Aircraft and test panels will be removed for survey purposes and decontamination studies, and the vessels thoroughly decontaminated in preparation for the next test.

DELETED Present plans include participation in shots [redacted] The project is closely associated with the fall-out studies of Project 2.5a and the panel studies of Project 6.5. DELETED

Support Requirements

The drone ships will be berthed off Parry (Elmer), with moorings also available at Bikini. The removal of the skeleton crews prior to shot time may require helicopters if the sea conditions do not permit the use of tugs for this purpose. Backup for the control from the P2V must be provided by an ATF and carrier aircraft.

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About 80 officers and men, ships crews, will be off-loaded [redacted] Since they will operate the ships during the test and return them to the west coast afterwards, it will not be possible to use them in the extensive decontamination operations, which will require large numbers of men in groups of 10 to 50 over a period of several days after each test. Men will be drawn largely from TG 7.3 and from other sources, and will require boat support. Personnel decontamination may be accomplished at a mobile center on a supporting boat, at the home units, or at the Rad Safe center on Parry (Elmer). If processed through Parry, escorts will be required since non-"Q" cleared personnel will be used.

The test aircraft, one per ship for each test for a total of six aircraft, will require an LCU or barge and a crane and dock mule ashore for off- and on-loading at Eniwetok (Fred). Handling at the ships will be by ships gear.

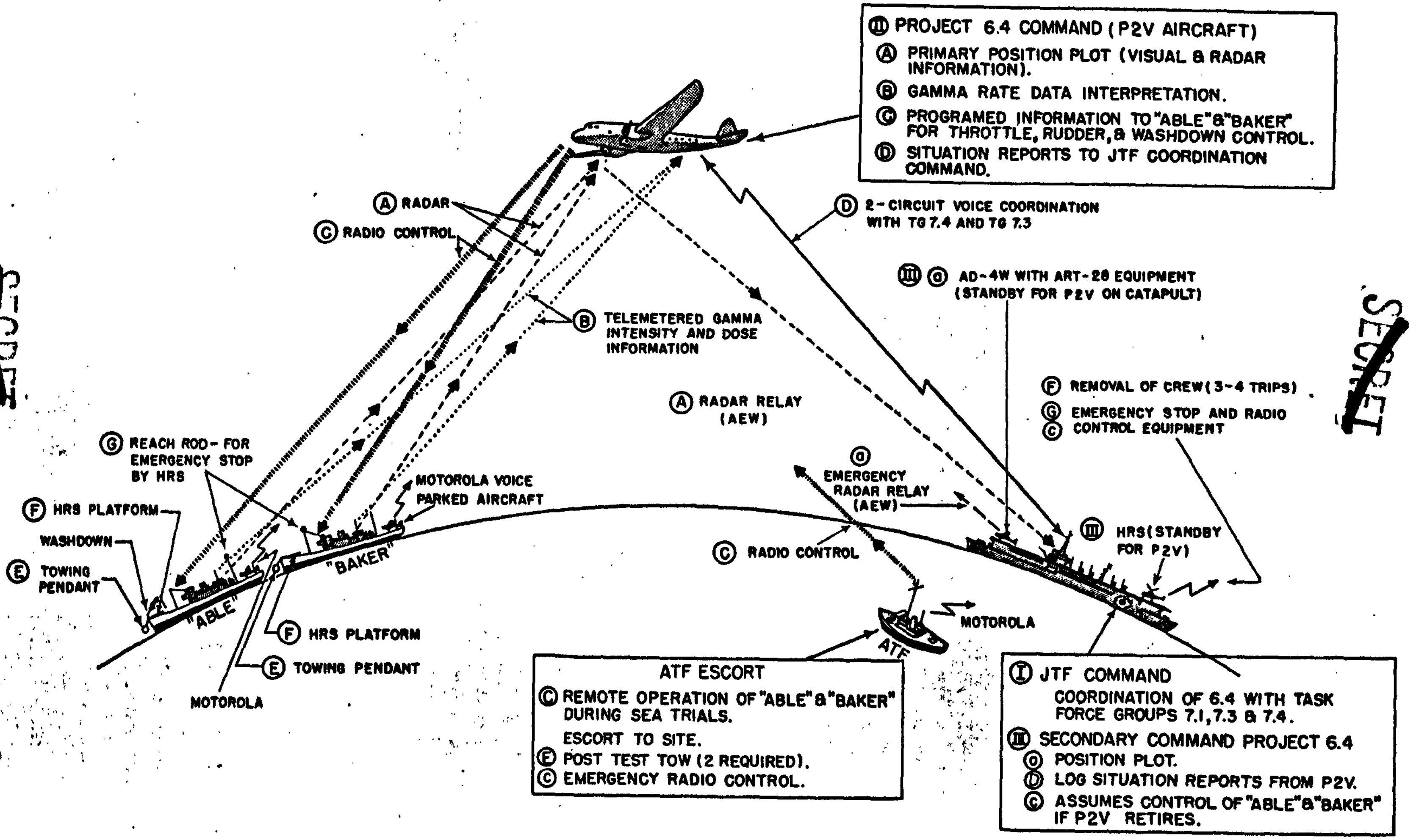
Total number of people: 151

Project Officer: Capt. G. G. Molumphy, USN
Bureau of Ships
Code 588
Navy Department
Washington, D. C.

Sponsor : DOD

PROJECT 6.4

PROOF TESTING OF ATOMIC WARFARE COUNTERMEASURES



PROJECT 6.5
DECONTAMINATION AND PROTECTION

This project is closely associated with Project 6.4. Its object is to determine the contamination and decontamination characteristics of representative harbor area construction surfaces and coatings when exposed to fallout from surface detonations over shallow water and land. Particular interest is concentrated on the wet contaminating particles since no field studies have been conducted under these conditions.

Method

A set of 14 construction material panels, each 4 feet square, will be mounted on each drone liberty ship of Project 6.4. These will operate in the heavy fallout areas [redacted] When the ships are returned to Eniwetok between shots, the contaminated panels will be removed to Parry (Elmer) for various types of decontamination procedures. Methods will include garden hosing, fire hosing, wet brushing, high pressure hosing with hot and cold water and steam cleaning. Intermittent radiation level readings will be made to determine the applicability of the different decontamination procedures. Project 6.5 will also perform operational procedures on Project 2.5a. fallout collectors on the drone ships.

Support Requirements

Panels will be decontaminated in an area adjacent to the Rad-Safe building on Parry (Elmer). It will be necessary to handle contaminated panels from the ships by boat and vehicle. Panels will be in frames with a total weight of about 3 tons and will require crane service. Crane, vehicle and boat support will also be necessary in rehandling to the drone ships. Supporting water and fuel service to the cleaning units will be necessary along with a storage tent. Panels will be returned to the ZI on board the drone ships. Total number of people: 5

Project Officer: Mr. J. C. Maloney
Chemical & Radiological Laboratories
Army Chemical Center
Maryland

Sponsor : DOD

PROJECT 6.6
EFFECTS ON THE IONOSPHERE

The objective of this project is to further investigate an ionosphere phenomenon recorded during Operation IVY that had not previously been observed in similar studies on GREENHOUSE, BUSTER/JANGLE and TUMBLER/SNAPPER. This phenomenon was the apparent increase in height of the F-2 layer and associated effects, beginning about the time the sonic wave from the blast would have reached the ionosphere. It is desirable to establish a cause and effect relationship for this phenomenon, because of its possible applications in long range detection and ionospheric research as well as predictions of radio transmission disruptions.

Method

A repetition of the IVY experiment will be conducted with some extension. Recorders will be operated at Parry (Elmer) and Rongerik Atoll for the Bikini shots [redacted] and at Enyu (Nan) and Rongerik [redacted] These will record heights of atmospheric layers by measuring the travel time of reflected radio signals. The signal will be radiated vertically by an antenna located beside the trailer housing the recording equipment. Sonic equipment capable of responding to periods as long as 10 minutes will also be operated in order to correlate sonic and ionospheric effects. Signals will be displayed on oscilloscopes and photographed for the record.

Support Requirements

The trailer on Parry (Elmer) will be moved to Enyu (Nan) [redacted] requiring space on an LST, and transfer to an LSU at Bikini (How). The other trailer will be moved to Rongerik Atoll about 1 January, to location which will have to be cleared. Support on Rongerik will be furnished by the Air Weather Service Detachment. Total number of people: 9

Project Officer: Capt. A. Giroux, USA
Evans Signal Laboratory
Belmar, New Jersey

Sponsor : DOD

[redacted]

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PROJECT 7.1
ELECTROMAGNETIC RADIATION CALIBRATIONS

The purpose of this experiment is to determine the characteristics of the electromagnetic pulses from nuclear detonations as a function of distance from the source.

Method

Equipment will be trailer mounted and located in an area of low background noise; at present its location is planned on Parry (Elmer). Fast sweep oscilloscopes with still and strip film data recording will cover the range of frequencies emitted. Additional stations outside the Task Force area will be established along northerly and easterly azimuths to obtain supplemental data relating to attenuation. The project will participate on all shots.

Support Requirements

One trailer will be located on Parry (Elmer) and will require positioning and utilities. In addition, a tent will be furnished in the scientific compound. Radio time notifications planned for Parry (Elmer) will be utilized. Telegraphic advices of changes in schedule and notification that the detonations have occured are required to specified addresses. After-the-fact knowledge of world time of detonation, accurate to the nearest millisecond will be required. This information is desired within 12 hours following an event. Total number of people: 4

Project Officer: Mr. J. A. Crocker
Headquarters, USAF
Office for Atomic Energy,
DCS/O
Attn: AFOAT-1
Washington 25, D.C.

Sponsor : DOD

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[redacted]

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[redacted]

PROJECT 7.2
DETECTION OF AIRBORNE LOW-FREQUENCY SOUND

The purpose of this experiment is to determine at long range the period, amplitude, velocity and azimuth of acoustic waves from atomic explosions.

Method

Generally, the method which will be used consists of microphones capable of detecting slight variations in atmospheric pressure (low frequency sound) caused by an atomic explosion thousands of miles away. By placing several microphones in a pattern and recording the "sounds" from each separately on a time record, it can be seen that an azimuth can be determined. If several such stations each get an azimuth on the explosion, its position can be plotted by triangulation. In the course of the azimuth measurement the period, velocity, and amplitude of the sound wave can be determined.

Acoustic equipment will be operated at existing experimental and operational stations located in Japan, Hawaii, Alaska, U. S. (east and west), Greenland and Germany. Each station will, in general, consist of three or more microphones located at the vertices of triangles or polygons, the sides of which will be 2½ to 14 miles in length. The microphones will be fitted with pressure averaging devices to reduce noise background and will send their signals to central recording stations. Standard equipment is available which is responsive to minute changes in atmospheric pressure in the frequency range from 1.0 to 0.01 cycles per second. In addition, special low-frequency equipment will be operated covering change of pressure or rate of change of pressure, for signal frequencies from 0.1 to 0.001 cycles per second.

The project will participate on all shots.

Support Requirements

After-the-fact knowledge of the time of detonation and location of each event is required. The requirement for time will be satisfied by that under Project 7.1. The locations of all shots are desired in degrees, minutes, and seconds of latitude and longitude. No personnel will be employed on site.

Project Officer: Mr. G. B. Olmstead
Headquarters, USAF
Office for Atomic Energy, DCS/O
ATTN: AFOAT-1
Washington 25, D.C.

Sponsor : DOD

[redacted]

[redacted]

[redacted]

PROJECT 7.4
CALIBRATION ANALYSIS OF A-BOMB DEBRIS

Radiochemical analysis of bomb debris as performed by Project 11.1 gives the bomb yield and efficiency when the bomb constituents are known exactly. AFOAT-1 is faced with the problem of obtaining this and other information on foreign nuclear detonations with no prior knowledge of the makeup of the bombs. The object in this experiment is to establish calibration or reference points, with data from analyses of gaseous and particulate debris from known bombs, for use in evaluating the data obtained by similar analyses of airborne debris from bombs of unknown origin, composition and design.

Method

Particulate and gaseous cloud samples collected under Project 11.2 will be divided among LASL, UCRL and AFOAT-1. The analyses of the AFOAT-1 samples will be performed by various contracting agencies and certain AEC installations under the technical direction of AFOAT-1. Surface fall-out samples, obtained from other projects, will be analyzed for correlation with the cloud samples. The project will participate in all shots.

Support Requirements

Laboratory space adjacent to the airstrip on Eniwetok (Fred) will be used for the handling of the gas sampling devices. Certain information is needed for the AFOAT-1 long range detection system, which will collect cloud samples independently of the CASTLE cloud sampling program. This information includes cloud dimensions, movement and characteristics, upper air data from Kwajalein, Ponape, Eniwetok, Kusaie and Bikini from H-12 to H+60 hours, and a preliminary yield estimate at H+12 hours.

Sample return flights to the ZI are required after each shot for the gaseous cloud samples. Project 11.2 handles the return of the particulate samples to the ZI; when these are divided, the AFOAT-1 portions will require a couriered flight to their destination. Total number of people: 13

Project Officer: Mr. Walter Singlevich
Headquarters, USAF
Office for Atomic Energy, DCS/O
ATTN: AFOAT-1
Washington 25, D. C.

Sponsor : DOD

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[redacted]

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PROJECT 9.1
CLOUD PHOTOGRAPHY

The objective of this project is to record cloud formation phenomena by photographic means in order to supply data which may be used in studying both the high yield bomb delivery problem and the correlation of fallout with cloud drift.

Method

Aerial and ground photography will be employed on all shots in order to determine the spatial dimensions and location of the atomic cloud as functions of time. The accuracy of these determinations is expected to be approximately 10% from zero time until the cloud attains its maximum height and approximately 25% thereafter.

The RB-36 and three C-54 aircraft used by Lookout Mountain Laboratory for documentary photography will be equipped with gyro-stabilized cameras for the needs of this project. Synchronized readings for clock timing, azimuth and camera tilt will be recorded on each negative. The RB-36 will operate above 30000 feet for about 10 minutes after zero time, while the C-54's will be at some lower altitude, about 10000 feet, depending upon local cloud cover. Photography from the latter aircraft will continue until the atomic cloud dissipates.

Motion picture cameras will record the early history of the cloud development from ground stations, as part of the requirements on EG&G under Project 13.2. This photography both ground and aerial, will cover all shots.

Support Requirements

Support of photography will be as required by EG&G and Lookout Mountain Laboratories in carrying out their respective missions. The aircraft will be based on Eniwetok (Fred) and will require maintenance and logistics services. All personnel will be carried under EG&G and Lookout Mountain allotments and are not listed separately.

Project Officer: Lt. Col. Jack G. James, USAF
Commanding General
Field Command
ATTN: CTU-13
Sandia Base
P. O. Box 5100
Albuquerque, New Mexico

Sponsor: DOD

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Radiochemistry

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New TITLE

PROJECT 11.1
ANALYSIS FOR FISSION AND FUSION ENERGY YIELD

Yield measurements of a nuclear explosion are highly important to the theoretician who designed the device, to the experimenter, who uses the yield figure in evaluating the results of his experiments, and to the military, looking at the effects aspects. By means of accurate yield figures, one is able to confirm or deny scaling laws, and add to our total knowledge of nuclear explosions.

There are several methods of determining yield. Most of these give results which involve a comparison with empirical data assembled from previous detonations, such as bhangmeter and pressure measurements. An absolute measurement would be one in which the total amount of fission and fusion material consumed in the blast is determined, and the yield calculated from the known energy release per fission and fusion. While the absolute method of fission yield measurement is well established, the measurement of fusion yield by radiochemistry is still on an experimental basis.

Method

A total yield determination by radiochemistry, as stated above, requires a knowledge of the number of fissions and fusions which have occurred in the blast. In the fission process, a number of product nuclei are created in amounts which have been established by experimental work. The radioactive isotope Mo^{99} is one of these fission products whose "yield" from a given number of fissions is well known. If the fission products of a bomb are collected, and the amount of Mo^{99} determined by first separating, then counting it, the analyst can calculate the number of fissions which occurred. Unfortunately, he must do this work on only a small portion of the fission products, that microscopic portion picked up by the sampling aircraft as they pass through the cloud. It is then necessary to find out what percentage of the total number of fissions this small sample represents. This is generally done by choosing one of the fissionable components of the bomb, say U^{235}, and determining the fraction of U^{235} from the original bomb which can be found in the sample. This fraction must include, in addition to those U^{235} nuclei which fissioned, as given by the number of fission products, those which underwent reactions by the capture of neutrons. Generally, a figure for the capture to fission ratio is used for this number. Thus, by determining the number of fissions in the sample, and the fraction of the unexploded bomb which the sample represents, the analyst arrives at a figure for the total number of fissions which took place. Multiplying this by the energy release per fission, determined experimentally, gives the total yield from fission.

[redacted]

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Evaluating the fusion yield involves somewhat different techniques. Here the products formed, helium, hydrogen, and tritium, are not readily susceptible to measurement. Instead it is necessary to count the number of neutrons which arise, one per reaction, out of the fusion processes. These neutrons have on the average around 14 Mev of energy. Hence, neutron detectors* whose thresholds are around that figure may be used to count the total number of neutrons. But it is necessary, in order to reduce error, to incorporate these detector elements inside or very close to the bomb so that the flux of high energy neutrons will not be greatly reduced in traveling through the bomb material and case. The detectors are vaporized in the fireball and become thoroughly diffused throughout the cloud; the sample fraction determination as made during the fission analysis applies here as well. Thus, in principle, by counting the number of reactions induced by the fusion neutrons and applying the cross section, or the probability per second of the reaction occuring in unit neutron flux, the number of neutrons from fusion processes can be calculated and the total energy released determined.

This discussion has ignored special problems and uncertainties involved in these determinations, such as fractionation** and other errors involved in securing a representative cloud sample. It is necessarily an oversimplification of the great amount of detailed analysis which must be done in order to secure reliable yield figures.

Support Requirements

This project will be based entirely in the ZI. Its overseas functions will be carried out by Project 11.2.

Project Officer: Dr. George A. Cowan ~~Dr. Roderick W. Spence~~
Box 1663
Los Alamos, New Mexico

Sponsor : AEC

* Refer to Project ~~2.3~~ 2.5.1

** Fractionation here refers to the preferential separation of elements which can occur due to a number of complex mixing and condensation processes. Unrepresentative samples are the result.

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[redacted]

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PROJECT 11.2
SAMPLE COLLECTION Sampling

This project has the responsibility of obtaining samples of the radioactive particulate bomb debris for projects 11.1, 11.3, 21.1, 21.3 and 7.1, and gas samples for Projects 7.4 and 21.4. These are samples from the main bomb cloud as distinct from the fallout samples collected by other projects.

The top of the cloud from a high yield weapon can rise to tremendous heights, well beyond the altitude capability of present aircraft. The planes are necessarily restricted to taking the samples from the lower sections of the stabilized cloud, and may not collect material which is representative of the total radioactive and unburned nuclear material remaining after the explosion. By comparing samples taken at various levels in the cloud the errors induced by this limitation may be reduced. ~~With the cooperation of Projects 2.5a and b, surface fall-out samples will also be collected to permit comparison of sample composition over a large range of collection altitudes.~~

Method

There will be ~~15~~ 10 F-84G's and ~~three B-36's~~ six B-57B's assigned to this project. ~~All will be cloud samplers except one B-36, which will act as a control aircraft.~~ Insert #1 The project leader will observe the cloud formation from this vantage point and will vector the aircraft through portions of the cloud at various altitudes. The F-84G's will each carry a gas sampler and two particulate samplers, making their runs in pairs so as to obtain a sufficient quantity of matter. It is hoped that the ~~B-36's~~ B-57B's with their higher ceilings will be able to penetrate at 50,000 feet or higher.

The particulate sample collectors are modified wing tanks which can be opened to the airstream by the pilot upon entering the cloud. Filter papers in the midsection remove the particles from the air, in effect sweeping out a volume of the cloud determined by the cross sectional area of the collector vent and the rate of air flow through it.

On some aircraft the gas samples are collected by means of a "snap" sampler which fills a plastic bag with approximately 15 cubic feet of gases and air when the pilot triggers the device. On other aircraft this sample is obtained by means of a newly developed high pressure pumping system which can be used to obtain a much larger volume of gas sample. Approximately ten of the F-84G's as well as the ~~two~~ sampling ~~B-36's~~ will be fitted with the new type of sample collectors. The remaining five F-84G's will carry the "snap" type samplers. (leave a blank space)

The conduct of the sampling mission is based on a pre-shot analysis of cloud phenomenology and is guided operationally by the absolute and

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relative indications of radiation instruments carried by the aircraft. Throughout the course of the sampling operation from approximately H + 2 to H + 6 hours, the maneuvers executed by the pilots will vary with the changing radiation conditions, which drop from hazardous to lower intensities as radioactive decay and cloud dispersal take place. In order to reduce both the hazard of an inadvertent high radiation exposure during the initial phases and the total exposure required to obtain the necessary amount of radioactive matter, the pilot is shielded to the greatest extent possible. The very nature of the mission however, makes it unavoidable that the pilot will acquire a controlled amount of radiation exposure on each flight. The final total exposure is measured by film badges and the maximum permissible exposure is established by Rad-Safe.

The filter papers and the gas samples are removed from the planes upon their return to Eniwetok, and dispatched to the interested agencies.

There will be a possible addition of other type aircraft to this project, a B-29 to augment the lower altitude sampling of the F-84's and a B-57 for the evaluation of its high altitude sampling capability.

Support Requirements

The sampling aircraft will be based on Eniwetok (Fred) and will require normal maintenance and logistic support. ~~A helicopter will be needed for the recovery of surface samples.~~ That portion of the cloud samples, gaseous and particulate, to be analyzed in the Parry (Elmer) laboratories will require transportation by helicopter or light plane, and boats. The remainder of the particulate samples will require ~~at least two~~ aircraft for delivery to either UCRL or LASL, depending upon the shot, where they will be further divided between UCRL, LASL, and AFOAT-1. Aircraft will then be needed to make the final distribution. Total number of people: 3

Project Officer: Dr. Harold F. Plank
Box 1663
Los Alamos, New Mexico

Sponsor : AEC

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PROJECTS 11.2 & 21.2

CLOUD SAMPLING

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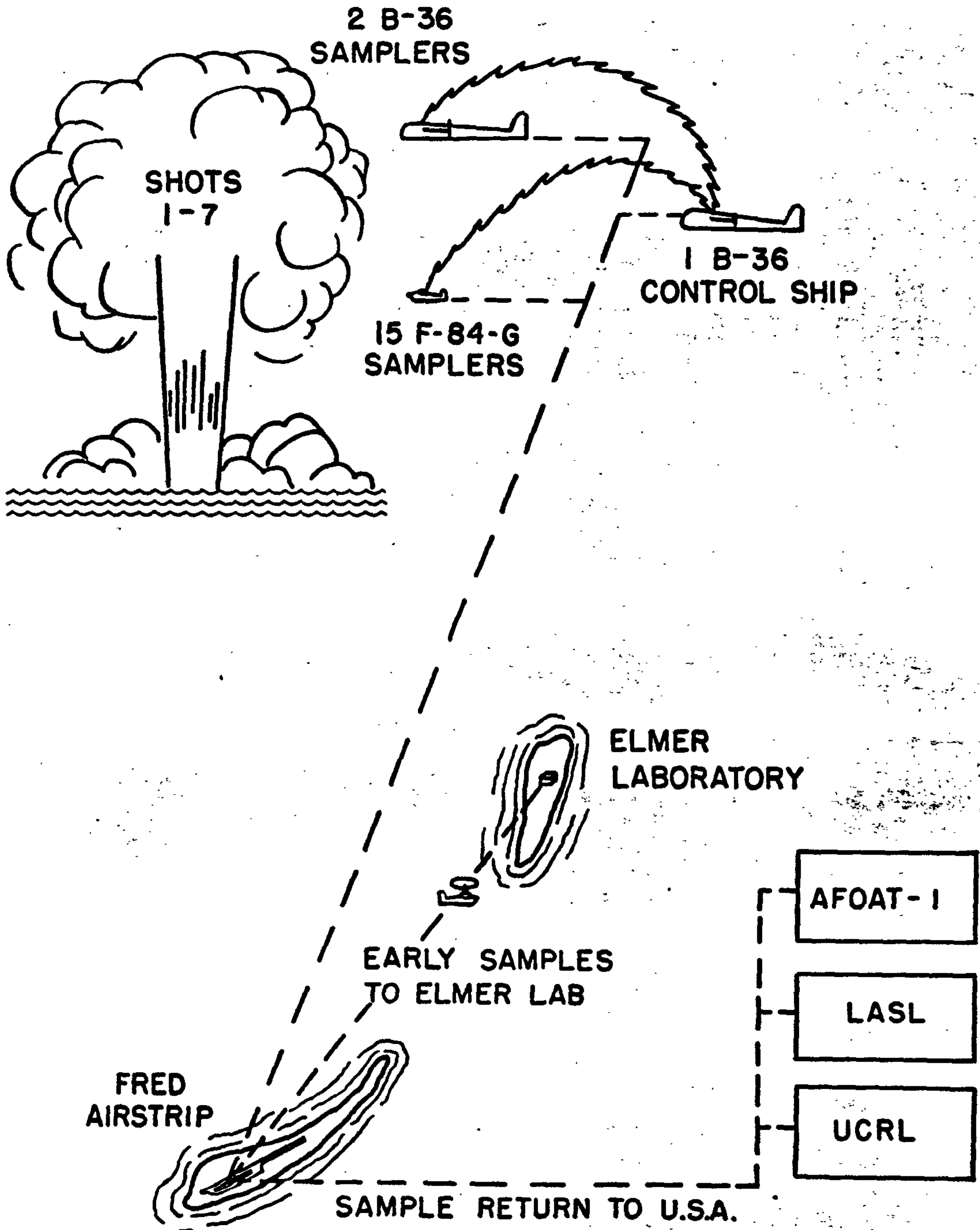

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PROJECT 11.3
HEAVY ELEMENTS INVESTIGATION

The term "heavy element", for the purposes of this project refers generally to those elements having a mass number greater than that of normal uranium. These are produced in a thermonuclear detonation by neutron bombardment of the unfissioned uranium. A quantitative study of the production of these heavy elements, and the discovery of new elements, will be of value to nuclear physics.

__Method__

The first few cloud samples to arrive at Eniwetok (Fred) from each shot will be taken immediately to Parry for chemical separation and counting. Thirteen people will be involved in this work, four from LASL and nine from UCRL, this being a joint enterprise of the two laboratories.

The remainder of the cloud samples will be couriered to the ZI where the work of this project will be continued on the longer half-lived isotopes, in conjunction with the work of Project 11.1.

__Support Requirements__

The delivery of the early samples by air to the Parry laboratory is the only outstanding requirement for this project. Total number of people: 13

Project Officer: Major Charles Browne
Box 1663
Los Alamos, New Mexico

Sponsor : AEC

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PROJECT 12.1
[redacted] REACTION HISTORY

Reaction history refers to a record of the development of a reaction, thermonuclear in this case. It attempts to give a quantitative picture of how and when a number of related events occur during the active lifetime of the device. This experiment is designed to answer questions relating to weapons material and design by measuring the time interval between the fission and fusion processes, the temperature attained during the latter, and certain peculiarities associated with the design.

Method

The information will be derived from experiments of the type called ganex and tenex. A ganex (gamma-neutron experiment) determines the rate of production of neutrons as a function of time by measuring the gamma radiation flux produced by the neutrons in a "converter" close to the neutron source. These gamma rays arrive at a scintillator-detector system where a current is produced which is proportional to the radiation flux. This current is displayed as a signal on an oscilloscope and photographed.

Tenex, or temperature neutron experiments, are designed to measure the temperature attained during the fusion process. This temperature is directly related to the efficiency of the device, higher temperatures meaning that a greater amount of material will "burn", and coincidentally, a greater number of neutrons will be produced. The signal derives from those neutrons escaping from the case with few or no collisions, which then travel some distance to the detection system. The signal displayed on the oscilloscope is, with some corrections, the neutron energy spectrum, since the distance the neutrons must travel will separate their arrival time according to their velocities and hence, their energies.

There will be an array of 12 eight-inch pipes held at a partial vacuum, one-tenth atmosphere or less, through which the various signals will pass from the device to the detectors. Some of these pipes will look at the same region of the fission bomb from various angles, this multiangle view serving two purposes. First, by comparing the ratio of the ganex signal strengths for different angles, the thickness of the bomb material, [redacted] may be determined as a function of time. This measurement will give a clearer picture of details of the bomb disassembly. Secondly, the multiangle view will be used to correct the observed tenex spectra for the Doppler shift caused by the directed motion of the source in the bomb disassembly period. This source motion would appear as a shift in the apparent energy of the neutrons, and an increase in the width of the spectra. The corrected width of the 14

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10

Mev neutron peak will be used to determine the temperature of the burn, and the shift in energy will give the disassembly velocity. Another one of these pipes will view the initiating bomb directly to obtain the alpha* of the fission phase.

The twelve vacuum pipes will extend 2500 yards from ground zero to the detector station on Namu (Charlie).

Support Requirements

Four shop and stock room trailers, located on Namu during the pre-shot period, will be needed on Eninman (Tare) and Eberiru (Ruby) for the UCRL shots. An 'A-frame' truck and other transportation will be required for work on the pipe system. Film will be recovered by helicopter. Total number of people: 86. This includes personnel of Program 22.

Project Officer: Dr. Stirling Colgate
University of California
Radiation Laboratory
Livermore Site
P. O. Box, 808
Livermore, California

Sponsor : AEC

* Refer to Project 15.1

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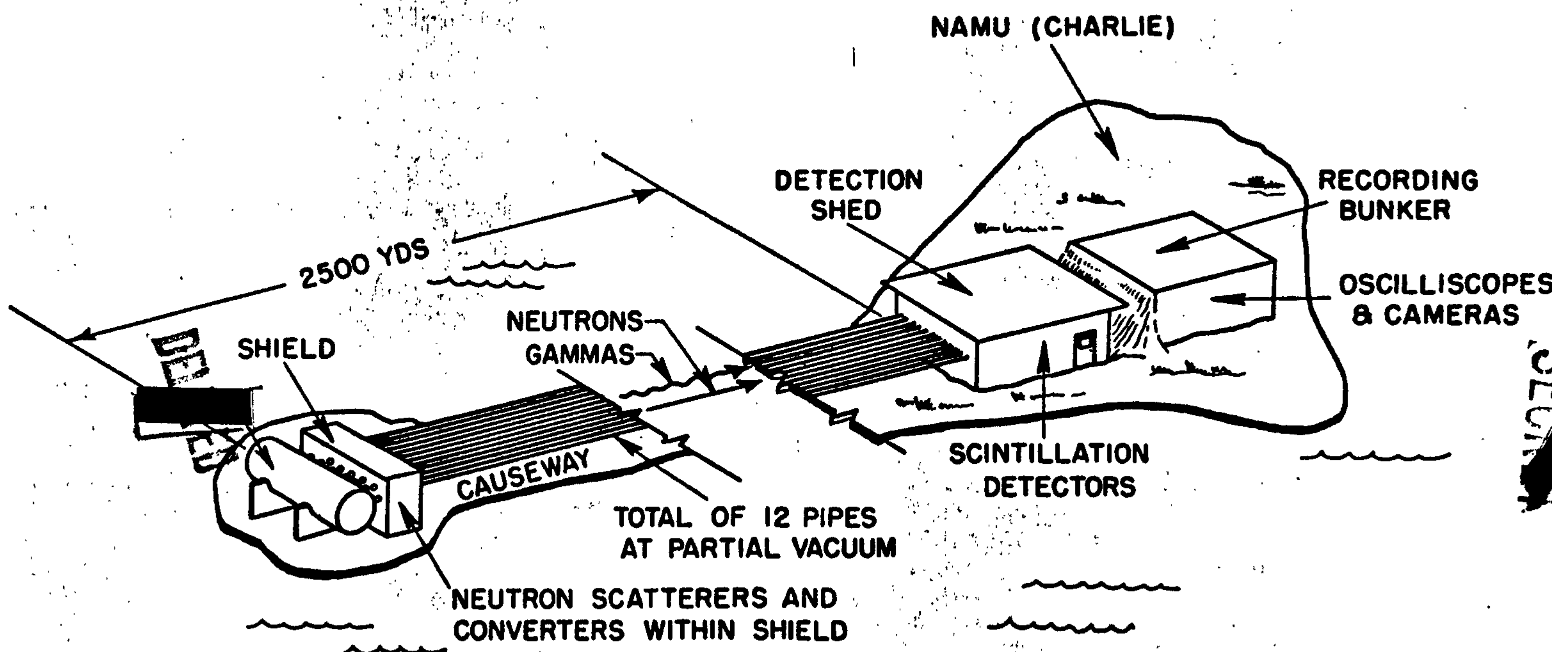
PROJECT 12.1

[redacted] REACTION HISTORY



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PROJECT 12.3
[redacted] REACTION HISTORY ~~SECRET~~

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This project is concerned with diagnostic measurements of events [redacted] Reaction History intimately related to certain design features. An attempt will be made to document the rate of growth of the "burn", or what may be called the alpha of the fusion process, in fine detail so that peculiarities in this process may be examined directly. Since the entire process involves time of the order of [redacted] the experiment is designed to have a high degree of resolution in order to "see" the series of events occuring in that process. The time interval between the fission and fusion reactions will also be measured.

Method

The gamma rays produced by the fission and fusion processes will be detected by phosphors in a bunker on Yurochi (Dog), 2300 yards away from the shot barge. In order to achieve the time resolution desired, the signals will be collimated in a series of four baffles, each with eight holes to provide eight separate channels of information. The collimating holes will restrict the field of view of the phosphors to those gamma rays either not scattered, that is, suffering no collisions on their path to the phosphors, or those scattered through relatively small angles. Large angle scatterers are largely eliminated in order to reduce the smearing of the signal caused by their later time of arrival, due to the greater path length traversed. The degree of collimation is necessarily restricted by the motion of the barge due to wind and wave action.

The primary bomb signal will initiate the sweeps of a few oscilloscopes, arranged so as to display the signals from both reactions, thus giving the time interval between the two. Other scopes will be delayed in time so as to display only the secondary bomb signal; on these the sweep speeds will be increased to show the signal in the fine detail desired. The amount of delay will be varied among these scopes to cover the range in error of the calculated time interval between reactions. Still other scopes will use a 'Rossi Display', in which the incoming signal is used to displace horizontally a constant sinusoidal signal applied to the vertical plates, the amount of the displacement being proportional to the signal strength.

Support Requirements

Film recovery can best be made by helicopter as soon after shot time as feasible. There are no further special requirements other than the movement of the shop and stock trailers involved in this project. Total number of people: 19

Project Officer: Dr. Bob E. Watt
Box 1663
Los Alamos, New Mexico

Sponsor : AEC

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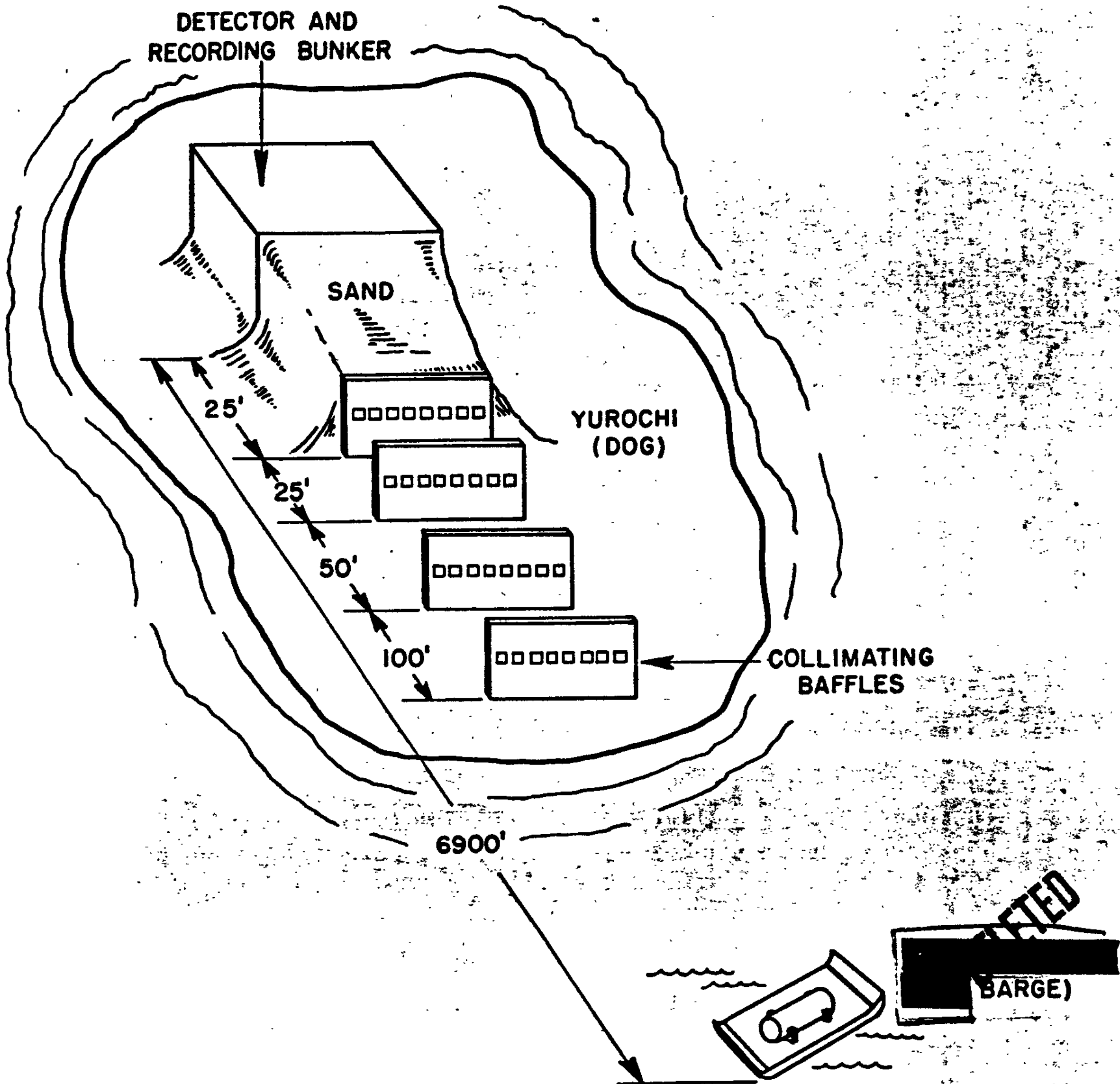
DELETED PROJECT 12.3

[redacted] REACTION HISTORY

[redacted]



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PROJECT ~~[illegible]~~ 10.1
~~BALL OF FIRE PHOTOGRAPHY~~ Fireball Hydrodynamics

A standard means of determining the yield of a nuclear detonation is the 'Ball of Fire' method, which uses data obtained from photographs of the fireball during early growth prior to breakaway. This now appears to be an absolute method for total yield, based on Porzel's analytic solution of the equations governing the motion of the shock wave, without references to previous shots or assumptions of scaling laws. From the photographs of the fireball, the log radius versus log time curve is constructed; the radius, time, slope and curvature of this curve are the values used in determining the yield, taking into account the difference in characteristics of the air and material within the fireball and those of an ideal gas.

The approximate yield figure is also obtained, using the simple "ϕ^5"* scaling method, which is based on a comparison of the diameter at a characteristic time with the data obtained from previous shots of known radiochemical yield.

Method

Data for this project will be furnished by Project 15.1.

The photographic techniques will be similar to those used in previous operations, the camera sites being carefully surveyed so that the film may be calibrated to yield an accurate diameter. Eastman (2500 and 500 frames/sec), Mitchell (100 frames/sec), Rapatronics (single, delayed exposure) and GMX Model Seven (100,000 frames/sec) cameras will be placed on Enyu (Nan), Bikini (How) and Eniman (Tare) for the first three shots, on Enyu and Bikini for the fourth, and on Parry (Elmer) and Engebi (Janet) for the shots on Eniwetok Atoll.

Support Requirements

The requirements for this project are ~~included in the general requirements of the firm of Edgerton, Germeshausen and Grier, contractors for much of the technical photography required during the operation.~~ small and include office and living space for two men at Parry and/or on the TG 7.1 Command Ship.

Project Officer: ~~Mr. Herbert E. Grier~~ Joseph C. Mullaney
~~Edgerton, Germeshausen and Grier Inc.~~ Box 1663
~~160 Brookline Avenue~~
~~Boston 15, Massachusetts~~ Los Alamos, N. Mex.

Sponsor : AEC

* $W = A\phi^5$, $\phi = \frac{R}{t^{2/5}}$, where W is yield in kilotons, A is considered a constant for given conditions, and R is radius of the fireball at time t after zero.

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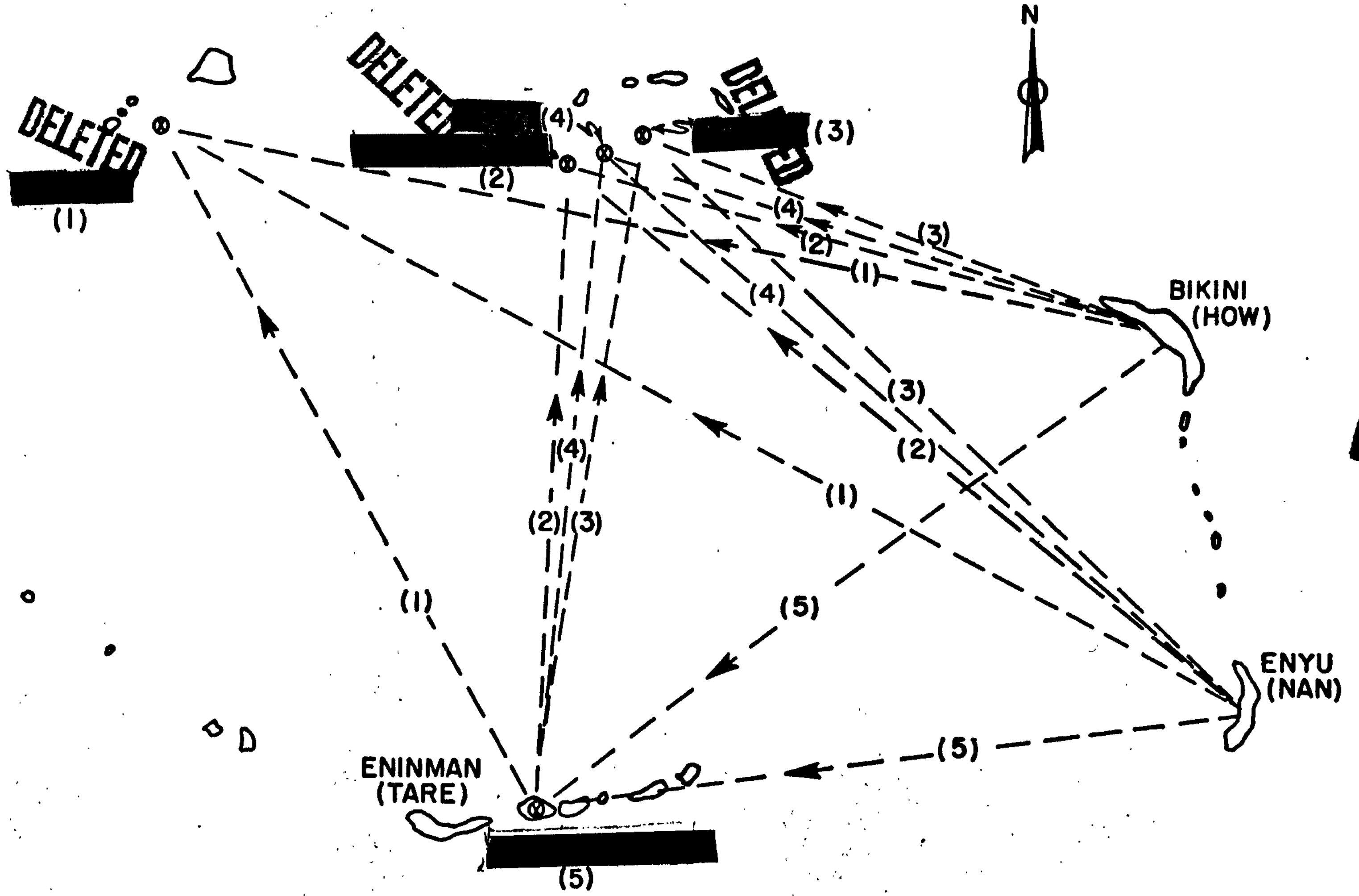
PROJECTS 13.1, 13.2, 13.3, 23.2

EG&G CAMERA LOCATIONS
(Bikini Atoll)



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PROJECTS 13.1, 13.2, 13.3, 23.2

EG&G Camera Locations
(Eniwetok Atoll)

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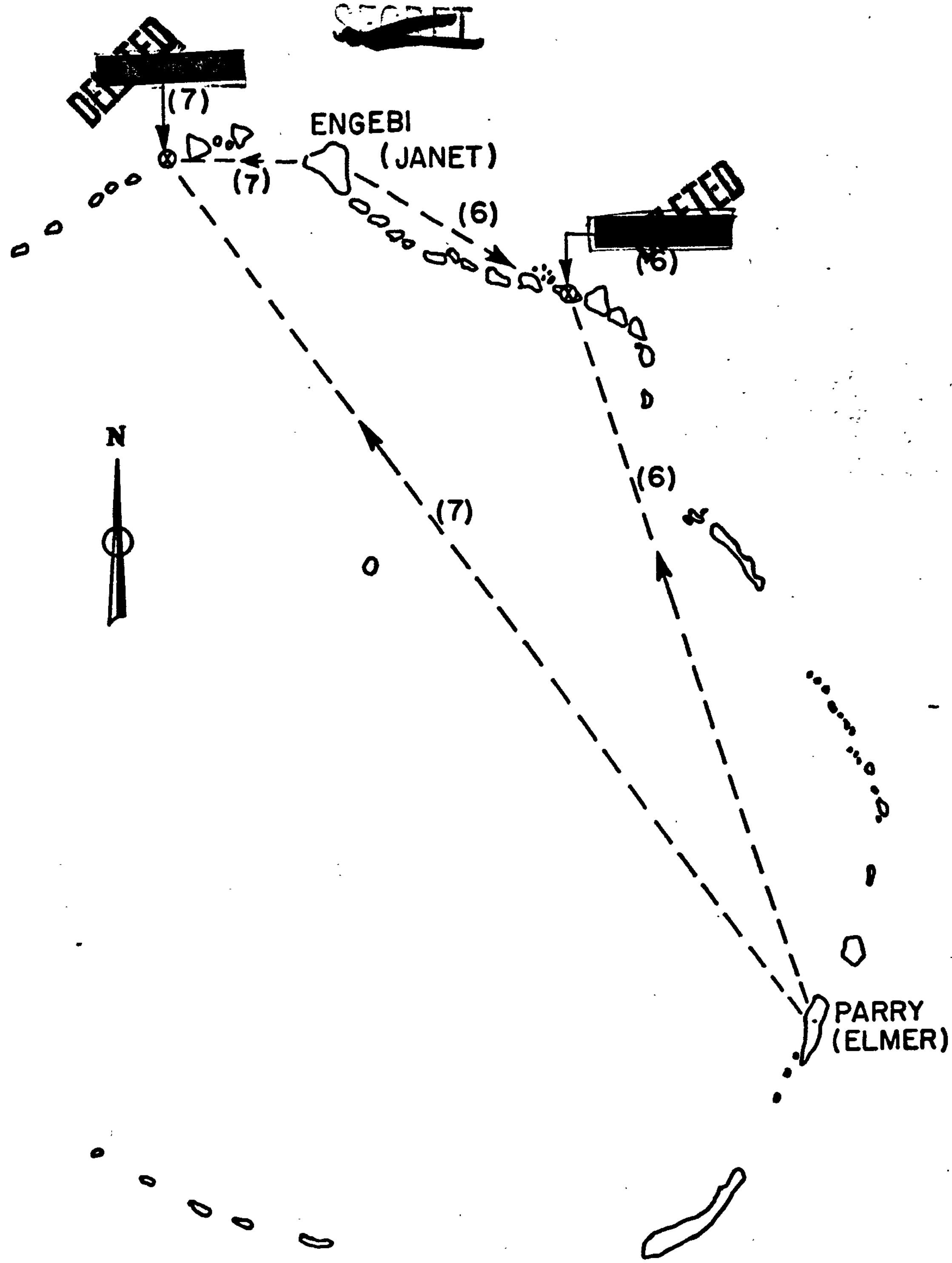

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PROJECT 13.2
CLOUD PHOTOGRAPHY

The photographs taken in this project will document the early cloud development, and depending upon atmospheric conditions, late cloud development as well, supplementing the data to be obtained in Project 9.1.

Method

In general the photographs used in this study will be those taken as part of the total photographic requirement of EG&G, with the additional requirement that the location, field of view, and timing of the cameras be established so that the cloud development can be followed in space and time.

The specific cameras to be used in this program are the Mitchell Hi-speed, standard movie, aerial mapping, and Robots, which take pictures automatically at definite time intervals. These will be distributed between stations on Bikini (How), Enyu (Nan), and Eninman (Tare) in the Bikini Atoll, and on Parry (Elmer) and Engebi (Janet) on Eniwetok Atoll.

Support Requirements

Requirements for this project are included in the total requirements for EG&G.

Project Officer: Mr. Herbert E. Grier
Edgerton, Germeshausen
& Grier, Inc.
160 Brookline Avenue
Boston 15, Massachusetts

Sponsor : AEC

[redacted] *see sheet*

PROJECT 13.3
BHANGMETERS

The Bhangmeter represents an attempt to secure an inexpensive and simple means of determining the yield of a nuclear bomb. It records the variation in time of the visible light from a bomb from the first appearance of the light through the minimum and part way up the second maximum*. It has been found that the time from the first light to the minimum varies with the yield of the bomb. This time can be compared with Bhangmeter data on previous shots of known yields to determine roughly the yield of the new device. Since the advent of thermonuclear devices it has been found necessary to redesign the Bhangmeter to enable it to follow the greater variation in light intensities for longer times. The Bhangmeter program can therefore be considered primarily a development and calibration test. (1)

Method

The Bhangmeter consists essentially of a photomultiplier tube which views the light and emits a current, an oscilloscope on which the current is displayed as a signal, and a camera which records the signal. An electronic timer interrupts the sweep of the oscilloscope momentarily at definite time intervals to provide the time reference. (2)

Bhangmeters will be located at the EG&G stations on *the Cutting,* Enyu (Nan), and Parry (Elmer) to cover the respective shots.

Support Requirements

The requirements for this project are included in the total ~~photographic~~ requirement of EG&G *listed under Project 13.1.* (3)

Project Officer: Mr. Herbert E. Grier
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1622 South "A" St ~~160 Brookline Avenue~~
Las Vegas, Nevada ~~Boston 15, Massachusetts~~

Sponsor : AEC

* This variation occurs because of the opacity of shock-heated air. After the air 'recovers', the bomb light is once again seen, this being the second maximum.

73

[redacted]

PROJECT 15.2
J-15 ~~HIGH SPEED~~ PHOTOGRAPHY

A portion of the energy released by the initiating bomb in a thermonuclear weapon is seen as light emission from the bomb case. Photographing the progress of this light will tell something of the nature and behavior of the detonation from its initiation thru the stages of case expansion, thermonuclear reaction and case disassembly. Knowledge of these events and their places in time can be invaluable to those concerned with the design and theoretical problems involved in thermonuclear devices.

__Method__

A bank of high speed framing cameras will record the development of the reaction, observing the progress of the light from the initiating bomb, the case expansion, disassembly and the early growth of the fireball.

Two types of cameras will be used, the GMX model six (~3 million frames/sec) and model seven (~ 100,000 frames/sec). The faster cameras will observe in detail the processes described above, while the slower will document the very early fireball growth. The latter cameras are actually a part of Project 13.1, and their operation a responsibility of EG&G; the data obtained from these early growth pictures will be combined with those from other photographs for a nearly continuous record of the fireball growth. Their discussion here seems appropriate since they are quite similar in operation to the model six cameras.

These cameras obtain their high framing rate by using rotating mirrors to reflect images onto a series of lenses, each one of which focuses an image upon a section of strip film. In effect, the action is stopped each time the rotating mirror face reflects light onto one of the lenses. Since the mirror face has a certain angular velocity, and the distance between lenses in known, the time between individual frames can be established, thus giving the time interval between observed events.

These cameras will be used on all LASL shots. ~~In addition, on~~ [redacted] a 'Hot Spot' experiment will be conducted. In this, Bowen cameras, which are discussed under Project 13.5, will observe certain isolated points on the bomb case through a pipe and mirror array which blocks out all other light from the bomb. The Bowens will record the appearance of light at each of the selected points, thus providing data for calculations of bomb operation.

Since the attenuation of light is a critical factor in this ex-

[redacted] EG&G

periment, the transmission along the light path will be monitored continuously by ~~Project 18.4~~ EG&G, starting several hours before zero time. Should the transmission drop so low as to jeopardize the success of the experiment, the go-no go system will prevent the firing of the bomb.

~~The bunker locations for this project are given in the accompanying sketch.~~

Support Requirements

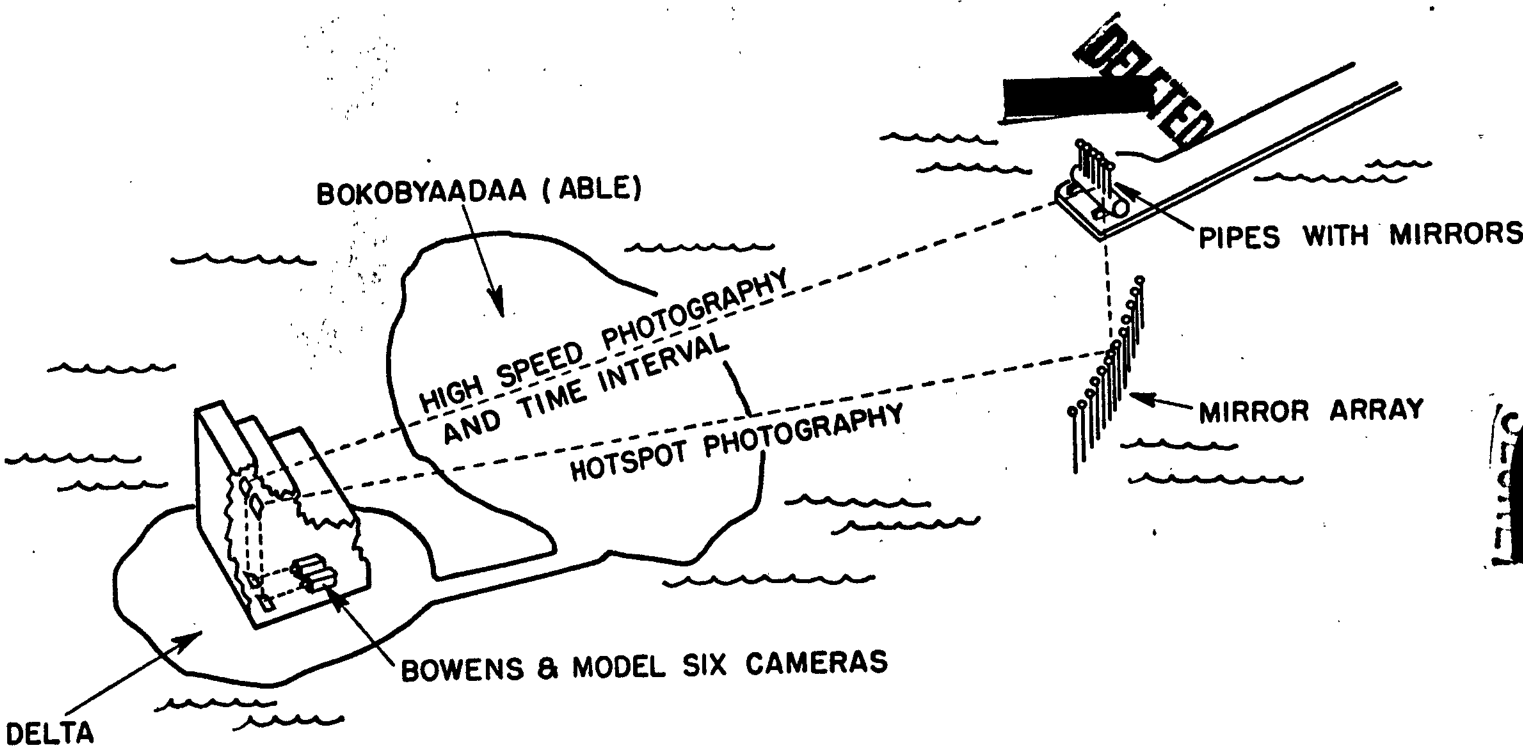
A DUKW, ~~full time,~~ fitted as a house-boat, and an LCU, ~~part time,~~ day, will be required for work on mirror alignment. Film recovery is to be by helicopter. There are five trailers associated with this project. Total number of people: 14.

Project Officer: Dr. Gaelen L. Felt
Box 1663
Los Alamos, New Mexico

Sponsor : AEC

PROJECTS 13.4 & 13.5

HIGH SPEED PHOTOGRAPHY & TIME INTERVAL WITH BOWENS



Note: Similar installations, less 'hot-spot' mirror array, on Aomoen (George) for [redacted] and on Bogallua (Alice) [redacted]

~~SECRET~~

PROJECT ~~13.5~~ 23.3
TIME INTERVAL ~~BY BOWENS~~ measurements

This program will measure the time interval between fission and fusion reactions by measuring the time between appearances of the 'Teller light'. This light, very short in duration, is produced by the interaction of gamma rays and neutrons with the air near the case. The time between appearances of the two lights can be measured by photographing them with a camera operating at a known speed. 23.3

Method

The Bowen camera employs a rotating mirror, with eight reflecting surfaces, to reflect light on a strip of film. This mirror rotates at high speed, so that one of its faces, in the proper position at zero time, travels thru some angle between the appearances of the two lights. This change in reflection angle separates the two images by a distance dependent upon the rotational speed of the mirror and the distance of the film strip from the mirror face. The time interval between the two reactions can be determined from the measured separation on the film and the measured writing speed. To prevent double exposure of the film, a shutter blocks out the bomb light before a second mirror face can come into position. This shutter consists of a small detonator butted against a clear glass plate in front of the lens system. A 'blue box', which detects the bomb light with a photocell, fires the detonator, shattering the glass and rendering it more or less opaque. Mechanical shutters and blast doors close at a later time before the arrival of the shock wave.

The Bowens will measure the time interval on all LASL shots from the bunkers of program 13.4.

Support Requirements

Helicopter recovery of exposed film is required after the Mohawk & Zuni shots. Other requirements ~~These~~ are covered in ~~Project 13.~~4. Consolidated UCRL Requirements

Project Officer: Harry B. Keller ~~Dr. Gaelen L. Felt~~ UCRL
~~Box 1663~~
~~Los Alamos, New Mexico~~

Sponsor : AEC

~~SECRET~~

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[redacted]

~~SECRET~~

PROJECT ~~14.1~~ 12.1
THRESHOLD DETECTORS

The work of this project is related to that of Project ~~2.3~~ 2.5.1 in that similar techniques will be used in both. The experiment is designed, however, for diagnostic rather than effects measurements, although the data will be used for the latter to a considerable extent. Primarily, Project ~~2.3~~ 2.5.1 is interested in the neutron flux at distances beyond the lethal range of thermal radiation or blast, while Project 14.1 requires that its stations be located as close to ground zero as feasible to reduce the air attenuation factor. The experimental results will provide the basis for a calculation of the total number of neutrons produced in both the fission and fusion processes; from this an estimate of the yield can be made. The results will also be used in other phases of neutron physics.

Method

Gold and tantalum will be used to detect the slow neutrons, using the cadmium difference technique mentioned in Project ~~2.3~~ 2.5.1. Sulphur (3 Mev), iodine (9.5 Mev) and zirconium (12.5 Mev) will detect the fast neutrons. Those neutrons which are captured in air before reaching the detectors, mainly by nitrogen, will be calculated by measuring the 10.5 Mev gamma rays arising from the capture. This is accomplished by using two samples of iodine, which has a high cross section for high energy gamma rays. One of these samples is unshielded, the other shielded with lead, which, because of its high cross section for gamma rays, will allow the iodine to see in general only the neutrons. The difference in activities induced in the two samples will then be due to the gamma rays, and the total neutron captures can be estimated from this difference. Other high energy gamma rays will be looked for with zirconium, using the same technique. From these measurements the total number of neutrons produced by fission and fusion will be calculated, and the yield estimated.

See Insert #1

The stations will consist of steel plates, to which the detector foils and lead shields are fastened, ~~mounted on concrete blocks set in a tide-washed reef area. The water will serve to reduce the radiological hazard to early recovery.~~

There will be eight such stations [redacted] in the range from 5100 feet to 7500 feet southwest of ground zero, most of them at 300 foot intervals. [redacted] 10 stations from 6600 feet to 11,200 feet on the reefs between Yurochi (Dog), Uorikku (Easy) and Romurikku (Fox). There will be only one station [redacted] at 8800 feet on Ruchi (Clara).

DELETED

~~SECRET~~

[redacted]

78

[redacted]

[redacted]

Support Requirements

The special equipment required by this project include a DUKW, ~~with an 'A' frame~~ [redacted] the necessary supporting boat, and a truck [redacted] Some counting will be done in the laboratory at Parry (Elmer), but for the most part the samples must be sent by courier to the ZI. Total number of People: 7.

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Sponsor : AEC

[redacted]

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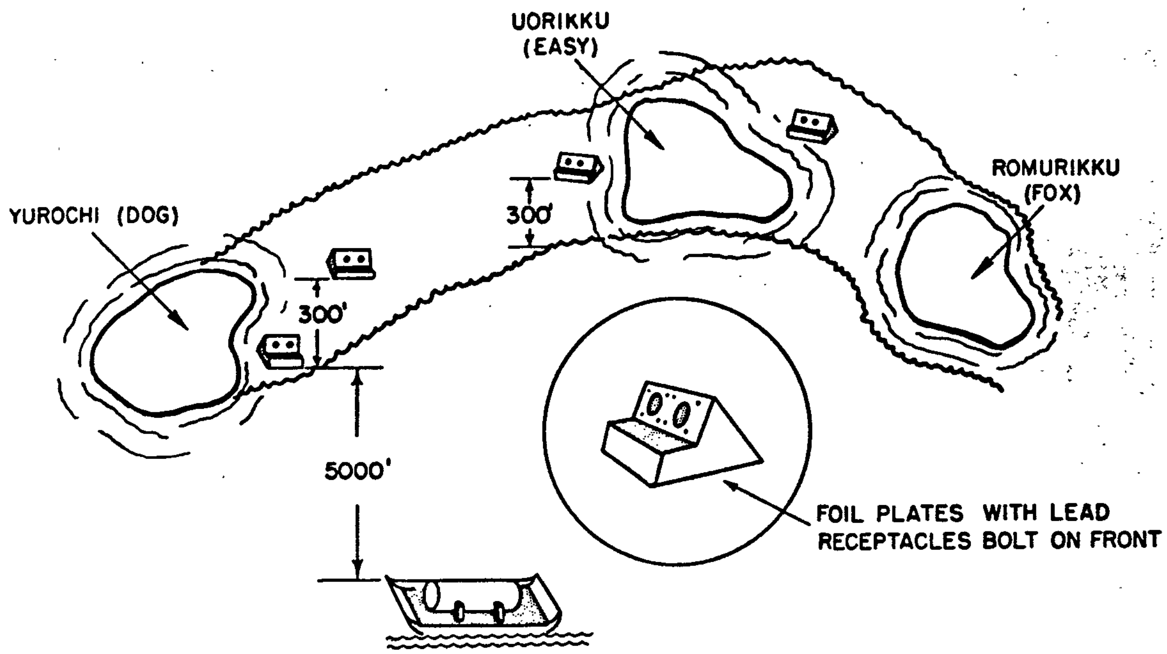
[redacted]

PROJECT 14.1

THRESHOLD DETECTORS

SE[redacted]



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LOCATION	NUMBER OF STATIONS
Bokobyaadaa (Able) and Reef	8
Yurochi (Dog) to Romirikku (Fox)	10
Ruchi (Clara)	1

80
79

[redacted]

[redacted]

PROJECT ~~19.1~~ 13.1

~~TELLER AND SCINTILLATION ALPHA~~

Fission Reaction Measurement, Land and Air

Thermonuclear weapons have as an integral part of their design a fission weapon to initiate the fusion reaction. One would like to know, in each thermonuclear shot, whether this primary fission weapon behaved as predicted, especially if the thermonuclear device were to give an unexpected yield. This information can be obtained by a measurement of the neutron multiplication rate in the fission process.

In a fission bomb, the components are imploded into a super-critical array by the detonation of high explosives. Near the time of maximum compression of the critical material a burst of neutrons starts the chain reaction. After this the number of neutrons present at any time is given by $N = N_0 e^{\alpha t}$ where N_0 is the number of neutrons in the initiating burst and α is the neutron multiplication rate.

Alpha is essentially constant for a short time after the initiating burst of neutrons, indicating an exponential rise in the neutron population. In general, the magnitude of this number will determine whether or not the predicted yield of the fission bomb was realized. At some time after this, the neutron population begins to decrease, and alpha takes on negative values, as the bomb disassembles and components are driven apart.

A portion of the neutrons arising from the fission processes suffer inelastic collisions with the heavy elements of the bomb. In this process gamma radiation, more easily detected than neutrons, is emitted. The rate of increase of the intensity of this radiation is directly related to the neutron production rate, and thus alpha can be determined by measuring the rise of the gamma signal.

<u>Method</u>

Two methods of determining alpha will be used, both involving the measurement of light intensity produced by gamma radiation. The first is the scintillation detector method, in which a photocell observes the light produced in a phospor by the radiation. In the second method, a photocell observes the phenomenon known as 'Teller Light', named for Edward Teller, who first suggested this experiment. The air surrounding the bomb case glows when ionized by gamma rays coming through the case. At very early times the light intensity follows the gamma ray intensity, and hence goes as the neutron multiplication rate.

In both methods the light will be collected by large concave mirrors at a station several miles away from the weapon. This collected

[redacted]

[redacted]

light will be brought through small ports in a recording shelter where it will be focused on the cathode of a photomultiplier tube. The output of the photomultiplier will be fed into a cathode ray tube and the signal on the tube face photographed. Using data from the photograph one plots the logarithm of the light intensity versus time on semilog paper. The slope of the line is proportional to the neutron multiplication rate, alpha.

The above measurements will be made on CHEROKEE [redacted] from a recording station on ~~Aomoen (George)~~ Namu (Charlie). DELETED DELETED

In order to compensate for the changing light refraction in air, and for the movement of the barge, a tracking device on the mirrors will keep them aligned with a steady light source located near the weapon.

Support Requirements

~~A considerable amount of work on the optics system must be done at night, and some travel between the recording shelters and barges will be necessary. Trailers for shops, stockrooms and data analysis must be moved in and out of the shot areas as called for in evacuation procedures.~~ Film recovery by helicopter after the shots, and the transportation of working personnel back into future shot areas, possibly contaminated, are further requirements. ~~Total~~ Number of people ~~14~~ for the total EG&G effort will reach a maximum of 95 at any one time.

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~~Los Alamos, New Mexico~~

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Sponsor : AEC

The above measurements will be made both at Bikini and Eniwetok. At Bikini CHEROKEE will be measured from a recording station on Namu (Charlie) and at Eniwetok LACROSSE, ERIE, Blackfoot and Osage will be measured from Runit (Yvonne).

8

PROJECT 15.1

TELLER AND SCINTILLATION ALPHA

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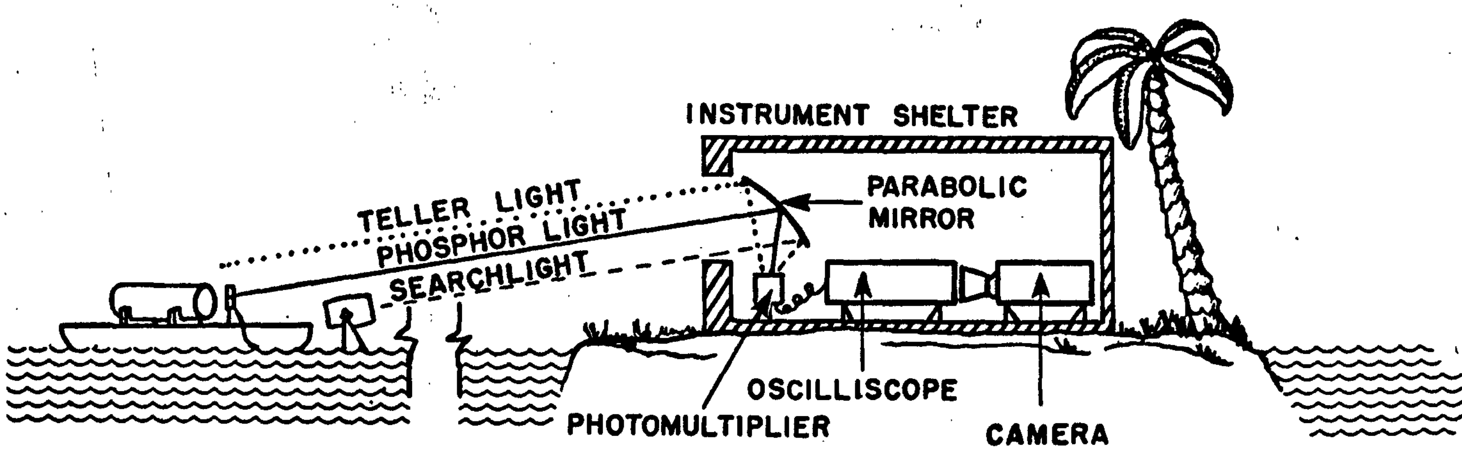

Note: Bunker on Aomoen will be used for all LASL shots at Bikini Atoll.

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PROJECT ~~15.2~~ 16.3
ELECTROMAGNETIC ALPHA [redacted]

A nuclear detonation is accompanied by an intense electromagnetic signal which covers a wide band of frequencies. Experiments have indicated that the early portion of the signal is an exponential with the same alpha as that of the bomb, at least for some portion of the time. A possibility exists, therefore, for the development of a method of measuring alpha remotely, and in a comparatively simple manner, by the detection of the electromagnetic signal generated during the early phases of the fission processes.

Method

The principal problem in this experiment is concerned with the design of an antenna with the proper response to an exponential signal. ~~The design presently calls for the half-rhombic array illustrated in the accompanying sketch.~~ An adjacent trailer will house the oscilloscopes and cameras for recording the signal.

The station will be located at ~~the high tide mark on Enyu (Nan), for the Bikini shots, and on Parry (Elmer) for the last shot.~~ Aniyaanii (Eniwetok atoll)

Support Requirements

There is one trailer associated with this project. ~~Since evacuation will probably be necessary, helicopter film recovery is planned.~~ Evacuation is not planned and the station will be manned during shot time. Total number of people: ~~8~~ 2

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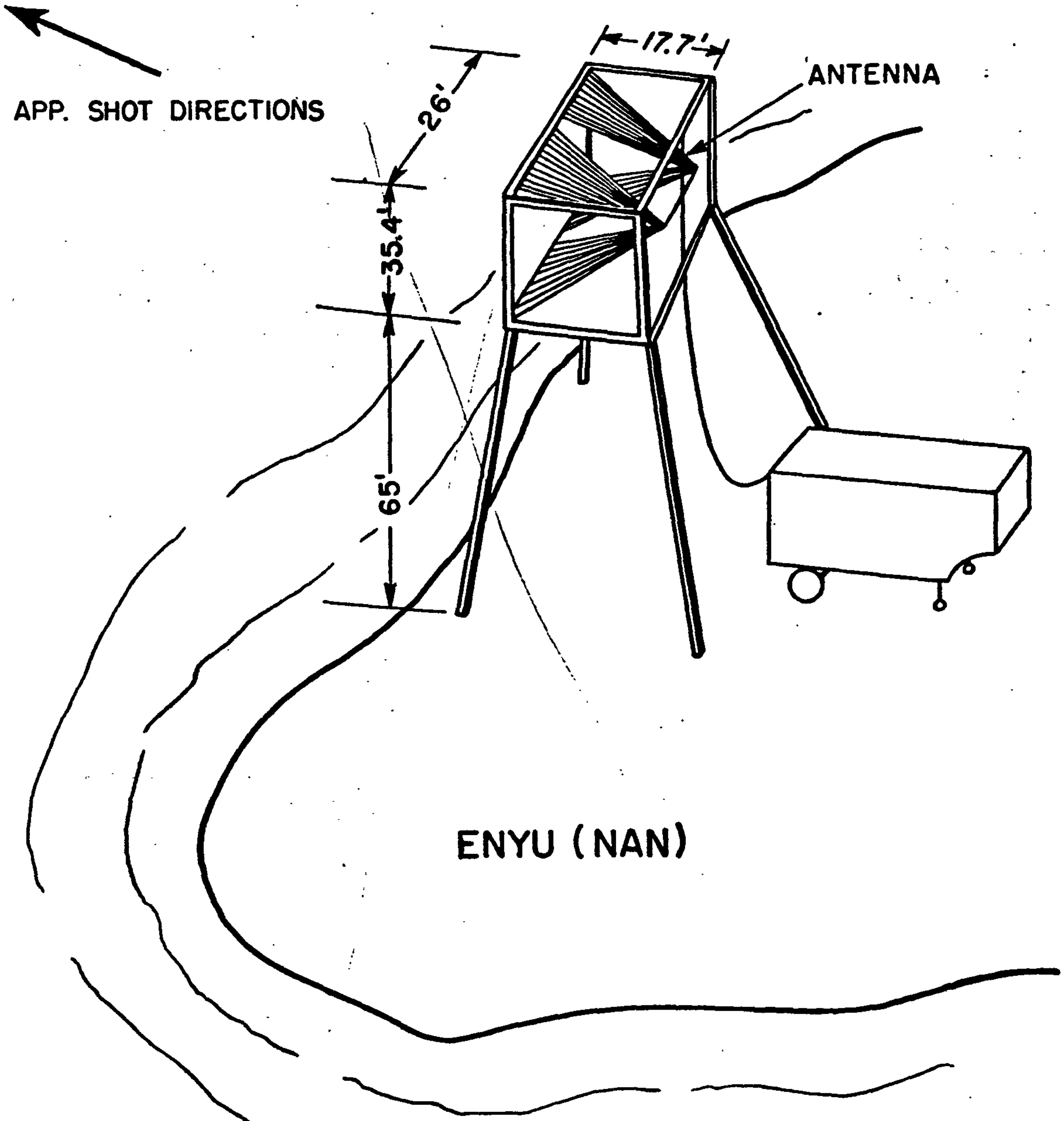
[redacted]

PROJECT 15.2

ELECTROMAGNETIC ALPHA

[redacted]



SIMILAR INSTALLATION ON PARRY (ELMER)

[redacted]

85

[redacted]

PROJECT 16.1
GAMMA INTENSITIES AT LATE TIMES

This is a yield measurement of a type not widely used heretofore. It involves the calculation of the total number of fission and fusion processes, each with a characteristic energy release, from a portion of the radiation emanating from a nuclear detonation. [redacted]

By 'late times' is meant the period starting about 10^{-4} seconds after the detonation, when the initial flood of radiation has passed. A certain percentage of the neutrons produced in the fission and fusion processes, having escaped from the case, are captured in nitrogen with the emission of gamma radiation. This radiation and that of the fission products as they are carried up in the fireball are the quantities measured in this experiment. Calculation and experience have shown that the neutron induced signal predominates at first, then decays in something like 10^{-1} seconds below the level of that due to the fission product radiation, which lasts on the order of 10 seconds. By calculating the contribution made by each of these, and by applying various correction factors, it is hoped that initial quantities can be established, and from these a yield determination made.

Method

This will be a 'hole in the ground' experiment, with the signal being detected by a scintillation detector system or ion chamber in a steel dome just above the surface. The recording equipment and battery power supplies, in water-tight containers, will be 20 feet below the domes, immersed in water for shielding from the gamma radiation. The stations are independent except for timing signals.

The detector signal will be fed into a logarithmic output amplifier so that all signal levels can be displayed on one oscilloscope. The signal will be seen on the scope as a vertical deflection, a strip film camera providing the horizontal time base for a period of about 15 seconds.

This project will participate in the first four shots, in the stations shown on the accompanying diagram.

Support Requirements

These are largely included with those of Project 12.3. A helicopter will be needed for film recovery. Total number of people: 4

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Sponsor : AEC

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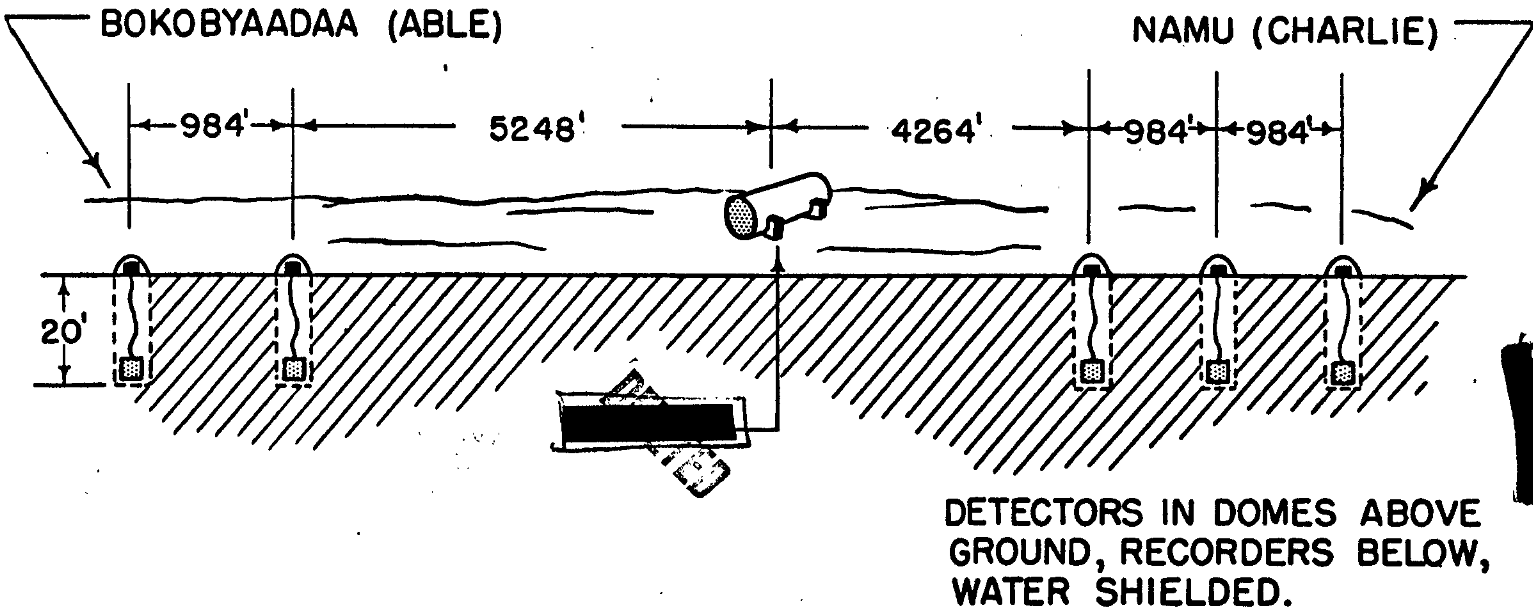
PROJECT 16.1

GAMMA INTENSITIES AT LATE TIMES



Note: Three other stations, at 6900 and 7900 feet on Yurochi (Dog), and at 9800 feet on Uorikku (Easy), [redacted]

PROJECT 17.1
MICROBAROGRAPHY [redacted]

It sometimes happens that a large explosion is heard at a great distance from the point of origin, and isn't heard at all at some nearer point. This phenomenon is due largely to temperature inversions in the earth's atmosphere, these being layers of air in which the temperature increases with altitude instead of decreasing as one would generally suppose. A sound wave in passing upward through a region of warmer air will be refracted, or bent back toward the earth's surface so that under given conditions it may strike the earth in some areas and skip others completely, the skip distances depending upon the altitudes of the inversions and the wind velocities.

The purpose of this project is to study this refraction phenomenon further, and to determine the possibility of predicting pressure patterns.

Method

A microbarograph is an instrument which measures small* pressure disturbances in the earth's atmosphere. It consists essentially of two chambers each containing a wire vibrating at a frequency common to both. The frequency of one wire is constant, while that of the other can be changed by the motion of a diaphragm to which it is attached. This frequency difference is measured and recorded as a pressure variation in microbars after proper calibration. The diaphragm is vented to the atmosphere by a leak system so that it will not respond to audio frequencies or barometric pressure changes.

There will be five microbarograph stations overseas, on Igurin (Glenn), Parry (Elmer), the CURTISS, and two in Kwajalein Atoll, one on Carlos and the other on Kwajalein island. Two stations will be located in the ZI to pick up long range signals.

Support Requirements

The stations will be manned during shot time only, by personnel drawn from Projects 1.2a, 1.3 and 1.7. Their transportation to and from Kwajalein Atoll will be the outstanding requirement.

Project Officer: Dr. John M. Harding
Sandia Corporation
Sandia Base
Albuquerque, New Mexico

Sponsor : AEC

* 1 microbar = 10^{-6} bars $\cong$ 14.7 x 10^{-6} psi

PROJECT 18.1
TIME INTERVAL BETWEEN REACTIONS

This project will measure the time interval between fission and fusion reactions, using the Teller lights as in Project 13.5. These will be observed, however, over greater distances and with different instruments. In addition, the radial distribution of the Teller lights will be measured.

Method

Photoelectric cells will view the event from about 20 miles away on each shot, through mirrors located high on adjacent phototowers. The output of one bank of these tubes will be displayed on oscilloscopes and photographed. The output of another bank will be used to control the operation of an eight megacycle oscillator, which is started by the first impulse and stopped by the second, these impulses being due to the Teller lights from the two reactions. The running time of the oscillator will be recorded by a mechanical counter on a dial which can be photographed a short time later. The number given on the dial will be related back to the frequency of the oscillator to give the time interval between the two reactions.

A Bowen camera will be used to measure the radial distribution of the Teller light by focusing the image of the light on the camera slit; the film will then be exposed in varying degrees from the center outward by the radial growth of the image. This variation in exposure can be interpreted with a densitometer for space and intensity distribution. In the course of this measurement, the time interval between reactions will also be given by the linear displacement of the two Teller light images on the strip film.

The photoelectric equipment will be housed in trailers on Eninman (Tare) and Bikini (How) and in the NRL bunker on Enyu for the first four shots, and in a trailer at Parry for the last shot. The Bowens will view the first four shots directly from the phototowers on Bikini and Eninman, and through a mirror system from the bunker on Enyu.

Support Requirements

Three of the four trailers of this project will be moved to Eniwetok after the fourth shot, the other remaining at Bikini for the roll-up. Helicopter recovery of film is required. Total number of people for program 18: 20

Project Officer: Dr. Harold S. Stewart
Radiometry Section I, Optics Division
Naval Research Laboratory
Washington 25, D. C.

Sponsor : AEC

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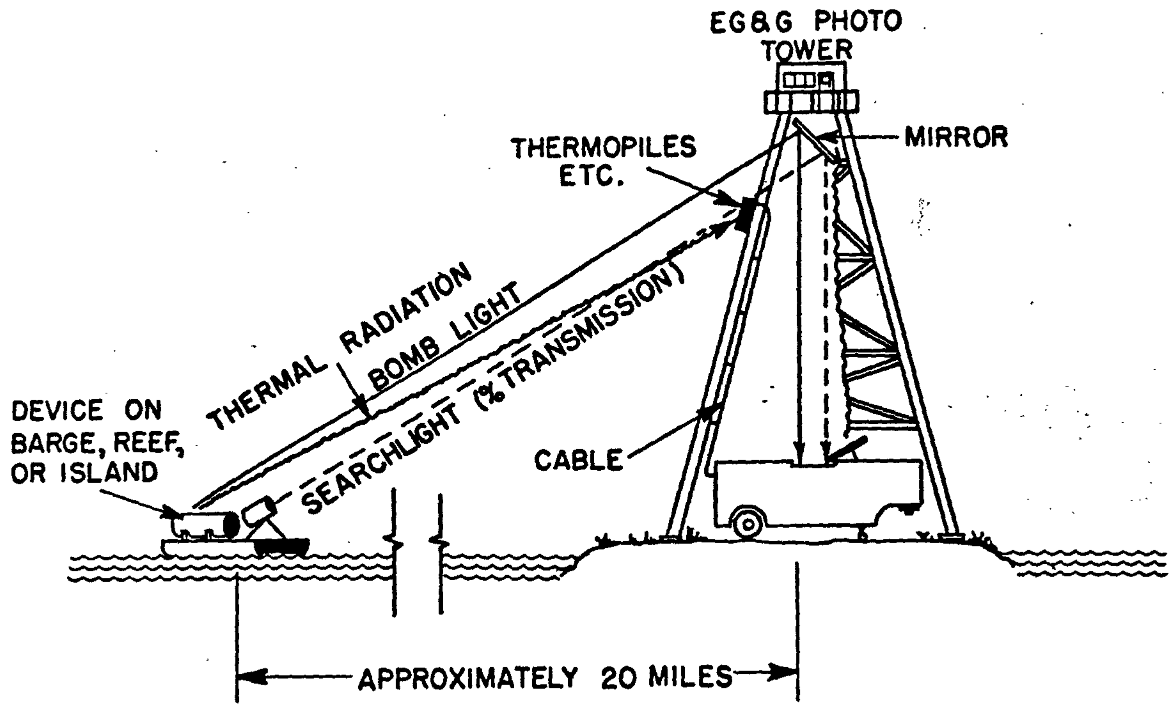
PROGRAM 18

THERMAL MEASUREMENTS

[redacted]



LOCATIONS OF INSTRUMENT TRAILERS

DELETED

.........................Bikini (How) and Eninman (Tare)
.........................Bikini (How) and Eninman (Tare)
.........................Bikini (How) and Eninman (Tare)
.........................Bikini (How) and Eninman (Tare)
.........................Bikini and Enyu (Nan)
.........................Parry (Elmer) and Engebi (Janet)
.........................Parry (Elmer)

NOTE: Bunker on Enyu (Nan) will also be used on first four shots.

[redacted]

[redacted]

PROJECT 18.2
POWER VS TIME MEASUREMENTS

This project is designed to measure power emitted as thermal radiation from the bomb as a function of time. This is in the nature of both an effects and diagnostic experiment; the effects people would like to know the intensity of thermal radiation as a function of time, while the diagnostician is interested in relating power to fireball opacity and yield.

Method

A modulated bolometer will be used to detect the variation of thermal radiation with time. A bolometer is essentially a length of blackened platinum wire, whose electrical resistance changes with temperature. A modulated bolometer consists of two such wires, one in each of two arms of a Wheatstone bridge, with a mechanically driven 'chopper' alternately exposing first one wire then the other to the thermal radiation.

If a DC voltage is applied at one end of the bridge, the result will be an AC output at the other end, in this case 240 cps., the speed of the chopper. This output is amplified and recorded on magnetic tape for later playback and analysis. The amplitude of the AC signal on the tape will vary in time since it is proportional to the number of calories per second which the bolometer observed from cycle to cycle. The proportionality factor is determined by calibrating the bolometer output with a standard heat source.

The equipment will be housed in 'coffins' 8 x 2 x 8 feet, which will also contain cooling and dehumidifying apparatus. Measurements will be made on all seven shots, with the coffins mounted on the EG&G phototowers on Bikini (How) and Eninman (Tare) for the first four shots, on Bikini and Enyu (Nan) for shot five, on Engebi (Janet) and Parry (Elmer) at Eniwetok Atoll for shot six, and on Parry for shot seven.

Support Requirements

The requirements for this project are included in those of Project 18.1.

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Sponsor : AEC

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[redacted]

[redacted]

PROJECT 18.3 [redacted]
SPECTROSCOPY

The objective of this project is the study of the spectra of the fireball throughout its duration and particularly in the first and second maxima*. In the first, the spectrum will be examined to determine the nature and characteristics of the absorption lines which predominate in this phase. These lines are due to the attenuation of fireball light by the air components and their reaction products, each of which absorbs light in characteristic wave lengths. The reaction products referred to are not fission products, but rather are those compounds and ionized molecules which are formed by gamma irradiation or by the heat of the explosion. In the second maximum the shock wave has separated from the fireball surface; the intensity of the gamma radiation and the temperature of the air in front of the fireball have decreased, thus permitting relatively better transmission of the light from the fireball. Typical spectra will show now the absorption and emission lines of the materials which make up the fireball. The lines appearing in the second spectrum can be used to determine the distribution in space and time of the bomb constituents and other materials.

Method

A spectrograph uses a light dispersing device, a prism or a grating, to separate a beam of light into its component wave lengths, which are directed onto a photographic plate. If the plate is stationary, and the spectrograph shutter remains open throughout, the spectrum obtained will be that of the total bomb light. If the plate moves at a known speed, as in a streak camera, the variation of the spectrum with time can be obtained; this last may also be obtained with a framing camera attached to the spectrograph. By properly timing the opening and closing of the shutters of two spectographs, individual spectra of the first and second maxima will be photographed. The variation of the spectrum as a function of radius of the fireball, indicating non-uniform distribution of the materials, may be observed by still another technique. The fireball image is focused on the center of the viewing slit of a spectrograph so that the spectral lines will lengthen with the growth of the fireball, each point on a line being related to the light emanating from a corresponding portion of the fireball surface. Non-uniform distribution of the materials would possibly be indicated by the appearance of lines originating some distance from the center.

All of the above techniques will be employed with spectrographs

* Refer to Project 15.1.

of various disperions and in selected wavelength ranges. These are to be housed in a concrete bunker ~~at the base of the 200 foot photo-tower on Enyu (Nan), and at a similar tower on Parry (Elmer)~~ on Aomoen (?). Mirrors ~~on the towers~~ will reflect the bomb light to the viewing slits of the spectrographs. These measurements will be made on ~~all LASL shots~~. Huron, Flathead and Navajo.

~~An absorption measurement is presently proposed for one or more of the Bikini shots, in which a spectrograph will view the light from a 60-inch carbon arc searchlight, located so that its beam will be tangent to the fireball diameter when the light is at the first minimum. A cinespectrocope will record the spectra as a function of time, so that absorption phenomena occuring in front of the fireball may be observed with a light of known emission.~~

Support Requirements

~~All Program 18 requirements are included under Project 18.1.~~

Project Officer: Dr. Harold S. Stewart
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Sponsor : AEC

At Bikini, Program 18 plans to operate from an electronics Trailer loaded aboard a LCU fitted out as a houseboat ~~[illegible]~~ after the islands become contaminated.

Other requirements are listed under Project 18.1.

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PROJECT 18.4
AIR TRANSMISSION

Light is attenuated in air to an extent that is dependent upon the density and humidity of the air, and the presence of dust particles and other scattering or absorbing materials. By transmission is meant that percentage of an original amount of light which will be received over a given light path, the balance being attenuated in the air. [redacted]

It follows that the transmission factor is of great importance to those experiments involved in photographing some phase of a nuclear detonation. Some of these, the 'Ball of Fire' photography for one, are important enough in themselves and in their effect upon other experiments to warrant delaying the shot should poor photographic conditions prevail. This is one of the reasons for monitoring the transmission continuously before each shot.

This transmission factor will also be used in Projects 18.2 and 18.5 in measuring the thermal radiation generated by the bomb.

Method

To monitor the transmission along a certain path, a search light of known luminous intensity will be set up near the zero point to send a focused beam of light down that path to a photocell receiver at the other end. This beam will be modulated at 60 cps by a mechanical chopper, with the receiver system arranged so that only light at this modulated frequency will be measured and recorded, thus making the system independent of daylight. On the barge shots, the search light platforms will be gyrostablized to compensate for motion of the barge. The output of the receiver will be tied in to the go-no go system so that should the transmission drop below a prescribed value and stay below that value for a certain period, the bomb firing system could be halted.

The light paths to be monitored will extend in each case from a point at or near the bomb cab to receivers on the EG&G phototowers and to the bunkers of Projects 13.5 and 23.1.

Support Requirements

These are included in the support requirement of Project 18.1.

Project Officer: Dr. Harold S. Stewart
Radiometry I, Optics Division
Naval Research Laboratory
Washington 25, D. C.

Sponsor : AEC

[redacted]

PROJECT 18.5
TOTAL THERMAL RADIATION

Since much of the energy in a nuclear detonation is released or transformed into thermal radiation, a measurement of the total amount of heat given off by a bomb can give an approximate yield figure. On the other hand, if the more exact yield figure determined by other means is accepted, the total thermal radiation measurement will give a figure for the partition of the bomb energy among the several forms of energy release. Besides the measurement of thermal power vs time (18.2) one also wants to obtain data on total thermal energy for the study of a variety of thermal effects.

Method

Epply thermopiles will be used to measure the total thermal radiation emitted in a thermonuclear explosion. The output of this instrument is proportional to the amount of heat absorbed, and can be measured and recorded on a potentiometer, the system being calibrated to give results in terms of calories per square centimeter of thermal radiation. With this figure one can work back along the light path, using the transmission factor from Project 18.5, and calculate the total energy emitted as thermal radiation.

These instruments will be housed in the containers which also house the bolometers of Project 18.2; their location for each shot is indicated in the discussion of that project.

Support Requirements

These are included in the support requirement of Project 18.1.

Project Officer: Dr. Harold S. Stewart
Radiometry I, Optics Division
Naval Research Laboratory
Washington 25, D. C.

Sponsor : AEC

[redacted]

[redacted]

PROJECT 19.1
MARINE SURVEY

This is a study of the effects of a nuclear detonation upon marine life. The plant and animal life of the area affected by the blast will be examined before and after the shot in a biological succession survey to study the phases of recovery of life in the area.

Method

[redacted] shot was chosen as presenting the best conditions for this study. Prior to the shot a survey will be made of the environmental conditions and the existing radiological contamination of the plant and animal life in the area. After the shot the initial destructive effects of the blast will be examined; following this, the repopulation of the test area will be studied for a period of about a year.

Samples of marine life will be taken from the selected sites and studied at Eniwetok; some of these will be frozen and shipped to the University of Washington for analysis.

The sites selected by the project will probably be around Kirinian (Lucy) and Aaraanbiru (Vera), with a control area located around Igurin (Glenn).

Support Requirements

An LCM to carry traps and other equipment, and a helicopter to recover samples, will be required. The project also requires aerial mapping of the selected sites.

Total number of people: 6

Project Officer: Dr. Lauren R. Donaldson
Applied Fisheries Laboratories
University of Washington
Seattle 5, Washington

Sponsor : AEC

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PROJECT 21.1
ANALYSIS FOR FISSION AND FUSION ENERGY YIELDS

This project is the Livermore counterpart of Project 11.1 conducted by Los Alamos; both will conduct the same sort of analysis of bomb debris collected from the cloud. Although the project ~~will have~~ primary responsibility on the analysis of cloud samples [redacted] it will share the filter papers from these bombs with LASL and ~~AFOAT-1~~. A similar distribution will be made by Project 11.1 on the LASL shots.

Method

The radiochemical analysis methods of this project are essentially the same as those of Project 11.1; one innovation is the use of [redacted] as a tracer for determining the bomb fraction. A certain quantity of this isotope will be placed in both the UCRL and LASL devices and looked for in the particulate cloud samples. The fraction of the bomb which the sample represents is then given by the ratio of the amount of present in the sample to that originally placed in the bomb.

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Support Requirements

As in Project 11.1, the analysis will be made in the ZI; the work of collecting and distributing the samples will be performed by Project 11.2. Total number of people: 2

Project Officer: Dr. Kenneth Street
University of California
Radiation Laboratory
Livermore Site
P. O. Box 808
Livermore, California

Sponsor : AEC

[redacted]

[redacted]

PROJECT 21.2
SAMPLE COLLECTION

By mutual agreement with LASL, the sample collections will be performed by one group under Project 11.2, made up of personnel from LASL and Livermore, thus avoiding duplication; the purpose of listing Project 21.2 was to indicate Livermore's participation in the operation.

Method

Refer to Project 11.2.

Support Requirements

Included under Project 11.2. Total number of people: 1

Project Officer: Dr. Peter Stevenson
University of California
Radiation Laboratory
Livermore Site
P. O. Box, 808
Livermore, California

Sponsor : AEC

[redacted]

PROJECT 21.3
HEAVY ELEMENTS INVESTIGATION

This project is another joint enterprise of UCRL and LASL, which share the responsibility for personnel and equipment for the investigation of the short-lived heavy elements.

<u>Method</u>

Refer to Project 11.3.

<u>Support Requirements</u>

Included under Project 11.3.

Project Officer: Dr. William Crane
University of California
Radiation Laboratory
Livermore Site
P. O. Box, 808
Livermore, California

Sponsor : AEC

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PROJECT ~~21.4~~ 21.3
GAS ANALYSIS [redacted]

At present no proven absolute method exists for determining fusion yield by radiochemical analysis, mainly because of the complex problem of collecting and analyzing for the products of fusion processes. Instead, an attempt can be made to determine the total neutron economy; that is, one attempts to account for all the neutrons produced in the device by measuring the products of all the known neutron induced reactions. One of these is carbon 14, produced in air by neutron bombardment of nitrogen. By measuring the amount of C^{14} collected as CO_2 in a gaseous cloud sample, the number of neutrons which escaped from the bomb case can be established, assuming that the sample is representative. The remainder of the neutrons presumably are accounted for within the bomb itself, their number being determined by analysis of particulate bomb debris. The fraction of the bomb which the gaseous sample represents will be determined by measuring the amounts of fission products in the sample, in this case the gases krypton 85 and krypton 88. Whether or not this is feasible will depend largely on the degree of fractionation of these gases with respect to other gases, a problem which will be studied by early analysis of the first samples to arrive after each shot.

Unburned tritium will be looked for in the gaseous samples since the amount present may be interpreted in terms of the extent of mixing of the bomb components during the critical 'burn' period, and hence is an indication of the efficiency of bomb design and construction.

Method

The first six cloud samples arriving at Eniwetok (Fred) after each shot will be taken to Parry (Elmer) for quick analysis to catch the short-life activities. Afterwards, these samples will be air couriered to UCRL for further analysis. An attempt will be made to modify the sampling and analysis techniques used during the operation on the basis of information gained from the early shots, in order to test more fully the feasibility of gas analysis as an acceptable method of yield measurement. This project will participate in all shots.

Support Requirements

Air or boat lift for gas samples from Eniwetok to Parry will be required, as well as airlift to the ZI some two days after each shot. Total number of people: 3

Project Officer: Dr. Floyd Momyer
University of California
Radiation Laboratory
Livermore Site
P. O. Box 808
Livermore, California

Sponsor : AEC

[redacted]

[redacted]

[redacted]

[redacted]

PROGRAM 22
Projects 22.1, 22.2, 22.3

GANEX, TENEX AND ALPHA

These three projects have been grouped since together they make up the reaction history of the Livermore devices, [redacted] just as Project 12.1 does [redacted] The same type of information is sought as in that experiment: time interval between reactions, rate of rise of the fusion process, the neutron energy spectrum, temperature of the 'burn', and alpha of the initiating bomb.

Method

The signals will be obtained from two evacuated pipes instead of 12 [redacted] Both of these pipes will carry a ganex signal, and one of them, looking directly at the fusion section, will be used to carry the tenex signal. Alpha of the initiating bomb will be measured by placing the phosphor and phototube close to the bomb, the signal being piped back to the recording station by coaxial cable.

[redacted] the bunker will be located on [illegible]ERE (Sugar) some 5600 feet east of the zero site. The bunker [redacted] will be on AOMON (Sally) about 3000 feet from zero.

Support Requirements

A truck with an A-frame will be needed at both sites in addition to other transportation, for the final alignment of the pipes. There will be three (3) trailers on both sites which will require evacuation. Film recovery is to be made by helicopter. The personnel for this program are included in Project 12.1.

Project Officer: Dr. Sterling Colgate
University of California
Radiation Laboratory
Livermore Site
P. O. Box 808
Livermore, California

Sponsor : AEC

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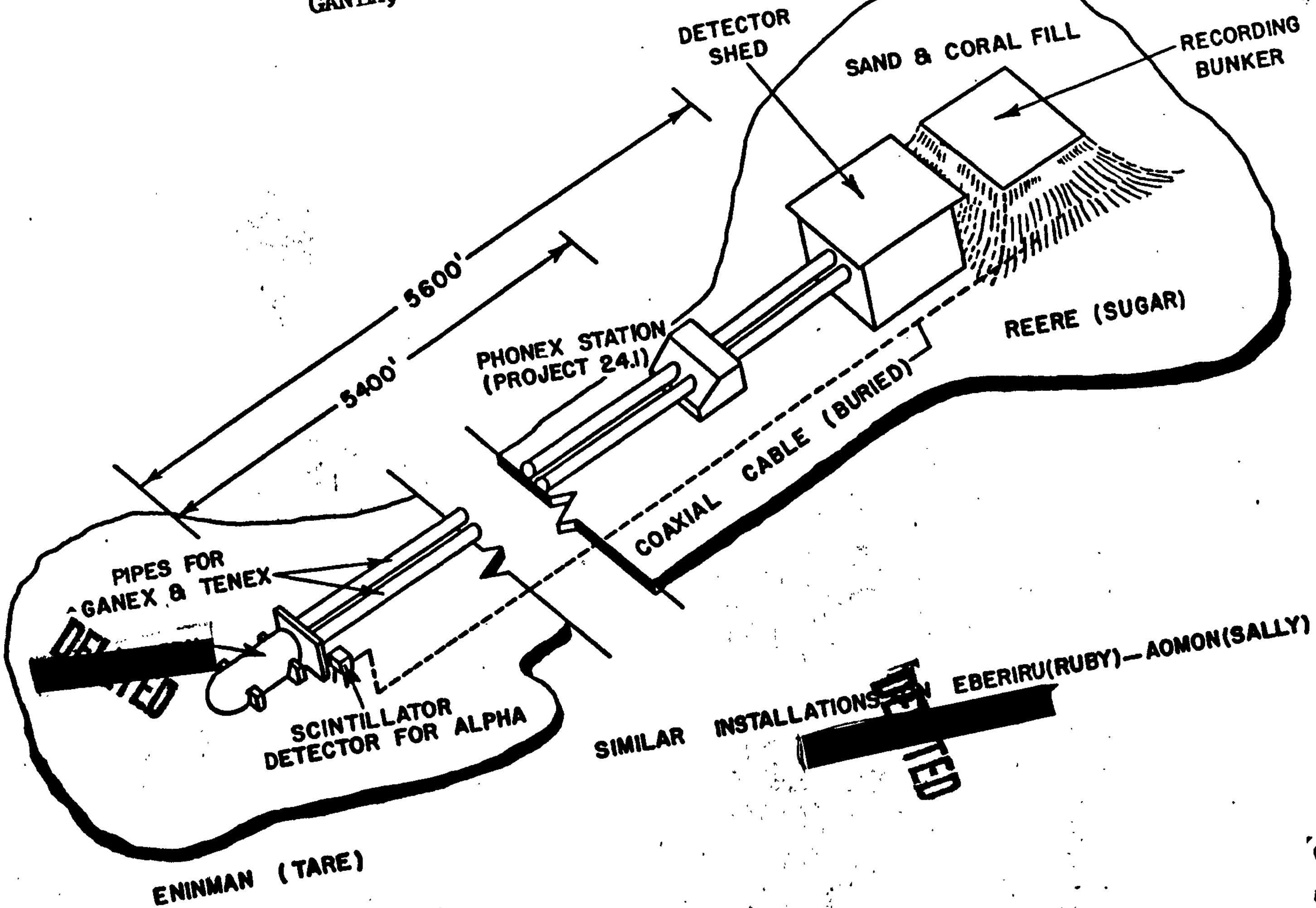
PROGRAMS 22 AND 24

GANEX, TENEX, ALPHA AND PHONEX



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PROJECT 23.1
HOT SPOT TIME INTERVAL MEASUREMENT

The purposes of this project and those of Project ~~13.4~~ 15.2 are quite similar, both being studies of the characteristics of the shock front from the initiating bomb. The measurements will afford a direct check on the designed hydrodynamics of the devices. } 23.4

Method

Certain selected spots on the bomb case will be viewed by Bowen cameras through a mirror array in such a way that the light from these spots will be isolated from the general bomb case light. The arrival of the shock wave at each of a series of such spots down the length of the case, indicated by strong light emission from the spot, will be recorded as a function of time, thus giving the speed of the shock front.

The pressure of the shock wave may be inferred from the speed with which the shock travels through a given material. By drilling out the bomb case at some points and adding pads of the same material to others, and by measuring the time for the shock to traverse these different thicknesses, the speed, and hence the 'strength' of the shock may be determined.

A total of ten 'spots' will be photographed by each of three Bowen cameras located in a bunker about two miles away. [redacted] the bunker will be located on Airukiraru (Peter) and fo[redacted] on Biijiri (Tilda).

Support Requirements

Helicopter film recovery will be required. ~~There will be two trailers involved in this project, one at each of the bunker locations, which will require evacuation at the proper time. Total number of people: 21~~ Other requirements are included in the consolidated UCRL requirements.

Project Officer: Dr. ~~W. Ball~~ Harry B. Keller
University of California
Radiation Laboratory
Livermore Site
P. O. Box 808
Livermore, California

Sponsor : AEC

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PROJECT 23.2
BALL OF FIRE PHOTOGRAPHY

This is a continuation of EG&G's responsibility for photographs as indicated in Project 13.1. The methods used on the LASL shots will also be applied in determining the yield figures from the fireball photography [redacted]

Method

The photographic methods are identical to those used in Project 13.1.

Support Requirements

These are included in EG&G's total requirements.

Project Officer: Mr. Herbert E. Grier
Edgerton, Germeshausen &
Grier, Inc.
160 Brookline Avenue
Boston 15, Massachusetts

Sponsor : AEC

[redacted]

PROJECT ~~24.1~~ 12.2 [redacted]

PHONEX

Phonex, neutron photography experiment, is designed to measure the neutron energy spectrum~~, providing a check on the results of the Tenex described in Project 12.1.~~

If a polyethylene radiator is placed in a beam of neutrons, 'knock-on' protons are produced with an energy distribution proportional to that of the incident neutrons, the proportionality factor depending upon the angle through which the protons are detected. The 'camera' for their detection is a photographic plate covered with a nuclear emulsion in which the protons are absorbed, leaving tracks of exposed grains to indicate their travel in the emulsion. These tracks can be counted and measured with a microscope, their number and length giving the data for the calculation of the neutron energy spectrum. When properly corrected for scattering and capture processes, the spectrum can give an estimate of the total number of neutrons produced in the fission and fusion reactions. The spectrum can also be used to calculate the temperature of the fusion process and the motion of the outer layer of burning fuel, these factors being theoretically related to the shape of the spectrum.

Method

One of the evacuated pipes of Project 22.1 will contain two polyethylene radiators for the production of protons by the neutron beam. The protons coming off the radiators at a 30° angle will travel through pipe extensions to the cameras where they will be stopped in the nuclear emulsion. Aluminum absorbers will be placed in some of the proton paths, different thicknesses of aluminum being used to absorb certain amounts of the proton energies in order to cover the whole range of neutron energies.

Soon after the signal has arrived, the exposed plates will be withdrawn from the pipe openings into a shielded region. This will be effected by a blast actuated mechanism.

See sheet

Support Requirements

Helicopter film recovery will be required. ~~Total number of people: 9~~
Other support requirements are incorporated under Project 12.1.

Project Officer: ~~Dr. R. Steven White~~
~~University of California~~
~~Radiation Laboratory~~
~~Livermore Site~~
~~P. O. Box 808~~
~~Livermore, California~~

Dr. Donald D Phillips
Box 1663
Los Alamos, N. Mex.

Sponsor : AEC

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PROJECT PARTICIPATION*

No.	Project Title	1	2	3	4	5	6	7
1.1a	Free Air Pressures	x	x	x	x	x	x	x
1.1b	Precursor Phenomena	x	x	x	x	x	x	x
1.1c	Base Surge Phenomena					x	x	
1.1d	Peak Pressure by Aerial Photo	x	x	x	x	x	x	x
1.2a	Pressures Less Than 40 psi	x	x	x	x	x	x	
1.2b	Pressures Greater Than 40 psi	x	x	x	x	x	x	x
1.3	Shock Winds		x	x	x	x	x	
1.4	Underwater Pressures vs Time		x	x	x			
1.5	Acoustic Pressure Signals in Water	x	x	x	x	x	x	x
1.6	Water Wave Studies		x	x	x			
1.7	Close-in Ground Accelerations					x	x	
1.8	Dynamic Pressure Measurements					x	x	
2.1	Gamma Film Dosage	x	x	x	x	x	x	x
2.2	Gamma Dose Rate vs Time	x	x	x	x	x		
2.3	Neutron Flux and Spectrum	x	x	x	x	x	x	x
2.5a	Fall-out Distribution	x	x	x	x	x	x	x
2.5b	Fall-out Distribution	x	x	x	x	x		
2.6a	RC Analysis of Ground Contamination	x	x	x	x	x	x	x
2.6b	RC Analysis of Ground Contamination	x	x	x	x	x		
3.1	Loading of Structures							x
3.2	Crater Survey & Evaluation	x	x	x	x	x	x	x
3.3	Tree Stand Studies					x		
6.2	Effects of Blast, Gust & Thermal on AC in Flight	x		x		x		x
6.4	Proof Testing of AW Countermeasures		x			x		x
6.5	Decontamination & Protection		x			x		x
6.6	Ionospheric Studies	x	x	x	x	x	x	x
7.1	Electromagnetic Radiation Calibration	x	x	x	x	x	x	x
7.2	Detection of Airborne LF Sound	x	x	x	x	x	x	x
7.4	Calibration Analysis of A-Bomb Debris	x	x	x	x	x	x	x
9.1	Cloud Photography	x	x	x	x	x	x	x

* This and the following page comprise Appendix II of Annex C, TG 7.1 Operation Plan 1-53.

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PROJECT PARTICIPATION

No.	Project Title	1	2	3	4	5	6	7
11.1	Analysis for Fission & Fusion Energy Yields	x	x	x	x	x	x	x
11.2	Sample Collection	x	x	x	x	x	x	x
11.3	Heavy Element Investigation	x	x	x	x	x	x	x
12.1	[redacted] Reaction History	x						
12.2	[redacted] Reaction History		x					
13.1	Ball of Fire Photography	x	x	x	x			x
13.2	Cloud Photography	x	x	x	x	x	x	x
13.3	Bhangmeters	x	x	x	x	x	x	x
13.4	High Speed Photography	x	x	x	x			x
13.5	Time interval measurements with Bowens	x	x	x	x			x
14.1	Threshold Detectors	x	x	x	x			x
15.1	Teller & Scintillaton Alpha	x	x	x	x			
15.2	Electromagnetic Alpha	x	x	x	x			x
16.1	Gamma Intensities at Late Times	x	x	x	x			
17.1	Microbarography	x	x	x	x	x	x	x
18.1	Time Interval between Reactions	x	x	x	x			x
18.2	Power vs Time	x	x	x	x	x	x	x
18.3	Spectroscopy	x	x	x	x			x
18.4	Air Transmission	x	x	x	x	x	x	x
18.5	Total Thermal Radiation	x	x	x	x	x	x	x
19.1	Marine Survey							x
21.1	Analysis for Fission & Fusion Energy Yields	x	x	x	x	x	x	x
21.2	Cloud Sampling	x	x	x	x	x	x	x
21.3	Heavy Element Investigation	x	x	x	x	x	x	x
21.4	Gas Analysis	x	x	x	x	x	x	x
22.1	Ganex					x	x	
22.2	Tenex					x	x	
22.3	Alpha					x	x	
23.1	Hot Spot Photography					x	x	
23.2	Ball of Fire Photography					x	x	
24.1	Phonex					x	x	

[redacted]

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PROJECT LOCATION BY ISLAND*

ENIWETOK ATOLL

Islands	Projects
BOGALLUA (Alice)	1.2b, 13.4, 13.5, 18
Reef: ALICE-BELLE	2.3
BOGOMBOGO (Belle)	1.2b, 2.3
Reef: BELLE-CLARA	2.3
RUCHI (Clara)	1.2b, 2.3
DAISY	1.2b
ELUGELAB (Flora)	15.1, 18, EG&G
TEITEIRIPUCCHI (Gene)	14.1
ENGEBI (Janet)	3.1, 15.1, 18, EG&G
Reef: LUCY-MARY	2.1
BOKONAARAPPU (Mary)	2.1
Reef: MARY-NANCY	2.1
YAIRI (Nancy)	2.1
AITSU (Olive)	1.2a, 1.3, 1.7, 2.1
RUJORU (Pearl)	1.1a, 1.2a, 1.2b, 1.3, 1.7, 2.3
EBERIRU (Ruby)	18, 22, 23.1, EG&G
AOMON (Sally)	1.2b, 2.3, 22, 24
BIIJIRI (Tilda)	2.3, 18, 23.1, EG&G
ROJOA (Ursula)	2.3, 11.2, EG&G
AARAANBIRU (Vera)	2.1
Reef: VERA-WILMA	2.1
PIIRAAI (Wilma)	2.1
RUNIT (Yvonne)	EG&G
PARRY (Elmer)	6.6, 7.1, 16.1, 18, EG&G, 15.2
IGURIN (Glenn)	17.1

* This and the following page comprise Appendix III of Annex C, TG 7.1 Operation Plan 1-53.

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PROJECT LOCATION BY ISLAND

BIKINI ATOLL

Islands	Projects
BOKOBYAADAA (Able)	2.1, 2.2, 2.5a & b, 13.5, 14.1, 16.1
Off Able	2.1, 14.1
DELTA	13.4, 13.5, 14.1, 18
NAMU (Charlie)	EG&G, 1.1a, 1.2b, 2.1, 2.2, 2.5a & b, 12.1, 13.5, 15.1, 16.1, 18
Reef east of CHARLIE	1.2b, 2.1, 2.3
Reef west of DOG	2.3
YUROCHI (Dog)	EG&G, 1.1a, 1.2b, 2.1, 2.2, 2.5a & b, 12.3, 14.1, 16.1
Reef: DOG-EASY	1.2b, 2.1, 14.1
UORIKKU (Easy)	1.2b, 2.1, 2.2, 14.1, 16.1
Reef: FOX-EASY	2.1
ROMURIKKU (Fox)	1.2a, 1.2b, 2.1, 2.2, 2.3, 2.5a & b, 14.1
AOMOEN (George)	EG&G, 1.2a, 1.3, 1.4, 2.1, 2.2, 2.3, 2.5a & b, 13.4, 13.5, 15.1, 18
BIKINI (How)	EG&G, 2.5a & b, 18
ROCHIKARAI (Love)	EG&G, 2.5a & b
ENYU (Nan)	EG&G, J.T.F., Office for Programs 12, 13, 15, 18; Proj. 1.6, 2.5a & b, 6.6, 15.2, 18
AIRUKIIJI (Oboe)	EG&G, 1.2a, 1.3, 2.1, 2.2, 2.5a & b
Causeway: PETER-OBOE	2.1
AIRUKIRARU (Peter)	1.2a, 1.3, 2.1, 2.2, 2.3, 23.1
Causeway: PETER-ROGER	1.2a, 2.1
BIGIREN (Roger)	1.2a, 1.3, 1.7, 2.1, 2.2, 2.3
Causeway: ROGER-SUGAR	1.2a
REERE (Sugar)	1.2a, 1.7, 22, 24
ENINMAN (Tare)	18, 22, 23.1, EG&G
ENIIRIKKU (Uncle)	1.1a, 1.2b, 2.1, 2.2, 2.5a & b, EG&G
RUKOJI (Victor)	2.5a & b
CHIEERETE (William)	2.1, 2.2, 2.5a & b
ARRIIKAN (Yoke)	2.1, 2.2, 2.5a & b
OURUKAEN (Zebra)	2.1, 2.2, 2.5a & b, 11.2
BOKUAETOKUTOKU (Alfa)	2.1, 2.2
BOKORORYURU (Bravo)	2.1, 2.2, 2.5a & b

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