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NAME: C.K. Mitchell
2ND REVIEW-DATE: 6/30/98
AUTHORITY: ADD
NAME: Patricia Budin
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ther fore" (also delete para. IX, A., pg. 6.5-3 and para. IX.B., pg 6-5-4 and substitute new para IX as follows: (The USNRDL is responsible for carrying out the experiment, coordinating it with other interested agencies, collecting the data and reporting it through the Program Director to the Scientific Director. Dr. Paul C. Tompkins, USNRDL, is the USNRDL Project Coordinator for GREENHOUSE and Mr. E. Tochilin, USNRDL, is the Project Officer responsible for the technical planning and execution of the project.)"

Alvin Graves

ALVIN C. GRAVES
Commander, TG 3.1

VD:lfs

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[redacted]

64 and 65 - J-10 (by hand)

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Table of Contents

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Lab-J-1017

DMB

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[redacted]

approved by following RDB action

JCS 1998/21 dated 20 March 1950

Program 6 - Physical Tests and Measurements
approved by following RDB action

JCS 1998/21 dated 20 March 1950

Program 7 - Long Range Detection
approved by following RDB action

JCS 1998/23 dated 21 April 1950

Program 8 - Effects on Aircraft
approved by following RDB action

JCS 1998/21 dated 20 March 1950
and reviewed by RDB in April 1950

On 7 March 1950 this office issued a directive, subject: Initial Detailed Proposal and Monthly Reports for DOD Program, to Project Directors (pages V through IX). From the reports received this book was compiled giving the details of each project. This "Green Book" supersedes and replaces the "Brown Book" dated 10 November 1949.

Personnel listings with dates of arrival at site and numbers involved are tentative at this time and will be reviewed periodically to ascertain that a minimum number of personnel, consistent with requirements, are scheduled to be at the test site.

This book shows status of projects and programs of about 15 April 1950. Monthly reports by project personnel will give subsequent data on progress and at such time that these reports warrant revision of the content of this book revisions will be made.

BY COMMAND OF LIEUTENANT GENERAL QUESADA:

Alvin C Graves

ALVIN C. GRAVES
Scientific Director
Joint Task Force THREE

[redacted]

Program 8 - Colonel Robert E. Jarmon, USAF - LASL

TU 3.1.4, Director of Assembly - Robert W. Henderson - Sandia Corporation

TU 3.1.5, Director of Radiological Safety - Brig. Gen. James P. Cooney, MC - AEC

TU 3.1.6, Director of Documentary Photography - Loris Gardner - LASL

TU 3.1.7, Director of Base Facilities - Paul W. Spain - AEC (LASL)

[redacted]

III. <u>Details of Progress to Date in Experimental and Theoretical Work</u>

A. Describe in detail the experimental and theoretical work that has been completed or is in progress. Indicate how this work directly or indirectly establishes or alters the previous conceptions of the necessity or desirability of the proposed experiment. Explain what fundamental data (e.g., nuclear and thermal radiation spectra, pressure vs. time, peak pressures, etc.) are considered to be lacking for a theoretical attack or detailed experimental planning.

IV. <u>Personnel Requirements</u>

A. Required at Test Site

1. Scientific Personnel -- indicate numbers of officers, enlisted and civilian personnel, give detailed description of duties of each in connection with the project at the site, and specify the organization furnishing the personnel. indicate those on hand and those yet to be procured.

2. Technicians -- same data as for Part IV., A. 1.

3. Laborers and Other Unskilled Help -- give descriptions of employment and indicate man-hours involved.

B. Project Work in Continental United States

1. Scientific Personnel -- indicate numbers of officers, enlisted and civilian personnel and give detailed description of duties of each in connection with the project. Indicate those on hand and those yet to be procured.

[redacted]

[redacted]

F. Commercially available equipment not yet procured or on order. List possible vendors and estimate number of months in which delivery can be expected.

~~CONFIDENTIAL~~

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[redacted]

3. Indicate in pounds material involved in roll-up, other than that listed in Part VII., B. 2, that cannot be returned by sea lift. Explain need for air lift.

C. Sea Lift (Personnel).

1. Indicate number involved and state number of days before test that personnel must reach forward area.

2. Indicate number involved in roll-up and number of days after test that they can commence return.

D. Air Lift (Personnel).

1. Indicate number involved and state number of days before test that personnel must reach forward area.

2. Indicate number involved in roll-up and number of days after test that they can commence return.

E. If the experiment and work at the test site will pose any particular logistics problem not covered above, explain in detail.

[redacted]

<u>Note:</u> The designations of the tests are Dog, Easy, George in that order. Indicate times in days prior to test: for example; D - 25.

VIII. <u>Collaboration</u>

List the agencies collaborating on the experiment or in whose behalf the data will be collected and used.

IX. <u>Responsibility</u>

A. List the person, persons or agency who will have the responsibility for carrying out the experiment, collecting data, and reporting it, through the Program Director, to the Scientific Director.

B. State the name of official address of the person (Project Officer) responsible for this project and from whom further details can be obtained.

X. <u>Funds</u> (Above Normal Operating Costs)

A. Fiscal Year - 1950

1. Total Estimated Cost.

2. Unexpended and unobligated funds available for project work.

3. Total expenditures and obligations to date.

4. Expenditures and obligations during the calendar month terminating within the period covered by this report, i. e., in the progress report for 15 May to 15 June, inc., state expenditures during period 1 May - 31 May, inc.

5. Estimated costs for the calendar month commencing within the period covered by this report, i. e., referring to the example in X.A.4, above, this would mean 1 June - 30 June, inc.

B. Fiscal Year - 1951

Same as items 1-5, inc., in X.A., above.

XI. <u>Facilities</u>

A. Power. Indicate total power requirements at each location. Present test site planning involves use of 110v, 60 cycle power, with voltage regulated to ± 3%. Any special voltages or frequencies needed will have to be furnished by the using agency; list these.

B. Communications.

1. The following timing signals will be available:

[redacted]

a. -15m $\pm$1 s
b. - 5m $\pm$1 s
c. - 1m $\pm$1 s
d. -30s $\pm$0.1 s
e. - 5s $\pm$0.05s
f. - 1s $\pm$0.05s
g. 0 $\pm$0.05s
h. + 1s $\pm$0.1 s

The signals are provided at the test island Signal and Communication Station in the form of the closing of a separate 10 ampere relay contact for each project's stated timing signal requirement except the +1 second which is in the form of deactivation of the relay contacts for the preceding signals. Indicate which of these signals are required and at what location. Any intermediate time signals must be provided by the using agency, utilizing the closest earlier signal given above; list the necessary intermediate signals.

2. Specify any special communications, telemetering or television requirements as follows:

a. Number of frequency bands required.
b. Type of equipment (if special, give frequency range of equipment).
c. Type of modulation, if any.
d. Band width required (6KC for AM voice).
e. Periods each frequency will be used during this operation.
f. Purpose for which each frequency band will be used.

Note: Inter- and intra-island telephone communications will be provided by submarine cable.

C. Laboratory Space and other Facilities. List all requirements and include drawings for laboratory space, storage space, distilled and-or temperature controller water supply, air conditioning, compressed air lines, etc.

D. Forward Area Transportation. List number and types of vehicles (jeeps, DUKWs, etc.) required and explain their employment. Indicate any aircraft, boat and vehicle requirements just prior to or soon after the test time.

XII. Remarks by Project Officer.

As may be appropriate.

[redacted]

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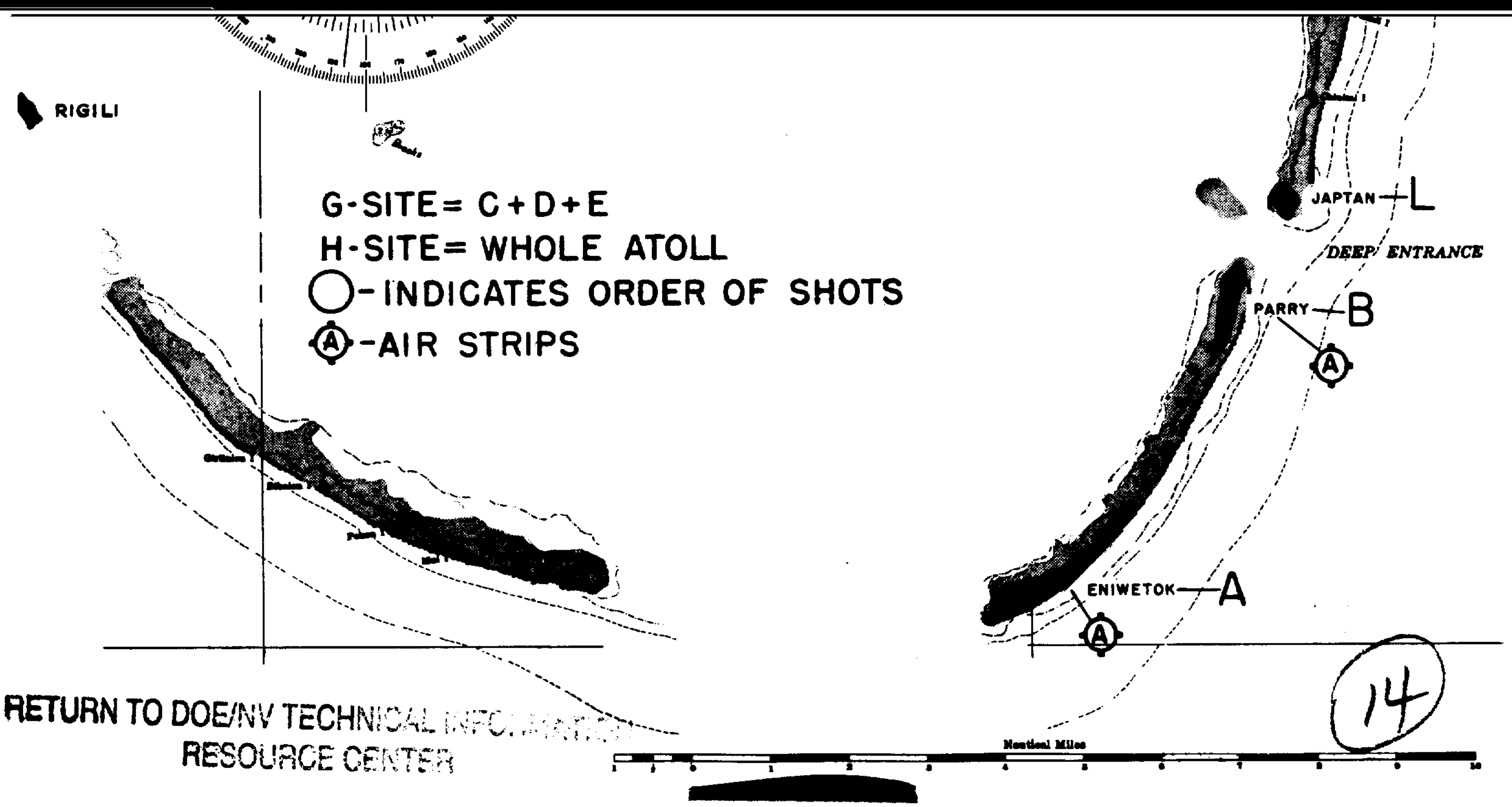
[redacted]



RIGILI
G-SITE= C+D+E
H-SITE= WHOLE ATOLL
-INDICATES ORDER OF SHOTS
(A)-AIR STRIPS
JAPTAN L
DEEP ENTRANCE
PARRY B
A
ENIWETOK A
A
Nautical Miles

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PROGRAM 2

JOINT ...

Program

Deputy

Program 1 has been removed from this book & placed in a separate file. CDD 11/8/50

Program II is prepared
and the participating agenc...

The agencies performing ... along with each
test. Abbreviations are as

LASL - Los Alamos Scientific Laboratory

NMRI - Naval Medical Research Institute

ORNL - Oak Ridge National Laboratory

2.0 BIOMEDICAL TEST PROGRAM

A. Objective: The fundamental objective of the biological program is to provide information which can be used in planning effective medical care for the victims of atomic warfare, and for the victims of industrial accidents in nuclear energy plants. Such planning must necessarily depend on radiobiological studies which utilize the unique radiation of the atomic explosion. A satisfactory biological test program should provide data which can permit evaluation of atomic bomb radiation injury in terms of the injurious action of roentgen, gamma and neutron radiations of a character that can be produced by conventional means in the laboratory. Adequate medical planning cannot be anticipated until it is possible to translate laboratory conditions to field conditions with a high degree of certainty.

B. The Program: which has been approved by the Division of Biology and Medicine, Atomic Energy Commission, and J-Division, Los Alamos Scientific Laboratory:

2.1 JAPTAN ISLAND DEVELOPMENT - LASL

The purpose of the development of this facility is to provide a place for the breeding and rearing of the experimental animals to be used in the Biomedical test program, and to provide laboratories and living facilities for Biomedical Program personnel.

2.2 PRODUCTION OF ANIMALS - NMRI

This project will provide an adequate number of animals for use at shot time. These animals will have been born and reared on Japtan Island and should then be acclimatized to the total local environment. Suitable control studies will be performed prior to the shots. The response of the animals will be tested with 250-KV x-rays after residence in the tropics. A holding colony has been developed at NRDL, where environmental studies are being made.

2.3 EXPOSURE EQUIPMENT - Captain R. H. Draeger, NMRI

This project is for the purpose of designing, engineering, testing, and procurement of the various types of exposure containers and equipment essential to the proper execution of the Biomedical program.

2.4 and 2.5 BIOMEDICAL EXPERIMENTS

2.4.1.1 Acute Radiation, Mice - NMRI

This experiment consists of the determination of the LD_X dose and distance for a standard strain of laboratory mice. Mice will be placed in suitable containers at varying distances from zero, the spacing being such that the radiation dosage received will range from an LD_{90} to an LD_5 dose. Animals will be recovered as soon after exposure as possible and returned to Japtan for mortality studies over a 30-day period.

[redacted]
spectrum from the detonation by means of a travelling shutter and filters.

2.4.3 Hematology - NMRI

This experiment involves the study of the effect of radiation on the periferal blood of all animals exposed to radiation under Projects 2.4.1.2 and 2.4.1.3.

2.4.4 Phantom Dosimetry - NMRI

This experiment involves the use of phantoms of unit density material approximating the size of mice and swine, in which have been placed film badges. These phantoms will be exposed in the same relative positions as the animals in Projects 2.4.1.1, 2.4.1.4, and 2.4.1.5. Film badges are so arranged within the phantoms that data will be obtained on the depth dose of ionizing radiation received from an atomic bomb explosion. Another series of phantoms consisting of spheres of unit density material containing film badges and an ionization chamber are to be placed at varying distances for the purpose of determining equilibrium thickness of unit density material (tissues) for gamma rays emanating from an atomic bomb explosion. Other dosimetric devices for personnel protection will be tested.

[redacted]
other radiation equipment. The experiment also calls for the placing of mice aboard the drone planes for the purpose of measuring biologically the radiation dosage received as a result of passage through an atomic cloud.

[redacted] of the neutrons alone measured as a function of distance from zero.

2.5.6 Genetic Studies - Cal. Inst. of Tech.

Neurospora and other microbiological systems will be exposed at various distances from the detonation and returned to the States where they will be examined for the number and rate of induced mutations.

2.5.7 Biotic Studies - University of Washington (Seattle)

This experiment involves a continuation of studies carried out both at Crossroads and Sandstone on the effects of an atomic bomb detonation on the biotic cycle of the islands.

C. Organization: The biological test program is planned as a cooperative activity involving representatives of the Atomic Energy Commission and the National Military Establishment. It is contemplated that all the biological research groups will obtain their animals from the animal colony, and will share the facilities of the biological laboratory. The design of the majority of the experiments is such that most of the studies on the exposed material can be performed in the United States. Extensive control studies of all phases of the Program are contemplated.

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LAB-J-979

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No. 5 of [illegible]

PROGRAM 3

EFFECTS ON STRUCTURES

Program Director - Mr. Sherwood B. Smith, AFSWP

Assistant Program Director - LCDR W. H. Rowen, J-10, LASL

Project Officers - 3.1 - Major Bruce D. Jones, CE, USA, Office Chief of Engineers
3.2 - LCDR S. Rockefeller, (CEC) USNR, BuYds & Docks
3.3 - Major Bert Pettitt, USAF, AMC
3.4 - Mr. Harlan Lenander, Sandia Corporation
3.5 -

In Program 3 a full degree of coordination has been affected and Projects 3.1, 3.2, and 3.3 are mutually complementary.

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[redacted]

[redacted]
effects will verify or indicate the required modifications to pursuant methods of analysis. The data will also provide check points for diffraction studies and model tests which should be made in the U.S. to complement the tests included in Program 3.

II. Method

Project Officers have designed or analyzed structures with a view to their securing technically desirable degree of damage at selected blast overpressures. Based on the dynamic analyses, the type location and range of transient measurements has been established while this was being accomplished, the Instrumentation Project Officer was testing the best available gages and recorders of the general types required. Instrumentation plans have now been developed cooperatively with the advice of a panel of consultants for all structures than can be instrumentated. It was not practicable to provide the quantity of electronic measurements desired by either the Army or Air Force. Procurement of gages and recorders is in process. High speed

[redacted]

of analysis of behavor of structures under blast loading and prediction of damage will be developed by the Department of Defense Project Officers.

III. Details to Data in Experimental and Theoretical Work

Beginning with the survey of damage resulting from the atomic bombing of Japan, considerable effort has been devoted to the development of a method of analysis of structures subjected to blast loading of long duration. Both elastic and plastic theories have been employed in the study of damage to Japanese Buildings. However, uncertainties with respect to blast loading, the design and quality of construction have hampered such efforts. Also, the resistance of materials and structural elements under rapid rate of loading was not well known. As a result of tests under dynamic loading of materials at the Bureau of Standards and California Institute of Technology and on reinforced concrete beams and slabs at Massachussetts Institute of Technology much better information is now available.

IV. Personnel Requirements

See Project Officers Proposals

V. Instrumentation and Equipment

See proposal of Instrumentation Project Officer

VI. Present Status of Equipment and Instruments to Perform the Experiment

See proposal of Instrumentation Project Officer

VII. Logistics

A. Sea Lift requirements for instrumentation are shown in Instrumentation Project Officers proposal except for mechanical equipment to be furnished by Holmes & Narver. Department of Defense Project Officers have no requirements.

B. Air Lift - See instrumentation project officers proposal.

C. Sea Lift (Personnel) - None unless air lift is not available.

D. Air Lift (Personnel) - See Project Officers reports. In addition the Program Director and Assistant Program Director will make two trips each to the site during construction and installation of gages and recorders, and will be at the site from D-15 to D+30.

VIII. Collaboration - The Department of Defense Project Officers planned the Tests of structures, have made dynamic analyses and designed the structures.

[redacted]
Defense Project Officers, employing the best available equipment and personnel. The accomplishment of construction is a responsibility of Task Group 3.1. Headquarters with the assistance of Program Director 3.0. See Project Officers proposals for detailed information.

X. Funds, Program 3

See Fiscal Sheet attached.

XI. Facilities

A. Power - See Instrumentation Project Officers Proposal.

B. Communications - See Instrumentation Project Officers Proposal.

C. Laboratory Space - All requirements can be met by use of test structures.

D. Forward Area Transportation - All transportation listed in Instrumentation Project Officers proposal will be furnished by Holmes & Narver. The Department of Defense Project Officers require a total of 5 jeeps for land transportation and boat transportation between Engibi and Muzinbaarika.

Program 3.0 Project No. and Title	Activity (Service)	[redacted] YEAR 1950		
		Estimated Cost	Deptm'tal (1) or AEC (2) Funds Available	Fund Requir from JT
3.1 Army Structures Project	(A)	1,003,328	325,000	678,328
3.2 Navy Structures Project	(N)	731,229	40,000	691,229
3.3 Air Force Structures Project	(AF)	1,580,421	116,000	1,464,42
TOTAL		3,314,978	481,000	2,833,97

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structures, of most sizes and types, when subjected to atomic bomb blast.

b. Securing of quantitative data and checking of theoretical data on blast pressure diffraction phenomena around structures.

c. Verification of laboratory and theoretical behavior of structural elements and structures under impulsive loads.

d. Comparing and testing of the strength of different types of structures and structural materials to resist the anticipated loadings.

e. Accumulation of basic data upon which future model programs can be based.

f. The testing of blast-resistant doors and the testing in cooperation with the Chemical Corps of automatic blast closure devices, a collective protector and an air lock arrangement (Sub-project 3.1.3).

g. Investigating pressure conditions under different amounts of soil cover (Sub-project 3.1.3).

h. Through instrumentation and examination of shelters and subsequent analysis to establish and verify criteria for the design of personnel shelters subject to atomic blast (Sub-project 3.1.3).

i. Evaluation and comparison of the fragmentation characteristics of different structural materials exposed to both heat and bomb blast (Sub-project 3.1.1).

B. What application will the data have.

1. Because it is manifestly impractical to construct above-ground buildings that would be proof against the atomic bomb near the explosion center, the Corps of Engineers test program has been directed towards gaining a knowledge of increasing a building's resistance to collapse at reasonable cost, thereby reducing the area within which building would be rendered useless (Sub-project 3.1.1).

2. Through instrumentation and examination of the test structures and subsequent engineering and the mathematical analysis it should be possible to establish criteria and procedure for the design and analysis of military and industrial structures subject to atomic bomb blast or other high transient loads, in order to provide maximun resistance at minimum cost.

3. Correlation between theoretical and actual data will allow future sound design generalizations. The principles to be established through the tests will undoubtedly be of value in modernizing structural design theory.

[redacted]

the elastic limit of the material. A study has been made of all available reports of tests of static and dynamic properties of structural materials and members. The ultimate strength of reinforced concrete members has been estimated by the "plastic theory" which is much more realistic than the standard "straight line theory" currently used in the design of ordinary buildings.

2. A study was made of the effect of A-bomb blasts on buildings in Japan and large bombs in Europe for the purpose of reconciling the proposed design procedure with past experience.

3. Instead of designing the structure so that the stresses in all parts are well below the elastic limit or yield stress, it has been assumed that, in order to utilize the reserve strength available in the plastic range of the material under dynamic loading, some of the members will be stressed beyond their elastic limit. The design is based upon allowing less distortion than would render the structure impractical to repair or safely use.

4. Based on examination of available data, analytical procedures have been developed for calculating the deformation of structural frames and members produced by blast loading. It is believed that these procedures will prove to be satisfactory but their application to any specific case depends on many assumptions and simplifications which will necessarily introduce uncertainties until they are verified by tests of prototypes such as herein proposed, supplemented by laboratory type research and analysis.

5. After thorough consideration of all uncertainties involved, the following design criteria were selected as being the ones which would probably give the most valuable test results (re: Multi-story Building):

   a. Windowless building frames are designed to have a horizontal displacement of 4.4 inches per story under 100% of the estimated blast load.

[redacted]
of known physical characteristics. The design theory can then be checked and refined, and reviewed for possible simplification. With that accomplished, the theory may be applied to structures of widely different proportions to determine the degree of bomb resistance of an existing building or to design new buildings for any specific set of conditions.

B. Detailed Description

1. Sub-project 3.1.1 - Multi-story Building.

This structure is a three-story composite building approximately 52' x 196' x 36' high and consists of seven separate sections arranged to respond independently.

The structure is arranged so that the effects of the diffraction of the blast wave and resulting pressure distribution on the front, top and rear faces of the individual sections will be similar to that experienced by a representative section of practical size building of similar type construction.

There are two main structural types employed. The center section constitutes one basic type construction wherein the resistance to lateral forces if provided by shear walls which receive lateral loads from the roof and floor slabs. The roof and floors acting as stiff plates or diaphragms receive the reactions of the blast-loaded exterior walls.

The two sections on each side of the center section constitute the second basic structural type namely the structural frame, employing two different

[redacted]

rectangular shelter structure to accommodate the Chemical Corps' study. A Collective Protector Field Unit with all necessary equipment will be installed in a joint investigation of the Chemical Corps and the Corps of Engineers.

[redacted]

ations and strains of representative elements of the structural framing, including roof slabs, beams and girders, exterior walls and columns, interior shear walls and columns and column and girde frame joints.

Expected accelerations and deflections, at the various points consider ed for instrumentation, have been calculated by Ammann and Whitney, thereby establi ing the range for selection of proper instruments.

4. Transient Photography

Motion picture photography will be employed to give a general view of the composite structure (Sub-project 3.1.1) during test. From one to four camera will be used; cameras will be oriented so that the four vertical faces of the build ing are covered.

[redacted]

5. Before and After Measurements

A complete still-photography coverage of test structures is essential. Approximately 200 before and 400 after the test still photographs will be taken in connection with the Corps of Engineers structures program.

It is of primary importance to record the initial and final displaced positions of the various parts of the test structures. A large number of survey check points have been included.

C. Dependency on Expected Yield of Weapon.

1. The structural design calculations for desirable test conditions and the limits for instrumentation measurements of of accelerations and displacements generally cover the range of from 50% to 150% of the estimated peak blast pressure (100%) at the distance of structure from detonation point. The above range in peak blast pressure corresponds to a range of approximately ±60% in the expected yield of the weapon (based on equivalent weight of TNT charge in pounds or kilo-tons), assuming the estimated peak blast pressure is calculated correctly. A ±25% uncertainty in the accuracy of estimated peak blast pressure would reduce the allowable range for desirable results in the expected yield of the weapon from approximately 60% to about 35%.

2. Any minor change in the date of the test will have no appreciable technical effect on the test of the Corps of Engineers structures. In regard to the time, or hour of the day, good daylight is important for any high-speed photography during test.

III. Details of Progress to Date in Experimental and Theoretical Work

A. Corps of Engineers Investigations.

1. A project has been conducted since May 1947 at Massachusetts Institute of Technology (MIT), under contract with the Corps of Engineers. The primary objectives of this research program have been the determination of the exact behavior of various types of structural elements under the action of suddenly applied forces which are maintained for periods of time ranging from a few hundredths to a large fraction of a second. This problem has been broken down into several subjects:

a. Behavior of beams in the elastic range.

b. Behavior of beams in the plastic range.

c. Behavior of slabs in the elastic range.

d. Behavior of slabs in the plastic range.

In all these subjects, there are two factors of importance, (a) the response of the structural system to the imposed force, and (b) the strength of the materials of the structural system under the rapid rates of loading to which they are subjected.

Currently the investigations are being extended to tests on simple frames and on joints.

Because laboratory experiments are necessarily confined to simple structural elements, and because of uncertainty in extrapolation from model scale up to full scale, it is essential to test and study the whole composite multi-story structure to get a complete understanding of the relative resistance and behavior of the various elements of the structures and the structure as a whole under dynamic loading.

2. Ammann and Whitney (A&W), Consulting Engineers have completed, under the technical direction of the Corps of Engineers, a comprehensive study and design of the two test structures. They were assisted in this work by the Corps of Engineers consultants Prof. Newmark, University of Illinois and Professors Wilbur, Norris and Hansen of MIT. The theories followed in the A&W investigations are described briefly in paragraph II.A above. This extensive study of all available data on the subject emphasizes the necessity and desirability of full scale tests to prove or disprove theories and assumptions.

IV. Personnel Requirements

A. Required at Test Site.

1. Scientific Personnel

a. One Project Officer (one or two trips to site during construction period for inspection and consultations, and attendance at test). Officer will be furnished by Corps of Engineers.

b. Two civilian engineers to represent the Corps of Engineers during the construction of test structures (about 6 months period at test site).

c. Two civilian scientists to represent the Corps of Engineers during instrumentation, installation and damage survey following the test (about 6 months at test site).

2. Technicians

It is estimated that one photographer plus an assistant will be required from a pool of such technicians to accomplish the required photographic coverage for the Corps of Engineers Structures.

3. Laborers and Other Unskilled Help

It is estimated that 2 men from a pool of laborers will be required to assist the Corps of Engineers representatives during the damage survey (for about one month following the test).

[redacted]

See paragraphs la, b and c above.

VIII. Collaboration

The Chemical Corps is collaborating directly in the Corps of Engineers test participation. Test of a Collective Protector Field Unit with necessary equipment is incorporated in the reinforced concrete shelter (Sub-project 3.1.3).

The Corps of Engineers is assigned the responsibility of establishing for the Department of the Army criteria and techniques pertaining to protective construction. The objective of the Corps of Engineers program of participation is to establish criteria for more effective design of structures subject to atomic bomb blast. All data and criteria developed will be made available to other military departments and appropriate governmental agencies.

IX. Responsibility

A. The Corps of Engineers program will be conducted under the direction of the Protective Construction Branch, Engineering Division, Military Construction, Office of the Chief of Engineers, U.S. Army. The damage survey, including the collecting test data and reporting will be accomplished by Massachusetts Institute of Technology, under contract with the Office, Chief of Engineers.

B. Project Officer for the Corps of Engineers (Department of the Army) program is: Major Bruce D. Jones, Protective Construction Branch, Office, Chief of Engineers, Room 2530, Building T-7, Gravelly Point, Washington 25, D.C.

C. Responsibility for accomplishing construction and instrumentation of all Corps of Engineers buildings resides with Task Group 3.1 and the Instrumentation Project Officer, respectively.

X. Funds

These are shown under Program 3.0.

XI. Facilities

A&B. Requirements in connection with Collective Protector equipment will be submitted in Chemical Corps Project proposal; requirements in connection with instrumentation will be furnished by the Instrumentation Project Officer.

The Corps of Engineers has no other special requirements for power or communication facilities.

C. Corps of Engineers representatives on the site during construction; instrumentation and damage survey will require 200 square feet of covered and enclosed space for field office and storage.

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LAB-J-981

PROJECT 3.2

NAVY STRUCTURES PROJECT

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I. Object of Experiment

A. The objective of this test program is two-fold. The primary objective is the evaluation of new designs with respect to blast action. These designs are under consideration for protective shelters of various types for equipment and material. The second phase of the program is the study of the damage in relation to that predicted in accordance with the dynamic analyses performed by this bureau. The information to be obtained will be of two general categories. The first is that furnished by electronic and self recording gages. These gages will furnish data on the blast phemonena as related to the structure; the displacement, velocity, and acceleration of the structure; and certain component elements. The remainder of the data will be gathered by careful photographic and visual inspection of structural damage such as crack patterns in the concrete, size of cracks, crumbling of concrete at working joints, yield of steel, notation of recovery, foundation movements, etc. The character of the data required may be summarized as information relative to forces in action on the structure, and the structural response.

B. The structures and their components have been carefully analyzed from a dynamic viewpoint with due regard to both plastic and elastic response depending upon applicability to the structural element under review. The aim of this review was to establish a set of predictions as to the response of the structure. It was intended to review the actual structural response under test in terms of these predictions, analyse the structures with revised data as a basis for improving design analysis or, if necessary, to develope new design analysis on the basis of the data obtained. Continuity of the program per se may be open to interpretation. However, the designs to be employed in the forthcoming test are either exact replicas of existing construction, modifications of existing construction, or expansion of precast designs which are of particular interest to this bureau and peculiar to it. Some structural elements and members employed in this program have been tested statically and under TNT bomb conditions. The structural concepts are in general new when employed in combination as set forth in these designs, but the basic elements are the culmination of many years of effort. It is considered that these designs are only on the threshold of their usefulness and that more tests, possibly of a different nature, will be required both on the basis of the test results to be achieved and on the basis of new ideas relative to design and construction.

II. Method

A. The general approach to the problem consisted of a study of damage at Nagasaki and Hiroshima which culminated in the development of a theoretical method of analysing structural damage. This was all accomplished on the basis of the information when available and was general in scope. Since then certain tests were performed at Bikini and Sandstone and additional information gained with respect

[redacted]

similar to the first one. These three layers are all bonded into a single acting mass by trusses extending from the top of the third to the bottom of the first layer. The forth layer is a thick slab of reinforced concrete. This roof design has been previously successfully tested for penetrating TNT bombs.

No instrumentation.

3.2.2a Panel Veneer Type F 1210 yds from GZ

This structure is approximately 20' x 40' in plan and 10' in height. The superstructure, that is the walls, bents and roof, are completely precast elements which are bolted and welded together in the field. The framing consists of three bents and the wall and roof employ 1¼" thick reinforced concrete panels stiffened by edge members and ribs.

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	2 displacement
	4 accelerometer	2 accelerometer
	5 displacement	

3.2.2b Panel Veneer Type G 1210 yds from GZ

This structure is approximately 20' x 40' in plan and 10' in height. It is twofold in character. The inner structure is a replica of normal one-story shop buildings found in the Naval Establishment employing brick walls and a timber roof. The outer shell employs the basic construction concept of 3.2.2a above as protection for the inner shell. However, no bents are employed.

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	None
	3 accelerometer	
	3 displacement	

3.2.3a Matchbox Type C, Near Location 800 yds from GZ

This structure is approximately 20' x 40' in plan and 10' in height. This structure is an adaptation of some of the design concepts of 3.21b for a building requiring less protection. It consists of panels fabricated from a number of small reinforced concrete boxes separated and joined by thin concrete faces and reinforcing rod diagonal truss members. These panels are assembled and joined by use of more trusses and grout. The net result is construction consisting of a grid of bar trusses with a strong reinforced concrete diaphragm on the inner and outer surfaces. Its apparent complexity is only a function of its newness because it adapts itself readily to mass production on a rapid fabrication schedule.

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	2 accelerometer
	3 accelerometer	
	5 displacement	

3.2.3b Matchbox Type C, Far Location 800 yds from GZ

Same as 3.2.3a

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	3 displacement
	3 accelerometer	
	4 displacement	

[redacted]
basic structural elements consist of half a cathedral-type rigid frame bent with an inverted channel cross section. Twenty of these elements with the end walls comprise the entire structure which is to be completely covered with two feet of fill.

Instrumentation:

Electronic Instruments	Self-recording
3 pressure	2 accelerometer
8 accelerometer	2 displacement
5 displacement	
8 earth pressure	

3.2.4b Precast Magazine Type D, Uncovered 1170 yds from GZ

Identical with 3.2.4a except that it is uncovered.

Instrumentation:

Electronic Instruments	Self-recording
9 pressure	4 accelerometer
8 accelerometer	2 displacement
7 displacement	

3.2.5 Concrete Arch, Type I 1170 yds from GZ

This structure is approximately 20' x 40' and 10' elevation at the crown. The concept of the structure is identical with 3.2.4a and b except that the structure elements are half arches rather than half rigid frames. This structure presents an opportunity for study of curved wall presentment to blast.

Instrumentation:

Electronic Instruments	Self-recording
15 pressure	4 accelerometer
3 accelerometer	
7 displacement	

3.2.6 Concrete Dome, Type E 1080 yds from GZ

This structure is approximately 32' in diameter and rises 16 feet at the crown. It consists of a number of trapezoidal shaped precast elements bolted together. Layout is such that there are four circumferential bents of the panels with a closure piece at the crown. Structure will be covered with two feet of fill.

Instrumentation:

Electronic Instruments	Self-recording
8 earth pressure	4 accelerometer
3 pressure	6 displacement
3 accelerometer	

3.2.7a Conventional Concrete Type H, Near Location 1180 yds from GZ

[redacted]

This structure is approximately 20' x 40' in plan and 10' in elevation. The main difference between these structures and normal concrete design for such buildings is that additional vertical steel has been added to the side walls to increase and strengthen as vertical cantilevers and thereby improve the structural resistance to shear and bending forces induced by the blast.

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	4 accelerometer
	4 accelerometer	2 displacement
	2 displacement	

3.2.7b Conventional Concrete Type H, Far Location 2260 yds from GZ

Same as 3.2.7a

Instrumentation:	Electronic Instruments	Self-recording
	4 pressure	4 accelerometer
	4 accelerometer	2 displacement
	2 displacement	

C. The details of the tests are independent of the date and time of the tests but highly dependent on the expected yield of the weapon. The structures have been located with respect to a certain pressure - time relationship of the blast wave. The instruments to be employed on the structures are set to operate within previously established ranges. The many variables of construction materials and design assumptions preclude exactitude in establishing the location and unpredictable range naturally is inherent in the structural response. Naturally, blast affect greatly in excess of that assumed in the design may be expected to result in damage which would invalidate further analysis. Peculiarly enough, blast of much less magnitude than that assumed would also have an adverse affect on the tests. Much of the Bureau's design is in the plastic range and much of our lack of knowledge is in the plastic range. Extrapolation of results from a dud to the structural response of these structures will be essentially guess work. It is to be pointed out that the damage to these structures caused by a dud would probably be so small as to leave the structures in a satisfactory condition for future tests.

III. Details of Progress to date in Experimental and Theoretical Work

A. The Bureau of Yards and Docks, in accordance with the request of the Program Director, will prepare a complete report on the theoretical work that has been accomplished in the formation of this program. Experimental work that has previously been accomplished was related solely to the construction problems, static load design, and response to semi-armor piercing bombs. This work has been extensive but no comprehensive report has been prepared inasmuch as the program is in the formative stage. It is felt, however, that such information is directly applicable to the immediate problem. It is not considered that there are sufficiently well established concepts at present which could be affected by the test now proposed and comment is therefore not made. As to the necessity for fundamental data, there is, of course, no question as to the requirement for information concerning the pressure time phenomena, the

[redacted]

B. Project Work in Continental United States

1. Scientific Personnel - 2 officers and 2 civilians

One officer will be the Project Officer for the program. One officer will perform necessary liaison duties, one civilian in charge of design and analysis, one civilians, structural analyst.

[redacted]

2. Technicians - 1 civilian draftsman and computer for structural design and analysis.

V. Instrumentation and Equipment Requirements

See proposal of Instrumentation Project Officer.

VI. Present Status of Instruments and Equipment Required to Perform Experiment

None

VII. Logistics

A. Sea Lift - It is assumed that this information will be provided by Holmes and Narver and Sandia Corporation.

B. Air Lift - It is assumed that pertinent information here will be furnished by Sandia Corporation.

C. Sea Lift Personnel - None

D. Air Lift Personnel - The following schedule is tentatively planned:

June 1 - one trip out
June 1 to December 31 - five trips out
five trips back
December 31 - one trip back
D -90 - one trip out
D -15 - five trips out
D - 5 to D +30 - four trips out
four trips back
D +30 - six trips back

E. Nothing

VIII. Collaboration

There will be collaboration with the Office of Chief of Engineers and US Air Force for the full structural program. It is presumed that there will also be collaboration with Los Alamos on information concerning blast phenomena.

IX. Responsibility

A. LCDR Stanley Rockefeller (CEC) USNR will be Project Officer for the Bureau of Yards and Docks structures test program and will have overall responsibility for the test, collection of data and reporting it to the Scientific Director via the Program Director.

B. The address of the Project Officer is Room 2A71, Bureau of Yards and Docks Annex, Washington 25, DC, telephone number, REpublic 7400, extention 61506.

[redacted]

X. Funds

These are shown under Program 3.0.

XI. Facilities

A. This information will be submitted by Sandia Corporation.

B. This information will be submitted by Sandia Corporation.

C. This information will be submitted by Sandia Corporation.

D. Two jeeps will be required for use by the survey teams. Boat requirements will depend upon housing facilities available for the teams.

XII. Remarks by Project Officer

It is planned to assign a Naval Inspector with the precast subcontractor. As soon as information is available as to who received the contract an inspector will be provided.

[redacted]

[redacted]
which is to obtain maximum effectiveness of the subject weapon.

1. The Air Force is charged with the responsibility for recommending targets for possible atomic attack and delivering bombs to such targets. The scarity of raw materials and the high cost of fabrication make it mandatory that the application of these weapons to targets yield the maximum return. Detailed and accurate knowledge of the effect of atomic bombs on targets is necessary in order to provide a firm basis for target selection and to insure that maximum of return is obtained. Such target studies form the foundation for plans of vital importance to the national security and welfare and influence to a large degree such important programs as the size and type of the strategic air force and the development and production of atomic weapons.

2. In addition to the offensive aspects of the problem, knowledge of the capabilities of atomic weapons is essential for estimating the vulnerability of the United States to such attack, so that adequate civil defense planning may reduce this vulnerability.

3. Predictions of damage to targets in their fullest sense will involve the following phases:

a. Determination of the features which peculiarly define the target such as structural types and strengths; topographic, meterological and geophysical factors; the grouping of individual types of structures in the target complex and the effects of shielding, etc.

b. Correlation of the characteristics of the weapon with the structural features of the target.

c. Calculation of probability of damage based on bombing accuracy and a consideration of the factors above.

4. Considerable information is available on the structural features as possible targets. Methods have been developed for calculating the probability of

[redacted]

6. It is generally considered that there are three lines of approach to the problem of correlating the characteristics of a blast wave and damage to structures:

a. Development and extension of theory.

b. Model experiments.

c. Full-scale experiments.

It is believed that a combination of these three methods will yield the best results and that, certainly, full-scale tests are required to serve as check and calibration points for model experiments and theoretical studies. The additional advantage of full-scale tests is that important information can be obtained which will be of immediate operational use when interpreted in the light of theory, model studies, and the past experience at Hiroshima and Nagasaki. This is especially important in view of the fact that the development, execution, and interpretation of a comprehensive, systematic experimental program involving models and possibly full-scale structures in conjunction with "pseudo-atomic blasts" undoubtedly will require a considerable and unpredictable period of time.

7. To obtain complete operational information directly and immediately by the use of full-scale structures in conjunction with the proposed tests is manifestly unfeasible. The purpose of the Air Force program is, therefore, to provide:

a. Immediate information of operational value covering the range of important structural types likely to be encountered in probable targets.

[redacted]
importance of such factors is recognized, but their solution will of necessity depend upon other programs of research and analysis some of which will be covered by other phases of the atomic tests.

9. Rather, this program is directed toward correlating damage with the parameters of blast wave under controlled conditions. Proper interpretation of this information is the light of theory, experience, and other experiments will permit much more reliable predictions of damage to targets under actual operational conditions than is now possible.

II. Method

A. General

1. The general method to be employed in the proposed experiment is to select the desired types of structures, erect them in locations where they will experience appreciable structural damage but not major collapse, instrument them as required and, from their behavior under the test, devise approved methods of target analysis, analysis of the structures, and recommendations for future tests. Specifically, the steps employed in this method are briefly as follows:

a. A detailed design of the structure to be tested.

b. A theoretical pre-test analysis which will serve to fix desired location of the various structures, predict the damage and determine the extent, location, and type of instrumentation to be comployed.

c. A Post-test survey of the damage based on photography and field measurements.

d. A study and analysis of the test results and the formulation of methods of analyses and recommendations for future tests.

2. The following types of structures are considered necessary to

[redacted]

cover adequately the range of possible targets and provide the necessary data desired for complete development of a proper continuing program:

a. Multi-story reinforced concrete. (The structure proposed by the Department of the Army, 3.1.1, will satisfy this requirement).

b. 3.3.3 - Single-story industrial with long spans and without cranes (C-1.1).

c. 3.3.4 - Single-story industrial with short spans and without cranes (A-2.1).

d. 3.3.5a - Load bearing wall, dwelling type F-2

3.3.5b - Load bearing wall, dwelling type F-2

e. 3.3.8 - This consists of the following models:

(1) 3.3.8a - Idealized model, closed, near location.

(2) 3.3.8b - Idealized model, front openings. 3' x 3'.

(3) 3.3.8c - Idealized model, front and rear openings 1 1/2' x 1 1/2'.

(4) 3.3.8d - Idealized model, front and rear openings 3' x 3'.

(5) 3.3.8e - Idealized model, front and rear openings 4 1/2' x 4 1/2'.

(6) 3.3.8f - 1/4-scale of idealized models.

(7) 3.3.8g - Idealized model, closed, far location.

(8) 3.3.8h - 1/4-scale model of 3.3.3 structure.

3. Sub-projects 3.3.3, 3.3.4, and 3.3.5 a and b, are considered typical of possible targets and are being designed on that basis.

4. For each of the industrial types a single example will be erected at such distance from the point of detonation as to result in substantial structural damage. An effort will be made to analyse as accurately as possible the distances so as to produce plastic deformation within major structural members but not to the point of complete collapse. Two (2) identical examples of the load-bearing wall structure will be erected since the difference between moderate damage and collapse is much narrower in this type than for the other structures and the significance of instrumentation will furthermore be appreciably less. Two (2) such structures will therefore greatly increase the probability of obtaining the required degree of damage. The prototype 3.3.3, its 1/4-scale model, 3.3.8h, and 1 simplified model, 3.3.8g, will be erected at the same distance in order to provide optimum correlation for studying model effects.

[redacted]

trusses. The roof trusses over the other two aisles are supported entirely by carrier trusses spanning three bays each. This building is representative of possible targets in such industries as aircraft assembly. The structure proposed is a typical intermediate section of a long building and will be oriented with the aisles normal to the blast. The front wall of the test structure is extended (in effect) by free-standing self-supporting wing walls. The purpose of these wing walls is to ensure that the behavior of the structures under the test more closely simulates an intermediate section of a long structure as it would exist in practice. These wing walls have been calculated to fail under a predetermined blast load to ensure that there are no excessive differential pressures existing inside of the building, and that the loading against the face of the front wall will more nearly approach the distribution to be anticipated against the face of an intermediate section of a long structure. This structure will be located at 2530 yds from GZ.

b. 3.3.4 - single-story industrial structure with short spans and without cranes. This structure is a four-aisle, three-bay light manufacturing building approximately 56' x 106' x 24' high and consists of precast reinforced concrete bents and tee columns supporting steel moniters and wood roof deck. The structure proposed is a typical intermediate section of a long building and will be oriented with the aisles normal to the blast. The front wall of the test structure is extended (in effect) by free-standing self-supporting wing walls. These walls are for the same purpose as mentioned above. This structure will be located at 2430 yds from GZ.

c. 3.3.5a and b - multi-story load-bearing wall structure. Two such structures are planned. These are two-story brick buildings approximately 40' x 30' x 36' high and consist of metal roofing, wood rafters, and wood floor joists. The interior partitions supporting the ceiling and floor joists are of bearing-wall masonry construction. Such structures are representative of urban construction in may cities both in the United States and abroad. They will be located to bracket the probable limits of damage. The buildings will both be oriented face-on to the blast, since the bearing partitions will constitute shear walls to render the structures less vulnerable in this direction. Structure a will be located at 1480 yds and b at 2340 yds from GZ.

d. 3.3.8h 1/4-scale model of the 3.3.3 - This structure will be, within practical limits, a faithful 1/4-scale reproduction of the prototype structure. Studies and discussions of possible scale ratios indicate that a 1/4-scale represents about the minimum desirable ratio for the type of data required. Complete model similitude is not considered necessary since many of the features are

[redacted]

not sufficiently important to the behavior of the structure to warrant the tremendous added expense of attempting to duplicate them in model scaling. Attention has been focused on ensuring that the important elements of the structure have been kept to model scale or, if not, to a degree so that it can be compensated for in the analytical treatment. This structure will be located at 2330 yds from GZ.

e. 3.3.8a - g, Idealized Models - These will consist of a total of six (6) simple steel-framed structures about 7' high and 14' x 21' in plan supporting simply-held concrete slabs and resting on a massive concrete foundation. In addition, there will be one 1/4-scale model, 3.3.8f, of these simplified models. These structures are described in more detail in the report cited in sub-paragraph 3 of this section. The purpose of these structures in general is to provide fundamental data on the manner in which the shock wave loads the structure, how it diffracts around corners and through openings and how a structure of relatively simple characteristics responds to such loadings. 3.3.8a - f will be located at 1240 yds and 3.3.8g at 2330 yds from GZ.

2. All test structures will be located on Engebi and Muzinbaarikku. In determining the location at which structures should be erected, preliminary locations were established by utilizing data from Japanese experience. This method was later revised on the basis of basic peak pressure and time-distance relationships furnished by the AEC. By utilizing this data, studies were made to determine the manner and rate in which the various structures might be loaded with the shock wave. With such loadings the structures were analyzed in detail to determine their expected response for the intansities governing at selected distances from the point of detonation. Such studies, coupled with examinations of existing damage reports and the efforts of other investigators, resulted in the proposed locations which were submitted to the AEC by the Air Force on 9 March 1950.

3. The studies and analyses discussed in the above paragraph also provided the information from which determination could be made regarding the number, location, and types of instrumentation that would be required to ascertain the actual behavior of the structure during the test. The types of instruments to be used are namely pressure gage, accelerometers, displacement gages, strain gages, recorders, time of occurence devices, motion and still picture cameras, and maxima gage devices. Considerable advantage has been taken of symmetry of structures and symmetry between like structures. In such cases only tie-in gages have been specified. The instruments have been so selected and located that the data and supplemental data, if proven applicable, from shock tube, wind tunnel and explosive tests will give a true picture of the physical movements, forces developed and loading of the structures. A full discussion of the method, objectives, philosophy of approach to the problem and detailed requirements for instrumentation is considered too voluminous to be included in this report. Reference is therefore made to "Recommendations Relative to Instrumentation for the Air Force Structures 1951 Test," Report No. 2 prepared by the Armour Research Foundation. This report may be obtained from the following sources:

Task Group 3.1.3
Directorate of Intelligence, Headquarters USAF
Joint Task Force THREE Program Director of Program 3.0 AFSWP
Project Officer, Program 3.3, Air Installations, Headquarters AMC

[redacted]

and mode of response.

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is believed that the loading method in its present form is a reasonably good representation of the actual physical picture, although it will undoubtedly be modified by further theoretical and experimental investigation. The extent or importance of these modifications obviously cannot be foreseen.

3. Armour Research Foundation was able to become rapidly acquainted with the work that had been done in the field of the dynamic response of structures to date. This process was speeded up immeasurably through the retention of two consultants of long experience in this field, Drs. N. M. Newmark and M. P. White. The situation for the structural analysis of buildings was somewhat different from that for the loading analysis, in that a general theory of the behavior of a complex structure under dynamic loading had been proposed and that problems could be formulated accordingly. For the case of actual buildings, however, this formulation would lead to extremely complex equations so that the main question was the determination of a rational set of simplifications which would render the problem soluble and

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idealized model buildings were so designed that they could be analyzed by more standard methods of dynamics. In these instances, the simplified nature of the structures and the clear definition of the principal masses enabled the formulation of the behavior of these structures by the usual methods of dynamics and with fewer assumptions of questionable validity. Indeed, this along with the procurement of diffraction data, was a primary purpose in the use of these models.

4. On the basis of the analyses discussed above the various structures were located at the site. Due to the obvious uncertainties involved, the results were checked as closely as possible against the records of studies of damage data, so that both analyses and experience would place the structures in approximately their final location. The buildings analyzed by the above methods were the following: 3.3.3, 3.3.8h, 3.3.4 and 6 idealized models with varying openings in the front and rear faces. No attempt was made to perform analyses of the 3.3.5 buildings, since this type of building has no definable structure in an analytical sense.

5. The big questions upon which the success of the program depends are:

a. Does a reliable relationship exist between the side-on overpressure and the face-on overpressure or will the effects of possible boundary layer prohibit the establishment of a correct relationship between these to quantities as they are being measured at present?

b. Can the results of wind tunnel, shock tube, and small-scale explosive tests be reliably extrapolated to full-scale structures for the purpose of furnishing external loading data?

c. Can the results of model explosions, both large-and small-scale, be reliably extrapolated to indicate the loading and response of full-scale structures?

6. The program as originally conceived contemplated the testing of nine (9) different types of key industrial facilities or structures, in order to provide an optimum number of full-scale results which would be of immediate applicability to target analysis. The present program has to some extent changed this concept in that it has severely reduced the number of full-scale types and placed greater emphasis upon the applicability of theory and model testing. It should be noted that the factors discussed in paragraph 5 above are common to both the original and present programs. However, all other factors being equal, the prosecution of target

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He will be responsible for continuing surveillance of the construction to assure that Air Force standards and requirements are being met. In this connection he will make appropriate recommendations to the USAF Civil Engineer at the site. (To be procured)

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administering and supervision of the project. (To be procured)

d. 1 Engineer (Structural) - This engineer will be employed as office engineer to exercise detailed supervision over the plans and specifications for structural features of the project and to compose, prepare and dispatch fund and progress reports which are required for this project. (To be procured)

[redacted]

[redacted]

1-Instrumentation Engineer		0	x
1-Instrumentation Technician		x	x
4-Engineers			x
Hq USAF, D/I			
1-Engineer	0	0	x
3-Engineers			x

VIII. Collaboration

The Air Force Structures Program 3.3 is being carried out for the Directorate of Intelligence, Headquarters USAF, by Headquarters AMC. Collaboration is being exercised with representatives of the Sandia Corporation and the AEC on matters pertaining to instrumentation and structure analyses, construction etc.

IX. Responsibility

A. Major Bert E. Pettitt, USAF, Headquarters AMC, Wright-Patterson AFB, Dayton, Ohio, has been designated as Project Officer for this program.

B. Major Bert E. Pettitt, USAF, Headquarters AMC, Wright-Patterson AFB, Dayton, Ohio, has been designated as Project Officer for this program.

X. Funds

These are shown under Program 3.

XI. Facilities

D. Forward Area Transportation - 2 jeeps.

Inter-island transportation will be required between Engebi and Muzinbaarika.

XII. Remarks by the Project Officer

None

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pages No. ......of......copies.
Series

LAB-J-983

PROJECT 3.4

STRUCTURES INSTRUMENTATION

This [redacted]

III. Details of Progress to Date in Experimental and Theoretical Work

A. In August 1949 a division known as SLA-6, was organized at Sandia Base for the purpose of assisting in the instrumentation and measurements of blast phenomena on structures in the "GREENHOUSE" Program Three. As originally planned, approximately 250 measurements would be made on not more than eight structures. Based on the above conception of the program Sandia began testing end-instruments in October 1949 both in the laboratory and under blast conditions. Testing under blast conditions was accomplished at Los Alamos. As progress was made on the design and pre-shot dynamic analysis of the structures it was decided that almost all of the buildings should be instrumented. In conference, held to decide on locations and type of instrumentation necessary, the total number of instruments was raised to approximately 900.

In order to facilitate the testing of gages under blast conditions, a blast site was set up in the New Mexico School of Mines area south of Sandia Base. The recording equipment and associated gear were moved from Los Alamos to the new site in December 1949 and blast evaluation of gages was resumed in January 1950.

On 1 February 1950 a preliminary list of instruments found to be suitable for use on the Structures Program was published. However, evaluation of instruments continued since final location, range, and type of instruments had not been decided.

On 1 April 1950 a final list of instruments found to be suitable for use on the Structures Program was published. Some self-recording instruments were reported although it is not known whether they will be satisfactory since the prototypes have not been received.

Timing circuits, burn-out circuits, and power circuits have been designed and prototypes constructed. Evaluation and modification of these circuits to fit the needs of each individual recording shelter is being carried out.

A study is being made of the Webster-Chicago Recorder and playback equipment. Sandia received one six-channel recorder and a two-channel playback with which these tests are being made. Modification of the amplifiers in order to match Wiancko gages is being studied and results should be obtained in the near future.

IV. Personnel Requirements.

A. Required at Site

1. Enclosure A, page 3.4-7 is a listing of personnel required at the test sit[e] by groups and whether they will be Sandia or Contractor personnel. This enclosure also specifies the duties of each group. The six supervisors to be furnished by Sandia are at present working on the project. The Holmes and Narver personnel shown under groups 1, 5 and 12 are at present employed on the project in Los Angeles.

[redacted]

A. The following equipment other than standard laboratory items will be necessary at the test site to carry out this program:

1. Spin-table for calibrating accelerometers.
2. Two hydraulic lift platforms (40' maximum).
3. One welding machine.
4. Two tractor swing-cranes.
5. Five cable carts.
6. Special equipment (wrenches, drills for gage points, etc.) will be reported when information becomes available.

B. All equipment can be assembled in the ZI and shipped to the test site ready for installation and test.

C. The assembly necessary at the test site will be the mounting of amplifiers, power supplies, and recorders in their respective racks prior to check-out and calibration. These operations will be completed by personnel in the Instrument Groups (Group 8 on the chart).

D. The calibrations to be made at the test site will be made in a central location for all recorders and the recording equipment then transferred to its respective shelter. A calibration curve will be made for each pressure gage, accelerometer, and displacement gage. A single step calibration is expected to be placed on each

[redacted]

[redacted]

B. Up to the present time orders have been placed according to the following table:

31 Magnetic Tape Recorders
31 Power Supplies
20 Racks (mounting)
553 Wiancko type Amplifiers
161 Strain Gage Amplifiers - Webster-Chicago
10 Test Sets
13 Timers
35 Instruction Books
124 Empty Spools
124 5-minute Tape Spools

Delivery to be made to Oakland as follows: 1/2 of each item by 1 October 1950, remainder by 1 November 1950.

252 Pressure Pickups	Wiancko Engineering	15 June 1950 to 15 Sept 1950
152 Accelerometers	Winacko Engineering	15 June 1950 to 15 Sept 1950

C. It is expected that the following orders will be placed:

200 Self-recording accelerometers - Engineering Research Associates 1 October 1950.

15 Footing Pressure Gages - Wiancko Engineering - 6 May 1950
23 Earth Pressure Gages - Wiancko Engineering - 15 September,1950
15 Delay Timers - R. W. Cramer - 15 July 1950

D. No complete development remains to be done.

E. Development is almost complete on the self-recording accelerometer designed and built by Engineering Research Associates. It is expected that delivery of prototypes will be made by 1 May 1950 at which time a complete evaluation will be made.

[redacted] ordered. It is expected that orders will be placed at an early date.

Perforating Machine for marking tape - Cummins - Chicago - 30 days
Storage Batteries for power source - Electric Storage Battery Co., Exide, Willard, U.S. Rubber Co. 60 days
Cable for end-instruments - Amphenol, Belden, Revere Corp - 60-90 days
Rectifiers - Vickers Electric, Federal Tel & Tel, Sorenson, McColpin-Christie Corp., - 60-90 days
Cable mounting clips and straps - Adel Precision Products - 30 days

G. It is expected that no equipment will be required from the Armed Forces.

H. It is expected that burn-out panels and timing panels will be built by this organization. All panels and circuitry will be completed for recording shelters A thru K by 15 September 1950.

VII. Logistics

A. Sea Lift

1. There will be 30 measurement tons requiring delivery to the test site prior to D-120. The remainder will be 78 measurement tons requiring delivery to the test site prior to D-90.

2. It is estimated that there will be approximately 80 measurement tons in roll-up and shipment can commence on D+15.

B. Air Lift

1. The only air lift required will be the forwarding of 15 footing pressure gages during May 1950. This shipment is estimated to weigh 300 pounds.

2. It is expected that all equipment will be shipped back to the States via water transportation.

C. Sea Lift (Personnel)

1. It will be necessary for approximately 20 men to arrive at the test site on D-120 to lay cable and install batteries. It will be necessary for approximately 60 men to arrive at the test site on D-90.

2. The above men can begin return on D+15.

D. Air Lift (Personnel)

1. It will be necessary that 8 men arrive at the test site on D-90.

[redacted] on location E. This would be more practical than storage space assigned on the control island.

D. Forward Area Transportation

The following transportation will be necessary to carry out this program:

[redacted]

8 - Pickup trucks or jeeps
2 - Jeeps for hydraulic lifts
2 - 6 x 6 trucks
2 - Swing cranes

The 8 pickups or jeeps will be assigned to the utility men in each of the Groups 8. The two jeeps for hydraulic lifts will be assigned to the Whittemore and survey groups.

The two 6 x 6 trucks will be used to transport batteries, recorders, amplifiers, etc. from storage to calibration building and then to the recording shelters. The two swing cranes will be used in conjunction with the loading and unloading of the 6 x 6 trucks.

PERSONNEL

Group	Sandia	Contractor	
1	1	1	Overall Supervisor
2	1		End-instrument Supervisor
3	1		Recorder and Amplifier Supervisor
4	1		External Circuits Supervisor
5	1	1	Logistics Supervisors
6	1		Special Measurements Supervisor
7		1	Surveying Supervisor
8		56	Instrument Group (2 recorder men, 2 end-instrument men, 2 cable men, 1 logisticor utility man)
9		4	4 soniscope and natural period group (2 men)
10		7	Survey Party (2 instrument men, 2 recorder, 2 chainmen, 1 rodman)
11		6	Whittemore Group (2 men)
12		1	Inspector
13		1	Draftsman
14		1	Steno-clerk
		79	TOTAL

REVISED 4-2-50

[redacted]

[redacted]

window construction to the crushing action of an atomic blast.

B. The data which will be secured from this test will be used by the Public Buildings Service in the design of new and in the remodeling of existing Federal buildings. The Civilian Defense Administration and the Housing and Home Finance Agency will also use this data in preparing standards for the construction of new and the remodeling of old structures that are used for housing. This experiment; however, it is desired to have other tests made in order to secure more extensive data on this subject than will be derived from this experiment.

II. Method

A. It is proposed to erect a prefabricated structure with various types of windows with different methods of glazing at a point about 10,000 feet from an atomic explosion. Photographs will be made showing the effects of this explosion and a written report prepared covering the entire project.

B. The proposed structure affords a test of five different kinds of glass mounted in eight different types of window construction exposed on both front and rear sides of the structure. Screens are installed on the inside of some of the windows to determine if such shielding will stop flying glass. There are to be no instrumentation points.

C. The structure itself is designed to resist the expected yield of the weapon; the only failures expected are confined to the glazing and window construction. The date and the time of the test are fixed under the general plans for the GREENHOUSE Operation.

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1. Scientific Personnel. One Project Officer will be required, together with a photographer, in order to make a written report of the results, illustrated with photographs.

2. Technicians. It is estimated that 30 man-days will be required to erect and anchor the prefabricated structure after it arrives at the island where it is to be located. The necessary personnel is now at the site.

3. Some laborers and other unskilled help will be required in connection with erecting the structure, and these men are now at the site.

B. All project work required in the United States has been completed.

V. Instrumentation and Equipment Requirements

No instrumentation or equipment is required, except a camera, to be furnished by TU 3.1.6, preferably a 4 x 5 Graflex, for making the necessary photographs.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

No equipment or instruments are required, except the aforementioned camera.

VII. Logistics

A. Sea Lift.

1. The crated parts of the prefabricated structure weigh approx- [redacted] The material is expected to reach the forward area by boat on February 5.

2. No material is to be returned to the United States after the test has been completed.

B. Air Lift.

No air lift is required, except possibly for 150 pounds of crated materials, including some Venetian blinds.

C. Sea Lift (Personnel.
No sea lift for personnel is required.

D. Air Lift (Personnel).

1. Air lift for the Project Officer who should arrive at E - 9 in the forward area is required.

2. No personnel are required in the roll-up. The Project Officer should remain in the forward area until E ≠ 12.

E. No unusual logistics problems are presented at the test site in connection with the installation of the prefabricated structure.

VIII. Collaboration

Agencies collaborating in connection with the preparation of this experiment include the Atomic Energy Commission, Joint Task Force THREE, Public Buildings Service, National Security Resources Board, Housing and Home Finance Agency, and the Civilian Defense Administration. (See also Section I, B.)

IX. Responsibility

A. The person who will have the responsibility for carrying out the experiment, collecting data, and reporting it through the Program Director to the Scientific Director will be Mr. Walton C. Clark, who has been appointed Project Officer in charge of this project.

B. Mr. Walton C. Clark
Consultant to the Director of Design and Construction
Public Buildings Service
Room 6316, General Services Building
19th and F Streets, N. W.
Washington 25, D. C.

X. Funds

A. For Fiscal Year 1950. None

1. Total estimated cost is $9,000.

2. None.

3. None.

4. None.

5. None.

B. For Fiscal Year 1951.

1. Total estimated cost is $9,000.

2. Unexpended and unobligated funds, $1,000.

3. Expenditures and obligations to date, $8,000.

4. Expenditures and obligations for January 1951, $8,000

5. Expenditures and obligations for January 1951, $8,000.

XI. Facilities

A. Power. None required.

B. Communications. None required.

C. Laboratory Space and Other Facilities. None required.

D. Forward Area Transportation.

Transportation will be required for one carpenter, one glazer, and the Project Officer on the sixth and seventh days prior to E-0 and transportation for the Project Officer and the photographer will be required on the third and fourth days after E-0.

XII. Remarks by Project Officer

None.

[redacted]

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PROGRAM 4

Cloud Physics

Program Director - Dr. Peter H. Wyckoff - Base Directorate for Geophysical Research
Air Force Cambridge Research Laboratories
230 Albany Street
Cambridge 39, Massachusetts

Project Officers - 4.1 - Phase A - Mr. Charles E. Anderson - AFCRL

Phase B - Dr. A. O. Mirarchi - AFCRL

4.2 - Mr. Robert M. Rados - AFCRL

4.5 - Mr. David Barber - AFCRL

4.6 - Mr. S. C. Coroniti - AFCRL

LASL Liaison - Capt. Robert E. Keegan, USAF

Program 4 tests were initiated for the purpose of determining the geophysical and meteorological phenomena associated with an atomic burst, and to study meteorological conditions as they might affect the overall operational plan for an atomic strike. This includes a complete study of cloud physica, wind phenomena, dynamics of tropical meteorology, and correlation of atmospheric conductivity with atomic cloud diffusion.

This program is directly under the Air Force Cambridge Research Laboratories, in collaboration with LASL, Air Weather Service, and AFOAT-1. The results obtained will be of interest to AEC, Army, Navy, and Air Force.

[redacted]

SECRET

[redacted]

[redacted]	FISCAL YEAR 1951					
	Estimated Cost	Deptm'tal(1) or AEC (2) Funds Available	Funds Required from JTF-3	Total Estimated Cost	Total Funds Available	Total Funds Required from JTF-3
	45,910	0	45,910	330,495	34,000	296,495
	17,400	0	17,400	90,000	0	90,000
	12,200	0	12,200	33,900	0	33,900
	38,505	0	38,505	63,825	0	63,825
	114,015	0	114,015	518,220	34,000(1)	484,220

[redacted]
Grier, who are under contract to LASL. This phase of photography will be included in the present contract.

I. Object of the Experiment

Phase A

A. The experiment is designed to obtain data on the thermodynamic structure of the cloud ensuing from the blast. Present instrumentation plans call for measurement of temperature and relative humidity at various pressure altitude levels within and around the cloud.

B. These data will be used in connection with an overall program whose objective is to determine the possibility of scavenging radioactive constituents of atomic clouds by precipitation, naturally or artificially produced. The subject experiment will yield data which is applicable to the problem of determining the possibility of inducing precipitation from atomic clouds by the use of artificial seeding agents.

Phase B

A. Sequential photographic records will be obtained of the cloud from fixed ground positions and from two B-50D aircraft.

B. Photographic coverage is such as to give clear and detailed sequential views of cloud over a vertical angle of 60 degrees, plus, and across a horizontal angle of 120 degrees. This experiment is part of a continuing program. It will be used to study development of the cloud and its diffusion.

II. Method

Phase A

A. A position - time cross-section of relative humidity and temperature will be made in various portions of the cloud by means of aerographs installed in drone aircraft.

B. Eighteen (18) drones will be equipped with Kollsman aerographs. This will include twelve (12) TB-17 and six (6) EQT-33 airplanes. The T-33 aircraft will be vectored into the lower portions of the cloud (approximately 6000 to 8000 feet altitude) and the B-17's will be vectored into higher portions of the cloud (8000 to 28,000 feet altitude). The aerographs are instruments which will detect and record automatically ambient air temperature, relative humidity, pressure, altitude, airspeed, and a reference time mark.

[redacted]
out", shears, etc.

C. Tests are relatively unrelated to estimate of expected yield of weapon, date, and time of tests. The only requirement is that there be sufficient light for photography.

III. Details of Progress to Date in Experimental and Theoretical Work

Phase A

A. The problem of the feasibility of inducing precipitation from atomic clouds using artificial seeding agents is under theoretical attack at the present time. The factors which are important in the formation of precipitation have been isolated and are being individually studied. Accordingly drop size distribution, liquid water content, temperature, air motions, cloud thickness and sublimation nuclei are the important variables which are influential in the precipitation process. Previous experimental investigations at other places have yielded methods whereby crude integrations of the above mentioned variables can be carried out in attempting to understand the mechanism of the precipitation process. The results of seeding trials carried out during the past 3 years have been studied and evaluated with the conclusion that the possibility of producing rain artificially depends very greatly on the magnitude of those variables mentioned previously. Therefore, it is imperative to know the values of these factors in the atomic cloud in order to determine theoretically the possibility of inducing precipitation from it.

Phase B

A. This photographic documentation proposes to be of such high quality that it will yield useful data for computing dimensions, rate of rise, and for giving useful aid to determine rain-out from the cloud, to determine aspects of the ice cap, if any, as well as to assist in the development theory on formation of the ice cap. The E G & G Co. is presently in course of determining all experimental requirements.

[redacted]

[redacted]

IV. Personnel Requirements

Phase A & B

A. Required at Test Site.

1. Scientific

a. Civilian

One civilian - Program Director - Dr. P. H. Wyckoff

One civilian scientist to be procured by Air Force Cambridge Research Laboratories to supervise the installation and operation of aerograph equipment. (Mr. C. E. Anderson). One civilian scientist on hand at Air Force Cambridge Research Laboratories to act as liaison with E G & G. (Dr. A. O. Mirarchi) One senior meteorologist to make a running commentary on the behavior of the cloud during the photographing period to be procured by University of California at Los Angeles under contract with AFCRL. (Dr. W. W. Kellogg).

b. Officers

One officer to serve as scientific liaison and coordinator on the aerograph installations to be procured by AFCRL. Two meteorological officers with photographic backgrounds to be procured by AFCRL stationed at remote photographic sites and give a running commentary of the cloud development. These officers will maintain liaison with the senior meteorologist and decide upon section of cloud to be photographed.

2. Technicians

a. One civilian technician to install and inspect aerographs to be furnished by Kollsman Instrument Division upon request of AFCRL.

b. Six enlisted men to be procured by AFCRL for assignment to 550th Guided Missiles Wing to maintain and pre-flight aerographs.

c. Camera operators on each of two B-50's: one for each aircraft to be supplied through E G & G.

3. None anticipated

B. Project Work in Continental U.S.

1. Scientific

[redacted]

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a. Civilian

Two civilians to analyze data gathered during tests and prepare necessary reports on the findings. One on hand and one to be procured.

One civilian project scientist furnished by AFCRL whose principal duties are to determine the overall requirements of the project and decide, in conjunction with E G & G Co. on the actual scope, purpose, and extent of tests.

One senior meteorologist to be procured under contract with UCLA to assist in setting up photographic analysis systems and to assist E G & G in determining camera coverage required.

V. Instrumentation and Equipment Requirements

Phase A

A. 1. Twenty two (22) aerograph systems complete.

2. Four (4) relative humidity calibration units

3. Two (2) converter 110 volt 60 cycle single phase to 24-28 volt D.C.

4. Converter 110 volt 60 cycle AC to 110 volt 400 cycle AC single phase.

5. Six (6) sets evaluating and data reducing equipment.

6. Four temperature resistance boxes.

B. All assembly will be completed in the ZI and be ready for installation at the forward area.

C. No instrument or equipment assembly or construction is anticipated at the site provided that delivery schedule is met by Kollsman Instrument Co.

D. Each aircraft will require a calibration flight upon completion of the aerograph installation at the site. Calibration of temperature and relative humidity elements will be performed before take-off on each aircraft.

1. Humidity Test Chamber

2. Temperature fixed resistance box

E. No protective equipment or construction will be required.

Phase B

A. 1. Six each K17 cameras per site. (E G & G).

2. Four each Mitchell cameras (E G & G).

3. Three each tape voice recorders.

B. Instruments and equipment will be assembled in the ZI.

C. No on-site equipment assembly will be required.

D. Accurate siting of 6 K17's and 2 Mitchell cameras for azimuthal and horizontal angles is required. (E G & G).

E. No protective equipment required.

1. Detailed drawings not available at this date.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

Phase A

A. No aerograph equipment is on hand at this time.

B. Purchase requests have been submitted for the following items from the Kollsman Instrument Division:

22 aerograph systems
24 each temperature and relative humidity probes
300 each aerograph recorder chart rolls
1 each spare part kit

Delivery of all equipment to be completed by 31 December 1950

C. The placing of no future orders is anticipated

D. The Development of this equipment is completed

E. The manufacturing commenced on 10 March 1950 and the first delivery is to be made in September 1950 and the total requirements will be delivered by 31 December 1950. The Kollsman Instrument Division of the Square D Company, Elmhurst, New York is the Contractor.

F. The following commercially available equipment has been ordered:

Two each Nobations Model E-28-10 from Sorenson.

G. The following Armed Forces equipment has been requisitioned and delivery date anticipated is by 1 July 1950:

1500 each Humidity Element Stock #26-702123990
6 each Calculator ML-322/UM S-NX26-704350100
6 each Calculator ML-323/UM S-NX26-704350200
6 each Calculator ML-324/UM S-NX26-704350225
8 each Calculator ML-326/UM S-NX26-704350300
5 each Scale ML-321/AMQ-2 Stock No. 26-704350370
1 each Gasoline Power Generator Output 110 volt 400 cycle.

Above at various supply depots. Delivery to be completed by 1 July 1950.

H. Five (5) humidity calibration boxes and five (5) fixed resistance temperature calibration boxes will be required. These can be built within 30 days.

I. The decision on the equipment and instruments to be used has been completed. There appears to be no need for assistance at this time.

Phase B

A. 100% of equipment is available to the contractor.

B. The E G & G Company has agreed to continue this project and has submitted a proposal draft which was considered acceptable.

C. Final draft of proposal is being prepared and being forwarded to LASL for inclusion within their existing contract with E G & G Co.

D. See A, B, and C above.

E. As above. Estimated time required for remaining development and procurement is estimated to be 15 April 1950.

F. Permission has been obtained to use the two AMC blast test B-50D's (8.1) with camera equipment aboard to continue mission and photograph cloud.

G. Not applicable

H. Not applicable

I. Not applicable

VII. Logistics

Phase A & B

[redacted]

A. 1. Five (5) M/T to be at site D - 10. This will be the same equipment which E G & G will use under AEC contract and is not an additional requirement.

2. Ten (10) M/T will be ready to be shipped G + 10. Five (5) M/T will be same equipment as in A 1. above.

B. 1. It will be necessary to transport approximately 4000 pounds of equipment to the forward area. This shipment must arrive D-60. This time will be required to unpack, install, and run calibrations of the aerograph systems in the 18 drone aircraft. This equipment will not be available for shipment until 31 December 1950.

2. 100 pounds of flight records to be returned to AFCRL. These will be available on G + 10.

3. It is requested that this aerograph equipment be removed from the aircraft in the ZI. This would eliminate the need for repacking the units. The equipment may possibly be left in certain of the drone aircraft for future experiments.

C. 1. Three (3) personnel by D-60.

Four (4) personnel by D-14 (movement of E G & G personnel planned under 1.0 Program)

2. Six (6) personnel by G + 14

Four (4) personnel by G + 7

D. 1. Five (5) each personnel by D-60

One (1) each personnel by D-60 (accompany equipment from Contractor to test site)

2. Three (3) each personnel by G + 7

E. No particular logistics problem anticipated.

VIII. Collaboration

The data collected will be available to any requesting agency.

IX. Responsibility

Phase A & B

A. 1. Mr. Charles E. Anderson Phase A, and Dr. A. O. Mirarchi Phase B joint

[redacted]

[redacted]

350 watts 24 volt D.C.
400 watts 110 volt 400 cycle A.C. single phase

B. 1. The timing signal requirements for the aerograph systems will be incorporated with the drone aircraft timing circuits.

2. No special communications telemetering or television requirements will be necessary.

C. Laboratory Space and Facilities: 1. Laboratory storage space 400 sq ft.

2. One standard 10 ft work bench with power outlets. (Eniwetok)

D. Three (3) 1/4 ton trucks or equivalent will be required to carry personnel and test equipment between laboratory and aircraft parking area. Up to eighteen (18) aircraft will be checked before each test.

XII. Remarks

Entire Phase B Operation will be operated by E G & G under their AEC contract. A tentative proposal has been drafted by E G & G in a series of three meetings during which detailed problems and requirements were resolved. A final proposal is now being drafted by E G & G for submission to LASL.

[redacted]

either to induce fall-out or to render the cloud visible after nightfall, it is necessary to introduce the seeding material after the cloud has cooled to a temperature at which this material will not vaporize. It may be most practical to introduce the seeding material into the afterwind draft so that it will be carried into the cloud when appropriate temperatures have been reached. In such an operation, the particle size of the seeding material would depend on the afterwind structure.

The proposed experiment is not an extension of previous experiments. The future of this observational program will depend on the adequacy of data collected during the coming tests, as well as on new requirements that may appear as the theoretical work in dependent problems progresses.

II. Method

A. General.

In general, it is planned to install wind measuring devices and accompanying automatic recording equipment at a number of points at varying distances from the blast centers in numbers sufficient to insure recovery of a large sample of wind data over the range of velocities estimated to occur during and after the blasts. By installing instruments at two heights above the ground surface, a measure of the vertical variation of wind will be obtained.

B. Detailed.

Specifically, it is planned to install 25 instruments in the area of the tests and at points selected with regard to the number and locations of the blast centers and the destruction and damage caused by the blasts. It was decided to locate the instruments on the basis of two blasts, one on the island of Engebi and the other on the island of Aomon, with some consideration being given to the possibilities of blasts on the island of Runit.

In order to check the assumption that only radial distance from the blast will affect the afterwind speed, the instruments will be staggered at different azimuths from the center of the blasts. Such a distribution of instruments will reflect any departures from point symmetry.

The concentration of sites is to increase toward the blast center, with the minimum and maximum radial distances dependent on the distribution effects of a 50-kiloton bomb. Several instruments are to be placed close enough to the blast center so that they are not expected to remain standing or in operation after zero time, despite safety factors added to the instrument's specifications. Such placement of instruments will result in information which will verify theoretical calculation and assist in the planning of future investigations and in the construction of instruments which could be used for measurements closer to the blast center.

All instruments will be so constructed as to permit measurements of winds at either the 6 or 12-foot level above the surface. Since the winds at either level can be recorded by all instruments, the exact number at each level is dependent on firm site locations and final decision will be made at a later date.

Wind measuring instruments employing two different principles of operation will be developed in connection with this experiment. It is planned to utilize instruments based on a pitot-tube speed and a vane with self-synchronous link for direction indication as first-line equipment. Twenty-four of these instruments will be of this type. An instrument utilizing an ambient temperature-insensitive thermocouple for speed and vane with self-synchronous link for direction indication will also be developed to insure availability of an alternate instrument should development and/or production of the pitot-type instruments fall too far behind schedule. This instrument will also be used for comparative measurement and testing in this program for possible use on future programs of this type.

A unit wind measuring installation will consist of the following components

1. Wind direction and speed pick-up unit, as described above.

2. Supporting 4" steel mast, guyed by 8 wires attached to 4 anchors.

3. Steel vault. This vault will be airtight, moisture-proof, and installed so that the lid will be level with the ground surface. It will contain the clock-driven recording apparatus and also the battery power supply for self-synchronous motor and activating relays.

With this arrangement, only the pick-up unit and mast are exposed to the blast effects. The recording units can be rewound and the power supply replaced after each blast. Copies of specifications given to contractors for development and production of the instruments are attached.

C. Dependence on Yield, etc.

Parts II, A & B, are predicated on the characteristics of a bomb yield in the order of 50 kilotons. A greater bomb yield will result in greater loss of instruments than anticipated and a corresponding decrease in data coverage.

Any appreciable change in estimated yield would require appropriate change in site location.

The time of the test will have no effect on this experiment; however, an earlier date would be detrimental to this project, since the present schedule allows barely enough time for development, manufacture, calibration, delivery, and installation of instruments.

[redacted]

III. Progress to Date in Experimental and Theoretical Work

A. Since the primary object of this project is to secure continuous record of wind velocity, the operations to date have been concerned solely with preparations. The nature of these observations is such that little theoretical work is required; however, since the locations of instruments and also the specifications for the instruments themselves are dependent on the destructive effects of the blast, recourse was made to theoretical work previously performed assuming a 20-kiloton bomb.

As a result of studies which determined the possible effects of the blast, the following instrument location chart was prepared showing instrument locations in terms of radial distance and azimuth from zero points. (See page 4.2 - 10)

IV. Personnel Requirements

A. Required at Test Site

1. Scientific Personnel -

No. Required	Status	Duties
1	1 Civilian - On Hand Mr. R. M. Rados	Project Officer will supervise: a. Project personnel on test site from D -10 to G +10. b. Collection of pertinent meteorological data from other recording agencies at the site. c. Final installation and instrumentation check. d. Collection of records. e. Roll-up operations.
2	1 Officer - On Hand 1 Officer or Civilian to be procured as soon as possible.	Project Engineers to perform: a. Supervision of personnel from Port of Embarkation until D -10. b. Supervision of uncrating and checking of instruments. c. Supervision of erection of mast, assembly and initial check of instruments at test locations. To include survey for installation.

[redacted]

No. Required	Status	Duties
		d. Make final instrument check. e. Coordinate work with other agencies at test site. f. Assist Project Officer as required. g. Perform Roll-up. h. Supervise shipment to States.

- - - - - - - -

2. Technicians -

10	10 EM or Civilians - to be procured. (5 to be trained; 5 to be picked up at POE.)	Weather equipment specialists to: a. Uncrate, assemble, check instruments. b. Install and test instruments at the site. c. Assist in surveying sites and tying in communications. d. Perform repairs and maintenance as required between blasts. e. Reassemble, pack, and crate instruments for shipment to States.

- - - - - - - -

3. Laborers -

Installation of vaults to be accomplished by Holmes and Narver (Construction Company).

All of the above (not on hand) have been requested through Air Force channels and are to be either Military Personnel supplied by Air Weather Service or civilians, for whom vacancies must be allocated.

b. Project Work in Continental United States

1. Scientific Personnel

No. Required	Status	Duties
1	1 Civilian On Hand (1/2-time duty)	Project Officer to supervise the following:

[redacted]

[redacted]

No. Required	Status	Duties
	(Mr. R. M. Rados)	a. Project requirements, coordination, and reports. b. Engineering personnel and technicians. c. Contract and contract monitoring. d. Instrument tests and modification. e. Collection of pertinent associated data. f. Analysis of records. g. Compilation of final report.
3	1 Officer - On Hand (Full-time duty) 2 Officers or Civilians - to be procured as soon as possible.	Project Engineers to perform: a. Determination of project requirements, assist on project reports. b. Expedite procurement of miscellaneous equipment, tools, paper, batteries, etc. c. Contract monitoring for instrumentation. d. Coordination and supervision of instrument calibration tests. e. Supervision of Los Alamos instrument test. f. Instruction of technicians on care, installation, maintenance and repair of equipment. g. Supervise packing, crating, and shipment of equipment and personnel. h. Assistance to Project Officer on data analysis and compilation of report. i. Arrangement of final instrument disposition.

- - - - - - - - - -

2. Technicians

No. Required	Status	Duties
5	5 EM or Civilians	Weather equipment specialists to be trained in installation, care, maintenance, and repair of test equipment.

Note: Above personnel, with exception of 1 Officer, are same personnel which will be assigned to test area as in IV, A.

V. Instrumentation and Equipment Requirements

A. 31 anemometer pick-up units.

25 masts and guys, including mooring anchors.

25 sets of recording devices.

90 battery supply units.

25 vaults to support masts and contain recording devices and battery supply units.

Tools for installation and maintenance of instruments.

B. Instruments and equipment can be assembled in the Zone of Interior with the exception that the final assembly must be done on site, since the indicating instruments must be fixed to masts and connected to recorders in vaults.

C. The recorders are delicate and must be protected from the blast. They are therefore emplaced in steel vaults, whose tops are ground level. The 10 technicians and at least one engineer will be required to assemble, install, and check the instruments.

D. At present, no calibrations at the test site are contemplated.

E. Covered in II B.

1. Detailed drawings have been submitted to Task Group 3.1.

VI. Present Status of the Equipment and Instruments

Required to Perform the Experiment

A. 0% already procured and on hand.

B. Purchase Requests were initiated with Friez Instrument Division of the Bendix Corporation and Hastings Instrument Company for wind instruments. Pilot models to be delivered in July, 1950. Final instrumentation to be complete by November, 1950.

C. Small orders - such as batteries, recording paper, ink, etc. - to be placed as required.

D. Yet to be developed - None.

E. An order will be placed for 30 pitot-type anemometers and recording devices, complete with battery supply units, as soon as procurement procedures can be accomplished. This order will be placed with the Friez Instrument Division of Bendix Aviation Corporation, Baltimore, Maryland. The desired delivery date is 1 November 1950. An order will be placed for development and procurement of 1 heated thermopile-type anemometer and recording device, complete with battery supply units, as soon as procurement procedures can be accomplished. This order will be placed with the Hastings Instrument Company Inc., Hampton, Virginia, with desired delivery date as 1 August 1950.

F. None.

G. None.

H. 25 vaults will be constructed by AEC contractor.

I. None.

VII. Logistics

A. Sea Lift

1. 25 M/T, D -60 (17 M/T vaults)

2. 5 M/T, G +7

B. Air Lift

None

C. Sea Lift (Personnel)

1. 12, D -60

2. 12, G +7

D. Air Lift (Personnel)

1. 1, D -10

2. 1, G +10

Air transportation is necessary because other duties of this person prevent the use of sea lift.

[redacted]

XI. Facilities

A. Power - None

B. Communications

1. Necessary signals on -15 m and -5 sec. No others are necessary.

2. Special communications - none.

C. This project will require shop facilities where anemometers and electrical recording equipment can be assembled, calibrated, and serviced. One shop will be sufficient to service all of the test installations of this project and may be located in any general shop area designated or already available on the atoll. A one-room shop of 600 sq. ft. floor space, containing 30 linear feet of standard benches, with 110V 60-cycle outlets at 6-foot intervals, will meet all the requirements for shop facilities.

D. Some manner of transportation must be provided for assembly of equipment at sites listed above. In addition, at least two boats or DUKWS will be required to transport personnel from individual islands or to individual islands just prior to the tests in order to set recording devices in operation.

XII. Remarks by Project Officer

None

Instrument Station Chart

Proj. & Acct. # 4.2

Site	Sta. No.	Yds. from Zero	Azimuth From Zero	User	Building	Site Power	Phones	Time Signals	H&N Drwgs. No.	Remarks
Reference E - Zero										
E	421	500	300°	METEOR	$2\frac{1}{2}$' x $2\frac{1}{2}$' x $2\frac{1}{2}$' Vault.	0*	1	-15 min. - 5 sec.		
E	422	600	305°	" "	" " " "	"	"	" " " "		
E	423	700	301°	" "	" " " "	"	"	" " " "		
E	424	800	281°	" "	" " " "	"	"	" " " "		
E	425	900	300°	" "	" " " "	"	"	" " " "		
E	426	1200	270°	" "	" " " "	"	"	" " " "		
E	427	1200**	308°	" "	" " " "	"	"	" " " "		
E	428	1200**	308°	" "	" " " "	"	"	" " " "		
E	429	1600	317°	" "	" " " "	"	"	" " " "		
S	4210	2240	317°	" "	" " " "	"	"	" " " "		
S	4211	2543**	316°	" "	" " " "	"	"	" " " "		
S	4212	2543**	316°	" "	" " " "	"	"	" " " "		
T	4213	3100	317°	" "	" " " "	"	"	" " " "		
P	4214	5680	310°	" "	" " " "	"	"	" " " "		
Q	4215	3650	095°	" "	" " " "	"	"	" " " "		
Q	4216	4060	095°	" "	" " " "	"	"	" " " "		

* To be self-contained.

** Two sites equidistant from reference, 15 ft. apart laterally.

Instrument Station Chart

Project 4.2 - Wind Phenomena

Site	Sta. No.	Dist. from Zero	Azimuth	Building Type	Site Power	Phones	Time Signals	H&N Drwg. No.
Reference D - Zero								
D	4217	600 yds.	295°	$2\frac{1}{2}$' x $2\frac{1}{2}$' x $2\frac{1}{2}$' Vault	0*	1	-15.0 min. - 5.0 sec.	
D	4218	800 yds.	245°	" " "	"	"	" "	
D	4219	1260 yds.	290°	" " "	"	"	" "	
D	4220	1900 yds.**	305°	" " "	"	"	" "	
D	4221	1900 yds.**	305°	" " "	"	"	" "	
R	4222	2640 yds.	317°	" " "	"	"	" "	
N	4223	4060 yds.	332°	" " "	"	"	" "	
Reference C - Zero								
C	4224	800 yds.	320°	" " "	"	"	" "	
C	4225	1500 yds.	325°	" " "	"	"	" "	

* To be self-contained.

** Two sites equidistant from reference, 15 ft. apart laterally.

and may result in severe criminal penalties under

II. Method

A. General.

The Base Directorate for Geophysical Research, Air Force Cambridge Research Laboratories, is at present supporting research in tropical meteorology at the University of California at Los Angeles on a contract basis. This research, under the supervision of Prof. C.E. Palmer (one of the few specialists in the field of tropical meteorology), is directed toward extending knowledge of tropical meteorology and improving tropical meteorology and improving tropical weather forecasting techniques, and otherwise has objectives similar to those of this project. This contract terminates on 30 June 1950 and negotiations have been initiated to extend and modify this contract to include the specific objectives listed above. In the meantime some work is being carried on under the present contract to meet test forecasting and general research requirements in the field of tropical meteorology.

B. Detailed Project Plan.

1. Background Research and Preparation (Phase I):

Prof. C.E. Palmer has been informed of test requirements through conferences with personnel of the Base Directorate, Air Force Cambridge Research Laboratories, and has submitted a proposal for modigying the present contract to meet these requirements. Negotiations to effect these modifications have been initiated.

Prof. Palmer has submitted recommendations to these Laboratories on the type and location of weather observing stations which he feels will best meet the requirements of the test and research programs. These recommendations have been submitted in turn to Lt. Col. George Taylor, Staff Weather Officer of JTF-3 for consideration in development of over-all weather service requirements.

Recommended meteorological data coverage is as follows:

a. Types of observations, in order of importance:

(1) Accurate upper winds - (a) radar, (b) double drift, (c) pibal.

(2) Aircraft weather cross-sections.

(3) Radiosonde observations and aircraft soundings.

(4) Surface observations.

It is desirable that accuracy in measurement of rainfall amounts be emphasized since this parameter is of special synoptic importance.

[redacted]

b. Observational network.

A fixed network of stations, assigned priorities 1, 2, and 3, in order of importance, as listed below (starred stations are south of the Equator).

Palmyra (1)
*Canton I. (1)
Baker (1)
Majure (1)
Kwajalein (1)
Eniwetok or Bikini (1)
Wake (1)
Tarawa (2)
*Nauru (1)
Kapingamarangi
(Hare I.) (1)

Truk I. (1)
Ponape (3)
Kusaie (2)
*Henderson Field (2)
*Manus (2)
*One station in No. Solomons
(Green I.) (2)
*Tutuila (3)
*Atafu (3)
*Funafuti (3)

All broadcasts of surface and upper-air data from Fiji and Western Samoa should be picked up.

c. Aircraft Observations.

Aircraft observations afford the only means of covering the areas to the east and northeast and to the west and northwest of Kwajalein. Regularly scheduled daily flights along fixed tracks would be of greatest synoptic use, and special emphasis should be placed on cross-section representations. If aircraft reports are available for the same grid points at the same time each day, time sections for these points may be drawn. The standard procedure of taking aircraft soundings at the turning points of the tracks should be followed, as has been done in previous tests.

d. Cloud Photographs.

The compilation of a tropical cloud atlas, especially one of precipitating clouds, would greatly facilitate studies of physical conditions necessary to produce precipitation from clouds in tropical regions. It is requested that photographs for such an atlas be taken from reconnaissance aircraft and by land station personnel using phototheodolites or special cameras.

e. Time Requirements.

For purposes of acquiring sufficient synoptic data for further research, it is desirable that this program be instituted two months prior to the tests and extend one month thereafter.

[redacted]

[redacted] project at UCLA, in addition to the services of the four AWS officers, have been offered to the Staff Weather Officer of JTF-3 for the period of the tests. The decision of the Staff Weather Officer on the utilization of project personnels' services is also pending. In this connection, Prof. Palmer has indicated his unwillingness to assist in forecasting at the tests if the minimum data coverage he has recommended as mandatory for successful forecasting cannot be supplied.

It is further planned that project personnel will assist in making special meteorological observations at AWS stations during the test period in an effort to get photographic observations of tropical cloud structure for future research on precipitation in the area.

3. General Research in Tropical Meteorology (Phase III):

After the test period the project group will continue research in tropical meteorology under terms of the contract, making full use of data collected during the tests.

C. Dependence on Yield, etc.

This project is not dependent on yield of the weapon, date or time of the tests.

III. <u>Details of Progress to Date in Experimental and Theoretical Work</u>.

A. The outstanding synoptic problems of tropical meteorology may be grouped under the following general headings:

1. The physical conditions governing the formation of cloud and precipitation in the tropics.

2. The status of "fronts", particularly the "equatorial front".

3. The description and explanation of the origin, development and movement of tropical storms.

Solutions to these problems would include fulfillment of the major objective of this project as listed under I A.

lation of adequate tropical meteorological data. Establishment of the data coverage recommended for the test period will afford an excellent source.

Since this project is in support of the tests rather than dependent on them, no fundamental data relative to blast conditions is required.

IV. Personnel Requirements.

A. Required at Test Site

4 - Air Weather Officers - MOS 8219 - Forecaster.
To receive special training under this project, for assignment to the Task Force Staff Weather Officer.
Will assist in test forecasting.
A request for assignment of these officers to the project has been sent to the Staff Weather Officer, JTF-3.

3 - Civilian Scientific Personnel.
Prof. C.E. Palmer, UCLA and 2 assistants presently employed on Tropical Project, UCLA. Services of these personnel are available

[redacted]

as required and compiling meteorological data at stations of Air Weather Service.

B. Project Work in Continental United States.

Same personnel as listed under A.

Duties:

4 Officers - presently at UCLA for graduate training in meteorology. Awaiting assignment to Tropical Project for training in tropical forecasting techniques.

[redacted]

3 Civilian Scientific Personnel - employed at UCLA on Tropical Research Project under contract to Air Force Cambridge Research Laboratories.

V. Instrumentation and Equipment Requirements.

None.

VI. Present Status of Equipment and Instruments.

See V.

VII. Logistics.

A. None.

B. None.

C. Sea Lift (Personnel)

1. 7 - Personnel

Should reach forward area 2 months prior to tests.

2. None involved in roll-up.

7 - Personnel can commence return 1 month after tests.

VIII. Collaboration.

University of California at Los Angeles, under contract to Air Force Cambridge Research Laboratories, will analyze data, and supply consulting services as required.

Air Weather Service will collect data.

Base Directorate for Geophysical Research, Air Force Cambridge Research Laboratories, will monitor and coordinate work of UCLA Group.

IX. Responsibility.

A. Prof. C.E. Palmer, UCLA, will report to the Project Officer.

B. Mr. David Barber, Atmospheric Analysis Laboratory, Base Directorate for Geophysical Research, Air Force Cambridge Research Laboratories, is Project Officer.

X. Funds.

This is covered in fiscal chart under Program 4 heading.

[redacted]

XI. Facilities.

A. Power - None required.

B. Communications - None required.

C. Requirements for space will be coordinated with Lt. Col. Taylor.

D. Transportation requirements will be coordinated with Lt. Col. Taylor.

XII. Remarks by Project Officer.

None.

[redacted]

Project 4.6 Atmospheric Conductivity

This [redacted]
No [redacted]

I. Object of the Experiment

A. Two B-50 aircraft and one L-13 aircraft will be equipped to obtain continuous records of the electrical conductivity in the atmosphere for positive and negative ions. Continuous measurements of large ion content and total nuclei per unit volume will also be obtained.

B. The results of the above data will enable a pilot to know when he is approaching a radioactive cloud. The tests will also determine how soon a plane which approaches a new radioactive cloud must turn aside before receiving serious contamination. Ground contour work will determine how soon the area where blast occurred will be inhabitable. This work is a continuation of previous experiments, which are of a continuing nature.

II. Methods

A. Before the blast conductivity measurement will be made to determine background value for the surrounding area. After the blast planes will first search for the cloud. After finding it the experiments will be carried out in and around the cloud.

B. 1. Diffusion of the cloud shortly after the blast (1 or 2 hours) will be determined by measuring the variation of atmospheric conductivity as a function of distance near the edge of the cloud.

2. Measurement of the time rate of change of conductivity in the fringes of the cloud for several days after the blast will give the rate of cloud diffusion. The vertical and horizontal diffusion will be of particular importance.

3. Measurements will be made in order to map contours of radioactive intensity as a function of time over the island where the blast occurred. From this can be determined the time rate of decay of radioactivity and the variation in intensity as a function of distance from blast area.

4. Determination will be made of cloud contours and its possible disintegration into smaller radioactive clouds. During this time the variation of height and width of the clouds with time can be measured. Also the position and speed of cloud will be determined.

5. From the above experiments estimates can be made of the total radioactive content of the cloud.

C. These measurements are not dependent on an estimate of the expected yield of the weapon. The time and date of the tests are not too important.

III. Details of Progress to Date in Experimental and Theoretical Work

A. The previous theoretical and experimental work of Drs. Wait, Gish, and others has shown that the presence of radioactive matter in the air can be detected from measurements of electrical conductivity in the atmosphere. This has been found more effective than any other existing method for detecting the presence of a cloud, of mapping its contours, and of determining from point to point the amount of radioactive matter in the cloud. This indicates the desirability of using conductivity equipment for such purposes. Several conductivity measuring units have been built. Conductivity apparatus has been installed in a B-17 for preliminary tests. Background measurements of conductivity have been made at different parts of the country. The diurnal variation and variation of conductivity with altitude have also been observed. The results have been compared with those of previous workers and found to be in good agreement. This group will participate in experiments at Los Alamos in the next few months. From the simulated blasts we hope to obtain the order of magnitude of results to be obtained in the Pacific tests. This will aid us in making the program more specific.

IV. Personnel Requirements

A. 1. Five civilian scientists and three military scientists having officers rank. The duties of the civilians are to plan the details of the experiment and to participate in obtaining the data. The duties of military officers are to participate in obtaining the data.

2. Two military officers, one for each B-50 aircraft. These men are rad safety officers who will fly with each mission and they will measure the radioactive contamination of the aircraft - to be furnished by TG 3.4.

3. Flying Personnel.

   a. Two complete crews for B-50 aircraft. The number of officers and men will be from 9 to 11 for each ship. (AMC)

   b. An officer pilot for the L-13 aircraft. (TG 3.4)

4. The scientific personnel will be furnished by the Geophysical Research Directorate of Air Force Cambridge Research Laboratories, Cambridge, Mass. Four of these are on hand. The others will be procured from Carnegie Institution of Washington, D. C. The military flight personnel will be furnished by the Air Materiel Command. The three military scientists will be made available by the Air Force. The two rad safety officers are to be furnished by Task Group 3.4.

B. 1. At the present time, this project is engaged in an active research program on atmospheric electrical conductivity background. Three flying officers, 2 enlisted airmen, one project officer, and 4 scientific personnel are presently assigned to the project. These tests are being conducted with a B-17 and a B-29 aircraft instrumented with small ion conductivity chambers. Plans are underway to have these personnel and aircraft participate in some AEC simulated bomb tests to be held within Los Alamos area and also some radioactive pollution tests to be conducted by the U.S. Army Chemical Warfare Service. In both of these tests, the measurement of electrical atmospheric conductivity will be used to determine the degree and contours of radioactive contamination on the ground. The rate of diffusion in space of the radioactive cloud will also be studied.

V. Instrumentation and Equipment Requirements

A. (a) 5 each small ion conductivity chambers with electrometers and recorders

(b) 2 each large ion conductivity chambers with electrometers and recorders

(c) 2 each atmospheric nuclei counters

(d) SCR 584 Radar (ground based)

(e) Loran navigation system or equivalent

(f) 2 each B-50 aircraft and 1 each L-13 aircraft

B. The conductivity apparatus will be installed and checked on the two B-50's and L-13 aircraft within the continental U. S. three to six months prior to the tests.

C. The SCR 584 radars are already planned to track drones which will participate in the test. The availability of this equipment for tracking air conductivity aircraft after the drone flights are completed will have to be determined.

D. It is assumed that Loran facilities are available in the Pacific. This will have to be determined because it is essential for long range navigation when aircraft are tracking the cloud. Calibration will consist primarily of measuring the conductivities of various altitudes and of flying some simulated patterns by the B-50's. Flying the patterns will be coordinated with the radar and Loran groups.

E. None

[redacted]

1. All instruments and equipment planned.

SECRET

[redacted]

VII. Logistics

A. Sea lift.

1. Aircraft should reach forward base 14 days before test.

2. Return shipment can commence 21 days after tests.

B. Air lift.

1. None (will be handled by project aircraft).

C. Sea lift - None.

D. Air lift. Will use project aircraft for airlift.

E. Logistic Problems. None, other than B-50 maintenance at Kwajalein and L-13 maintenance at Eniwetok.

VIII. Collaboration

The collaborating agencies are: AEC and AFOAT-1. The data will be collected for AFOAT-1 and for the Geophysical Research Directorate of the Air Force Cambridge Research Laboratories, Cambridge, Massachusetts.

IX. Responsibility

A. The responsible person will be Mr. S. C. Coroniti of AF Cambridge Research Laboratories, Base Directorate for Geophysical Research.

B. Mr. Samuel C. Coroniti
Atmospheric Physics Laboratory
Base Directorate for Geophysical Research
Air Force Cambridge Research Laboratories
230 Albany Street
Cambridge 39, Massachusetts

X. Funds - This is shown in fiscal chart under Program 4.

XI. Facilities

A. Power facilities

1. 28-32 volts D.C. at 100 amperes total power 3.2 K.W.

2. 115 volts 60 cycle total power 2 K.W.

3. 115 volts 400 cycles total power 3 K.W.

[redacted]

B. Communications

1. Power - None

2. Special communications

a. Communication frequencies for 2 each B-50 aircraft and L-13 aircraft on both HF and VHF.

C. Laboratory space and other facilities on Kwajalein:

1. Laboratory space. Area - 240 square feet.

a. Two 6 foot laboratory work benches having the following electrical outlets:

6 - 115 volts - 60 cycles
4 - 24 volts - D.C.
4 - 115 volts - 400 cycles.

b. Drawing - Submitted separately.

c. 5 laboratory stools

d. Storage cabinet. 7 ft x 3 ft x 2 ft. Must have 2 shelves, 2 ft apart. Cabinet must have doors with lock.

e. Compressed air desirable but not necessary.

f. Water

2. Office space at Kwajalein

a. Area - 360 square feet

b. 7 desks

c. Phone facilities - at least 2 phones.

3. Forward area transportation Kwajalein

1 staff car
1 jeep

These will be used for transportation and cargo hauling to and from various parts of the Island, especially from Headquarters to the air field.

XII. Remarks by Project Officer - None

[redacted] of an atomic bomb detonation, the many [redacted] airborne, that have been under development by the Armed Services since Operation SANDSTONE. The results will be of interest to all the Armed Services and civil defense agencies and should indicate the optimum direction for future development and continuing laboratory work.

[redacted]

Program 5 / Project No. and Title	Activity (Service)	FISCAL YEAR 1950 Estimated Cost	FISCAL YEAR 1950 Deptm'tal(1) or AEC(2) Funds Available	FISCAL YEAR 1950 Funds Required from JTF-3	FISCAL YEAR 1951 Estimated Cost	FISCAL YEAR 1951 Deptm'tal(1) or AEC(2) Funds Available	FISCAL YEAR 1951 Funds Required from JTF-3	Total Estimated Cost	Total Funds Available	Total Funds Required from JTF-3
5.1 ~~Service Test~~ of ~~Radiological Detection Devices~~ EVALUATION OF GROUND RADIAC EQUIPMENT	OCSO (A)	13,000	10,000 (1)	3,000	167,000	140,150 (1)	26,850	180,000	150,150	29,850
	NRDL (N)	39,100	0	39,100	32,450	0	32,450	71,550	0	71,550
		52,100	10,000	42,100	199,450	140,150	59,300	251,550	150,150	101,400
5.2 Airborne Radiac Equipment	BuAer (N)	15,000	0	15,000	35,000	35,000 (1)	0	50,000	35,000	15,000
	AMC (AF)	118,800	118,000 (1)	800	9,410	0	9,410	128,210	118,000	10,210
		133,800	118,000	15,800	44,410	35,000	9,410	178,210	153,000	25,210
	Total	185,900	128,000	57,900	243,860	175,150	68,710	429,760	303,150	126,610

[redacted]

[redacted]

EVALUATION OF GROUND RADIAC EQUIPMENT

I. Object of Experiment

Study and evaluation of the adequacy of radiological instruments being developed by the Army and Navy when used under field conditions.

A. It is planned to make a study and actual field usage evaluation of the adequacy of these equipments to include:

1. Performance of segregation and quick-reading dosimeters under field conditions over a wide range of dosages, dose rates and blast conditions.

a. Dosimeters of the following types will be tested under ground conditions.

1. Quartz Fiber Electrometer.

2. Inonization Chamber.

3. Photographic.

4. Color changing alkali-halide crystal.

5. Energy storage phosphor.

6. Conduction crystal.

7. Color changing glass.

8. Chemical.

[redacted]

[redacted]

of exposure to ionizing radiation. Measurements will be made of the change in flourescence of activated phosphate glasses similarly exposed. Other effects of the radiation of these "crystals" and "phosphors" will be observed or measured.

3. Test and evaluation of portable survey instruments for measuring radiation intensity of contaminated areas resulting from Atomic experiments.

4. Evaluation of a mobile radiological field laboratory containing equipment for determination of the necessary information for formulation of an estimate of the hazard in occupying a contaminated area, including nature, quantity, energy and decay rate of contamination, etc.

B. It is planned to analyze the behavior and operation of the devices listed above for military adequacy and to determine necessary modifications.

[redacted]

as integrating dosimeters. It is desired to determine the accuracy, constancy, reliability, adequacy, and overall practicality of such "crystal dosimeters" when used to measure the intensity of ionizing radiation with the wide energy spectrum associated with atom bomb detonation. The mineral dosimetry experiment is an extension and modification of an experimental project in progress at NRDL.

2. Dosimeter data to be obtained as a result of the experiment will be used to determine the adequacy of the instruments with respect to the following:

a. Tactical uses and applications.

b. Sensitivity and accuracy.

c. Stability and reliability.

d. Blast, pressure, heat and light.

e. Physical design.

[redacted]

f. Component stability under irradiation.

g. Energy dependence.

h. Decontamination.

i. Saturation.

j. Reusability

k. Shielding.

II. Method

A. General Method. It is proposed to use, test, and evaluate individual dosimeters, portable survey instruments, and a radiological field laboratory under conditions following atomic detonations. Dosimeters will be placed at stations, the locations of which are to be determined by expected gamma dosage, prior to each detonation and read as soon after each event as possible. The stations will be located as follows:

Station	Dose
1	5 r.
2	25 r.
3	50 r.
4	100 r.
5	200 r.
6	500 r.
7	750 r.
8	1000 r.
9	3000 r.

Some dosimeters will be carried by the Rad-Safe monitors and others placed on panels mounted inside drone aircraft. Survey instruments will be carried into the area after the detonation. The radiological field laboratory will be stationed outside the area expected to be affected by the explosion. Personnel will bring samples, etc. to the laboratory for analysis.

[redacted]

[redacted]

bers correspond to those assigned under II.A., above. The results obtained will be compared with official dosage data.

It is intended to secure the dosimeters on panels approximately 30" by 30" and secure these panels to upright stakes approximately 5 feet high. Detailed construction of the panels is now under consideration and several different types of panels and mountings are being investigated. Locations of the stations are based on an estimated gamma dosage. The expected yield of the weapon will fix the actual distance from ground zero. The stations and dosimeters to be located at each station are as follows:

Station 6 - Estimated dosage 500 r.

- Polaroid 3-Step - 50-100-200 r.
- " Multi-Step (High) - 10500 r.
- Conventional Photographic Badge.
- Ansco Print-out Dosimeter.
- Crystal (color) 5-200 r.
- Crystal (conductivity) 1-200 r.
- Chemical - 4-Step - 25-50-100-200 r.
- DT-43/PD - 5-50-500 r.

Station 5 - Estimated Dosage 200 r.

- Polaroid 3-Step - 50-100-200 r.

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Polaroid Multi-Step (High) - 50-500 r.
Conventional Photographic Badge.
Ansco Print-out Dosimeter.
Crystal (color) 5-200 r.
Crystal (conductivity) 1-200 r.
Chemical - 4-Step - 25-50-100-200 r.
DT-43/PD - 5-50-500 r.
Landsverk - 200 r.

Station 4 - Estimated Dosage 100 r.

Polaroid 3-Step - 50-100-200 r.
" Multi-Step (High) - 10-500 r.
Conventional Photographic Badge
Ansco Print-out Dosimeter
Crystal (color) 5-200 r.
Crystal (conductivity) 1-200 r.
Chemical - 4-Step - 25-50-100-200 r.
DT-43/PD - 5-50-500 r.
Victoreen - 100 r.
Landsverk - 200 r.

Station 3 - Estimated Dosage 50 r.

Polaroid 3-Step - 50-100-200 r.
" Multi-Step (High) - 10-500 r.
Conventional Photographic Badge.
Ansco Print-out Dosimeter
Crystal (color) 5-200 r.
Crystal (conductivity) 1-200 r.
[redacted]
DT-43/PD - 5-50-500 r.
Victoreen - 100 r.
Landsverk - 200 r.
Landsverk - 50 r.
AN/PDR-24 - 5-50 r.
IM-33/PD - 0.5-5-50 r.
K. K. 161 - 50 r.

Station 2 - Estimated Dosage 25 r.

Polaroid Multi-Step (Low) - 0.5-25 r.
Conventional Film
Landsverk - 50 r.

AN/PDR-24 - 5-50 r.
IM-33/PD - 0.5-5-50 r.
K. K. 161 - 50 r.
Victoreen - 100 r.

Station 1 - Estimated Dosage 5 r.

Polaroid Multi-Step (Low) - 0.5-25 r.
Conventional Photographic Badge
IM-33/PD - 0.5-5-50 r.
Landsverk - 50 r.
K. K. 161 - 50 r.
K. K. 141 - 5 r.
K. K. 151 - 10 r.
AN/PDR-24 - 5-50 r.

(b) Twenty (20) of each of several of the lower range types will be carried by rad safe monitors. Two instruments of each type will be carried by each Rad-Safe monitor, but not all types will be carried by each monitor. This procedure has been coordinated with the Radiological Safety Officer, Brig. General J. P. Cooney. The types to be used are listed in paragraph V.

(c) Dosimeter panels carrying several type dosimeters will be installed in the drone planes which will fly into and around the cloud following zero time. Each panel will measure 20" x 22". Dosimeters to be mounted on these panels are listed in paragraph V.

(2) Experimental approach

(a) Equipment will be procured, tested and calibrated at SCEL to obtain the following data prior to shipment to test site:

1. Sensitivity

2. Energy dependence

3. Leakage

[redacted]

be adapted as segregation or casualty instruments will be exposed with and without the shield normally used to correct for varying energy sensitivities. Such tests will be used to determine if this shield can be eliminated without an appreciable change in dosage reading.

(c) Following completion of tests, instruments will be returned to SCEL for a repetition of the tests conducted in (a) above.

(d) NRDL Dosimetry Program:

1. Seventy (70) crystal dosimeters will be prepared by NRDL (or under the supervision of NRDL) for use in the test. Five different types of crystals or materials will be used, and there will be fifteen of each type. The five types of materials are expected to be

   Lithium Fluoride
   Potassium Bromide
   Potassium Chloride
   Sodium Chloride
   A Phosphate Glass

[redacted]

[redacted]

2. Each dosimeter will consist of a crystal (probably embedded or "potted" in lucite), the whole encased within a light-tight box of aluminum or bakelite. The box will probably be a cylinder about an inch in diameter and three inches long. It will be provided with lugs for mounting on a panelboard or standard.

3. The dosimeters will be calibrated and packaged at NRDL precisely as used in the field. The calibration will include, besides dosage dependence, such variables as energy dependence (the effect of the frequency of the ionizing radiation), temperature dependence, color stability, and the effect of radiation rate.

4. It is expected that vertical instrument boards or panelboards will be erected at various stations, and that the dosage at these stations will be measured. For the purpose of this experiment the NRDL wishes to place five crystal dosimeters, one of each type, on the panelboard at each station.

5. Dosimeter stations will be located so as to provide the following estimated dosages (station numbers refer to stations listed under II.A)

Station	Dose
3	50 r.
4	100 r.
5	200 r.
6	500 r.
7	750 r.
8	1000 r.
9	3000 r.

6. The crystal dosimeters will be exposed to the total radiation of the weapon.

[redacted]

They will then be demounted (never letting them out of their light-tight boxes) and their color intensity measured with a densitometer or photofluorometer under the conditions prescribed by the calibration. In the case of the phosphors, the change in fluorescence will be measured with a fluorometer.

7. Other suitable physical characteristics of the crystals may be observed or measured for purposes of check.

8. It is proposed to supply about four extra crystal dosimeters for mounting on the drone airplanes - two on each of two air-planes. The instruments should be mounted at places where the total radiation is measured by other means (e.g., the high intensity rate meter used in Project 6.8). If this is carried out, no special preparation will be required.

2. Portable Survey Instruments.

a. Five (5) of each type of portable survey instrument will be tested. The instruments will be carried into the area at the earliest practicable moment after the event to obtain dosage rates. This test will not be part of the radiological safety monitoring operation. The instruments to be used are listed in paragraph V.

3. Radiological Field Laboratory. This laboratory is a truck K-53 (2½-ton, 6 x 6, with van body) modified to accommodate equipment for analyzing water, air, and ground samples for checking alpha, beta, and gamma contamination (energy, quantity), measurement of decay rates, etc. In military situations the data from the field laboratory will be furnished to the Radiological Defense Officer for his use in advising field commanders on radiological matters. The laboratory is designed for solution of problems not solvable by radiac equipment issued to lower echelons. The field laboratory includes a one-ton trailer containing a gasoline power unit. The laboratory does not contain running spares other than for field laboratory equipment. It is planned to leave the field laboratory on Parry Island and bring samples, etc. from the test area to the laboratory for analysis after each event.

C. Dependance on Yield of Weapon

The actual location of the three (3) stations listed in paragraph II.B.1.a.(1) above, will be dependent on the expected gamma radiation from the weapons.

The crystal dosimeter stations will be so located as to give sufficient data for determination of the objectives listed under paragraph I.A.2. above.

III. Details of Progress to Date in Experimental and Theoretical Work

A. Equipment will be tested only where it is either impossible or impractical to carry out tests under controlled laboratory conditions. Controlled laboratory tests will be carried out on dosimeters, survey instruments, and a radiological field laboratory to insure that the equipment has met all requirements that can be checked except under conditions incident to atomic weapons blasts. The results will be used to either improve equipment or define surther needs. Much work has been conducted at previous atomic weapons test sites using and evaluating radiological instruments. As a result, certain devices were abandoned, others evaluated as promising and the many practical lessons learned from the Rad-Safe program have been incorporated into instrument design. The evaluation and test of radiological instruments is part of a continuing program directed toward the design and development of radiological instruments satisfactory for issue to military and civil defense organizations.

1. Dosimeters have been developed to the point where they are adequate for Industrial use under controlled conditions, with very low permissible dosages and dose rates and radiation of known energies. Military dosimeters, however, require use under uncontrolled conditions of dosage levels approaching and even exceeding lethal amounts at very high dose rates and unknown energies. Controlled laboratory experiments cannot provide the dose rates and the wide range of energies which result from an atomic detonation. The range of energies and the dose rates under which military instruments will be used cannot be simulated, but can only be provided by actual atomic explosions. The tests are designed to evaluate newly developed dosimeters under these conditions. The results will be used to guide further development.

a. NRDL Dosimetry Program.

(1) Various materials have been studied for the effects of the various variables involved in

crystal dosimetry. The data obtained however, are insufficient to make proper decisions as to what is wanted for crystal dosimeters in the ABD test.
Kevatron (see Project 6.5) is needed to supply much of the missing information. It is anticipated that more definite information will be available about 1 July 1950 on mineral dosimeters.

(2) Material Effect.

Crystals of the following four alkali halides have been investigated:

Sodium Chloride
Potassium Chloride
Potassium Bromide
Lithium Fluoride

In addition, silver bearing phosphate glasses have been examined.

(3) Dosage response.

For each of these four crystals, the change in color density resulting from varying total dosages of radiation has been determined at only one energy range of the spectrum (250 K.V. X-rays). The radiation rate was held fairly constant and the total dosage varied by varying the length of time of the exposure.

(4) Energy dependence.

For each of the four crystals the change in color density resulting from the constant dosage of 500 r. was determined at various energies. Only the region from 250 K.V. X-rays down and the gamma ray region in the neighborhood of 1 M.e.v. have been explored.

(5) Sensitivity.

[redacted]
obtained must be extended and then critically evaluated for use in so wide an energy spectrum as that resulting from ABD.

(6) The color stability of each of the four crystals was investigated. The study measured bleaching (F-center decay) in the dark up to a week. (KBr was found to be particularly bad, KCL and NaCL poor. and LiFl to be very stable for the week tested.) Since bleaching is believed intimately connected with thermal agitation of the crystals, it is desired to investigate the effect of temperature on bleaching characteristics.

(7) Temperature dependence has not been investigated. It was felt that the effect of the primary variables should be evaluated first.

(8) Rate of radiation dependence has been investigated only for the range from 100 r per minute to 17000 r per minute. In this range no appreciable effect was found. A thorough investigation of the effect of high rate of radiations will be possible with the Kevatron (see Project 6.5).

(9) Saturation of the crystals, it has been found, occurs at such high total dosages (millions of roentgens) that it has been of no interest in the Laboratory. However, it would be desirable to have some information as to where saturation occurs for the large dosages that will result from ABD. The Kevatron (see Project 6.5) should prove of value here.

S [redacted]

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to be interesting. The search goes on.

(12) Phosphate Glasses have been investigated for the change in fluorescence resulting from varying dosages, energies, etc., as with the alkali halide crystals. In sensitivity, the phosphors have been found to compare favorably with the crystals.

b. Army Dosimetry Program.

(1) Some dosimeters have been ordered, chiefly those on which development contracts are in effect. Although procurement data has been prepared, the actual procurement of dosimeters must depend on the availability of FY-1951 funds. A listing of pertinent dosimeters and quantities required is contained in paragraph V.

(2) Ground Panels.

Six ground panels for Stations 1 through 6 (See paragraph II.A.) are contemplated. Dosimeters will be mounted on panels at stations which correspond

[redacted]

[redacted]

to 1/4, 1/2 and full scale readings of the dosimeters. The panels will be supported so as to "ride" with the shock wave to reduce impact effects and more accurately reproduce conditions of dosimeter usage by personnel. An alternate type arrangement is being considered which would permit complete blast shielding. This would consist of hemispherical aluminum shells similar to those which will be used to house animals during the test. If room is available within the animal shelters, then these same shelters can be used. In this type shelter, the wooden panels can be replaced by simple canvas belts with suitable pockets. Pending further information, plywood panels painted white and supported by 2 x 4 wooden supports sunk into the ground will be used.

(3) Drone Panels.

Twelve plywood mounting panels approximately 22" x 20" and weighing 16 pounds will be prepared. Mounting straps or clips will secure the dosimeters to the panel. Dosimeters will be mounted on both front and back sides of the panels to reduce area of panel. There will be sufficient room for supporting brackets.

(4) Ground and Drone Panels - General.

(a) Design of panels, shock mounting, color, method of holding dosimeters to panel, are subject to change depending upon the nature of information received concerning shock, blast, over-pressure, temperature, etc.

(b) Five of each type dosimeter will be mounted on each panel, i.e. 60 instruments on the drone panel representing 12 dosimeter types. This will increase the value of data taken in that variation of response among dosimeters of particular types, variation of response among dosimeters of different manufacture and statistical variations in response will be observed.

[redacted]

[redacted]

(5) Point-Check Calibration.

Tentative design, now under consideration, will include a shielded 4-curie source of Cobalt 60. Dosimeters will be symmetrically placed about the source which will be remotely controlled by mechanical means. This method will allow good geometry reproducibility, and will provide for a check before and after field exposure. It is contemplated that each instrument will be checked at the mid-point range. In the case of 3-range dosimeters, checks will be made at the mid-point of the intermediate range.

2. Considerable effort has been put into the development of survey instruments to meet military requirements. Current instruments will detect beta radiation and measure gamma dose rates from background to 50 roentgen per hour. Instruments under development will extend the gamma dose rate range to 500 roentgen per hour. The above described field test of survey instruments will provide results which will be used in the further development of survey instruments. All survey instruments to be tested have been ordered.

3. The radiological field laboratory will be used to provide radiological measurements which cannot be made by dosimeters or survey meters. It must provide these measurements under atomic or radiological warfare. No tests have been conducted to date because equipment has not been available. It is planned during calendar year 1950 to conduct tests at restricted Atomic Energy Commission areas and at Dugway to determine the military effectiveness of a model of the field laboratory now under development. Conditions at these sites approach those of radiological warfare. Conditions approaching these of atomic warfare can be provided only by an atomic explosion. The field laboratory is in process of construction by the Signal Corps Engineering Laboratories.

IV. Personnel Requirements

ARMY

A. The table which is appended lists personnel required by the Army at the test site. Detailed description of the duties of each position is given in the following paragraphs.

[redacted]

[redacted]

other than that being tested. Extracts and collects data which pertain to the maintenance problem from all experiments.

d. Survey Meter Engineers. Prepare and revise plans for survey meter experiments, and submit them to the Group Chief. Supervises execution of approved plans. Breaks down the data therefrom and aids in its collection and evaluation.

e. Dosimeter Engineers. Prepare and revise plans for dosimeter experiments, and submits them to the Group Chief. Supervises execution of approved plans. Breaks down the data therefrom and aids in its collection and evaluation. One specializes in chemical dosimeters; one in photographic dosimeters.

f. Field Laboratory Engineers. Prepare, review, and direct the execution of field laboratory experiments. Aid in collection and interpretation of data.

g. Dosimetry and Survey Meter Technicians. Aids the dosimeter and survey meter engineers in a planned phased manner. Calibrate, place, retrieve and read dosimeters and record resultant data. Carry and read survey meters staying close to health physics survey men. Record data. Serve in varying general capacities as draftsman, clerk or driver.

h. Field Laboratory Technicians. Aid the field laboratory engineers. Carry out counting work and chemical assay. Secure samples from the field.

[redacted]

[redacted]

2. One mobile electronic repair truck for general electronic maintenance and repair of equipment to be tested.

[redacted]

3. Portable survey instruments: Five (5) of each type will be used in comparative tests:

AN/PDR-T1	Ionization Chamber
AN/PDR-T2	Geiger Counter
AN/PDR-23(XE-1)	Ionization Chamber
AN/PDR-23(XE-2)	Ionization Chamber (Probe type)
AN/PDR-23(XE-3)	Ionization Chamber (Probe type)
AN/PDR-27A	Geiger Counter
AN/PDR-T1	(modified for alpha counting)

4. Individual dosimeters:

a. The quantity of dosimeters indicated below will be required:

Pocket Chambers

L-50 Landsverk 50 r - 25

L-50 Landsverk 200 r - 100

Victoreen - 100 r - 100

DT-43/PD - Beckman - (5-50-500 r) - 105

Pocket Electroscope

K-141 Kelley-Koett 5 r - 10

K-151 Kelley-Koett 10 r - 10

K-161 Kelley-Koett 50 r - 100

IM-33/PD Beckman (.5-5-50 r) - 120

AN/PDR-24 Victoreen (5 - 50 r) - 100

IM-9A Kelley-Koett (0 - 200 mr) - 30

[redacted]

[redacted]

Conventional Photographic Dosimeter (Dupont 510 + 605)

5. Dosimeter panels will be utilized for tests in drone aircraft. The dosimeters to be mounted on these panels are as follows:

DT-43/PD Beckman (5-50-500r)
Polaroid wide range dosimeter (1-1000r)
Polaroid segregation dosimeter (50-100-200r)
L-50 Landsverk (200r)

[redacted]

[redacted]

K-161 Keleket (50r)
Conventional photographic dosimeter (200r)

6. Radiological Field Laboratory

One (1) Radiological Field Laboratory AN/MDQ-1( ) will be tested.

NAVY. The following instruments and equipment will be required:

1. 70 (Or 78) crystal dosimeters
2. 2 Densitometers
3. 2 Fluorometers

B. The instruments and equipment described in paragraph V-A above will be assembled in the ZI by the Signal Corps Engineering Laboratories and shipped to the test site. Before exposure to test conditions, necessary technical checks such as battery installation, calibration, etc. will have to be made. Instruments will be attached to special mounting brackets where necessary prior to installation at test site. Navy instruments and equipment will be prepared and assembled stateside, shipped to test site, ready for installation and test.

C. There will be no instrument or equipment assembly nor construction performed at the test site other than outlined under Paragraph II above.

D. Calibrating facilities will be established at the test site to determine the performance of instruments before and after exposure in accordance with paragraph III.A.1.b.(5). These calibrations will be made at the site laboratory and will involve only those items of radiological equipment being tested.

E. Other than the laboratory protective shielding indicated in paragraph V-D above, no protective equipment or construction will be required. Approximately seven (7) mounting boards or panels will be required for the Navy dosimeters.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment.

A. Percent of equipment already procured.

[redacted]

[redacted]

ARMY. The following is a schedule of the expected availability date of the test instruments:

1. Dosimeters

Landsverk (50 r)	Sept 50
Victoreen (200r)	**Oct 50
L-50 Landsverk (200r)	**Sept 50
DT-43 Beckman (5-50-500r)	Aug 50
K-141 Keleket (5r)	**Sept 50
K-151 Keleket (10r)	**Sept 50
K-161 Keleket (50r)	**Sept 50
IM-33 Beckman (0.5-5-50r)	Aug 50

**These items are commercially available.
*These items may not be available in time for testing.

AN/PDR-24 Victoreen (5-50r)	Aug 50
Polaroid segregation dosimeter (50-100-200r)	Aug 50
Conventional photographic dosimeter (0-200r)	**Jul 50
Ansco print-out dosimeter	Dec 50
Polaroid wide-range dosimeter	Aug 50
Conductivity crystal dosimeter (1-200r)	*Mar 51
Color changing crystal dosimeter (5-200r)	*Mar 51
Chemical dosimeter (50-100-200r)	Aug 50

A number of the above items are commercially available and will be procured immediately. None of the development items have been procured but it is expected that 90% of all dosimeters will be procured by November 1950.

2. Radiological Field Laboratory

The truck K-53, trailer power supply and component complement (scalers, count rate meters, geiger counters, etc.) are available and are being assembled into a working unit. Militarized components that become available in time for the proposed tests will be substituted for present commercial items. Procurement of the above unit is estimated to be 75% complete.

3. Survey Instruments

AN/PDR-T1 (revised)	Jun 50
AN/PDR-T2 (revised)	Jun 50
AN/PDR-23 (XE-1)	Jun 50
AN/PDR-23 (XE-2)	Jun 50
AN/PDR-23 (XE-3)	Mar 51
AN/PDR-25	Jul 50
AN/PDR-27A	Dec 50
AN/PDR-T1 (Modified for alpha)	Oct 50

Procurement of the above items is estimated to be 10% complete.

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1950. Procurement of the Cobalt 60 sources will be initiated by July 1950. Estimated delivery date for these sources is October 1950. Initiation of procurement for an Electronics Repair Shop will be affected by Aug. 1950. Estimated delivery date is October 1950.

D. The Mobile calibration facility (source container and protective shielding) requires development. The development will be carried out at Evans Signal Laboratory. It is anticipated that two-man months will be required to complete the development by October 1950. Development work on the Radiological

[redacted]

[redacted] instruments with the exception of AN/PDR-T1 and AN/PDR-T2 are considered as partially developed.

F. Measuring instruments required by NRDL are commercially available and will be ordered. Crystals are not commercially available. It is possible that commercial vendors may be able to manufacture and package the required crystal dosimeters. This matter is contingent on research now in progress.

G. No Armed Forces equipment will be required.

H. The equipment and instruments required will probably have to be built by Signal Corps Engineering Laboratories, NRDL or Facilities available to these laboratories.

I. Laboratory investigations of materials will continue by NRDL. A decision is expected about 1 Aug 50 as to which materials are to be selected as the most promising for the field test of crystal dosimeters.

VII. Logistics

A. Sea Lift

All Army material can be shipped by sea. All material should reach the forward area by D-15. Logistics are as follows:

	Army	Navy	Total
Measurement Tons (40 cu/ft x 1 m/t)	128.4	0	126.4
Weight, lbs.	34,000	0	34,000

All material will be returned and shipment can begin on G/5.

B. Air Lift

Not required for Army material.

1. Instruments and equipment to be used by NRDL, packaged ready for shipment, will weigh about 300 pounds. It is vital for

[redacted]

NAVY. None.

D. Air Lift (Personnel)

1. Eleven (11) Army personnel are to be transported by air. Total Naval personnel to be transported by air are seven (7): (two officers, two enlisted men, and three civilians). Only those personnel will travel by air whose additional duties in the United States require that their travel time be reduced to a minimum.

[redacted] forward area. Only two of the Naval personnel will be involved in Roll-up and return may commence any time three (3) days after test.

VIII. Collaboration

A. The following will collaborate in these experiments:

1. Signal Corps Engineering Laboratories
2. Army Chemical Center, Edgewood, Maryland
3. Naval Radiological Defense Laboratory
4. Bureau of Ships

B. Data will be collected for and used by:

1. Army Field Forces
2. Signal Corps

[redacted]

[redacted] effort under Project 5.1. Dr. Paul C. Tompkins, Associate Scientific Director, Naval Radiological Defense Laboratory has responsibility for carrying out the experimental work of NRDL. Mr. A. Loveff, Bureau of Ships, Navy Department coordinates the Navy program.

B. Lt.Col. Earle F. Mitchell, Evans Signal Laboratory, Belmar, New Jersey has responsibility for project. Further details can be obtained from him.

X. Funds

This information is contained in fiscal chart, page 5-2.

XI. Facilities

A. Power. Laboratory space should be equipped with 60 cycle, 120 volt single phase. The Field Laboratory has its own power supply. Maximum requirements are 10 KVA.

B. Communications. No timing signals or special communications required.

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Transportation must be provided from this site to A (for drone planes) and to sites near shot islands to plant and retrieve instruments, to collect samples for Field Laboratory, and to transport monitors with survey instruments.

XII. Remarks by Project Officer.

1. The following comment by the Naval Radiological Defense Laboratory is transmitted as of interest regarding the program being undertaken by that activity.

"The development of crystal dosimeters sensitive enough to serve as personal dosimeters is limited at present by the fact that such crystals are sensitive to light."

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PROJECT 5.2

EVALUATION OF AIRBORNE RADIAC EQUIPMENT

I. Object of the Experiment

A. The Department of Defense desires to conduct field tests on four airborne radiation detection instruments. These instruments are droppable gamma intensity telemetering equipment (AN/USQ-1) and (AN/ARR-29), surface radiation intensity survey equipment (AN/ADR-4), radioactive cloud detector and tracker (MX-1117). These instruments are being developed in accordance with the requirements and characteristics determined by the Armed Forces Special Weapons Project Instrumentation Committee. This test and evaluation cannot be accomplished except in conjunction with an actual atomic bomb explosion.

B. As stated above, the primary purpose of this project is test and evaluation of Airborne Radiac Equipment. However, the information obtained will also be of value in determining gamma radiation intensity, distribution and decay characteristics in the blast area.

The aerial survey to be carried out for the evaluation of the surface radiation intensity survey equipment is a continuation of the experiment conducted by Dr. King at Operation Sandstone. It is considered that all of the instrument evaluation is part of a continuing program.

II. Method

A. Briefly, the proposed field tests would consist of the following:

1. Droppable gamma intensity telemetering equipment -

This test would require the dropping of a number of transmitter units into the crater area as soon as practicable after the blast. The airplane dropping these units would contain the receiver and would remain in the area for several hours to monitor the transmitter units. Information received would be of value in correlating the readings obtained by the surface intensity survey equipment, and also in determining when the crater area could be entered with safety.

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tracking by an Air Force B-17. Both airplanes will be completely instrumented to allow flexibility in case of instrument or airplane failure.

C. No details of the proposed program are dependent on the estimated yield of the weapon or the date or time of the test.

III. Details of Progress to Date in Experimental and Theoretical Work

A. All experimental and theoretical work which can be accomplished without the actual conditions existing in atomic bomb explosion have been accomplished. The primary purpose of this project is to determine the validity of the theory which has been used. It is not considered that any fundamental data as to the physical properties of an atomic bomb explosion is lacking. What is lacking is confirmation of some of the theories which have been used in the instrument design.

IV. Personnel Requirements

A. A total of 14 people will be required at the test site. This number will include 8 officers, 2 enlisted men, and 4 civilians. Six officers and 2 enlisted men will comprise the aircraft crews. Two officers and 4 civilians will comprise the operating personnel for the equipment to be evaluated. All personnel will be provided by the Air Force and Navy. Personnel who will be engaged in instrument evaluation are already on hand. Plane crews will be assigned at a later date.

[redacted]

[redacted]

V. Instrumentation and Equipment Requirements

A. All instruments and equipment to be used have been previously described.

B. All instruments and equipment will be assembled and installed in the aircraft in the zone of interior and flown to the test site.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. All of the subject instruments have either been developed or are in final development stages. Present plans call for delivery of all of these instruments by late summer 1950. The P2V and B-17 airplanes will be available in the near future. It is expected that all aircraft modification and instrument installation will be completed by the end of the calendar year 1950.

VII. Logistics

A. Sea Lift.

1. Four (4) M/T will be required for sea lift. This equipment should be at the forward area 20 days before test Dog.

2. Same amount will be required for return shipment. Shipment can start 10 days after test George.

B. Air Lift.

All equipment to be forwarded by air will be transported in the planes to be used for the project.

C. Sea Lift (Personnel).

1. It will be required that one man be furnished transportation by sea lift. It is required that he reach the test area twenty days before the date of test Dog.

2. Return transportation by sea lift will be required for one man. He can commence return 6 days after test George.

[redacted]

D. Air Lift (Personnel).

1. The remaining 13 people will be transported to the test site in the planes to be used for the test.

2. There will be no roll-up involved in this project. Planes and personnel will commence return immediately after test George.

VIII. <u>Collaboration</u>

This is a joint Navy - Air Force project.

IX. <u>Responsibility</u>

A. Lt. Cdr. John H. Terry ~~Cdr. L.K. Bliss~~ has been designated the project officer for this experiment.

B. Lt. Cdr. John H. Terry ~~Cdr. L.K. Bliss~~, Bureau of Aeronautics, Department of the Navy, Washington 25, D.C., is responsible for this project and further details can be obtained from him.

X. <u>Funds</u>

This information is contained in the fiscal chart preceding the program.

XI. <u>Facilities</u>

A. Power. 28 volt d.c. and 115 volt, 400 cycle, a.c., will be required in the laboratory space used for instrument maintenance. These voltages and frequencies will be furnished by the using agencies.

B. Communications.

1. No timing signals will be required.

2. Special requirements.

a. 5 frequency bands, each 2 megacycles in width, will be required for the gamma intensity telemetering equipment.

b. This equipment will cover the frequency range of from 160 to 172 megacycles.

c. Pulsed frequency modulation will be used.

d. Band width - 160 to 172 megacycles.

e. It is expected that this equipment will be used intermittently from approximately + 1 hour to + 4 days after each test.

In addition to this, communications will be required on standard aircraft frequencies.

C. Laboratory Space and other Facilities. It is considered that all necessary laboratory facilities are included in the proposals which have been drawn up by the Program Director.

D. Forward Area Transportation. One jeep will be required for personnel operating in the forward area.

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LAB-J-912

PROGRAM 6

PHYSICAL TESTS AND MEASUREMENTS

Director: Lt. Comdr. Victor Delano, USN,
Los Alamos Scientific Laboratory

This [redacted]

Project Officers:
6.1 - Mr. John P. Mitchell, Army Chemical Center, Maryland;
6.2 - ~~Dr. Paul C. Tompkins, NRDL, SFNSY, San Francisco, Calif.~~;
6.3 - ~~Dr. L. A. Delsasso, Ballistics Research Laboratories, Aberdeen Proving Ground, Maryland~~;
6.4 - ~~Dr. Paul C. Tompkins;~~
6.5 - ~~Dr. Paul C. Tompkins;~~
6.6 - Mr. Elmer H. Engquist, Army Chemical Center, Maryland;
6.7 - ~~Dr. Paul C. Tompkins;~~
6.8 - ~~Dr. Paul C. Tompkins~~;
6.9 - Lt. Col. Frank H. Steadman, Office of QMG, Washington, D.C.;
6.10 - ~~Mr. B. L. Karpel, Army Chemical Center, Maryland.~~

OBJECTIVES OF THE PROGRAM:

In general, the objectives of this program are to determine many physical effects and characteristics of an atomic bomb detonation of which relatively little or nothing is presently known and that would be of value in defensive planning as well as in continuing analytical and laboratory work in the United States. The interested agencies are the Air Force, Army, Navy and, to an extent, the Atomic Energy Commission. The objectives of the individual projects is defined in the project write-ups following.

PROPOSED LABORATORY SPACE AND FACILITIES:

Included in Program 5. See page 5-3.

CAUTION

Thi[redacted]cting the Na[redacted]s trans-[redacted] of its contents in any [redacted] ma[redacted] penalties under and [redacted] applicable Federal laws.

Project Officers:
6.2 Dr. Andrew Guthrie, USNRDL, San Francisco, Calif.
6.3 Mr. Norman W. Arnold, BRL, APG, Maryland
6.4 Dr. Frank R. Holden, USNRDL, San Francisco, Calif.
6.5 Mr. E. Tochilin, USNRDL, San Francisco, Calif.
6.7 Dr. L. W. Lerner, " " " "
6.8 Mr. George Koch, " " " "
6.10 Mr. Frank G. Ort, ACC, Maryland

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[redacted] ...ated ...t	FISCAL YEAR 1950 Deptm'tal(1) or AEC(2) Funds Available	FISCAL YEAR 1950 Funds Required from JTF-3	FISCAL YEAR 1951 Estimated Cost	FISCAL YEAR 1951 Deptm'tal(1) or AEC(2) Funds Available	FISCAL YEAR 1951 Funds Required from JTF-3	Total Estimated Cost	Total Funds Available	Total Funds Required from JTF-3
00	0	36,400	129,900	35,000(1)	94,900	166,300	35,000	131,300
19	0	28,119	30,550	25,000(1)	5,550	58,669	25,000	33,669
19	0	64,519	160,450	60,000	100,450	224,969	60,000	164,969
00	0	12,000	60,000	0	60,000	72,000	0	72,000
00	11,000(1)	2,000	24,000	14,500(1)	9,500	37,000	25,500	11,500
00	11,000	14,000	84,000	14,500	69,500	109,000	25,500	83,500
00	180,000(1)	0	215,000	215,000(1)	0	395,000	395,000	0
92	0	3,892	5,900	0	5,900	9,792	0	9,792
79	0	75,179	53,800	0	53,800	128,979	0	128,979
00	0	1,000	8,000	0	8,000	9,000	0	9,000
67	0	11,067	50,640	0	50,640	61,707	0	61,707
0	0	0	15,000	15,000(1)	0	15,000	15,000	0
67	0	11,067	65,640	15,000	50,640	76,707	15,000	61,707
89	0	24,589	59,550	0	59,550	84,139	0	84,139
28	134,628(2)	0	0	0	0	134,628	134,628	0
17	134,628	24,589	59,550	0	59,550	218,767	134,628	84,139
00	14,300(1)	0	30,500	8,000(1)	22,500	44,800	22,300	22,500
00	0	9,500	17,500	0	17,500	27,000	0	27,000
74	339,928	203,746	700,340	312,500	387,840	1,244,014	652,428	591,586

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fractionated on the basis of size and density will show the correlation of

particle size with chemical composition, total radioactivity, and the chemical conditions under which the radiocontaminants exist in the cloud.

5. Chemical analyses and particle size measurements of the samples will show whether previous non-isokinetic methods of particle collection provide samples which are representative of the cloud.

6. Gross decay curves of such representative dust samples will provide data for predicting the gross decay rate of a cloud which might settle out in the habitated regions as a result of a nearby atomic burst. It will also indicate whether or not serious fractionation of the fission products has occurred.

II. Method

A. General method

Each drone aircraft will be equipped with apparatus designed to obtain representative samples of the cloud for the determination of cloud particle size and distribution. In view of the limited laboratory facilities at the test site, no extensive field work will be conducted there. The samples will be shipped by air to the Army Chemical Center, The Naval Radiological Defense Laboratory, and/or their contractors for extensive investigation.

B. Detailed

1. The Chemical Corps will equip each drone aircraft with the following apparatus for particle size distribution determinations:

a. One (1) modified cascade impactor, designed to separate the particulate contaminant into four (4) size fractions.

b. One (1) centrifugal conifuge designed to separate the cloud contaminant into a continuous spectrum of particle size fractions

c. One (1) snap sampler of approximately ten (10) cubic foot capacit which will be designed to obtain a cloud sample for ultimate anal which will include gaseous and particulate determination and micr chemical and radiochemical analysis.

d. Sampline will be done isokinetically, as far as practicable, base on NRDL results in developing such an apparatus.

2. The Naval Radiological Defense Laboratory (BuShips) will devise and equip each drone aircraft with two "isokinetic samplers" for collecting representa ive samples of the particulate matter from the ABD cloud. This sampler is designe to have an air intake stream parallel to, and equal in velocity to, the air stream ing by outside of the collector. After entrance through a small hole, the intake stream is slowed by a widening in the collector and the particles in the stream ar precipitated out. An electrostatic prepipitator and a thermal precipitator will b used on each drone aircraft.

a. The two samplers to be used on each drone are expected to be mounted on the underside of the plane with their axes parallel to the line of flight and about five feet apart. These collectors should be mounted with intake as far forward as possible, in order to sample relatively undisturbed air in front of the plane.

b. A collector will consist of the following principal parts:

(1) Intake nozzle
(2) Diffusor section
(3) Precipitator section
(4) Exhaust
(5) Venturi cowl

The intake nozzle will be a straight tube, the forward section of which will be vaned and connected by means of a universal joint and flexible rubber hose to the rear section of the nozzle. The rear section of the nozzle will lead into the diffusor section which will be conical in shape with a total expansion angle of 6°. From the diffusor, the air will enter the precipitation section at a greatly reduced velocity due to the expansion in the diffusor. Upon leaving the precipitator chamber, the air leaves the collector via the exhaust opening at the rear of the collector. A venturi cowl will be placed concentric with the exhaust opening in order to provide absolute pressure at the exhaust which will be low enough to compensate for the internal friction of the collector and maintain the intake stream velocity equal to external air velocity.

c. The precipitator section of one of the collectors on a drone will consist of an electrostatic precipitator. The precipitator section of the other collector will provide a source from which to draw samples through one or more thermal precipitators.

d. Power packs for the collectors will be mounted inside the fuselage. Power packs will provide electric current at desired voltage for the electrostatic precipitator. The drone plane electric power will also be required for operation of the motor for the thermal precipitator and for heating its precipitating wires.

C. Dependence on yield of weapons

It is believed that the expected yield of the weapons will not exert significant influence on the details provided in Part II (A) and (B). The date of test is of importance. Any significant alteration in the direction of an earlier test date could result in the inability to complete the preparation for this project.

III. Details of Progress to Date in Experimental and Theoretical Work

A. Background

[redacted]

3. Size of mushroom = volume of stem.

Based on these conditions, the volume of the cloud is 1.15×10^{11} cubic feet or 3.26×10^{12} liters. The following table gives the total concentration and particulate density per cc for various homogeneous particle dispersions:

Diameter (microns)	Total Particle Concentration	Total Volume of Cloud (cc)	Particles/cc
20	1.4×10^{15}	3.26×10^{15}	0.43
10	1.1×10^{16}	3.26×10^{15}	3.4
5	8.9×10^{16}	3.26×10^{15}	27.0
1	1.1×10^{19}	3.26×10^{15}	3.4×10^{3}
0.5	8.9×10^{19}	3.26×10^{15}	2.7×10^{4}
0.1	1.1×10^{22}	3.26×10^{15}	3.4×10^{6}

[redacted]

[redacted]

isokinetic air sampler are completed. The general features have been described in the preceeding section. Models with varying inlet diameters and varying collector lengths were made to permit experimental evaluation of the instrument. Arrangements were made with Ames Aeronautical Laboratory, Moffett Field, California, to test the aerodynamic properties of the isokinetic sampler. This study will soon be completed.

2. Electrostatic Precipitator - Tests performed with a model electrostatic precipitator showed that high flux radiation fields do not interfere significantly with the precipitator. A field created by one Mev. X-rays (100,000r/hr) did not cause demonstrable change in breakdown potential. Tests made in a Bowser Chamber at simulated altitudes and temperatures expected in the drone planes showed that the precipitator functions properly. Voltage requirements for operation of the precipitator at various altitudes were measured. A test set-up was made to measure the efficiency of dust collection of a model electrostatic precipitator at various voltages under controlled air flow conditions. It was found that the corona (ion current) from a typical tapered central electrode was insufficient for efficient dust collection. The central electrode was redesigned to yield higher ion current. First attempts with a sharp edged disc at the end of the central electrode were unsatisfactory due to uneven distribution of the field which strongly favored the nearest point on the wall of the outer electrode. A second design of the ion current generator on the central electrode was highly successful. The central electrode was increased in diameter to provide rigidity, to decrease the distance of travel of particles, and to attempt to increase the unit field flux between it and the outer electrode. The central electrode was then terminated in series of pointed wires, set as spokes at the end of the electrode. Each point had, in series, a resistance which prevented any point from discharging a disproportionate amount of ion current. The resulting uniform corona precipitated the dust evenly. Latest tests indicate that the original design is preferable when suitably modified. A central electrode in the form of a thin wire appears to give satisfactory results. Further tests are now in progress. Experiments were made on the design of holding strips for electron microscope screens and glass slides for collection of samples of dust for photomicroscopy and subsequent size measurements. Considerable progress was made in the development of a system for treatment of glass slides to make them conduct electric current. Such a step was necessary to insure the efficient collection of a representative sample of the collected particles. Further experimentation is proceeding on this problem. Concurrently, optical and electron microscopy techniques are undergoing evaluation. A statistically valid method for combining optical and electron microscope measurements to provide an overall size distribution was developed. Phase microscopy is being examined as an adjunct to optical measurement of dust particles.

[redacted]

3. Particle collection tests to be made on the model electrostatic precipitator will be as follows:

a. Determination of fractionation of particle size along the length of the precipitator tube by making particle size distribution measurements of particles deposited on optical and electron microscope screens placed on the collecting wall of the precipitator during runs in which air velocity and pressure are the same as those contemplated in the ABD sample collections.

b. Determination of efficiency of collection of particles at various air speeds will be made by determination of the proportion of particles stopped by the electrostatic precipitator to those held by a filter which will be placed behind the precipitator. This proportion will be measured by the use of radioactive phosphorus adsorbed on the alumina aerosol as a tracer. Iron carbonyl aerosols can be used on this measurement, using chemical analysis for iron as the means of following the deposition of the aerosol.

c. Tests (a) and (b), above, will be made using alumina and carbonyl iron as aerosols to measure the effect of particle density on precipitator performance.

d. The efficiency of the precipitator will be tested under the influence of high intensity ionizing radiation, probably by use of a high power, industrial X-ray machine as the source of ionization.

4. Thermal Precipitator

Original plans called for the utilization of the thermal precipitator for the collection of cloud particle samples for size measurement and for the identification of time of entry into and exit from the cloud by the drone plane. Further consideration of the objectives indicates that the rotating, oscillating thermal precipitator would be extremely complex. The mechanical obstacles in the path of development of the device seem insurmountable within the time limitations imposed. It was therefore decided that the thermal precipitator would be used solely for the collection of a representative portion of the ABD cloud particulate matter for size measurement of the distribution of active and inactive particles. Present work is directed towards increasing the capacity of the oscillating thermal precipitator to insure that it will collect a sample of adequate size. An improved type of thermal precipitator has been designed which, it is hoped, may be substituted for the oscillating thermal precipitator. It was further decided that identification of time of entry into the ABD cloud by the drone planes could be determined best by a large capacity jet impactor. As this latter instrument was not submitted to the Joint Proof Test Committee for consideration previously, a brief will be prepared describing it and a request will be made for authorization for its use.

C. Chemical Corps

Experimental evaluation of the apparatus planned for use in this test program is underway with pre-cut size fraction of Al_2O_3. These fractions are for diameters from 20-10; 10-5; 5-3; and less than 3 microns. They will be set up as [redacted] and low altitudes. The elements to be analyzed are near the peaks and valley of the expected fission product curve and should provide data on the degree of fission product contamination present, and serve as a reference for other collection systems.

b. Gaseous analysis for xenon and krypton. This analysis will be undertaken by gas counting techniques and by studies on the decay products.

c. Tracerlab also plans to carry out the following analyses on the sample:

   (1) Determination of size of active particles.

   (2) Determination of activity as a function of particle size.

   (3) Microchemical analysis for iron, uranium, and aluminum.

C. Additional data desired

Theoretical calculations on the expected activity level and particulate concentration per unit volume; or pressure, temperature, time data from which particle size calculations might be made.

IV. Personnel Requirements

A. Required at test site

1. Officers - 1 from NRDL available.

2. Civilians - Six (6) total; three (3) from Chemical Corps, three (3) from NRDL. The duties of these personnel will be to install and test apparatus, remove the samples collected, and pack the material for stateside shipment. One person will be respponsible for each of the following apparatus; cascade impactor, conifuge, thermal precipitator, electrostatic precipitator, and snap sampler. One person will be an instrument technician who will install, service, and calibrate the scalers and survey meters used on this project. The group will operate as a team to remove the various samples from the drone aircraft.

3. Laborers - Four (4) - none available.

Time required - 150 man-hours.

B. Project work in continental United States

1. Naval Radiological Defense Laboratory

a. Development of the ESP Unit:

1 Chemist from NRDL available.

1 Physicist from NRDL available.

1 Technician from NRDL available.

b. Development of the Thermal Precipitator Unit:

2 Physicists from NRDL - 1 available.

c. Chemical and Radiochemical Processing of Samples:

1 Chemist from NRDL available.

2. Chemical Corps

a. 4 scientific personnel available.

V. Instrumentation and Equipment Requirements

[redacted]

D. Calibrations at Test Site

Flow rate measurements must be made at the test site after assembly on the aircraft, based on the operating altitudes and other factors. These will be made with flow meters or with pressure measuring devices. All the personnel will be so engaged.

E. Protective Equipment

[redacted]

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[redacted]

All protective equipment will be designed, built and tested in the ZI. It is anticipated that samplers will be removed from the drone planes by remote control.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. Percent procured - none.

B. Orders placed - none.

C. Orders to be placed:

Cascade impactors - 1 July 1950

Conifuge - 1 Sept 1950

Snap samplers - 1 Sept 1950

Electrostatic Precipitators - 15 June 1950

Thermal Precipitators - 15 June 1950

D. Whether work will be contracted or performed by government facilities has not been decided. Delivery will be scheduled for 1 August - 1 November 1950.

E. Partially Developed

1. Cascade Impactor Modification - complete in six weeks.

2. Conifuge Modification - complete in ten weeks.

3. Electrostatic Precipitator Design - 15 June 1950.

4. Thermal Precipitator Design - 15 June 1950.

F. Commericially Available Equipment to be Procured

1. None of the equipment for sample collectors or precipitators is commercially available with the possible exception of the power packs. Development of the precipitators will soon be sufficiently advanced to specify power pack design, and data on possible sources of these items will be collected.

2. Three (3) Geiger-Muller Scalers, Nuclear Instrument and Chemical Corporation. Order to be placed in two weeks, no delivery date known.

G. Armed Forces Equipment

Armed forces equipment required will consist of protective clothing and monitoring service for crews handling samples.

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(1) 2 boxes on Los Alamos sample planes a few hours after test.

(2) 4 boxes (each weighing less than 200 lbs) to leave one or two days after test.

Radiation intensities are expected to be less than 1r at 1-foot from the boxes.

[redacted]

b. Chemical Corps

The Chemical Corps weight requirement is approximately 1000 lbs per test. It is anticipated that the U.S. Air Force will provide an aircraft for returning the snap samplers to Boston, Mass. Utilization of this aircraft will be made to return selected samples to the Army Chemical Center. It is anticipated this plane will leave within a few hours after each test. The remaining material is to be returned by air at the latest D+3 days, E+3 days, and G+3 days.

C. & D. Sea Lift or Air Lift

Personnel

1. To Site - 7 Men - D-30

2. Roll-up - 7 Men - G+7

VIII. Collaboration

Collaborating agencies are:

A. Technical Command, Chemical Corps, Army Chemical Center, Maryland.

B. Naval Radiological Defense Laboratory, Bureau of Ships, San Francisco, California.

C. AFOAT-1, USAF.

D. Tracerlab, Inc., Boston, Massachusetts.

E. Ames Aeronautical Laboratory, Moffett Field, California is assisting in the aerodynamic design and testing of the sample collector. Samples collected will be shared with the Los Alamos Scientific Laboratory.

IX. Responsibility

A. Chemical Corps will be responsible for accomplishing the test program, collecting data, and reporting it through the Program Director to the Scientific Director. Dr. Paul Tompkins, Associate Scientific Director, NRDL, is responsible for the NRDL phases of the experiment.

B. Project Officer - James P. Mitchell, Technical Command, Army Chemical Center, Maryland.

X. Funds

This information is contained in fiscal chart, page 6-2.

[redacted]

XI. Facilities

A. The facilities provided on Eniwetok as described in Los Alamos Scientific Laboratory Letter SD-1382, dated 9 March 1950, will be sufficient for the project. (see page 5-3).

B. Forward area transportation.

One weapons carrier for transportation of personnel and equipment between the unloading area and the aircraft installation area.

[redacted]

[redacted]

acteristics for the absorption and reflection of radiant thermal energy.

3. Determination of the influence of the environmental situation on material damage to permit extrapolation from results obtained at Eniwetok to other geographical regions. This will require a documentation of the environmental conditions at the moment of the test.

4. Correlation between effects of small and extended radiant beams on material samples (to obtain laboratory scaling factors).

5. Temporal observations of the development and propagation of fire and flame under field conditions.

6. Analytical studies by the Army Ordnance Department of the effects of geometry on fire initiation in order to aid in the more effective planning of field and laboratory tests.

7. Check of the predictions of the combustibility of common structural materials with a small number of samples.

This [redacted] pages.

[redacted]

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[redacted] of materials, design of equipment and structures, disaster planning, etc., will be based on the foregoing information plus knowledge of factors contributing to the origin and spreading of fires. One very important problem to attack in this connection is the determination of whether or not primary fires constitute a significant factor in defense planning, particularly from the point of view of target vulnerability estimates.

The proposed experiments extend previous studies associated with the detonations at Hiroshima, Nagasaki, Bikini and Eniwetok. The calibration and standard materials studies form the core of a continuing program in progress at NRDL, NML, BRL, and other DOD agencies.

[redacted]

II. Method

A. The project consists of two distinct parts.

1. For an assessment of the ability to simulate in the laboratory and measure the thermal effects of atomic bomb detonations on materials, the general method will be to expose pretested materials and instruments at operationally important distances. Where this is feasible, protected instruments will be placed to record the instantaneous environmental conditions so that the important attributes of the associated detonation phenomenology can be selected for future laboratory reproduction. Data derivable from NRL or other measurements will not be duplicated.

2. The second part consists of the exposure of small samples of common materials which are believed to be important as potential sources of primary fire hazard. Incendiary properties of these materials are being predetermined in the laboratory as far as possible with available thermal sources. Extrapolation from incendiary properties under conditions of varied geometric configurations and particularly on exposure to an extended and collimated radiant beam can be done only by means of the field test. Meteorological instruments are being provided for recording environmental conditions. The effects of the thermal field on the materials will be recorded photographically.

B. Proposed experimentation.

1. Proposed experimentation is designed in three parts:

(a) Continuing laboratory studies of materials, exposure and evaluating techniques, measuring instruments and methods, and construction of field test equipment.

(b) Installation and testing of equipment at the field site. Field analysis of the test conditions and the exposure results.

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ports in the front face of each blockhouse.

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[redacted]

TABLE II. B.3

Site Code	Label	Distance (Approx.)	Construction	Function	Documentation
E	Engebi 622 NML	1400 yds	Excavation for 1 rack	Physical characteristics of thermal radiation (Passive receivers)	Self-recording
S	Muzin 623 NML and USNRDL	2300 yds	Excavation for 2 racks and 1 blockhouse. Construct 1 concrete blockhouse	Physical characteristics of thermal radiation. Passive receivers and active instruments.	Self-recording
S	Muzin 623a USNRDL	2440 yds	None	Incendiary effects	Motion Pictures (USNRDL)
S	Muzin 623b USNRDL	2430 yds	Camera House	Photography of incendiary array	None
S	Muzin 624 NML and USNRDL	2510 yds	Excavation for 1 rack	As for 622	Self-recording
S	Muzin 624a USNRDL	2510 yds	←-------------	As for 623a	----------------→
S	Muzin 624b USNRDL	2500 yds	←-------------	As for 623b	----------------→
T	Kirinian 625 USNRDL	3090 yds	Excavation for 2 racks and 1 blockhouse. Construct blockhouse.	Physical characteristics of thermal radiations. Incendiary effects.	Self-recording and motion pictures (USNRDL)
T	Kirinian 625a NML	3090 yds	None	As for 622	Self-recording
T	Kirinian 625b USNRDL	3080 yds	←-------------	As for 623b	----------------→
T	Kirinian 625c USNRDL	3090 yds	←-------------	As for 623b	----------------→
T	Kirinian 626 NML	3500 yds	←-------------	As for 625a	----------------→
T	Kirinian 626a USNRDL	3500 yds	←-------------	As for 625	----------------→
T	Kirinian 626b USNRDL	3490 yds	←-------------	As for 623b	----------------→
T	Kirinian 626c USNRDL	3500 yds	←-------------	As for 623b	----------------→

[redacted]

[redacted]
exposure items chosen for the study of incendiary properties.

(a) Passive receiver panels. The items in this case are being chosen primarily to obtain information concerning the total thermal energy and the spectral characteristics of this energy. In addition, a number of receivers at each station will be devoted to a study of the time-intensity relationship, of the effect of collimation, of the effect of field influences such as weathering, spray, sand-blast, etc., of area and edge effects and of the influence of backing material. Most of the materials have already been selected on the basis of laboratory tests while others are still being calibrated. Materials already selected are shown in Table II.B.4. Several items may be added to this list prior to the test. A number of the items being mounted on the NML racks have been selected by the Quartermaster Research and Development Laboratories. Also, a number of flame and moisture proofing materials are to be added by the NML. The study of the spectral distribution will be made on the U. S. Naval Radiological Defense Laboratory racks primarily by the use of heat-resistant filters, Corning #9-54, #0-52 and #2-58, which will split the spectrum into three regions. Some special filters to get information on narrower spectral bands are being considered. On the NML racks, Corning filters #3-75, #0-54 and #7-57, as well as quartz, are being used with certain items.

(b) Incendiary materials panels. The interest here is primarily in the effects of such factors as reflectance, conductivity, area, backing and geometry on the initiation of fire and its subsequent behavior. The bulk of the samples are plane and besides being photographed will also be examined prior to and subsequent to the detonation.

Most of the materials to be used have been chosen and are listed in Table II.B.4. Several other items may be added prior to the test.

[redacted]

[redacted]

TABLE II.B.4

LIST OF EXPOSURE ITEMS

I. This list is divided into two types of materials. The first group lists materials which act as passive receivers, while the second list comprises items selected for the study of incendiary phenomena.

A. Passive receivers (NML and USNRDL)

1. Woods - Douglas fir, Maple, Mahogany, White Oak untreated
   Mounting - Behind Corning filters

2. Metals
   Materials - 10 different metals, surface treated and surface untreated
   Thickness - Determined by sensitivity of material
   Mounting - No filters, behind quartz windows, behind Corning filters

3. Paper
   Material - Unsized paper, treated paper
   Type - Kraft, heat recording
   Color - Brown (Kraft), Yellow (heat recording)
   Mounting - Behind quartz windows, behind Corning filters

4. Fabrics
   Materials - Cotton, wool, rayon, nylon
   Weights - Cotton (shirting, duck)
   Wool (summer, winter)
   Rayon (average)
   Nylon (average)
   Colors - (a) Low reflectance in visible and IR regions
   (b) High visible reflectance, low IR reflectance
   (c) Low visible reflectance, high IR reflectance
   Mounting - Behind quartz windows

5. Plastics
   Materials - Methyl methacrylate, cellulose acetate, cellulose nitrate, bakelite, teflon
   Colors - Clear and pigmented (high absorption)
   Teflon - neutral only
   Mounting - Behind quartz windows

6. Weather protective coatings
   Materials - Paint, varnish, lacquer
   Colors - Paint - standard green; varnish and lacquer - clear
   Thickness - Single and multiple coats to be applied by standard Navy coating process
   Base Materials - Douglas fir, Mahogany, steel
   Mounting - Behind quartz windows

[redacted]

[redacted] ing the use of external power for their operation. The types of instruments to be used are oscillograph recorders and rotating drums.

(a) Oscillograph recorders. The instruments to be used are Oscillograph Recording Cameras, manufactured by the Heiland Research Corporation, Denver, Colorado. The input signals to this recorder will be supplied by thermopiles and photocells, with no intermediate stages of amplification. This system is intended to provide information regarding the time-intensity relationship for several spectral regions. With the thermopiles, it is planned to use the same types of filters as for the passive receivers (Corning #9-54, #0-52 and #2-58). It is contemplated that Corning filters #9-54 and #7-60 will be used with the photocells. Some thermopiles will be devoted to a study of scattered radiation. One recorder with associated thermopiles and photocells will be located in each of the concrete block houses (stations 623, 625 and 626a). It will be necessary to use duplicate thermopiles and photocells for each spectral region to ensure covering the range of intensity likely to be encountered. The heat capacity of the thermopiles will result in an integrated time-intensity curve while the time constant of the photocells is expected to be sufficiently small to result in a differentiated curve. The time constants of the system are under study.

[redacted]

(1) Recorder characteristics
Power supply - 24 Volts D.C.
Number of channels - 12
Method of recording - galvamometers plus photographic paper.
Galvanometer constants - flat response to approximately 80 cps; impedance of 8 ohms; gives trace about 0.2 mm wide; sensitivity linear for 9 cm of photographic paper.
Photographic paper - width of 4 inches; speed from 3 to 24 inches per second; time marks at 0.01 second intervals; trace discrimination at intervals of 1.20 seconds.

(2) Thermopiles
Geometry corresponds to calorimeters designed and tested at the USNRDL.
Receiving area of 0.5 sq. in.

(3) Photocells
General Electric Photronic Cells (copper-copper oxide).

(b) Rotating drums. These instruments consist of drums rotated by means of 12V D.C. motors. The speed of rotation is adjusted so that all thermal energy from the detonation is received during the course of one revolution. A record of the time versus intenisty is obtained on heat sensitive paper. The three spectral regions determined by the Corning filters #9-54, #0-52 and #2-58 are being studied. The principal problem with this system is in providing a suitable sensitive recordingmaterial.

6. As noted in section II.B.3 above, observations of incendiary phonomena during the field test will be made by the use of GSAP and K-25 cameras. These cameras will be located in camera houses approximately 30 feet from the centers of the incendiary displays at stations 623a, 624a, 625 and 626a. At each of these stations a camera house is provided so that essentially frontal views of the displays are obtained. In addition, at each of the stations 625 and 626a a camera house is located so that side views of the displays are obtained. A total of six GSAP and two K-25 cameras will be provided for each camera house. Both color film and black and white film will be used, although a final division has to be made. The GSAP cameras will be operated at speeds between 16 frames per second and 64 frames per second, thus giving recording times from about 2 minutes to about 30 seconds. The K-25 cameras will be operated in run-away condition, giving somewhat less than 1 frame per second or a recording time of about 35 seconds. Timing marks will be provided by the timing signals and by the arrival of the shock wave. Consideration is being given to the provision of further timing marks.

C. The experiment outlined in A and B will not depend essentially on the yield of the weapon because the panels to be exposed will necessarily provide for 100 per cent variation in the radiant energy exposure. A shift in the date of the test will make no difference, but a change in the expected time of day will have to be taken into account in the photographic programming.

III. Details of progress to date in experimental and theoretical work.

A. Intense sources have been set up at the USNRDL and the NML for testing and measuring extreme energy effects on materials. A good deal of effort has been devoted to developing methods for analyzing the output of these sources. The calibration is adequate for the testing of the exposure items and this testing is proceeding. Navy searchlights are being used at both installations for this work.

An analysis of the behavior of electrical recording systems using input signals from thermopiles and photocells has been carried out. The electrical recorder being used is a Heiland Oscillograph Recording Camera. The interest has been in determining the feasibility of using this type of system to obtain a time-intensity record for several parts of the spectrum. The suitability of the system for this purpose has been established and final tests under simulated field conditions are proceeding. A final determination of the expected time resolution is being made.

The revolving drum system has been studied with regard to its feasibility for determining time-intensity relationships for several spectral regions. Experimental work has been carried out with the system and tests have been made to determine the most suitable recording materials to achieve a maximum sensitivity. This has necessitated the calibration of several materials with the laboratory arrangement of sources.

A laboratory set-up is being established for testing the photographic program in connection with incendiary phenomena. An attempt is being made to duplicate, as nearly as possible, conditions expected in the field. The greatest uncertainty here is in the validity of available light curves. An analysis of the pertinent information desired from the field test concerning the physical characteristics of the thermal energy and its interaction with various materials has been made. Factors such as backing, mounting geometry, area and edge effects and environmental influences have been considered. The selection of passive receivers and incendiary materials is being based on this analysis.

All experimental and theoretical work conducted to date emphasizes the need for information from atomic detonations to guide a laboratory program on thermal radiation. At the present time, the available information from previous field tests is inadequate to provide any real assurance that existing laboratory arrangements correspond closely to field conditions. Until such assurance can be obtained, it will not be possible to set up a standard procedure in the laboratory for the routine testing of materiel of interest to the Department of Defense, to arrive at the best possible defensive measures or to provide the most suitable methods for treatment of casualties resulting from atomic detonations.

IV. Personnel requirements

A. Required at the test site

1. Eight civilians, two to be provided by the NML, the remainder to be contributed by the USNRDL. The civilians will be responsible for the installation of recording and measuring equipment, its calibration and pre-test checking and the documentation and assessment of data.

2. One enlisted man, who is expected to be a Chief Photographers Mate. He will assist the scientific personnel in setting up cameras and making test runs with these cameras.

3. Approximately 900 man hours of unskilled labor will be required for loading and unloading equipment and for the transportation and erection of racks and panels. Approximately 70 man hours of an electrician's time will be required for installing and checking electrical circuits. Approximately 70 man hours of photographic labor will be required for processing test film.

B. Work in Continental United States

Project work in continental U.S. is under way at NML and USNRDL, using respectively 4 and 6 professional grade workers to design test equipment and to make analytic studies. Technicians will be available as needed.

V. Instrumentation and Equipment

A. Instruments and equipment required.

1. Additional intense sources of thermal radiation.

2. Structural racks for mounting panels of passive receivers and incendiary materials.

(a) 5 dural racks provided by the NML

(b) 6 steel racks provided by the USNRDL

(1) 4 racks for passive receivers

(2) 2 racks for incendiary materials

Each agency is fabricating and shipping, in disassembled form, its own racks.

3. Panels carrying exposure items.

(a) Passive receiver panels. Both the NML and the USNRDL are providing panels. Each agency will assemble these panels of materials and ship them ready for belting to racks at the site.

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prepared by the National Bureau of Standards under contract with the Ballistics Research Laboratories are being packaged and shipped by the USNRDL.

4. Cameras

(a) 50 GSAP cameras

(b) 15 K-25 cameras

Cameras, together with filters, mounting brackets and sighting attachments are being packaged and shipped by the USNRDL.

5. Weather recording equipment.

These are instruments designed to give a record of meteorological conditions for several days before the detonation and, if possible, for one or two days after the detonation. It is uncertain that the latter condition can be satisfied completely due to likely damage to certain of the instruments by the shock wave.

(a) Frieze Aneroid Barographs. One each at stations 623, 625 and 626a. Pen and ink recording on paper with approximately 15 minutes time resolution. Operation by 24 hour spring-wound clock.

(b) Frieze Hygro-thermographs. One each at stations 623, 625 and 626a. Two spares. Pen and ink recording on paper with approximately 15 minutes time resolution. Operation by 24 hour spring-wound clock.

(c) Bendix-Frieze Totalizing Cup Anomometer. One each at stations 623, 625 and 626a.

(d) Taylor wet and dry bulb hygrometers. One each at stations 623, 625 and 626a.

(e) Frieze precision Aneriod barometer. To be used in standardization of barographs.

[redacted]

[redacted]

(b) 36 Thermopiles, USNRDL design

(c) 6 General Electric Photronic Cells

One recording system, consisting of a Heiland recorder with thermopiles and photocells, is being provided for each concrete blockhouse.

7. Rotating drum systems.

(a) Total of six, two for each concrete blockhouse, are being provided.

B. All instruments will be shipped to the site, ready for installation.

C. The structural racks for panels of passive receivers and incendiary materials must be assembled and the panels mounted. Incendiary materials must be mounted on the walls of buildings 311, 333 and 334. The oscillograph recording systems, the rotating drum systems, and the meteorological recording equipment must be installed in the concrete blockhouses. The cameras must be mounted in the camera houses. All personnel listed in Part IV will be engaged in these activities during the pre-test period.

D. There are no true calibrations to be made at the test site. However, it will be necessary to check and adjust all recording instruments. For this purpose dark room facilities and equipment for processing photographic film and paper must be available on Site B.

E. Three concrete blockhouses and six concrete camera houses are required, as described in section II.B.3 above. Excavations for racks at stations 622, 623, 624, 625 and 626a are required.

1. Concrete blockhouse: See Holmes and Narver Sheet No. 3T-5680. Concrete camera houses: See Holmes and Narver Sheet No. 3E-5637, plan 302e. Excavations: See USNRDL Drawing No. P-50-41-1 Sheets 1,2,3 and 4. One additional excavation 16 feet by 20 feet and 3 feet deep is required at station 622.

[redacted]

[redacted]

by December 15, 1950.

VII. <u>Logistics</u>

A. Sea Lift

(1) 33 M/T to reach forward area at D-21

(2) 33 M/T roll-up to commence at D≠1

[redacted]

B. Air Lift

(1) 4 M/T to reach forward area at D-21

(2) None

(3) None

C. Sea Lift (Personnel) *

(1) One person from USNRDL to reach forward area at D-21

(2) One person from USNRDL to leave forward area at D+10

D. Air Lift (Personnel) *

(1) (a) 3 persons from USNRDL to reach forward area at D-21

(b) 1 person from USNRDL to reach forward area at D-15

(c) 1 person from USNRDL to reach forward area at D-8

(2) (a) 1 person from USNRDL to leave forward area at D+5

(b) 1 person from USNRDL to leave forward area at D+8

(c) 3 persons from USNRDL to leave forward area at D+10

E. None

VIII. <u>Collaboration</u>

This is a joint Department of Defense program -

Cognizant Agency:	BuShips (USNRDL - NML)
Participating Agencies:	BRL, representing all branches of the Army, Air Force: Assistant to Director of Research and Development for Atomic Energy, Headquarters, USAF, Washington, D. C. (ATTENTION: Col. B. G. Holzman)

* Two persons from the NML are to reach the forward area at D-21 and are to leave on D+20. Final arrangements regarding the mode of transportation are yet to be made.

[redacted]
be carried out by these organizations in their respective laboratories in the ZI. Coordination of the project, including evaluation of the data obtained, will be the res›onsibility of the USNRDL.

[redacted]

[redacted]
expected to provide calibration data for both calculations and laboratory experiments involving the test tank and other armored weapons.

II. Method.

A. General method.

It is proposed that, depending on the particular location of the combat vehicles, the data desired will be measured as follows:

[redacted]

[redacted]

b. Buttons will be exposed in and outside the tanks to determine slow and fast neutron densities.

2. Interior wall temperature. - Resistance gauges placed at several locations on the interior tank wall surface (the location depending on the vehicle orientation) will indicate the rise in wall temperature. Head-sensitive papers or paints will be used in those vehicles in which no recording equipment will be used.

3. Adiabatic heating of the interior air. - A device indicating the change in sound velocity with temperature rise will be placed in those vehicles for which recording of data is planned.

4. Rise in interior pressure. - Pressure gauges indicating pressure as a function of time will be placed in those vehicles for which recording of data is planned. Bursting disphragms will be used to indicate maximum pressure rise for non-recording locations.

5. Acceleration measurements. - Recording acclerometers and mechanical accelerometers will be used to obtain normal and cross accelerations, both as functions of time, and the peak values, depending on the location of the combat vehicles.

6. Strain measurements. - Strain gauges will be used to determine the stress on critical portions of the tank members.

7. Ordnance technical inspections using standard tool kits will be performed to evaluate automotive and structural damage. When background radiation has reached sub-hazard levels, experience technicians will critically examine the combat vehicles to determine the bomb effects upon the vehicles with regard to their usefulness as a weapon of offense or defense under similar field experiences.

B. <u>Detailed description of the experiment.</u>

The combat vehicles (medium tanks) will be distributed as follows:

1. Group I (azimuth 96°, 100°). Two tanks, side on, and tail on orientation, will be placed 500 yards from the bomb tower.

2. Group II (azimuth 87°, 90°, 92°). Three tanks, head on, tail on, and side on, will be located 750 yards from the bomb tower.

[redacted]

3. Group III (azimuth 95°, 97°). Two tanks, side on, and tail on, will be located 1000 yards from the bomb tower.

4. Group IV (azimuth 82°, 84°). Two tanks, head on and side on, at 1250 yards from the tower.

5. Group V (azimuth 122°). One tank, side on, at approximately 1400 yards from the bomb tower.

Using the group designation indicated above, the dats which will be gathered at each instrumentation location are detailed in the following paragraphs.

Group I

Because of the severe accelerations predicted at this location, no time function recording equipment will be installed. Ionizing radiation will be obtained from film badges, maximum pressure rise from ruptured disphragms, maximum accelerations from displacement measurements, vehicle member stresses from stress paints if possible, and interior wall surface temperatures from head-sensitive paper or paint. Vehicles will be given an Ordnance technical inspection after exposure.

Group II

One 24 channel magnetic tape recorder will be placed in each of the three tanks at this location. Data to be obtained are as follows:

a. Ionization measurements from film badges and/or phosphor glass dosimeters depending on the results of experiments now being carried on to determine temperature sensitiveness of the film badges and energy dependence of the phosphor glass crystals. High rate counters will be used to determine background radiation after the burst has passed. Buttons will be placed to measure neutron density inside and out.

b. The rise in interior air temperature (from adiabatic heating) will be recorded.

c. Interior pressure as a function of time will be recorded.

d. Interior tank wall temperature will be recorded.

e. Normal and cross accelerations as functions of time will be recorded.

f. Measurable strains will be recorded.

g. Vehicles will receive an Ordnance technical inspection after exposure.

[redacted]

probably be included. These vehicles will receive a technical inspection if it seems warranted.

Group V

No time function recording equipment will be employed at Group V. The only measurements made will be those of total ionizing radiation (chambers or phosphor glass dosimeters) and the interior depth dosage (simulated human) obtained from a "Phantom". This vehicle will receive a technical inspection if it seems warranted.

C. Dependence of A and B above upon expected bomb yield and date and time of [redacted] any yield which lies within ± 40% of the estimated yield and thus give all the information desired pertaining to the stated objective of the experiments. The experiments are designed to preclude any dependence upon date or time of the test.

III. Details of Progress to Date in Experimental and Theoretical Work.

The program to date has mainly been along theoretical lines, that is, the assembly of basic information and the computation of effects at various distances. In addition, the problems of instrumentation availability and suitability have been investigated and tentative decisions made in some cases as to what instrumentation shall be used.

As a result of the theoretical and some of the experimental investigations, certain items were brought to light which tend to focus attention on those quantities which now appear to limit ultimately the usefulness of an occupied combat vehicle engaged in a tactical mission. Computations show that the tank will suffer little or no damage at burst distances quite fatal to human occupants. Some structural damage to the tank is expected to occur close in. Reasonably good ionization measurements then become the data of greatest interest and importance and considerable thought must be given to the obtaining of accurate results.

[redacted]

[redacted] factor which considers the intensity transmitted after one or more scatterings within the shield. Assuming an average shield thickness of four inches and an average energy of 4.5 mev, the expected dosages are given.

Distance	Outside Dosage	Inside Dosage	Loss of Combat Effectiveness
500 yds	100,000 r	20,000 r	Immediate
750 yds	20,000 r	4,000 r	1 hr
1000 yds	5,300 r	1,060 r	3-12 hrs
1250 yds	1,400 r	280 r	days
1500 yds	400 r	80 r	-

[redacted]

[redacted]
density of .06 after oven exposure whereas another sample at room temperature had a density of .02. Another sample was exposed to approximately 10,000 r, then to the oven, and had a density of 1.74. A similar sample exposed to 10,000 r and then to room temperature (for the same length of time) showed a density of approximately 3.6. Results of this test indicate that for the range of 5000 - 30,000 r, the film might be practical since it appears that the temperature effects might be calibrated.

At the present the Burear of Standards is conducting tests on film covering the range from 1000 - 2500 r. Results from these tests are not at the moment available.

[redacted]

calibration for a larger laboratory program. It is easily possible to conceive of a betatron furnishing sufficient energies to simulate actual exposure conditions, hence permitting many measurements to be taken within many different vehicles under laboratory-controlled conditions. However, the actual test appears necessary, if only for calibration data.

B. Wall temperature.

The problem insofar as temperature is concerned is to determine the possibility that occupants or material will suffer from heat effects upon coming in contact with the inner surface of the tank walls. The source of this temperature rise stems directly from the bomb's thermal radiation rather than any transfer from the air heated by the passage of the shock wave. It appears that a two-inch steel wall exposed at 500 yards to the full thermal radiation and reflecting none of the energy, might experience a considerable rise in temperature on its inner surface. However, the dust obscuration and the possible reflection of a sizeable portion of the incident thermal energy will probably limit the temperature rise on the inner surface of the tank to perhaps 20° C. Nevertheless, it is felt that a measurement of the temperature rise is necessary as close in as possible to verify computations.

[redacted]

[redacted]

[redacted]

E. Acceleration**s**.

Differential inductance gauges for measuring acceleration are available. It is proposed to measure a minimum of three accelerations in each vehicle. These will be the horizontal acceleration perpendicular to the shock front through the c.g., the vertical acceleration through the c.g., and an additional vertical acceleration to determine the moment. Whether or not any additional measurements, particularly cross acceleration, are desirable has not yet been determined.

Computations on maximum accelerations of the tank from the blast wave impact have been carried out and these are summarized in the following table:

Distance	Attitude	Max. Velocity	Distance Moved	Max. Acceleration
500 yds	Side	27 ft/sec	30 ft	78g
	End	13.7 "		39g
750 yds	Side	15.4 ft/sec	10 ft	22g
	End	7.3 "		10g
1000 yds	Side	8.6 ft/sec	3 ft	10g
	End	3.8 "		4g

It should be noted that the maximum accelerations exist for a very short period of time, about two milliseconds, and fall off quite rapidly. Nevertheless, the maximum accelerations must be considered in the design of instrumentation and recording equipment. As the magnetic recording equipment which will be used has been designed for 20g, it is seen from the above table that use of such instrumentation closer than 750 yards is impractical.

From the above it is seen that in order properly to plan this program, information is necessary on the following aspects of the phenomenology of an atomic explosion:

1. Ionization, including intensity and energy of gamma radiation, neutron density, induced radioactivity and contaminations.

2. Intensity and duration of radiated heat vs. distance.

3. Pressure and duration of shock wave vs. distance.

4. Velocity and duration of winds.

5. Ground shock effects.

In addition, data are necessary on the following:

1. Time dependent effects of ionizing radiations on combat efficiency of operating personnel.

[redacted]

1. Tanks, medium, M-26 or M-46, (10).

[redacted]

[redacted]

2. 24 channel Webster magnetic tape recorder, (6).
3. Accelerometers, (11).
4. Accelerometers, maximum acceleration.
5. Sound velocity measuring units.
6. Pressure-time gauges.
7. Maximum pressure gauges, disphragm type.
8. Film badges 5000 - 30,000 r.
9. Film badges 1000 - 2500 r.
10. Dosimeters 500-2000 r.
11. Dosimeters 50 - 500 r.
12. Dosimeter.

(Items 8–12: The use of these items will depend upon forthcoming decisions of the AEC, Bureau of Standards, and Signal Corps on what types are to be prepared for the test.)

13. Ionization counters.
14. Phantoms.
15. Strain gauges.
16. Stress paint.
17. Heat-sensitive paint.
18. Resistance temperature gauges.
19. Heat-sensitive paper.

B. Instruments and equipment will be assembled in the ZI and shipped to the test site ready for installation and test.

C. No assembly or construction at test site.

D. Calibration devices will be built into the equipment.

E. No protective equipment or construction required.

VI. Present Status of the Equipment and Instruments Required to Perform Experiment.

A. Already processed - none.

[redacted]

B. The magnetic tape recorders, and associated equipment, have been ordered by addition to the AMC contract with Webster-Chicago Co. Complete delivery should occur prior to November 1950 with partial deliveries prior to August 1950. Action has been initiated to obtain ten (10) medium tanks. Delivery is expected by the end of June 1950.

C.

Item	Supplier	Date Of Placing Order	Delivery Date
Pressure gauges	Wianco	May 1950	July 1950
Accelerometers	Wianco	May 1950	July 1950
Temperature gauges	Local	April 1950	July 1950
Strain gauges	Local	April 1950	July 1950
Film badges	Coordinated with Signal Corps		
Phantoms	Coordinated with BioMedical program		
Heat-sensitive paints	Local	May 1950	July 1950
Stress paint	Local	May 1950	July 1950
Counters	?	May 1950	Aug 1950
Bursting diaphragm	Local	May 1950	July 1950
Neutron buttons	Los Alamos	May 1950	?

D. Instrumentation yet to be developed.

Item	Development Agency	Time Required	Procurement Time
Air temperature gauge	Local	Two months	Two Months

E. Partially developed instrumentation.

Item	Development Agency	Time Required	Procurement Time
Phosphor glass badges	NRL	?	?

F. Commercially available equipment not yet procurred or on order.

Two cable for close-in vehicles, miscellaneous wiring, electronic components not included in standard stock cataglogue are types of equipment not yet considered. Possible vendors are unknown, but four months delivery should be possible.

G. Ten (10) medium tanks are in process of procurement.

H. See sections C and D above.

I. No decision as yet on counters or usage of phosphor glass badges. Decision on these matters can be expected in May 1950. Technical data on energy dependence of phosphor glass and temperature dependence of film badges are incomplete. Final results of tests now being run will make possible a decision on the

[redacted]
in analyses of results to be expected from tactical use of this type weapon.

[redacted]

[redacted]

IX. Responsibility.

A. Mr. Norman W. Arnold, Ballistic Measurements Laboratory, Ballistic Research Laboratories, Aberdeen Proving Ground, is the person responsible for carrying out the experiment, collecting data, and reporting results.

B. ~~Dr. Louis A. Delsasso~~ Mr. Norman W. Arnold, same address, will be the Project Officer responsible for this project and is the source from whom further details can be obtained.

X. Funds.

This information is contained in fiscal chart, "page 6-2."

XI. Facilities.

A. Power.

1.5 Kilowatts of 110 v, 60 cycle power will be required at each location. Battery voltage of 24-28 volts d.c. will be furnished by the using agency using battery chargers.

B. Communications.

1. The following timing signals will be required at 6.3(2), 6.3(3) and 6.3(4):

- 30 minutes
- 1 minute
- 5 seconds
- 1 second
 0 second
+ 1 second

2. No special requirements.

C. Laboratory space and other facilities.

Laboratory space as listed in SD-1382 dated 9 March 1950. (See page 5-3). No special requirements.

D. Forward area transportation.

One jeep on the site will be required from the arrival of test personnel until evacuation prior to the shot. A $2\frac{1}{2}$ ton truck and a 10-T wrecker may also be required for short periods.

XII. Remarks.

A. Information is requested on the hours of the work week. It is assumed to be whatever is necessary. If limitations are to be imposed, a revision of logistic times may be required.

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PROJECT 6.4

FALL-OUT DISTRIBUTIONS

I. Object of the Experiment

A. This experiment is designed to determine the test site fall-out pattern from the Greenhouse Atomic Bomb Detonations, particularly as they are influenced by the meteorological conditions.

In addition, it is desired to appraise the potential health hazard from external and internal exposure to the fall-out products.

The information gathered from the Greenhouse detonations will be valuable in predicting fall-out patterns for other ABD air-bursts. In addition, it will indicate probable external and internal hazard from the fall-out products to personnel who are in the ABD zone or who must enter the zone at a later time.

B. The fall-out samples will be used to gather the following data:

1. Test site, fall-out pattern.
2. Distribution of fission products and fissile materials in samples.
3. Concentration pattern of fall-out products.
4. Particle size distribution of fall-out products.
5. Radiochemical analysis of fall-out products.
6. Potential external and internal health hazard from fall-out products.

II. Method

A. The general method of collection of fall-out samples is to place collecting surfaces at chosen locations on the islands which make up the Eniwetok Atoll. The collecting plates will be recovered after the ABD and examined for any radioactive particles which settled on them.

B. 1. It is proposed that 5 one-foot square, glass collection plates, covered with a thin layer of lubriseal and suitably mounted, be strategically located at two different sites on each of the following 12 islands designated as marked on the official site code:

A, B, L, K. M, N, R, P, T, S, Q, F

[redacted]
This document contains information affecting the
[redacted]
Applicable Federal laws.

[redacted]

Subsequent to each ABD, the plates will be recovered and returned stateside for analysis. Each sample will be weighed and subjected to radioactivity detection (radioautographs) and analysis, and to measurement of particle size distribution. Attempts will be made to specifically isolate any radioactive particles which are found.

2. Each collector will consist of a rugged device for supporting the one-foot square, glass collection plate. The plate holder will be fastened to the coral by spikes driven through openings in the legs. The legs will be about one-foot in height.

C. It is not expected that the yield of the weapon will exert a significant influence on the test procedures.

III. Details of Progress to Date in Experimental and Theoretical Work

A collection plate holder was designed and tested at NRDL. The device is believed to be satisfactory for manufacture in quantity for the 6.4 program.

Several coating materials were tried on the glass plate and Lubriseal was found to have the desired properties as a particle trapping medium. Lubriseal is a trade product of undisclosed composition. It melts at 43°C. and is readily soluble in petroleum ether.

The Lubriseal is applied to the glass plate as a thin film from evaporation of a petroleum ether solution.

A system for making a radioautograph of the collecting plate was developed and techniques for separation of the dust from the Lubriseal were devised.

IV. Personnel Requirements

A. Required at Test Site:

1. Scientific personnel - one civilian required for recording, assembly of data, guidance in placing samplers, and for general consultation on the project. To be furnished by NRDL.

2. Technical personnel:

Number of Men	Duties	Organization furnishing personnel	No. on Hand	No. not on Hand
4	Install, remove and ship 124 collecting plates for each ABD	- -	0	4

3. Laborers:

Number of Men	Duties	Organization furnishing personnel	No. on Hand	No. not on Hand
4	Set-up plate holders and package plates for shipment	- -	0	4

B. Project Work in Continental United States:

Manufacture 124 fall-out collectors with 372 glass plates. Process the collecting surfaces on the plates and prepare them for shipment to the test site.

One chemist will be needed for two man months to supervise the manufacturing and to process the plates.

V. Instrumentation and Equipment Requirements

A. One hundred twenty-four (124) fall-out collectors and three hundred seventy-two (372) glass collecting plates must be manufactured. Shipping containers to send the devices to the test site and for returning the plates stateside will also be needed.

B. It is planned to assemble the instruments in the ZI for shipment to the test site. The collectors will be ready for installation and use at the test site.

C. None is contemplated.

D. None will be required at the test site.

E. All protective equipment will be designed, built and tested in the ZI. It will consist of equipment for remote handling and shipping of any plates which are definitely "hot".

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. None of the field equipment for project 6.4 has been acquired.

B. None of the equipment for project 6.4 has been ordered.

C. When new personnel are obtained by the Health Physics Branch, one chemist will be assigned to project 6.4 procurement.

D. See C above.

[redacted]
schedule as requested under Project 6.1.

3. None.

C. Sea Lift (Personnel):

1. None.

2. None.

D. Air Lift (Personnel):

1. None.

2. None.

E. None.

VIII. <u>Collaboration</u>

Los Alamos Scientific Laboratory.

[redacted]
earlier than two days prior to shot time. The five boats (Ducks) for transportation to the different islands should be available at that time and as soon after the shot as possible.

XII. Remarks by Project Officer.

The Program Director is requested to make provision for the placement of the [redacted] Project write-up. It is considered that a minimum of five square feet is necessary to present any probability of collecting a reasonably sized radioactive sample by means of fall-out. These are packaged in individual one-foot square units to facilitate placement and return of the samples to NRDL.

The attention of the Program Director is called to the fact that the primary unique data to be attained by this Project is the potential correlation of the fall-out from the particle size concentration and distribution as determined by Project 6.1. Also the fall-out samples, if enough radioactive particles are collected to be significant, should provide a relatively good source for the isolation of individual radioactive particles.

Attention is also drawn to the fact that the fall-out pattern might be determined better by survey measurements made by the Radiological Safety Monitoring Group. If this unit could be persuaded to take quantitative measurements during the course of their operation and, if they are in a position to search a territory somewhat larger in area than that required for personnel safety, they could do a much better job of plotting the actual fall-out pattern. It is requested that attempts be made to get the Radiological Safety Group to incorporate such measurements in their operations plans. The plates can then serve as a correlating check on the observed distribution.

[redacted]

A. General Method - Contaminated sample strips of ABD fission material attached to drones flying through the radioactive cloud, will be flown to the laboratory. The energy distribution of the active fission material will be studied by spectrographic methods. Ionization measurements will be obtained with beta ray extrapolation chamber and secondary standard gamma ray measuring instruments. The relative survey instrument response to the fission material will be determined for all types of detecting apparatus available at the time.

B. Description of the proposed experiment - It is proposed that twelve 12 by 12 inch squares of flat metal be attached to the outside structure of the drone planes. Each square will, in reality, consist of twelve one inch strips, twelve inches long, held together. The strips will be separated as desired at the laboratory and at no other time. It was further proposed that the metal sheets be coated with a thin film of silicone grease for the purpose of retaining a maximum amount of radioactive material. The location of the sample strips on the drones is not particularly critical, but should be in places where the probability of catching the fission material is good. The strips should be flown to the laboratory as soon as possible following the exposure.

C. The details of Part II, A and B, are not dependent upon the estimate of the expected yield of the weapon. The yield could provide some information concerning the initial activity of the test strips. However, the relative uncertainty in the positions of the drones in the cloud and in the ratios of the fission material in cloud to material retained by strips would normally offset any accurate information available to this effect.

[redacted]

III. Progress to Date

A. The relative response of beta-gamma survey instruments in terms of ionization dose rate has been studied for both beta and gamma (plus low energy X-rays) radiation over a relatively wide range of energies. Information, therefore, exists concerning the rep and roentgen response of representative instruments to known radiation energies. Absolute instruments for the measurement of ionization rates for beta and gamma radiation have been constructed and are currently available. Construction of a beta ray spectrograph is now in progress. No fundamental data is considered to be lacking for a theoretical attack or detailed experimental planning.

IV. Personnel Requirements

A. Required at test site - No trained personnel, technicians, or laborers related directly to this problem will be required at the site. Location of the test strips on the drones and air mail shipment to the laboratory is the only handling required and can be fitted in with other projects of similar requirements (6.1 and 6.7).

B. Project work in continental United States

1. Scientific personnel - Six scientists are needed full time as the nucleus of this project, and will be disposed in three groups: the radiation analysis group, the instrument response group, and the theoretical analysis group. All will work as a close-knit team. At the time of the actual determination of the results, additional personnel as required will be available. The radiation analysis and instrument response groups are on hand and actively pursuing the project. The theoretical analysis group needs to be augmented with two new men: a top-notch theoretical physicist and his assistant.

2. No technicians required.

V. Instrumentation and Equipment Requirements

A. With the exception of the procurement of various survey type instruments, all equipment will be standard laboratory type instruments, either purchased or designed by the laboratory.

B. No instruments or equipment, with the exception of the test strips, will be required at the test site.

VI. Present Status of Equipment and Instruments Required to Perform the Experiment

A. With the exception of the completion of the beta ray spectrometer, the existing equipment (beta ray extrapolation chamber, beta ray surface chambers (extrapolation chamber type), dosimeter type; gamma and X-ray dosimeters (secondary standards)) [redacted] the various agencies which support the Naval Radiological Defense Laboratory.

IX. Responsibility

A. Dr. R.I. Condit, Chief, Physics Branch, NRDL, will have the responsibility for carrying out the project, collecting the data, and reporting it through the Program Director to the Scientific Director. The Senior Investigator under Dr. Condit is Mr. Eugene Tochilin, Physics Branch, NRDL.

[redacted]

B. Project Officer responsible for this project is Dr. Paul C. Tompkins, Associate Scientific Director, Naval Radiological Defense Laboratory.

X. <u>Funds</u>

This information is contained in fiscal chart, page 6-2.

XI. <u>Facilities</u>

No field facilities aside from that already provided in SD-1382 dated 9 March 1950 are required, (see page 5-3). The field facilities requirements for this project will be handled completely under the operation of Project 6.7.

XII. <u>Remarks by Project Officer</u>

The high intensity radiation source for all of the projects involving the testing of radiac equipment is being financed by funds provided by Project 6.5. The irradiation source to be used is a Kevatron.

The designs for the Kevatron are about 90% complete; construction is expected to be completed on or about 1 July 1950. The instruments utilized in Projects 6.1, 6.5, and 6.8, as well as high intensity exposures for small animals in the Bio-Medical program will utilize the services of this equipment.

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PROJECT 6.6

EVALUATION OF FILTER MATERIALS [redacted]

I. Object of the Experiment

A. Data will be obtained on the filtration efficiency of Chemical Corps filter material used in gas mask canisters and collective protectors. The synthetic filter material now under development for the AEC and Hq., USAF for use in sampling airborne contamination will also be evaluated.

B. The data obtained will be used to determine the protection afforded by gas mask canisters and collective protectors against radioactive particulates resulting from an atomic explosion. Techniques of sampling and efficiency of methods of collection of airborne contaminants will be evaluated.

II. Method

A. General. Filter materials in multi-layer pads will be placed in each of twelve drone planes for each detonation. A sample of the cloud will be passed through the filter pads. As soon after the test as possible the individual layers of the pads will be measured for gross radioactivity at the test site. Subsequent analysis will be made at the Army Chemical Center by counting and radioautograph techniques to obtain data on the penetration efficiency of filter material and to check, qualitatively, particle size measurements made by other methods.

B. Detailed. Five types of filter material will be evaluated, (1) Chemical Corps Type 5, (2) Chemical Corps Type 6, (3) Chemical Corps Type 7, (4) Chemical Corps all-synthetic filter material for airborne sampling (5) latest developmental type of filter material available at time of test. Each type will be arranged in a pad of several layers to insure that essentially zero detectable penetration results through the last layer. The pads will be arranged on a single sampling unit of cubical shape. 100 square centimeters of each pad will be evaluated at a flow rate of 32 liters per minute, the flow provided by a motor-blower unit mounted on the sixth side of the cube. The area and flow rate chosen are the Chemical Corps standards. Since each pad will have only a slightly different resistance from any other pad, individual orifices will easily be able to control the flow through each pad by adjusting the orifice sizes. This method will provide a flow of contaminated air at 32 liters per minute $\pm 10\%$. The motor-blower combination will draw the total air sample of 160 liters per minute by preadjusting the motor speed.

The contaminated cloud will be sampled isokinetically and the sample

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National Defense of the U[illegible] States. Its trans-
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applicable Fed[illegible] laws

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[redacted]

passed into a spherical chamber containing the sampling apparatus. Thus, a representative sample of the cloud will be insured for evaluation.

The efficiency of each type of filter material will be determined by beta activity on successive layers calculated from the following equation:

$$\text{Percent Penetration} = \frac{\text{disintegration per/minute (layer 1)}}{\text{D/M (layer 1)} + \text{D/M (layer 2)} + \text{D/M (layer 3)} \ldots\ldots}$$

A sufficient number of layers of each type of filter material will be used to give a negligible activity on the final layer. Alpha activity will be measured on selected samples at the Army Chemical Center. Radioautograph techniques will be used to determine if the activity is due to isolated highly active particles, or to a general distribution of submicron particles.

C. Influence of Weapon Efficiency on Experiment. No dependence on expected yield of weapon or on date or time.

III. Details of Progress to Date in Experimental and Theoretical Work

A. Progress has been confined to selecting the types of filter material to be evaluated, and conceiving the design of the apparatus for evaluation of the material. Rough sketches have been prepared of the apparatus size, layout, and design details. Final engineering drawings of the prototype model, suitable for procurement, are being prepared from the sketches. Data are already available on the resistance and penetration efficiency of some of the filter materials to be evaluated so that pad assemblies can be made. Provision has been made for the location of the apparatus in the nose of the drone aircraft from which a probe 0.28 inches internal diameter will lead ahead of the nose into free air. This diameter permits sampling isokinetically 160 liters per minute at 150 mph, the estimated speed of the aircraft. Additional study is being given to insure isokinetic sampling at varying plane speeds.

IV. Personnel Requirements

A. Required at Test Site

1. Scientific Personnel - Two scientific personnel are required at the test site. These will be furnished by the Chemical Corps from its own personnel. Their duties will consist of unpacking the filter material samplers, installing the apparatus in the drone aircraft, making the preliminary adjustment of motor-blower speed based on the known altitude at which the aircraft will be operated, and making a final check of the flow rate through each filter pad after installation.

Following each test shot their duties will consist of removing the

[redacted]

B. Project Work in Continental United States

1. Scientific Personnel -- one (1), whose duties are to supervise the design of the apparatus, continue the study of isokinetic sampling, plan the evaluation of the prototype apparatus, and develop methods and techniques for analysis of samples.

2. Technicians - one (1), an engineering draftsman, who is designing the apparatus.

V. Instrumentation and Equipment Requirements

A. Equipment

1. Thirteen (13) Filter Material Samplers

2. Two (2) Scalers, Geiger-Muller

3. Two (2) sets flowmeters for 32 liters per minute.

4. Spare sets of orifice plates

5. Additional sets of filter material pads.

B. Assembly. The instruments and equipment will be completely assembled in the ZI and shipped to the test site, ready for installation and test. Installation consists of securing the unit in the aircraft and connecting the power cable. Approximately four man-hours per unit is required to test and adjust after installation.

C. Assembly at Test Site - None.

D. Calibration at Test Site - Checking of the individual flows on each unit will be carried out at the test site to insure no change or damage to the filter material resulting from shipment. A flowmeter will be used in these measurements.

E. Protective Equipment - None.

VI. <u>Present Status of the Equipment and Instruments Required to Perform the Experiment</u>

A. Percent Procured. Approximately 40%, since the motor-blower units and filter material are available in Chemical Corps stock.

B. Orders Placed - None.

C. Orders to be Placed - For the assembly of thirteen (13) complete units. The order will be placed about 1 July 1950 for delivery by 1 October. The contractor will be a local sheet metal shop or Technical Command Shop.

D. Yet to be Developed - None.

E. Partially Developed - Filter Material Holder; see C. above.

F. Commercially Available Equipment Not yet Procured. Two standard scalers with mica window counter tubes. To be ordered this month from Victoreen, Tracerlab, Inc., Nuclear Instrument and Chemical Corporation, or Berkeley Scientific Company. Delivery estimated at three months.

G. Armed Forces Equipment to be obtained - None.

H. Equipment and Instruments Required which can be Built at Army Chemical Center. Flowmeters - two weeks.

I. None.

VII. <u>Logistics</u>

A. Sea Lift.

1. Shipping - to site - 1/4 measurement ton; D-28.

2. Roll-up - 1/4 measurement ton; G + 7.

B. Air Lift - samples collected 1/8 M/T; G + 14.

C. Sea Lift (personnel) - None.

[redacted]

experience of the Chemical Corps that the resistance of the filter materials is relatively constant for production-made materials of the type to be evaluated. The resistance of the pads to air flow at 32 liters per minute will be measured accurately on a standard instrument at the Army Chemical Center prior

[redacted]

[redacted] an isokinetic sample of the cloud will be sampled into a plenum to provide a cloud atmosphere in which the pad holder will be installed. In the expected size range of particulate matter, 0.1 to 20 microns, impingement at low flow rates within the chamber is not considered a serious factor. Adequate evaluation of the prototype unit is planned.

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PROJECT 6.7 LAB-J-919

CONTAMINATION AND DECONTAMINATION STUDIES (ALOFT)

This do[redacted]ages

[redacted]

I. Object of the Experiment

A. Data to be obtained - The data to be obtained are those which determine:

1. The contamination and decontamination characteristics of various standard surfaces exposed to an atomic cloud. This takes into account the surface material or the protective coating on the material, and physical characteristics of the surface, such as roughness.

2. The efficiency of decontamination methods and decontamination agents at differing times after ABD.

3. Capabilities of methods in respect to full scale operational decontamination.

B. Application of the data

1. Results of the field experiments on the relative contaminabilties of various structural material surfaces and protective coatings will be compared to the results of contaminability experiments conducted in the laboratory in order to determine the extent of correlation between field and laboratory tests.

2. The relation will be established between the efficacy of decontamination methods in the field and in the laboratory. These correlations are essential to determine the extent to which laboratory studies can be relied upon to predict field behavior.

3. The data will lead to a better understanding of the factors that influence the contamination and decontamination of materials, and hence make possible the creation of more efficient field operational decontamination procedures. Greater knowledge of contamination-decontamination factors will assist in the development of new materials resistant to contamination and will also provide suitable design criteria for materials employed in military equipment and construction.

4. The data will yield a better understanding of:

a. Mechanism of contamination and decontamination.

b. The chemical and physical nature of the contaminants in the cloud.

c. The fractionation of fission products in the cloud due to differences in chemical and physical properties.

CA[redacted] d. Preferential decontamination.

[redacted]ctivity levels obtainable in decontamination.

[redacted] of its contents in any
[redacted]er to an unauthorized person is pr[redacted]
[redacted]under
[redacted] laws.

[redacted]

[redacted]
cies will go out two and seven days after sample exposure. Specimens to be used for determining the effect of time on ease of decontamination will be removed from the plane, monitored, and decontaminated by a standard procedure at intervals of thirty minutes to one hour. Part of this will be done on Eniwetok, and the remainder stateside. The exact distribution of samples and measurements will be determined by 1 August 1950.

4. All samples, whether done at NRDL or ACC, will be subjected to radiochemical analyses and standard decontamination tests.

[redacted]

adhere to the surface, will be investigated to determine the relative contaminabilities of the materials exposed. An effort will be made to study the effects of variation of aerosol particle size and variation of conditions of exposure on contamination of the materials. The results of the laboratory tests will determine the ultimate choice of specific materials to be mounted on the drone planes.

c. Development of a procedure for contamination and decontamination evaluation; critical examination of decontaminants and decontaminating methods:

(1) Decontamination procedures involving different agents and methods of evaluation will be studied. These may involve vacuuming, water wash, scrubbing, use of detergents, complexing action, etc. The basic research program for these various methods will be conducted by the Chemistry Branch at NRDL. The data and recommendations resulting will be developed to operational field conditions by the Engineering Applications Branch at this laboratory, and in this sense evaluated.

(2) From the results obtained in the two preceding paragraphs, (b) and (c)(1), a standard testing procedure will be devised to evaluate materials to be exposed to the atomic cloud. After sample exposure in the cloud, the test rating for laboratory-produced aerosol and "natural" aerosol contamination will be compared.

(3) The results of the two preceding paragraphs, (c)(1) and (c)(2), will determine the choice of decontamination procedures to be applied to the test samples exposed to the atomic cloud. Use of these decontaminants will permit the correlation between laboratory and field applications to be noted.

(4) Autoradiographic studies will be carried out on the contaminated materials, and the techniques developed will be applied to the samples contaminated at the test. It is planned to procure autoradiographs before and after decontamination studies are performed.

d. Mounting and handling of test specimens. Concurrently with the three preceding paragraphs (a), (b), and (c), the following will be undertaken: One of the drone planes from the AED tests at Sandstone has been procured. A detailed study of the location and level of activity on this aircraft will be made in an attempt to determine positions of maximum activity. It is planned to affix the test specimens at the points of maximum activity provided:

(1) Such placement does not affect the aerodynamic properties of the aircraft.

[redacted]

test panels of Alclad 24ST aluminum, although some will be made of stainless steel and surface-treated mild steel.

IV. Personnel Requirements

A. Required at test site

1. Scientific Personnel

[redacted]

3. Laborers and Other Unskilled Help.

The extent of laborer aid should require 500 man hours. All laborers will be closely directed by the scientific personnel. The laborers will assist in preparing drones before the test, and will assist in transporting the equipment used for the removal of the test plates and in packaging the plates.

B. Project Work in Continental United States

1. Scientific Personnel

	NRDL	ACC	Total
Officers	0	0	0
Enlisted Men	0	0	0
Civilians	6	4 (part time)	10

Four men at NRDL will be concerned with the following duties:

a. Preparation of contaminated material for aerosol production.

b. Generation of aerosols and exposure of materials.

c. Study of contaminability of samples.

d. Study of decontamination methods and agents.

[redacted]

6. 3 ion chamber-type survey instruments (includes 1 alpha survey meter for ACC).

7. 15 shipping containers (18" x 18" x 18").

8. Remote handling devices and shields for test plates.

9. 30 lineal feet of counter space in the Los Alamos 24' x 24' aluminum building - table of sufficient strength to support two lead caves, each weighing approximately 300 pounds.

10. 2 sets of aluminum absorbers.

11. 1 portable scaler (for ACC).

B. Assembly in ZI

Instruments and equipment can be assembled in the ZI and shipped to the test site, ready for installation and test (with the exception of mounting of samples for later tests).

[redacted]
will be necessary. This will be located in the 24' x 24' aluminum building on Eniwetok.

2. Remote control device for handling samples.

3. Face masks, respirators, rubber gloves, and protective clothing sufficient for continuous use by six men.

4. One radiochemical hood in area near drones for standard decontamination test on panels.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. Equipment already procured

About 10 per cent for NRDL; about 50 per cent for ACC.

B. Orders placed

Two Argon - CO_2 counters; ordered by NRDL (to be made at NRDL and expected 1 August 1950). Orders for panels and coating materials by ACC are either placed or being placed.

C. Orders to be placed - none

D. Yet to be developed

Sample attachment, remote handling equipment, and detailed test procedures by NRDL. Standard decontamination prodecure for time evaluation is to be developed by ACC. It will be completed and equipment will be completed by 1 October 1950.

E. Partially developed - none

F. Commercially available equipment not yet procured or on order

None by NRDL. A counting rate ionization chamber meter is on requisition but not on order by ACC.

G. Armed Forces equipment not yet obtained

Packaged steam cleaning unit by NRDL. Inquiries as to the location and availability are being made. Material will be procured and evaluated before test data. None by ACC.

H. Equipment and instruments required which can be built by facilities available to the using experimental group

None by NRDL. For decontamination an apparatus consisting of motor-driven propulsions traveling over the panel surface at a predetermined rate, using already established concentrations of detergents, will be investigated by ACC and will be ready for shipment by 1 October 1950.

I. "No Decision" equipment

There has been no decision by NRDL, as yet, on specific remote control equipment. A decision will be reached by 1 June 1950. Final decision by ACC on type of counting device to be made no later than 1 June 1950.

VII. Logistics

A. Sea Lift

1. 35 M/T, to arrive 30 days before test.

2. 35 M/T, return to commence 10 days after test.

B. Air Lift

1. Personnel - none

2. Material - It is necessary that the shipments noted below be made to NRDL and ACC in order:

a. That short-lived activities and their decontamination may be studied using the facilities of a large laboratory.

b. To permit a larger scope of "immediate" study then would be possible at the test site.

c. Information bearing on choice of materials to expose will become available prior to the second and third tests.

Shipping schedule (half to NRDL, half to ACC):

2 boxes - 2 hours post shot

2 boxes - 2 days post shot

4 boxes - 7 days post shot

Each box will measure 18" x 18" x 18" and will not be over 300 pounds in total weight. The radiation intensity will not be greater than 1 r/hr at one foot from surface.

3. None

C. <u>Sea Lift (Personnel)</u>

1. None

2. None

D. <u>Air Lift (Personnel)</u>

1. The following schedule is desired:

a. 7 men to arrive D - 7 days.

1 man to leave D + 2 hours.

1 man to leave D + 2 days.

1 man to leave D + 7 days.

b. 2 men to arrive E - 7 days.

1 man to leave E + 2 hours.

1 man to leave E + 2 days.

1 man to leave E + 7 days.

c. 2 men to arrive G - 7 days

1 man to leave G + 2 hours.

1 man to leave G + 2 days.

1 man to leave G + 7 days.

It is necessary for the above schedule to exist, in order that:

a. An average of four men will be at the test site until 2 days after any test.

b. Each air shipment be accompanied by one man.

[redacted]

the storage site, and the drone aircraft.

XII. Remarks by the Project Officer

The NRDL is incorporating all of its transportation and facilities requirements for Projects 6.4, 6.5, 6.7, and 6.8 under Project 6.7. Although two jeeps and one one-ton truck are not required for this specific project, the additional jeeps will be necessary to care for this project plus the transportation requirements of the remaining projects.

[redacted]

[redacted]
of ionization chambers with its associated recording equipment. In principle, the general procedure is the same as that applied to any rate or intensity meter of the recording type.

B. Detailed Description of Proposed Experiment

[redacted]
The details of the proposed experiment do not differ significantly from the discussion of Part I above.

[redacted]

A. General

The energy spectrum of the fission products at short times after detonation has been determined insofar as present data permit. If it is assumed that the ionization intensity in air is proportional to the total disintegration rate of the fission products at any time, the theoretical curve derived by Hunter and Ballou may be used to estimate the radiation intensity in the cloud at any given time after detonation. Further work on the measurement of both the beta and gamma spectrum of fission products between a few minutes to twenty-four hours is in progress at the NRDL under Problem Number 141. Similarly, the ionization intensity observed from mixed fission products uniformly spread over a surface are being measured with extrapolation chmabers as a part of Project 6.5. The existing knowledge of fission chains, their radiations, and the energies of these radiations are not known with any degree of certainty at the early times under consideration. This experiment will tend to correlate with and check the predictions based upon the existing Laboratory data.

IV. Personnel Requirements

A. Required at test site

1. Scientific personnel will be distributed as follows:

Officers	None
Enlisted Men	None
Civilians	Five

These men will be supplied by the NRDL and are presently employed by the Laboratory. Duties at the test site include checking the calibration and performance of the instruments, timing signals, relays, etc. They will also be responsible for removing the chart records from the drone aircraft, and making preliminary conversions of the observed time intensity data to geometric location with respect to the cloud versus distance form.

2. Technicians: None

3. Laborers, Unskilled Help: None anticipated as this experiment is

[redacted]

[redacted]

B. Project Work in Continental United States

1. Scientific personnel

Five electronic scientists, including two physicists and one electronics engineer and two laboratory mechanics, are employed full-time on the Project. These men are responsible for the development, checking, and calibration of the proposed instrument and its recording system, the construction of a prototype, and the development of specifications for the production of the twenty instruments required for the Project. No additional people are to be procured.

2. Technicians: None

V. Instrumentation and equipment requirements

A. Instruments and equipment required

The basic instruments required for this project are at present under construction at NRDL (high intensity instrument) and at the General Electric Corporation under contract to the Bureau of Aeronautics (low intensity instrument). The only additional instruments required for this project are standard electronic and circuit testing equipment.

B. The instruments will be produced and mounted in the drone aircraft in the Z.I.

C. Instrument assembly in the field: None

D. Calibrations:

Currents expected at various radiation rates will be simulated by the use of a high impedence current source. Linearity of the ion chamber, and particularly the response of the logarithmic recorder, will be rechecked just prior to the test. The equipment necessary for these calibrations include a Beckman ultrohmeter and a high impedence current source.

E. Protective equipment: None

VI. Present Status of equipment and instruments required

A. Percent of equipment already procured: 25%

B. Orders placed during the month: None

C. Orders to be placed during next month: None

[redacted]

[redacted]

D. Instruments yet to be developed: See paragraph E below

E. Instruments partially developed:

The ion chamber for the high intensity radiation detector is under development in NRDL. Time required for completion of a working prototype is approximately four months. It is expected that such a prototype will be ready for flight testing by 1 July 1950. There are no outside contractors or agencies involved in the development or procurement of this instrument except for certain components of the recording system. The development of the high intensity radiation detector began 15 August 1949 and is considered to be an entirely new design.

F. Commercially available equipment not yet procured or on order: None

G. Armed Forces equipment not yet obtained: None

H. It is planned that all of the high intensity radiation detectors will be constructed by the San Francisco Naval Shipyard. Time required will be approximately three months.
The KEVATRON, which will provide the high intensity radiation source required for the calibration of all radiac equipment used by the NRDL for the test is being constructed on funds provided through Project 6.5. It is under construction at the present time and should be completed on/about 1 July 1950.

I. Outstanding decisions to be made: None

VII. <u>Logistics</u>

A. <u>Sea Lift</u>

1. Four M/T to reach the forward area by D minus 30.

2. Approximately four M/T which may be started at D,E, or G plus 4 to 7, depending on the number of shots in which the instrument is used.

B. <u>Air Lift</u> - None

C. <u>Sea Lift (Personnel)</u>

1. Three to reach the forward area by D minus 30 days.

2. Three involved in roll-up to commence at D, E, or G plus 4 to 7.

[redacted]

[redacted]
tific Director.

B. ~~Dr. Paul [illegible]. Tompkins, Associate Scientific Director~~ Mr. George Koch, US NRDL, is the Project Officer responsible for this project. Further details on the experiment may be obtained.

X. <u>Funds</u>

This information is contained in fiscal chart, page 6-2.

XI. <u>Facilities</u>

No facilities other than those already prescribed in SD-1382, 9 March 1950, are required for this project. (See page 5-3). Transportation on Eniwetok is covered under the transportation requirements of Project 6.7.

XII. <u>Remarks by Project Officer</u> - None [redacted] by the use of expendable absorbent materials in the wash wheel to trap the contamination;

(f) The problem, and possible solutions thereto, of the disposal of contaminated waste water from the decontamination operations.

B. Application of the data

General.

1. The data developed will be applicable to both military and civil defense activities; it will provide information as to the offensive effectiveness of the induced and fall out radioactivity hazards of a low altitude burst of an atomic bomb with respect to the effectiveness of clothing materials and their decontaminability.

2. Protective Clothing Phase.

   Protective clothing may be required for damage control and rescue crews as well as for survey teams who must enter contaminated areas after a low burst, a surface or sub-surface burst, or an underwater burst, or an area heavily contaminated by fall out. Even though the clothing is not designed primarily to minimize radioactive contamination, knowledge of relative contaminability and decontaminability may be used in the selection between materials otherwise suitable for the general purposes for which worn, as for instance, firemen's clothing. The comparative economy and utility of reusable and "throwaway" types of protective items may be critical in supply of an important military operation, or in the disrupted economy of a city hit by an atomic bomb. The test data will indicate the types of materials which should be used in the manufacture of protective clothing which may be used in such conditions. The data developed will be complementary to that developed in the companion Decontamination Phase.

3. Decontamination Phase

   (a) The data as to the decontaminability of the clothing materials tested will support the protective clothing project in the selection of the optimum materials for the manufacture of protective clothing.

   (b) Reusable protective or other clothing worn by rescue and by damage control crews entering areas contaminated by an atomic bomb burst, as well as the clothing of survivors of such a burst will require decontamination as an economic necessity. It must be anticipated that an atomic bomb burst will destroy most stocks of clothing in the immediate vicinity of the burst, and that the supplies not so destroyed will be urgently needed for relief of the survivors. Furthermore, unless very inexpensive throw-away types of protective clothing for the use of rescue and of damage control crews can be developed, the cost of establishing adequate stocks of such protective clothing for all large centers regarded as probable primary targets for attack by atomic bomb would be prohibitive. It appears

[redacted]

that if they became contaminated beyond a "safe" level, they were disposed of.

(b) Decontamination Phase.

Investigation of radiological decontamination practice followe by the AEC Laboratories indicates that the problem was solved em- pirically as a plant service problem and that little or no theor- etrical basis exists for the choice of the formulas used. Furth more, the types of contamination in the AEC laboratories is not believed to be of the same nature as that which may be anticipat from an atomic bomb burst, particularly with reference to the pa iculate form in which the contaminating material may reach the clothing.

5. Continuing Program

The experiment, in both phases, is a part of a continuing program wh

[redacted]

includes protection from and decontamination from radioactive contamination from both atomic bomb burst and radiological warfare dissemination of radioactive particulates. Only as a result of an atomic bomb burst can fall out type contamination be obtained for evaluation of protective clothing and laundering decontamination of that type of contamination. Preliminary evaluation of equipment and formulas will be conducted by operations in the United States using contaminated clothing from one of the AEC laboratories. Further work will continue with radiological warfare agents.

II. Method.

A. General method

1. Protective Clothing Phase

(a) Items of protective clothing needed for wear by the personnel entering the contaminated areas will be manufactured of a selected variety of materials in both reusable and "throw-away" types. The items will be cross mated as to materials and issued in optimum variety of materials to personnel of each party entering the contaminated area after the burst. Protective items would be monitored upon removal by the personnel returning from the contaminated areas. Items will then be transported to the decontamination unit where those susceptible to decontamination will be processed through that operation. The susceptibility of the items to decontamination will be carefully determined by monitoring by appropriate means before and after decontamination operations.

2. Decontamination Phase

The specially trained QM Laundry detachment will operate the QM mobile laundry equipment, now being used at Eniwetok for the logistic support of the construction forces, and which will be replaced by permanent laundries, to decontaminate the launderable protective items worn into the contaminated areas, and if possible, the clothing worn by the drone aircraft handling and decontamination crews. The decontaminability of the clothing items, the contamination susceptibility of the laundering equipment, and its susceptibility to field decontamination procedures, and the problems of laundry waste water disposal would be evaluated and promising methods of solution tested. In the event that the burst conditions and the safety control of personnel entering the areas so reduce the contamination experienced, salvage clothing of various types will be deliberately contaminated and processed in decontamination. Operation at Eniwetok will also provide the variables of brackish water, and salt water for evaluation in the process.

[redacted]

[redacted]
methods for field use will similarly be studied for the non-decontaminable materials, and for materials which practical decontamination methods do not reduce to a safe level.

(e) Comparative decontaminability of the various materials will be evaluated in the decontamination phase. Items processed in decontamination will be issued for wear into the contaminated areas to determine the effects of decontamination on contaminability.

2. Decontamination Phase.

[redacted] explored. Removable accessory parts will be attached to washer cylinders, or into the shell for trial.

(f) The disposal of contaminated waste water will be evaluated as to the degree of hazard involved, and as to possible methods of handling the problem if it is found to be material.

1. The waste will be monitored as to the degree of activity.

2. The absorption or removal of the contaminats will be tested by the use of filter materials and if promising in laboratory tests, the ion exchange system, or by temporary storage in portable tanks, to permit treatment for precipitation or other means of concentration of the contaminats.

3. The methods of disposal of contaminated waste without any special treatment will be studied.

III. Details of Progress to Date in Experimental and Theoretical Work.

A. 1. The Chemical Corps, who carry the basic theoretical investigation phase of both phases of the experiment have explored the experience and especially the theoretical basis of the operations in the AEC laboratories. Having found only empirical solutions, and in the field of clothing, usage of standard laboratory and working garments,

[redacted]

they are considering the basic aspects of the two problems. Limited preliminary evaluation has unexpectedly indicated that a smooth filament yarn type of fabric showed a higher susceptibility to contamination with radioactive particulates than cotton fabrics.

2. Basic work in detergency is being reviewed and preparations are being made for comparing the detergent effectiveness of tentative formulae on the various types of materials being considered. Improvement of particulate removal from clothing is desired in order to shorten the formulas times now being used in the AEC laboratories.

3. A special QM laundry detachment has been authorized and is being manned. Four officers who have been assigned have completed the Radiological Defense course at the Chemical Corps School. Arrangements are being made for this detachment to operate experimentally at the Oak Ridge National Laboratory in the decontamination of laboratory clothing. The monitoring equipment calibration will be checked with the equipment in use at that laboratory.

4. The facts that existing decontamination procedures have been based upon emphirical derivations, and that waste disposal has been through sewage disposal systems including filter beds indicates the degree of lack of basic knowledge involved, especially those peculiar to field operations.

5. Decontamination by dry cleaning procedures in mobile equipment will be tested in preliminary work in the United States. If the results are sufficiently promising, a request for expansion of the test to include the use of such equipment may be initiated.

IV. Personnel Requirements

A. Required at Test Site.

1. Scientific Personnel

(a) One officer, Project Officer, to supervise the entire project operation at the site, on hand.

(b) One officer (or civilian), Decontamination Officer to supervise activities in laundry equipment decontamination and treatment and disposal of contaminated waste, on hand. (This position will be located with the decontamination operation at the site, or in the U.S., depending upon location of activity in the test.)

2. Technicians

[redacted]

(a) Protective Clothing Phase: Four technicians will be provided by QM laundry detachment already at the site.

1. One technician to supervise issue, monitoring, and recording of use of protective items and clothing.

2. Two clothing monitors and one recorder for storage, handling, issue, receipt, monitoring and disposal of protective items and clothing.

(b) Decontamination Phase.

1. QM Laundry detachment, 4 officers and 12 enlisted men, which includes three men listed in IV A 2a(2) above. Depending upon the phasing out and return movement of the construction support phase at Eniwetok, it may be possible to utilize six men of appropriate categories already at the test site.

(c) In summary, the personnel requirements are:

2 Scientific personnel
16 Laundry Det. (may require movement of only 10).

3. Laborers - only as included in laundry detachment, as semi-skilled personnel.

B. Project Work in Continental United States.

1. Scientific Personnel.

Basic work preparatory to and supporting this project is being carried extensively by personnel operating in closely related fields. That personnel is on hand and will continue to work in the general field through the period of the test. Two of the personnel on hand are listed above for participation at the site.

2. Technicians. Technicians involved are supporting the basic work in conjunction with related work in closely allied fields. If the decontamination operation must be performed in the United States, then 24 persons will be required to operate in the decontamination phase of the project.

V. Instrumentation and Equipment Requirements.

A. Instruments and Equipment required.
Protective bootees, test
Protective gloves, test
Clothing, fatigue, test

Clothing monitoring equipment
Equipment monitoring equipment
Water monitoring equipment
Laundry, Semi-trailer, 2-wheel, van type
Unit, dry cleaning - laundry, mobile (U.S. Operation only)
Accessory laundry detachment equipment
Tanks, water, collapsible
Salt water conversion unit, if available
Ion exchange water decontamination unit, if available
Salvage clothing, 2 bales

B. Instruments and equipment assembly.

Assembly of all test items equipment and instruments can be made in the U.S. The laundry semi-trailer, 2-wheel, van type will be available at the test site.

C. Test site assembly.
None.

D. Test site calibrations.

The monitoring equipment will be calibrated to a standard source.

E. Protective equipment or construction.
None.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment.

A. Percent of equipment already procured.

1. None of the protective clothing items have been fabricated. The standard fatigue clothing type will be available from stock. Materials for most special items are available in stock and require fabrication only into the adopted designs.

2. Two clothing monitoring units are available. Two additional ones will be required if decontamination must be operated in the United States.

3. Standard types of equipment monitoring equipment will be used, and is available.

4. Water monitoring equipment and methods are under development.

5. Laundry equipment is en route to, or at Eniwetok. Similar equipment is available for immediate issue for operation in the United States.

6. Unit, dry cleaning-laundry, mobile is hard.

7. Accessory equipment and tanks are available for immediate issue.

8. Salt water conversion unit and Ion Exchange water decontamination unit are under development.

9. Salvage clothing is immediately available.

B. No orders placed during month.

C. Very limited orders to be placed.

D. Monitoring equipment is being developed by the Chemical Corps. Salt Water conversion unit is being developed by Corps of Engineers for other purposes. Status of ion exchange decontamination unit is undetermined.

E. Partially developed. Selection of materials for protective clothing is being studied. No contractors will be involved.

F. No commercially available equipment not yet procured or on order.

G. Armed Forces equipment not yet obtained, see A above.

H. See VI A 4 above.

I. Utilization of the salt water conversion unit will depend upon the availability of sweet water from other sources. Utilization of the Ion Exchange unit depends upon its degree of development, availability, and if available, results of preliminary testing.

VII. Logistics

1. Estimated maximum of 5 measurement tons of equipment and instruments, other than protective items and clothing which replace like quantities otherwise required to be shipped. Shipment should reach area by at latest D-10.

2. Estimated maximum of 2 measurement tons roll up to return instrument. Equipment will be expended, or will be turned over to Logistics support group for disposal. Return can be made approximately G + 21.

B. Air Lift.

1. None to forward area.

2. All material can be returned by sea lift.

[redacted]

X. Funds. This information is contained in fiscal chart, page 6-2.

XI. Facilities

A. Power. Power requirements for lighting only will be required. Power for the laundry equipment will be furnished by mobile generator.

B. Communications

1. No timing signals will be required.

2. No special communications will be required.

C. Laboratory Space and Other Facilities included in estimates for projects 6.6 and 6.7.

[redacted]

[redacted]

D. Forward Area Transportation .

Depending upon the locations of facilities in the base area one jeep (T K 3/4 T) or one truck 3/4 ton will be required to transport protective items and clothing and operating supplies between storage, laundry, air strip, and change houses.

[redacted]

[redacted]

I. Object of this Experiment:

The object of this experiment is to determine the efficiency of collective protective equipment in preventing the entrance of radioactive contaminants into a shelter. An important phase of this experiment is the evaluation of an anti-blast closure for the protection of the particulate filter components during the extreme thermal and pressure conditions of an atomic detonation. These data will supplement data previously obtained using chemical and biological agents, and will afford a basis for continuing development work in this field.

A. Data to be obtained:

1. Radiological.

a. Radioactive penetration through the collective protector as a function of time.

b. Total activity from radioactive particulates within shelter.

c. Total activity retained by the collective protector.

2. Pressure.

a. Pressure as a function of time, both outside and within the shelter.

b. Peak pressures on interior side of each anti-blast device. (A series of these devices to be located at various distances from zero point.)

B. Application of Data:

Information on penetration of radioactive particulates matter into a protected shelter due to an atomic detonation is necessary to supplement and complete previous Chemical Corps work on protected shelters. Extensive laboratory and field work have provided data in the evaluation of protective shelter methods and equipment against chemical and biological agents. No performance data has been obtained during the conditions of an atomic explosion. This is part of a continuing program in the field of collective protection.

[redacted]

[redacted]

[redacted]

II. Method:

A. General.

The experiment is essentially a test of two items of equipment; the Field Collective Protector, E24R4, and an anti-blast closure. The field collective protector will be installed in a reinforced concrete structure, constructed by the Corps of Engineers. The shelter will be equipped with air locks containing Chemical Corps regulating valves together with anti-blast closures at the air intake and exhaust. The collective protector will be placed in operation before the blast. Performance of the protective equipment will be assayed by air flow, pressure, and radiometric instrumentation.

Anti-blast closures will be installed at a series of distances from zero point to a distance of 3500 feet. The protected side of each closure will be instrumented to indicate peak pressure. This phase of the test will determine if particulate filters, (bursting pressure 7 pounds per sq. inch.), can be protected by the use of this closure device at each distance from zero point.

B. Detailed Description of Experiment:

1. Shelter Phase.

The collective protector will be installed in the shelter, air lock regulating valves and air flow will be adjusted to obtain the required positive pressure within the shelter. The anti-blast closure at the shelter air intake and exhaust will be closed preceding the blast. A timing device will be used to operate a solenoid reopening the shelter anti-blast closures at zero + 1 Minute. Pressure instrumentation will be provided by the Corps of Engineers to give continuous pressure readings inside and outside the shelter.

A continuing sample of the collective protector effluent will be drawn past a beta sensitive tube, shielded from gamma radiation, which is attached to a counting rate meter and recorder to provide a permanent record of the activity in this air stream. Air samples from various points within the shelter will be drawn through suitable Chemical Corps filters to provide a measure of total activity within the shelter. The total activity removed by the collective protector will be measured by monitoring the filter units of the protector following the blast. No attempt is being made to obtain a continuous measurement of activity on the influent air stream due to the inherent fragility of G.M. tubes and because ion chamber instruments do not provide a good beta count.

The instruments and collective protector will be powered from the normal atoll power source, 110 volts AC, 60 cycles. An emergency power supply consisting of a gasoline or diesel-operated AC generator will be

[redacted]

[redacted] be used to measure peak pressure in the surge chamber of each anti-blast closure.

Radiometric instrumentation is fairly well established as to equipment and method of sampling.

There have been no changes from the basic information sought in the original program outline.

[redacted]

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[redacted]

A 2. Necessity for this Experiment:

The blast closure will be evaluated on the Shock Tube Tester at Aberdeen Proving Ground within the pressure limitations of this equipment. However, a full range of pressure and thermal conditions cannot be smulated except by the proposed experiment.

Collective protector filters, (particulate), have been evaluated against chemical, biological agents, and partially against radioactive materials. Investigative work has been planned to complete radioactive evaluation so that the equipment will fulfill the military requirement of ABC protection. This experiment is a vital part of this evaluation. In addition, the test will offer an opportunity to determine the hazard of penetration of filters by radioactive gases which decay to particulates. Furthermore, it will enable the determination of any special problems engendered by the thermal and pressure effects of an atomic bomb detonation.

IV. Personnel Requirements:

A. Scientific Personnel and Technicians - Organization Furnishing.

Officer - 0	Not applicable
Enlisted-0	Not applicable
Civilian-2	Chemical Corps

B. Duties.

1. 1 Civilian - To supervise the installation of Chemical Corps equipment, and to assume responsibility for the operation of the protective shelter during test. To obtain the required data and prepare subsequent reports.

2. 1 Civilian - To assist in equipment installation, and in all phases, of test preparation, as well as test operations.

3. Laborers and Unskilled Help.

a. Laborers required - two (2) (to be procured) for field installation of anti-blast closures: 48 man hours required.

b. Laborers required - two (2) - Corps of Engineers for test site installation of Chemical Corps protective equipment within the shelter. 112 man hours required. (Corps of Engineers has agreed to complete physical installation of equipment).

C. Project Work in Continental United States.

1. Scientific Personnel.

a. Officers - 0
Enlisted - 0
Civilian - 3

[redacted]

[redacted]

2. Duties.

1 Civilian - Project Officer
1 Civilian - Design of anti-blast closures.
1 Civilian - Test operations of anti-blast closures.

3. Technicians (None).

a. No additional requirements.

V. Instrumentation and Equipment Requirements:

A. Instruments and Equipment required for Test.

1. Collective Protectors, E24R4, with hoses	-	2 ea
2. Spare parts kits for above	-	2 ea
3. Air regulating valves, M1	-	3 ea
4. G.M. Tubes	-	6 ea
5. Esterline Angus Recorder	-	2 ea
6. Counting Rate Meter	-	2 ea
7. Anti-blast closure,(field installation), with surge tank	-	10 ea
8. Anti-blast closure(shelter), with surge tank and with solenoid	-	4 ea.
9. Emergency power supply,(gasoline or diesel-operated electric generator), and spare parts	-	1 ea
10. Floater valve or automatic relay	-	2 ea
11. Ammeter	-	2 ea
12. Vacuum pump for penetration sampling	-	1 ea
13. Shielding material (lead bricks)	-	20 ea
14. Pitot tube	-	1 ea
15. Draft gauge	-	2 ea

B. All instruments and equipment can be assembled in ZI.

C. Justification for Instrument Assembly or Construction at Site.

Not applicable.

D. Calibrations Required on Test Site.

1. Collective protector air flow and shelter pressure measurements.

(a) Equipment required.

1. Pitot tube, rubber tubing, 3" draft gauge and water manometer.

[redacted]

2. Calibration of radiometric instruments.

E. Protection or Construction Required for Instruments and Locations.

1. Shelter - installation of Chemical Corps regulating valves anti-blast closure, etc., located in Corps of Engineers reinforced concrete structure. Field installation of anti-blast closures at 70, 300, 800, and 1150 yards from zero point (3' x 3' x 3' hole at each location).

2. Drawings have not been completed.

VI. Present Status of Equipment and Instruments required for Experiment:

A. Percent of Equipment Already Procured.

1. Zero

B. Orders Placed During Month.

1. None

C. Orders to be Placed:

	Item	Expected Date of Order	Vendor	Desired Delivery Date
1.	Collective Protectors & Spare Parts.	1 July 1950	Cml C	15 Oct 1950
2.	Air Regulating Valves, M1	1July 1950	Cml C	15 Oct 1950
3.	G.M. Tubes	1 June 1950	Radiation Counter Lab.	15 Oct 1950
4.	Esterline Angus Recorders	1 June 1950	Esterline Angus Co. Inc.	15 Oct 1950
5.	Counting Rate Meters	1 June 1950	General Radio Co.	15 Oct 1950
6.	Blast Closures with Surge Tanks (field)	1 Sep 1950	Cml C	1 Nov 1950
7.	Blast Closures with Surge Tanks (shelter)	1 Sep 1950	Cml C	1 Nov 1950
8.	Emergency Power Supply	1 July 1950	U.S. Motor Corp.	15 Oct 1950
9.	Automatic Relays	1 June 1950	Mercoid Corp.	15 Oct 1950
10.	Ammeters	1 July 1950	Western Electric Co.	15 Oct 1950
11.	Vacuum Pump	1 July 1950	Gast Mfg. Co.	15 Oct 1950
12.	Shielding Material	1 July 1950	Tracer Lab.	15 Oct 1950
13.	Pitot Tube	1 July 1950	Industrial Engr.	15 Oct 1950
14.	Draft Gauges	1 July 1950	Ellison Draft Gauge Co.	15 Oct 1950

D. Items yet to be Developed.

1. None.

[redacted]

7.	Vacuum Pump	Gast Mfg. Co.	3 months
8.	Shielding Material	Tracer Lab.	1 month
9.	Pitot Tube	Industrial Engr. Instrument Co.	2 months
10.	Draft Gauges	Ellison Draft Gauge Co.	3 months

G. Armed Forces Equipment Required.

1. None, with the exception of Chemical Corps items.

H. Equipment to be Built by Shops of the Experimental Group.

Item	Estimated of Construction Time
1. Collective Protectors, E24R4	2 months
2. Air Regulating Valves, M1	2 months
3. Anti-blast Closure (field)	2 months
4. Anti-blast Closure (shelter)	2 months

I. No Requirements.

VII. Logistics:

A. Sea Lift.

1. Total weight of equipment in measured tons:

$5\frac{1}{2}$ measurement tons. Must reach forward area four weeks prior to test.

2. Roll-up Tonnage of equipment:

$4\frac{1}{2}$ measurement tons. Return shipment to be at convenience of Task Force.

[redacted]

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B. <u>Air Lift</u>.

1. No Requirements.

2. 100 pounds to Army Chemical Center, Maryland. Shipment will consist of filter units containing particulates and are to be subjected to laboratory analysis for particle size and composition.

3. Other items to be returned by air lift:

None.

C & D. <u>Sea Lift or Air Lift Personnel (Task Force Convenience)</u>.

1 & 2. Two (2) persons to arrive at test site three (3) weeks prior to test and return two (2) weeks following test.

E. Not applicable.

VIII. <u>Collaboration</u>:

Dr. C.W. Lampson, BRL, Aberdeen Proving Ground is collaborating with this agency in the anti-blast closure design and test work.

The Corps of Engineers are constructing the shelter for the collective protector installation as well as instrumenting the structure for pressure measurements.

IX. <u>Responsibility</u>:

A. Protective Division, Technical Command, Army Chemical Center, Maryland, is the agency responsible for accomplishing the test program.

B. Project Officer: Mr. Frank G. Ort ~~Bertram L. Karpel~~, ~~Protective Division~~, ~~Technical Command~~, Army Chemical Center, Maryland.

X. <u>Funds</u>:

This information is contained in fiscal chart, page 6-2.

XI. <u>Facilities</u>:

A. <u>Electric Power</u> - 20 Amperes at 110 volts AC 60 cycle to be supplied to protective shelter.

B. <u>Communication</u>

1. Timing signals included in requirements of 3.1.3.
2. No special requirements.

[redacted]

C. Laboratory Space.

1. Space for measuring penetration radioactivity on filter material samples (space 50 sq. ft.). Requirement will be met by portion of buildings 117A and 117B.

2. Storage space for unused equipment at each test.

a. Unused collective protector equipment and spare parts. 20 cubic feet.

b. Unused radiometric equipment - 10 cubic ft.
c. Unused closures - 10 cubic ft.
d. Miscellaneous - 10 cubic ft.

3. No requirements for other service.

D. Forward Area Transportation Required.

1. One (1) Jeep with trailer.

a. This vehicle is required because of the bulk and weight of the equipment involved in this experiment. Transportation of this is necessary for movement of equipment to and from the test shelter. Field installation of the anti-blast closures will require mechanical transportation to each installation point.

XII. Remarks:

1. None.

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LAB-J-923

PROGRAM 7

LONG RANGE DETECTION

Program Director - Dr. Donald H. Rock, AFOAT-1, USAF.

Project Officers - 7.1 - Dr. William D. Urry - AFOAT-1

7.2 - Mr. George B. Olmsted - AFOAT-1

7.3 - Mr. Phillip W. Allen - AFOAT-1

7.4 - Dr. William D. Urry - AFOAT-1

7.5 - Dr. William D. Urry - AFOAT-1

7.6 - Dr. Herbert Friedman - NRL

7.7 - Mr. J. Allen Crocker - AFOAT-1

7.8 - Dr. William D. Urry - AFOAT-1

LASL Liaison - LT Dick G. Wilson, USN

Note: The outline of Program 7 will be superceded in the near future by a detailed proposal.

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LAB-J-724

PROJECT 7.1

RADIOCHEMICAL, CHEMICAL AND PHYSICAL STUDIES OF ATOMIC BOMB DEBRIS

I. Object of the Experiment

A. This project is designed to provide knowledge of all the parameters required to evaluate the significance of radiochemical, chemical and physical studies of atomic bomb debris captured in small amounts at great distances from foreign explosions. As a result of continuous researches since the 1948 tests, these parameters are well defined and some are reasonably well established. Certain measurements must be made on atomic bomb explosions for confirmation, others can only be made at the time of an atomic bomb explosion with full knowledge of the weapon data and conditions of the explosion.

B. Technical Objectives:

1. Calibrations for certain fission product ratios for fission bomb neutron energies.

2. Relation between fission product yields, type of fissionable material and neutron energy.

3. Comparison of fission product ratios for bombs and fast reactor; estimate of bomb neutron spectrum.

4. Determination of possible fractionation of fission products and fissionable material in the original cloud.

5. Evaluation of estimates of total energy as determined from capture to fission ratio and tamper content of debris.

6. More information on relation between particle size and the conditions of an atomic bomb explosion.

7. Effect of different types of carrier material on properties of the debris and any influence on radiochemical and other analyses.

8. Effect of small proportions of large particles on estimate of total activity from distant measurements and on radiochemical and other analyses.

9. Estimation of total energy from specific activity and tamper content of the debris.

10. Feasibility and accuracy of all newly developed analytical techniques for:

a. Fission product and neptunium analyses.

[redacted]

[redacted]

[redacted]

b. Alpha-partical emitters.

c. Ultra-microchemical analyses of the debris.

d. Physical properties of particles.

[redacted]

[redacted] ives of the experiment are:

1. To establish the change in character of acoustic signal with distance from the blast.

2. To establish the existence of directional effects in propagation to long distances from large explosions.

3. To compare the effectiveness of several types of acoustic equipment during actual field test.

4. To establish, if possible, the correlation between infrasonic wave propagation to long distances from large explosions and infrasonic wave propagation to short distances from small explosions.

5. To establish the optimum characteristics to be desired in acoustic detection equipment. (Frequency range, maximum sensitivity, etc.)

6. To establish the effect of meteorological conditions on the accuracy of azimuth determination at considerable distance from the blast.

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LAB-J-926

PROJECT 7.3

LOCATION OF A-BOMB CLOUD BY OBSERVATION OF AIR CURRENTS

I. Object of the Experiment

A. Upper-air weather observation stations will be established, in addition to those in permanent operation, improving the coverage of meteorological data over the areas of LRD operation. These data will be analyzed and correlated with radiological observations:

1. To study the rates of diffusion and settling of particles.

2. To test cloud tracking and forecasting techniques.

3. To facilitate the collection of samples of debris at great distances, and to determine the extent to which GREENHOUSE particles will be collected in the routine operation of the present atomic detection system.

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disposition of the bomb debris as related to particle size can be ascertained with the proposed, relatively light, flight schedule.

B. Technical Objectives:

1. Supply filter samples of airborne atomic bomb debris taken under specified conditions in support of Project 7.1.

2. Obtain filter samples of airborne atomic bomb debris as a means of detecting the transport of the debris in the atmosphere and for determination of particle size as a function of the distance and vertical disposition. Particle size will be determined under Project 7.1.

3. Test a large "super-sampler" filter unit designed to provide a sufficiently large sample for analysis in the event that only very low concentrations of atomic bomb debris are available in the atmosphere.

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LAB-J-928

PROJECT 7.5

INSTANTANEOUS DETECTION OF ATOMIC BOMB DEBRIS BY BALLOON-BORNE DETECTORS

I. Object of the Experiment

A. Determine the feasibility of measuring at long range, the concentration of atomic bomb debris continuously from ground level to 90,000 feet.

B. Ascertain the reliability of counter equipment developed for balloon-borne instrumentation in detecting and measuring the concentration of widely dispersed atomic bomb debris.

C. Obtain a vertical profile of the distribution of atomic bomb debris from Eniwetok at four key locations for correlation with objective described under A1b. and A2b. under Project 7.4

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ibration of results which might obtain at various distances from the site of future atomic explosions of unknown origin.

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LAB-J-930

PROJECT 7.7

SEISMIC WAVE PROPAGATION STUDIES

I. Object of the Experiment

A. To establish criteria for distinguishing between an earthquake and an atomic explosion; to clarify the limits on range at which seismic observations may be made and to ascertain the effectiveness at long range of seismic methods in determining accurately the time, place, nature, and magnitude of an A-bomb explosion in order that the seismic component of the atomic detection system may be evaluated in the light of the I.O.7 objective.

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LAB-J-931

PROJECT 7.8

DETECTION OF A-BOMB DEBRIS BY ATMOSPHERIC CONDUCTIVITY

I. Object of the Experiment

A. Locate particular sources of atomic bomb debris in the vicinity of the site as an aid to collection of specific samples as follows:

1. Fall-out below the cloud.

2. Fringes of the easterly moving cloud shortly after formation.

3. After cloud becomes invisible but before it is widely dispersed.

B. Determine the feasibility of detecting the presence of atomic bomb debris instantaneously in an aircraft at great distance with atmospheric conductivity apparatus.

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LAB-J-932

PROGRAM 8 This documen[redacted]s

EFFECTS OF AIRCRAFT [redacted]

Program Director - Col. Robert E. Jarmon, USAF - J-10, LASL

Technical Advisor to Program Director - Mr. J. Kelley, Jr. - AMC

Project Officers - 8.1 - Mr. J. C. Wayne - AMC

8.2 - Phase A - Aircraft Panels - Mr. D. L. Grimes - AMC

Phase B - Pressure-time-distance measurements (Buck Gage) - Lt. Cdr. John E. Kirk - LASL

In Program 8, Projects 8.1 and 8.2 are complimentary as they both deal with blast effects on aircraft structures and both are required to verify or properly modify theoretical studies being conducted at present. In view of this an overall scope and objective is included for program 8 as well as detailed proposals for projects 8.1 and 8.2.

This program was drawn up by the Air Force in collaboration with AEC (LASL); however, the data that will be obtained are of real value to all the services and will be made available to them. It is of vital importance to the Air Force as it will give data on safety of the atomic bomb carrier in actual operation as well as design criteria for future airplanes. These data may well dictate new delivery techniques as blast yields of atomic bombs are increased. The airplanes for this program are carrying equipments or specimens for Programs 1, 2, 4, 5, 6, and 8.

In Phase B of 8.2 information is also being obtained for pressure-time-distance curves which are a definite requirement. Please note that Phase A and Phase B of project 8.2 are separated for sake of continuity.

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PROGRAM 8

I. Object of the Experiment

The technical objective of Program 8 is to synthesize structural design requirements which may be used by the Department of Defense in the design of future atomic air weapons. The operational objective is to gather and otherwise collect data on atomic explosions in the field of interest to the Air Force which may serve as a basis for the structural design requirements established in the broader technical objective set forth above. More generally, the objective is to learn as much as possible about the mechanism of blast resulting from atomic explosions so that the yet unanswered questions which are vitally important to Air Force strategic planners may be dealt with.

A. The data to be obtained will be measured in the air and on the ground in projects 8.1 and 8.2, respectively. These projects are described in detail in their respective reports.

B. The data collected in the forthcoming tests, both in the air and on the ground, will be utilized to the fullest in correlation studies to verify the theoretical work which will run concurrently with and continue after the subject tests. It is intended that the studies and experimental investigations directed toward the complete analysis of the response of an aircraft to a blast loading will continue long after the 1951 tests are completed. The complexity of the problem involved and the continuous and rapid change of the weapon development programs require that this project be a continuous one. It is believed that the results of this collective study, together with the assembled data, will profoundly affect the course of strategic thinking in the Department of Defense where the optimum utilization of atomic and thermonuclear weapons is concerned.

II. Method

A. The following is a general description of the various phases of work which is proceeding now or will be undertaken in the near future under Air Force Contract AF 33(038)-8906 at the Massachusetts Institute of Technology.

1. A complete bibliography will be compiled of the theoretical and experimental research in those parts of the fields of structural dynamics, aero-elasticity, compressible flow aerodynamics and blast phenomena which may pertain directly to this problem. This bibliography will also include complete and thorough presentations of all data accumulated not only from previous atomic tests but from Operation Greenhouse as well. It is anticipated that this document will be made as complete as possible to insure that the foundations so necessary to fundamental research studies are adequately documented.

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2. An accelerated study of the entire problem will be conducted with the objective of specifying completely and clearly the characteristics of the external loading and of the aircraft itself which would need to be measured in full scale flight and ground research. Since very little change could be accomplished when the instrumentation designs became frozen, these preliminary studies were given a high priority so that pertinent decisions could be made at the earliest possible date regarding the entities to be measured.

3. This phase will entail a study directed toward the establishment of some acceptable external pressure loading criteria. It is realized that a complete study of the physics of the external pressure-velocity loading must be conducted in order to arrive at acceptable criteria. This part of the problem will require continuous development, refinement, and very extensive coordination with the Air Materiel Command and other agencies up to the time of the tests.

4. This phase of the theoretical studies will run concurrently with Phase C and will be mainly directed toward a comprehensive dynamic stress analysis in a way which will permit easy prediction of changes in the stress and deflection patterns in the structure of the drones if and when it becomes necessary to make changes in the external pressure loadings. These changes may arise as a result of changes of the position of the aircraft in the field of disturbance or changes in the intensity of the disturbance itself. In addition, the concurrent study in Phase C can be expected to yield an improved knowledge of the characteristics of the disturbance as the investigation progresses, and hence it will be desirable to change the dynamic stress analysis to incorporate such improvements.

5. This phase of the work will begin after the tests have been completed. It will concern itself with the data reduction of all pertinent entities measured both in the flight and ground program. A careful study and evaluation of all results will be undertaken together with a correlation of all test results with theoretical methods. This phase of the task will bind together all of the previous work on the project and will form the basis for the design criteria.

6. This phase will be concerned with the formulation of specific overall design criteria for present and future military aircraft, and will be based on the results and conclusions of Phase E. A design criteria will be written upon which the Strategic Air Command will formulate air tactics and techniques and the Air Materiel Command will base their approvals of the structural integrity of all future air weapons.

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Phases 1 through 4, inclusive, come within the limitations of the work which can be completed at the present expenditure of effort prior to the 1951 test. Phases 5 and 6 are to be carried out after the tests are completed.

B. The details of the proposed experiments to be run in the air and on the ground are discussed at great length in the program reports of Project 8.1 and 8.2, respectively.

C. A disturbed airplane must be treated as an elastic body which vibrates freely. At present reliable theories are being developed which can be used to predict the dynamic stresses in airplane structures subjected to rapidly varying external loads. These loads are directly a function of the yield of the weapon under test and therefore the placement of the drone aircraft at zero time is very much a function of the expected yield. In this case, the location of the drone aircraft for any of the shots will be made on the basis of maximum expected yield values.

III. Details of Progress to Date in Experimental and Theoretical Work

A. Very little experimental and theoretical work have been done in the past which can have an important bearing upon the problem of "aircraft response to a blast loading." Eight atomic bombs have been exploded, but very little data, of use in the solution of the dynamic stress analysis problem, have been collected. Research at the Massachusetts Institute of Technology is now being conducted under AF contract. Certain phases will be completed prior to the 1951 test. They involve the calculation of the complete elastic and inertial properties of the aircraft to be used in the 1951 test and the formulation of satisfactory theories to predict the dynamic stresses arising from the rapidly changing external loads. This structural problem, naturally, is coupled with a study of the theoretical methods and experimental data for predicting the mechanisms of the free air pressure-time history for a given weapon yield. Because of the sparseness of reliable experimental data collected in previous tests, this has proved to be a more difficult problem than heretofore contemplated. A second and related problem entails the determination of the effect of traveling pressure waves in the atmosphere in producing forces and moments on the aircraft lifting surfaces. This is an extremely complex theoretical problem not only in non-stationary aerodynamics, but also in the dynamic stability of elastic aircraft. Theoretical methods are necessary to treat this problem since no experimental techniques are available other than a test involving a full scale atomic explosion. Finally and most important will be a thorough comparison of the computed dynamic stresses to the allowable design stresses of the aircraft which will not only indicate the severity of the loading but also will designate the positions in space that can be occupied by test aircraft in the 1951 test. It has already become evident that the lack of reliable experimental data from previous tests will make it difficult to position aircraft in the test with certainty. It is almost certain that these data are too meager to form the basis for a reliable structural design criteria for future weapons and weapon carriers. It is, therefore, extremely essential that proper experimental data be obtained in

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the structural basis in the drone aircraft will provide an indication of the accuracy of the proposed methods of analysis, and, it is hoped, will point means of improvement of the theory. Data of a general nature must be pooled with data previously obtained in an effort to improve our position concerning the knowledge of the mechanism of blast wave propagation. Finally, when it has been established that a reasonable understanding of the principle physical phenomena has been attained, studies aimed at the formulation blast loads and structural design criteria can then be undertaken.

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Program 8 Project No. and Title	Activity (Service)	F[redacted]L YEAR 1950			FISCAL YEAR 1951			Total Estimated Cost	Total Funds Available	Total Funds Required from JTF-3
		Estimated Cost	Deptm'tal(1) or AEC(2) Funds Available	Funds Required from JTF-3	Estimated Cost	Deptm'tal(1) or AEC(2) Funds Available	Funds Required from JTF-3			
8.1 Test of Aircraft Airborne	AMC (AF)	3,672,273	3,658,063(1)	14,210	451,289	218,404(1)	132,885	4,123,562	3,876,467	147,095
8.2 Static Tests of Aircraft Panels	AMC (AF)	407,075	0	407,075*	79,570	0	79,570	486,645	0	486,645
	TOTAL	4,079,348	3,658,063	421,285	530,859	218,404	212,455	4,610,207	3,876,467	633,740

*This includes $84,975 for on-site construction to be directed from JTF-3 funds to H & N (AEC Contractors)

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LAB-J-933

This [redacted]
No. [redacted]

TEST PROPOSAL

PROJECT 8.1

Test of Aircraft Airborne

I. Object of the Experiment.

A. The data to be obtained from these tests concern the nature and magnitude of the loads and forces induced in aircraft structures in flight when adjacent to an atomic explosion.

B. The measured data will be applied to a theoretical analysis thus to derive a verified or corrected theory of the loading encountered by a airplane in the presence of a blast wave. Such a theory will then define the safety limits for airplanes used in the tactical employment of violent explosives. By defining the nature of the airplane loading, the theory should suggest tactical employment or deployment of current airplanes to avoid critical or dangerous loading while making optimum use of the explosive. Further, the theory should identify the necessary modifications to existing structural design criteria to include such operations as part of the mission for which future military airplanes are designed. This type of theory will be of continuing value in the further exploitation and development of Air Force vehicles.

II. Method

A. The general purpose of Project 8.1 will consist of the measurement of the induced loads; such as increased lift, structural strains in the wings, and the dynamic response of the complete airplane in the presence of the blast wave. The complete problem is divided into two parts. The first part will consist of a theoretical analysis and the second part will consist of a proof of that analysis by actual measurements. The theoretical analysis will incorporate a generalized evaluation of the blast wave, the generalized effect of the blast on the stability and load parameters of the airplane, and a detailed analysis of the structural loads to be expected on the specific airplanes to be used on these tests. This analysis is being performed under Engineering Division Project MX1452. The measurements from Project 8.1 will be made at specific points in the air space around the blast. Since it is necessary for the completed theory to apply to airplanes anywhere in the air space around the blast and in any practical flight altitude, a great number of data points are required to substantiate the theoretical analysis.

B. In order to attain this generalization it is planned to select seven points from each test at which the induced loads will be measured. These points will be carefully selected in accordance with the theoretical analyses prior to the test. Specifically, the points will include two at which the airplane structures should be stressed to limit loads. Two more points will be selected at which airplane stresses should approach, but not reach, limit values. These four data points, for purposes of reference termed "critical" points, will be occupied by drone

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[redacted] er distances at the time of the blast and that the data to be thus collected will be considerably lower in magnitude, such data will provide additional points of information and will be useful for extending the theoretical analysis to extremely safe locations.

C. A yield higher than that predicted may cause the loss of one or more of the critical drones but this possibility should not eliminate the Air Force test

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celeration measurements were made on a few of the "Crossroad" drones by means of the Flight Analyzer. This instrument consists of a mechanical accelerometer of very low response frequency supplemented by air speed and altitude records. The low frequency response of this instrument prohibits any detailed analysis of these data to determine structural loads. Oscillograph records of wing loads, and airplane accelerations were made on three test airplanes on operation "Sandstone". The data collected from these airplanes provide a measure of the loads experienced by a particular airplane at a particular location with respect to the blast. However, the data cannot be generalized to a sufficient extent to assist materially the perfection of the theory. The data do indicate, however, the nature of the problem and provide three check points for the development of the theory. Further, these data will indicate the techniques to be followed in collecting information from the forthcoming tests. The theoretical work involved in the present project is being performed by the Massachusetts Institute of Technology. Certain

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fundamental data with regard to the blast will be necessary in order to provide a basis for the theoretical analyses. Such data will include the expected intensity of the blast, approximation of the shape of the present-time curve in the wave, the character of the wave propagation, the attenuation or intensification of the pressures by atmospheric conditions, and various reflection effects in the blast wave. These data must be supplemented by information concerning the airplane structures and their dynamics. These data are being assembled by the Massachusetts Institute of Technology and will be evaluated to determine what additional information may be required.

IV. Personnel Requirements.

A. Required at Test Site

The personnel to be required at the test site for this project will be essentially for two purposes. The first purpose and the largest group of personnel will be for the maintenance and operation of the recording equipment. The other group will supervise the project, assist with calibrations, and perform a preliminary reduction and analysis of the data as they are collected in order that the location of both the test auxiliary airplanes and the safety of the crews involved may be the best obtainable.

1. Instrumentation Personnel - An organization is being arranged with the 550th Guided Missiles Wing for the purpose of maintaining and operating the instrumentation. It is presently planned that this group will include one officer and twenty-four airmen. This group will be trained in the operation and maintenance of the equipment and will make the preliminary installations and calibrations in this country. It is intended that this group will operate and maintain the instruments in both the drone and the "manned" aircraft. In order to implement this requirement it will be necessary to assign a few members of this group to airplanes which will be based at Kwajalein. Advisory and assisting personnel for this group will need to be assigned from the Air Material Command or from its contractors. It is estimated that two Air Material Command personnel and three contractor's personnel will be working with this group for advice and assistance in their operations. In the organization plan of the Task Force the precise arrangement of these personnel is not immediately obvious. Because of problems of integrating the maintenance of the instruments with the training and "checkout" operations of the airplanes, crews, and radio control equipment, it is believed to be most expeditious to maintain the assignment of this group to the same operational organization which is responsible for the operation of the drones. Although the personnel are not to be directly assigned to Project 8.1, the function will be closely allied and close liaison will be required.

2. Project 8.1 Personnel - These personnel will be required to work very closely with the instrumentation personnel on decisions regarding the proper utilization of the instruments and on the removal of the data from the airplanes after the completion of each test. The data will then be integrated into the theoretical analysis to determine the appropriateness of the data and of the installation of the measuring instruments. As the test progresses the reliability

of the theoretical analysis should be improved and proven so that the locations of the test aircraft should be more precise for each succeeding test. Specifically the personnel on this project will include:

a. Jay C. Wayne, Mr. USAF AMC D-45
(Project Officer for entire Project 8.1)

He will be responsible for Project 8.1 which includes the preparation of plans and arrangements for the execution of the project in accordance with the policies of the program director.

b. Joel C. Lehmkuhl, Mr. USAF AMC D-45
(Assistant Project Officer)

He will be directly responsible to the project engineer for liaison with the Instrumentation Unit of the Drone Organization. He will be responsible for the implementation of the plans for the location, maintenance and operation of the instruments and for the collection, transcription and interpretation of the data.

c. T. S. Lewis, Captain USAF A0381234 D-45

This officer will be responsible for the communication and other electronic equipment for Project 8.1. He will have an advisory capacity to the Assistant Project Engineer and thereby to the Instrumentation Unit on matters of the operation of the recording and telemetering equipment.

d. C. W. Orr, 2nd Lt. USAF A0838132 D-45

This officer will be responsible for the collection of the structural data from the B-50D aircraft in accordance with the plans of the project engineer. This responsibility will include supervision of the maintenance, calibration, and operation of the instruments and instructions of the flight crews. These airplanes will be based on Kwajalein and this officer will represent the Project Engineer in the operations of the B-50 airplanes.

e. R. H. Rice, 1st Lt. USAF A0818023 D-45

This officer will be responsible for the collection of the structural data from the XB-47 airplane in accordance with the plans of the project engineer. This responsibility will include the supervision of the maintenance, calibration, and operation of the instruments and instruction of the flight crews. This airplane will be based on Kwajalein and this officer will represent the Project Engineer in the operation of this airplane.

f. C. W. Luchsinger, Mr. USAF AMC D-45

This man will be responsible to the Assistant Project Engineer for the transcription, tabulation, and reduction of the structural data

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ized in the preparation of the B-17 test aircraft. The T-33 test aircraft are being prepared under contract by the Sperry Gyroscope Company. It is presently planned that the B-50 and B-47 airplanes will be modified at Oklahoma City Air Material Area. In addition to the above operations, the selection and arrangement of the instrumentation, supervision of the development of the required instruments, and the detailed engineering on installation and connection of the instrumentation is presently being performed at Headquarters, Air Material Command. The training for the maintenance and operation of the instruments is being initiated by the Air Proving Ground Command. An estimate of the total number of people within the Continental United States presently engaged or concerned with the above functions would be very difficult to determine. A great number of people within the various divisions of the Air Material Command are concerned with this project

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in their normal functions of Supply, Maintenance, and Engineering. Further, several contractors or major division thereof are engaged almost entirely in preparing equipment for the project. Thus an estimate of the number of people so engaged is not practical.

V. Instrumentation and Equipment Requirements

A. The instruments and equipment presently being prepared for Project 8.1 are as follows:

1. Magnetic Tape Recorders

Because of the response of other means of recording to shock and angular accelerations, it was decided to use magnetic tape as the medium for local recording within the airplanes. At the time this decision was made the Webster-Chicago Corporation had produced three prototype recorders for the Air Material Command on a previous contract and had initiated preliminary design of an instrument having twenty-four recording channels, two per-cent accuracy (or better), and 500 cycle frequency response. Acceptance tests on the prototype indicated an accuracy of within plus or minus two per-cent and a frequency response approximately fifty per-cent better than that anticipated (200 cycles) for the prototype. A first model of the twenty-four channel recorder, exclusive of the amplifier, is presently being subjected to preliminary temperature and acceleration tests at Headquarters, Air Material Command. The tests show the instrument to be satisfactory to date.

2. Telemetering Equipment

Telemetering transmitters will be of type AN/AKT-6 and the receivers will be of type AN/UKR-1. The transmitter provides twenty-eight data channels. Twenty-four of these channels will transmit data from those channels which are also recorded on the local recorder; the additional four channels will be used to provide information for the pilot controlling the airplanes from the ground. The telemetering receivers are being installed in a single ground station and the flight information will be transmitted to the ground stations (radar flight control and landing control trucks) by means of wire line (ref. par. VI. B. 3.a. and b.).

3. Sensing Elements

a. Strain Gages - Strain gages will be used to measure bending, torsion, shear, and elevator position. The gages will probably be Baldwin-Southwark type SR-4, 400-ohm gages. The techniques of applying these gages will need to be improved over that used in previous tests because of the humidity and corrosion problems which are present. A study is presently being pursued by Purdue University to investigate and compare the various techniques of cementing strain gages and to develop an instrument for determining the adherence of the gages.

b. Accelerometers - It is presently planned that unbonded resistance-wire type accelerometer as manufactured by the Statham Laboratories will be used.

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occupy, a high frequency pressure recorder will be provided for the Air Force B-17 drones. This recorder will consist of a crystal pressure transmitter mounted on a boom ahead of the airplane feeding into a recorder which includes an oscilloscope. The trace on the oscilloscope tube will be recorded on photographic film.

5. Auxiliary Equipment - Certain items which are required for the support of this operation will be provided within mobile laboratories. One of these laboratories will contain the telemetering ground station together with a radio transmitter which will provide a synchronizing pulse for the recorders in the various airplanes. This pulse will be transmitted by VHF radio to the airplanes; there it will be decoded and applied to the recorder. This pulse will be applied at one second intervals starting at To minus five seconds. The first of these pulses to be received in the airplane will initiate the recording cycle which will continue for approximately five minutes. As an added safety feature, it is also planned to initiate the recording cycle by means of an instrument which will detect the intense light from the detonation. In the event that the recording cycle has already been initiated, the signal from the light detector will mark To on the tape. According to present plans this instrument, in sufficient quantities for all of the airplanes, will be developed and provided by Edgerton, Germeshausen and Grier, Inc. (contractors to the AEC). The detailed requirements for this detector were discussed with Mr. B. J. O'Keefe of that company. A mobile laboratory will also be provided for the maintenance of magnetic tape recorders, fur use in the transcription of the magnetic tape records, and for the processing of oscilloscope records from the magnetic tape playback. Five type AN/MSQ-1 radio ground stations will be required for determining and recording the position of the critical drones. These radio equipments are being requisitioned and will be manned and operated by the drone organization.

B. The brackets, wires, and mountings for the equipment will be installed in the test airplanes at the depots and contractors as noted above. The remainder of the recording and telemetering equipment, together with the sensing instruments

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and the associated equipment, will be installed at Eglin Air Force Base and flown in the airplanes to the test site.

C. It should not be necessary to assemble or construct any of the instrumentation at the test site. However, due to the complexity and novelty of the equipment, a considerable amount of attention to the instrumentation is anticipated. Also, the nature of the tests, the fact that delays or interruptions due to instrumentation are intolerable, and the degree of reliability required of the instrumentation will demand a thoroughly trained, well equipped organization to maintain, adjust, and operate the equipment.

D. According to present plans the equipment will be installed and calibrated at Eglin Air Force Base prior to shipment to the test site. However, due to the number of airplanes, the calibrations of some of the installations will be approximately six months old at the time of the test. Therefore, it will be necessary to check at least a part of the calibrations before the first test. In order to verify the recorded data as much as possible it is also planned to repeat the "check" calibrations after each test on those airplanes which are available. It may also be necessary to repeat or check calibrations when equipment is replaced or repaired in the field. The equipment to be used in such calibrations will be contained within the mobile laboratories or taken to the test site by the operating organization. This will include such equipment as a shock tube, accelerometer calibrator, electrical standards, pressure equipment, and jigs and fixtures for loading the aircraft structures. In connection with the calibration of the airplanes, a hangar or suitable shelter will be required to protect the airplanes from the affects of the wind. The requirement for this hangar will be discussed in detail in paragraph XI.C.a., below.

E. It is not anticipated that any protective equipment will be required other than that which is discussed in Paragraph XI.C., below. Since it is not anticipated that the manned test airplane will be flown into contaminated air, protective equipment is not planned for these installations.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. It is estimated that approximately 90 percent of the equipment required for this project is already on procurement.

B. The orders placed to date include:

1. Recorders - A developmental contract, No. AF33(038)-6118, was placed with Webster-Chicago Corporation for four recorders and one 12-channel playback during fiscal year 1949. This procurement was supplemented by an additional order, Contract No. AF33(038)-10326, for twenty-one recorders, one 2-channel playback, and the associated test equipment from fiscal year 1950 funds. The first 4 recorders are presently scheduled for delivery approximately 25 April 1950. The 12-channel playback is scheduled for delivery approximately 1 June 1950. The remaining 21

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3. Due to changes in the number and locations of test airplanes to be used on this project, the number of spare recorders has been reduced to three. It is not expected that this amount of spares will be sufficient because of the complexity and novelty of the recording equipment. It is, therefore, planned to place an order with the Webster-Chicago Corporation for spare parts in the amount of approximately $50,000. It is expected that this purchase will be initiated prior to 15 May 1950.

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ped with recorders only and five for the Air Force will be equipped with telemetering as well as local recorders. The airplanes are now at Middletown Air Material Area in the process of modification. The engineering information for the installation are almost complete. The details of the pressure transmitters installations are being prepared and this should complete the installation data. The first instrumented airplane is scheduled for delivery 1 July 1950.

2. QT-33 - Six of these drones are being prepared by the Sperry Gyroscope Company. The first of these drones is being prepared for training only and will not be equipped with instruments. The remaining five drones will be equipped with telemetering and local recorders. The engineering data for the instrument installations are complete except for the light detector and for the sensitivity controls for the pressure transmitters. This data will be provided as soon as possible. The final approval inspection of the modifications to the airplane is scheduled for 19 April 1950. The first instrumented drone is to be delivered 1 September 1950.

3. B-50D - Two of these airplanes are to be used on the test as manned airplanes. The airplanes will come directly from the production line to the depot. The details of the installations in these airplanes are presently being evolved. It is planned that two recorders, of twenty-four channels each, will be installed in each of these airplanes. One of these airplanes will be located on a radial line from the blast and the other will be located so as to receive the shock from the side.

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Trailer (Electronic Maint)	1 ea.	D-45	3360 ft^3
Trailer (MSQ-1, Radar)	4 ea.	D-45	13440 ft^3
Trailer (Power Source, MSQ-1 Radar)	4 ea.	D-45	13440 ft^3
Accelerometer Shake Table	1 ea.	D-45	20 ft^3
Weapons Carriers (Ground Control)	3 ea.	D-45	2940 ft^3
Power Units (Ground Control)	3 ea.	D-45	378 ft^3
Oscillograph Paper	130 rolls	D-45	12 ft^3
Airplane Weighing Kit	1 ea.	D-45	6 ft^3
Crates (Spare Parts, Stationery, Hand Tools, etc.)	4 ea.	D-45	150 ft^3
Telemetering Spares	5 ea.	D-45	8 ft^3
			47,194 ft^3
		Measurement Tons	1,180

2. It is expected that the above-listed equipment will be returned to the Continental U.S. after the tests except for the oscillograph paper. Roll-up should be initiated immediately after the last test.

B. Air Lift

The following listed equipment will need to be transported by air freight:

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Item	Quantity	When Needed at Site	Volume
Recorders	6 ea.	D-30	360 lbs
Amplifiers	6 ea.	D-30	240 lbs
Recorder Playback	1 ea.	D-30	300 lbs
Crate (Accessories)	1 ea.	D-30	200 lbs
			1100 lbs

2. This equipment will be used in final check-out and calibration of instruments in the U.S. The equipment will be in use here until the departure of the test airplanes. It may be possible to transport this equipment in the test airplanes.

3. The only material which will require return by air freight will be the records, magnetic tape and oscillograph paper. It is hoped that a considerable quantity of such material will require transportation. These data will be highly classified and will be urgently required for reduction and analysis. Permission for the return of one hundred pounds of such material by air freight is requested.

C. Air Lift - Personnel

In view of the urgent need for all of the personnel listed for this project (ref. par. IV.A.2., above), it is desirable that these people be provided air transportation both to and from the test site. These people will be required at Eglin Air Force Base until the departure of the test airplanes (D-30) and should be at the test site as the airplanes arrive to continue their duties. After the test they will be required at Wright-Patterson Air Force Base for assistance in the reduction and analysis of the data.

VIII. Collaboration

The data from this experiment will be incorporated in the Structural Design Criteria for United States Air Force airplanes under Engineering Division project MX-1452, Expenditure Order 451-368. Under that project the Massachusetts Institute of Technology is performing a generalized study to analyse the problems in detail and is collaborating in the location of measuring points on the test airplanes and in the locations of the airplanes themselves. Other agencies of the Air Material Command are collaborating in the preparation of the test airplanes and considerable assistance in the fundamental parameters concerned in this test has been obtained from personnel of the Los Alamos Scientific Laboratories. The Sandia Laboratory has collaborated in the selection and development of the instrumentation. A large amount of collaboration has been and will continue to be necessary with Air Task Group 3.4 which is being organized, equipped, and trained by the Air Proving Ground Command. This organization will have operational control of the test drones and are thereby assuming responsibility for the equipment installed for the Air Force test. Close coordination with that group will be maintained throughout the operation.

IV. Responsibility

A. The Aircraft Laboratory, Engineering Division of the Air Material Command has been assigned responsibility for Project 8.1. It is assumed that the Drone Unit of Air Task Group 3.4 will be formally assigned responsibility for the calibration, maintenance, and operation of the necessary instrumentation for this experiment under the general supervision, advice and coordination of this project. An organization is being established within the Electronic Section of the Drone Unit to perform this function.

B. The project engineer for Project 8.1 will be Mr. Jay C. Wayne. Correspondence with Mr. Wayne should be addressed to Commanding General, Air Material Command, Wright-Patterson Air Force Base, Dayton, Ohio, ATTENTION: MCREXA83.

X. Funds

These are shown under program 8.

XI. Facilities

A. Power - The ground-based equipment for this project is, for the majority, being designed for the use of 110 volt, 60 cycle, single phase power. Approximately 30 kilowatts will be required for the telemetering ground station trailer and an additional 30 kilowatts will be required for the instrumentation maintenance trailer. It is presently planned that these trailers will be located on Site A near the Electronics Supply and Maintenance Shops adjacent to the drone parking area. Approximately 2 kilowatts of power will be required at the Radar Site between the north beach of Site A and the roadway, approximately across from the midway point on the loading strip. Electric power, not to exceed 2 kilowatts at each location, will also be desirable at the airplanes in the drone park. This requirement was discussed with Mr. J. C. Clark of Los Alamos, who agreed to consider the proposal. This power could be obtained by means of portable motor-generator sets if the provision of outlet boxes is not considered feasible. Twenty-eight volt, D. C. power will also be required in the trailers for the operation of instruments and radios, but this power will be derived from rectifiers or motor-generator sets provided therein. A request has been forwarded to the Drone Unit for an estimate of their power requirements and these requirements will be included in a monthly progress report when it is received.

B. Communications

1. Time Signals - The only time signals to be required by Project 8.1 is the minus thirty second (-30s) signal. The signal will be used (by means of VHF radio) to start the recorders in the drone airplanes. The signal will be required at the telemetering ground station and the closing of a relay contact will be sufficient to initiate this action.

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2. Radio Frequencies

a. Radio frequencies by equipment to be used specifically for Project 8.1 of this operation are as follows:

(1) AN/MSQ-1

No. of frequency bands required for operation	four
Type of equipment	Ground, radar tracking 2700-2900 megacycles
Frequency range of equipment	
Type of modulation	Pulse-time
Band width	4 megacycles
Power output	120 kilowatts
Purpose	Radar tracking and control of drones
Period used	Continuous during drone operations

(2) AN/AKT-6

No. of frequency bands required for operation	Four
Type of equipment	Telemetering transmitter
Frequency range of equipment	2200-2300 megacycles
Type of modulation	Pulse-time
Band width	1 megacycle
Power output	15 watts average 300-400 watts peak
Purpose	Telemetering of data from 4 drones in ground station
Period used	Continuous during operation of critical drones

(3) BC-640D (P/O telemetering Receiving Station)

No. of frequency bands required for operation	One
Type of equipment	Communications transmitters
Frequency range of equipment	100-156 megacycles
Type of modulation	AM (tone modulated)
Band width	10 kilocycles
Power output	50 watts

[redacted]

[redacted]

(4) BC-640D (P/O AN/MSQ-1)

No. of frequency bands required for operation	Four
Type of equipment	Communications transmitter
Frequency range of equipment	100-156 megacycles
Type of modulation	AM (voice modulation)
Band width	10 kilocycles
Power output	50 watts
Purpose	Ground to air communication used with ground radar to vector four (4) director aircraft.
Period used	As needed during drone operation

b. Only those equipments and frequencies peculiar to Project 8.1 of the operation are specified in detail paragraph a., above. It should be noted, however, that many of the frequencies required for the complete drone operation will contribute to phase 8.1, i.e., are shared by Project 8.1 and other programs. The following is a general outline of the frequencies required for the drone operation.

Equipment	No. of Channels Req'd.	Frequency Range	Purpose	Remarks
AN/MSQ-1	4	2700-2900 mc.	Radar control & tracking	Project 8.1 A/C only
AN/ARW-41	12	30-45 mc.	FM Radio control	4 of 12 channels used with Project 8.1 A/C
AN/AXT-2(Mod)	10	264-372 mc.	Television telemetering of flight data	2 of 10 channels used with Project 8.1 A/C
BC-1158 (P/O AN/MRW-3)	1	93 mc.	Control link between grd stations	Used w/all drones for take-off and landings
AN/AKT-6	4	2200-2300 mc.	Telemetering of test data	Project 8.1 A/C only

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Equipment	No. of Channels Req'd.	Frequency Range	Purpose	Remarks
BC-640D	1	100-156 mc.	Transmit timing signal to drone A/C	Used in 4 Project 8.1 A/C and approx. 4 other drone aircraft
AN/APS-10	10	9345-9405 mc.	Navigation of director A/C	2 of Project 8.1 directors equip'd with AN/APS-10
AN/ARC-3 & BC-640D	14	100-156 mc.	Communication air to air and air to ground to air	All A/C and ground stations. A maximum of 8 channels to be available on any one airplane or ground station.

c. The equipments and frequencies outlined above are those known to be required for the drone operation. It is not, however, a complete listing of the equipments installed in the aircraft. Other equipments could be used at the discretion of the operating group. For reference, the following listing of equipments by aircraft is included:

QB-17

1 ea. SCR-274N
1 ea. SCR-522 (receiver only)
1 ea. AN/APN-9A
1 ea. AN/ARN-7
1 ea. AN/ARN-5A
1 ea. RC-103A
1 ea. SCR-718
1 ea. AN/AIC-2A
1 ea. SCR-695B
1 ea. AN/ARC-8
1 ea. AN/ARC-3
1 ea. AN/ARW-40
1 ea. AN/AXT-2 (mod)
2 ea. AN/APW-11 (see Note 1)
1 ea. AN/AKT-6 (see Note 2)
1 ea. RC-193

DB-17

1 ea. SCR-274N
1 ea. SCR-522
1 ea. AN/APN-9A
1 ea. AN/ARN-7
1 ea. AN/ARN-5A
1 ea. RC-103
1 ea. SCR-718
1 ea. AN/AIC-2A
1 ea. SCR-695B
1 ea. AN/ARC-8
1 ea. AN/ARC-3
1 ea. AN/APS-10
2 ea. AN/ARW-41
2 ea. AN/AXR-1
1 ea. RC-193

QT-33

1 ea. AN/ARC-3
1 ea. AN/AIC-2A
1 ea. AN/ARN-12 or RC-193
1 ea. AN/ARN-6
1 ea. AN/ARW-40
1 ea. AN/APW-11
1 ea. AN/AKT-6

DT-33

1 ea. AN/ARC-3
1 ea. R-77A/ARC-3
1 ea. AN/AIC-2A
1 ea. AN-ARN-12 or RC-193
1 ea. AN/ARN-6
1 ea. AN/ARW-41
1 ea. AN-ARA-8A

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Note 1: Two (2) complete AN/APW-11 sets will be installed in five (5) each QB-17 aircraft and one (1) set of beacon components only will be installed in twelve (12) each QB-17 aircraft.

Note 2: Radio Set, AN/AKT-6 will be installed in five (5) each QB-17 aircraft only.

3. Telephone or Wire Lines

a. Four sets of three-conductor lines are required from the telemetering trailers to each of the four radar stations. These lines will carry the telemetered flight information from the airplanes for the benefit of the pilots controlling the test aircraft. Four channels of such information will be received at the telemetering station and must be presented to each pilot at the Radar Site. Two additional pairs of lines from the telemetering trailer to each of the radar stations should be included in this installation for telephone communications and for time synochronization.

b. A similar installation of four sets of three-conductor lines will be required from the telemetering trailer to each of the landing control ground stations: one off the west end of the landing strip and the other about 1/3 of the way down the strip on the north side. Of the four three-conductor lines from each of the telemetering receivers, two of these lines should go to each of the ground control points. These lines will provide the telemetering flight information for the benefit of the pilots who will control the landing of the test drones. Telephone communication lines between these control stations and the telemetering trailer are also required.

c. Telephone communications with other agencies on the atoll is also requested. Several other agencies; the Sandia Laboratory, Aberdeen Proving Ground, and Project 8.2; will be engaged in the maintenance and operation of equipment similar to that being maintained in the instrumentation maintenance trailer. It is expected that frequent communications with these agencies will be required. It is, therefore, requested that one station of the inter - and intra - island telephone network be provided at the telemetering trailer.

d. Telephone communications between the telemetering ground stations and the airplanes in the drone park was discussed with Mr. J. C. Clark at the same time that the subject of provision of 110 volt a.c. power at the airplanes was discussed. This communication will be especially valuable during checking and calibration of the telemetering equipment. Such communication could be provided by "handy-talkie" radios, but it is believed that the use of telephones would avoid further complication of an already crowded radio frequency spectrum. Information on more recent decisions in this matter would be appreciated.

C.. Laboratory Space and other facilities

a. Hangar - Experience gained during Operation Sandstone indicates that the need for hangar facilities is extremely urgent. A hangar large enough to [redacted] instrumentation at the test site. If hangar facilities are not provided, the original strain gages must be installed and the original calibration must be performed, prior to embarkation and accepted, without verification, throughout the operation.

b. Laboratory Space - A working area for the technicians who will maintain the recording and telemetering equipment is desirable. It is understood that this building is being requested by the Drone Unit but is included here for reference. Approximately 1,000 square feet of floor area are estimated to be required and provisions should be included for work benches and for adequate lighting to permit normal operation at night.

c. Fresh Water - A supply of fresh water will be required at the instrument maintenance trailer for the processing of photo-sensitive records from the telemetering receivers and from the magnetic tape transcription equipment.

D. It is estimated that three jeeps will be required for the use of personnel on this project. Two of these jeeps will be used on Site A and the other will be assigned to project personnel on Kwajalein. It will be necessary to transport considerable equipment between the airplanes and the trailers and to other parts of the island. Considerable coordination will be required between personnel of this project and other agencies on the island, such as the Atomic Energy Commission and the Drone Unit; and transportation for personnel and equipment will be required. Additional vehicles for overwater and air transportation will be required occasionally for travel to Sites E, P, Q and S in order to assist with the instrumentation of Project 8.2. However, it is assumed that such transportation will be available as required. A suitable tractor will be required for moving and locating the thirteen trailer-vans involved in this project. No particular increased transportation requirement immediately prior to or after the test time is anticipated.

XII. Remarks by Project Engineer

A. Some of the estimates, expecially in paragraphs VII. and XI., above, may overlap or duplicate estimates presented or being prepared by the Drone Unit. However, in order to avoid the possibility of omitting an important item, this report has included rather than excluded items which may be requested elsewhere. When it is determined that such items are definitely duplicated in other requests, this fact will be noted in future reports.

B. It is requested that the use of photo-sensitive recording paper by this project be cleared with those agencies responsible for the security of the test area. Considerable difficulty was encountered on Operation Sandstone due to a misunderstanding of the purpose of such paper. The use of the photo-sensitive paper to violate security by taking photographs is practically impossible and sufficient security measures will be taken to insure against such use. However, the requirement (as in the previous instance) for accounting for every scrap of this paper is prohibitive in time and effort. Unexposed paper will be protected under locks, but it is desired to avoid the requirement for depositing such paper with the security police as was previously required.

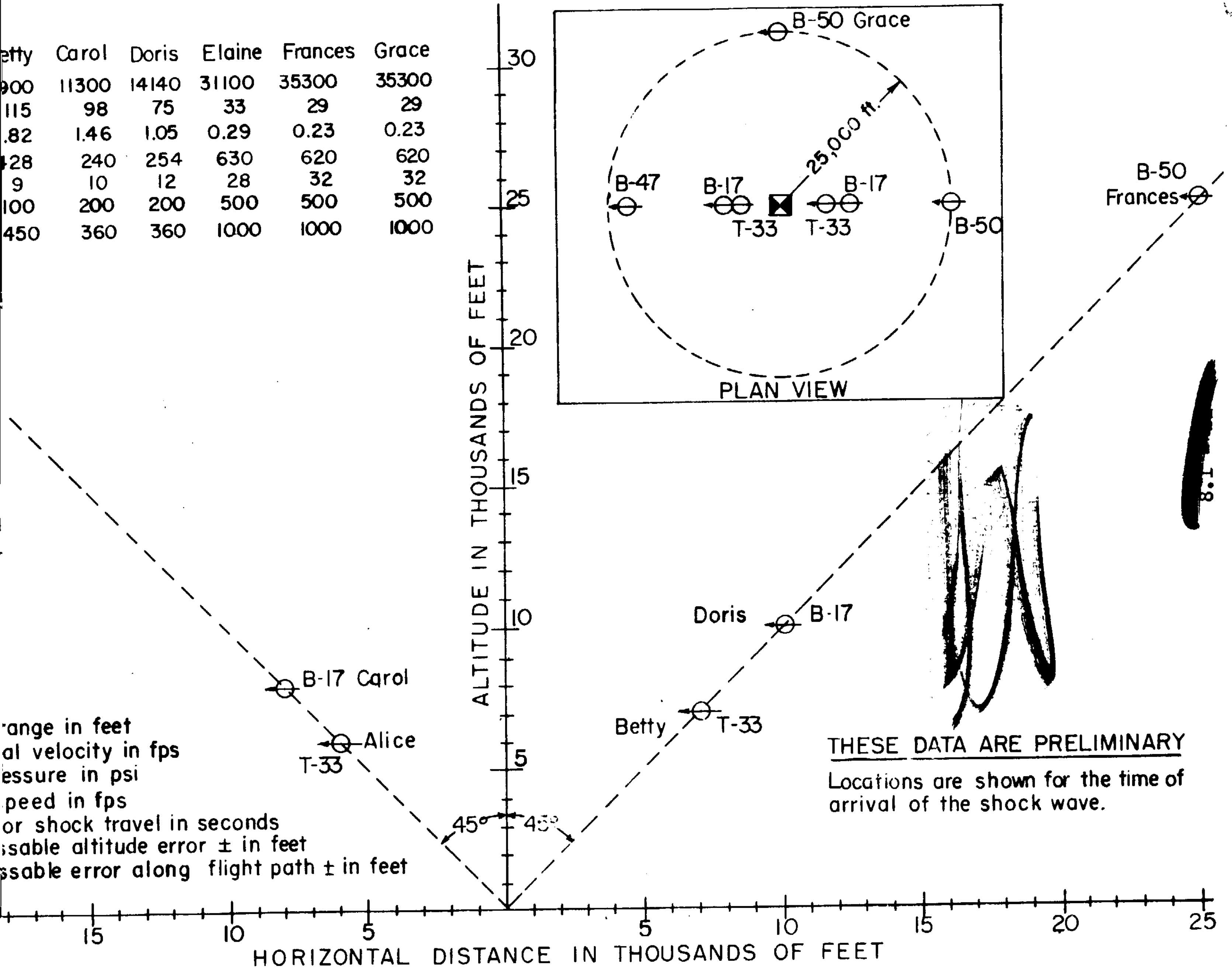
C. The preliminary estimate of the locations of the test airplanes for this project has been reviewed. On the basis of the present state of the Massachusetts Institute of Technology analysis another estimate of those locations has been prepared and is inclosed with this report as Figure 1, page 21. The locations as indicated are still preliminary and will be examined further as the analysis progresses. The predicted overpressures and material velocities are shown for each location. As shown in Figure 1, some of the airplanes will be going away and others will be heading toward the blast. For the information of those who inquired as to the possibility of vertical photography, none of the test airplanes should be within a sixty degree cone (thirty degrees each side of vertical) at the time of the detonation according to this plan. The manned XB-47 will be the nearest airplane over the blast; at about 30 degrees from the vertical point and at about 22,000 feet altitude.

DISTRIBUTION OF TEST AIRPLANES – PROJECT 8.1

[redacted]

[redacted]	etty	Carol	Doris	Elaine	Frances	Grace
[redacted]	900	11300	14140	31100	35300	35300
[redacted]	115	98	75	33	29	29
[redacted]	.82	1.46	1.05	0.29	0.23	0.23
[redacted]	28	240	254	630	620	620
[redacted]	9	10	12	28	32	32
[redacted]	100	200	200	500	500	500
[redacted]	450	360	360	1000	1000	1000

[redacted] ange in feet
[redacted] al velocity in fps
[redacted] essure in psi
[redacted] peed in fps
[redacted] or shock travel in seconds
[redacted] sable altitude error ± in feet
[redacted] sable error along flight path ± in feet



THESE DATA ARE PRELIMINARY

Locations are shown for the time of arrival of the shock wave.

[redacted]

[redacted] aircraft components in the path of the blast, and under carefully controlled conditions to measure and evaluate the effects mainly of the blast, but also heat and radioactivity on these structural components.

A. What data are to be obtained.

1. Air load and air pressure measurements on an ideal rigid wing.

2. Structural measurements on an ideal simple wing, both straight and swept design.

3. Qualitative data on vented and unvented components.

4. Qualitative data on secondary items such as canopies, antennae, pitot tubes, fuel tanks, rudders, etc.

5. Qualitative data on new experimental structures utilizing new materials and/or new design principles.

B. 1. These data will be used in conjunction with general blast loads study to establish design criteria and to determine safe operational tactics for atomic bomb delivery by air.

2. It will be used to determine hazards encountered by aircraft when subjected to the shock wave of the A-bomb.

3. To determine and evaluate methods of relieving structures from collapse or explosion due to differential pressure.

4. To evaluate the effects and reponse to an A-bomb on structural components fabricated of new materials and to new design trends.

[redacted]

The need for data obtained from ground tests on aircraft structures in addition to air tests on drones is very important. The ground tests provide an opportunity to gather data under closely controlled conditions (as compared to flight conditions) on simplified structures. This is extremely important, since the use of simplified models rather than complex aircraft structures permits a correlation of theory and experiment with the minimum of attention to superfluous details. In addition, it provides an opportunity to make reliable observations on the effects on aircraft structures at relatively short distances from the center of burst. These observations are valuable in determining the effects and extent of local blast damage on secondary and primary structural components. These types of damage cannot be reliably predicted by methods of analysis, yet may be important factors in the failure of certain types of aircraft structures.

This proposed experiment is a partial extension of previous experiments and will probably be a continuing program according to results of this test and future changes in atomic warfare.

II. <u>Method</u>

A. General Method:

1. Air loads and air pressure measurements will be made on an ideal rigid two-dimensional wing to determine accurately the actual loads which the wing experiences.

2. Structural measurements will be made on an ideal structural model to determine dynamic response of airfoils to an A-bomb blast. The "Structural Model" will be of the simplest possible design which will behave structurally in the simplest manner in order to verify methods of dynamic stress analysis. The structural model design will have the same airfoil section as the "rigid model" in order that dynamic response can be correlated directly with known air loads.

3. Qualitative tests will be conducted on vented and unvented simple cylinders and simple airfoil shapes to determine the effect of the shock wave and the alleviation effect of vented holes.

4. Qualitative tests will be conducted on new experimental structures to determine the effects of the heat, radio activity, differential pressure, etc., on the new materials and structural designs.

B. Attachment "A" is a list of the specific test articles listing the quantity and the specific test site. Attachment B,C, and D are schematic sketches of the "rigid Wing Model", "Structural

Straight Wing Model", and "Structural Swept Wing Model", respectively. All three types of these models are to be supported on pylons approximately 10 feet above the level of the ground. The pylons will be anchored to the ground by reinforced concrete bases. Attachment E is a perspective drawing of the test set-up for the rigid and structural models illustrating the attachment of concrete base, pylon, and test articles.

The "rigid models" will be used to completely determine the air loads and pressures caused by the blast wave on a two-dimensional airfoil section. This model will be instrumented with pressure sensing elements and a balance system. The pressure elements will record the chordwise pressure distribution at a given section. The "structural models" will be used to check the method of dynamic stress analysis. They will have the same airfoil section as a "rigid" two-dimensional model. These models will be instrumented with strain gages.

It is tentatively planned to place a pair of rigid and structural wing models at each of four ranges. In addition, a swept structural wing model will be placed at each of these ranges. Selected items from the other specimens mentioned above will also be located at each range.

C. The range of the test articles with respect to the center of blast is based entirely on over-pressure as predicted from the estimated yield by AEC. The design of the models is based on predicted over-pressures and gust velocities. It is, therefore, apparent that the expected yield is directly related to all phases of this project. However, in anticipation of errors in over-pressures, effects of ground terrain and other variables and in order to bracket the required data, the test specimens are identical for each range or island test site. Therefore, a change in the yield would change predicted results, but this should not greatly affect overall results unless a terrific change in expected yield occurred.

The details of Part II A and B are dependent on date and time of the test only to the extent of meeting shipping schedules, etc. An arbitrary date, 1 December 1950, has been established by the project engineer as the expected date on which all material for this project must leave the United States.

III. Details of Progress to Date in Experimental and Theoretical Work

A. A complete study of the mechanism of the blast wave and the variation of the pressure behind the wave and the resulting loads on the aircraft is in process. The theoretical work requires that the over pressure in the blast wave and the variation of pressures behind the wave be transposed to a force-time distribution on the aircraft structure which is assumed elastic and capable of vibrating freely. It is then possible to calculate analytically the stress in the aircraft structure resulting from this force-time distribution. Sufficient data has been accumulated to permit design of the various models to be initiated. While the actual blast wave does not greatly alter the design of the models, it directly affects the range chosen for the specific models.

The present study reveals the lack of experimental data on the effect of atomic blast waves on aircraft structures and the necessity and desirability of the proposed experiment. This project, therefore, forms a basis for a fundamental understanding of the quantities involved by comparing theory with experiment.

IV. Personnel Requirements

A. Required at Test Site

1. Scientific personnel -
Four (4) civilians
One (1) each officer

a. One (1) each civilian, Mr. D. L. Grimes, project officer for this entire project to be furnished by USAF, AMC, MCREXA-8. This civilian will be in charge and responsible for the entire project 8.2 operation. This includes: all preparation for the test such as design and fabrication of test articles, pylons, anchor bases, etc.; the erection and operation of the test articles and the instrumentation at the various test sites; the observation of results; the collection of all data; and the preparation of the final report. This man is on hand and working with the project.

[redacted]

b. One (1) each civilian, assistant project engineer for the entire project to be furnished by USAF, AMC, MCREXA-8. This man will assist the project engineer in discharge of all duties and responsibilities as outlined under a. This man is on hand and working with the project.

c. One (1) each civilian to act as scientific advisor on all items that affect the engineering and scientific data being gathered under project 8.2. This includes, presentation of the test articles, terrain effects, instrumentation problems, etc. This civilian will be furnished by USAF, AMC, MCREXA-8. His services are being procured under contract No. AF33(038)-8906. This man is from MIT and is working with the project.

d. One (1) each civilian, to be furnished by the USAF. He will be responsible to the project engineer for installation and operation of all instrumentation required on project 8.2. This will include installation and operation of pressure gages, stress gages, temperature elements, all wiring, recorders, amplifiers, etc. He is on hand and working with the project.

e. One (1) each officer to be furnished by the USAF. He will be the assistant instrument man to the civilian listed in d. above. He will be required at the test site to assist in the supervision of the installation, maintenance, calibration and operation of project 8.2 instrumentation. He will assist in the transcription, tabulation and reduction of the structural data collected. He will perform the required liaison work between island test sites and project 8.1 instrumentation sites. He is on hand and working with the project.

2. Technicians:

a. One (1) each Master Sergeant, MOS-750, airplane maintenance technician.
Three (3) each Technical or Staff Sergeant, MOS-747, airplane and engineer mechanic.
One (1) each Sergeant, MOS-555, airplane sheet metal worker.
These personnel are to be furnished by the USAF. They have not yet been procured. All five of these enlisted men are to be used in the same type of jobs

[redacted]

[redacted]
mentation for this project.

c. Five (5) each, enlisted men, MOS-867. These people to be furnished by the USAF. They have not yet been procured. It will be the duty of these men at the test site to set up, service, and operate the "Buck" gauges being used for measurement of pressure versus time for the whole test area. These measurements are being made in cooperation with J-10 personnel,(J.E. Kirk), under Phase B of this project.

B. Project Work in Continental United States

1. Scientific Personnel

Nine (9) each, civilians, and one (1) each, officer:

1 each civilian - David L. Grimes, Project Officer
1 each civilian - Lloyd J. Breidenbach, Ass't Proj. Officer
1 each civilian - Edward H. Schwartz - Overall Advisor
1 each civilian - Joseph Kelley - Advisor on Design Criteria
1 each civilian - Ralph C. Lenz, Jr. - In Charge of instrumentation for this project.
1 each civilian - L. Levy - MIT)
1 each civilian - C.S. Doherty - MIT) Theoretical Study
1 each civilian - R.L. Bisplinghoff - MIT)
1 each officer - 1st Lieut. A. Sapowith - Instrumentation

2. Technicians

1 each civilian - E. Zink

V. <u>Instrumentation and Equipment Requirements</u>

A. 1. Reinforced cement anchor bases to be constructed on the island test sites for all of the test articles.

2. Pylons and/or jigs to hold the test articles to the anchor bases in the correct attitude.

3. Test articles as listed in attachment "A".

4. Instrumentation consisting of 24 channel recorders, strain gauges, pressure sensing elements, temperature sensing devices, etc.

5. Instrumentation room.

B. The anchor bases will, of course, be fabricated on the island test sites. The pylons and jigs are to be completely or partially assembled in the ZI. The strain gauges and possibly the pressure sensing devices will be assembled into the test articles. The test articles will be completely assembled in the ZI prior to shipping.

C. The fabrication of the concrete anchors at the test site is readily justified due to size and method of fabrication. The assembly of the pylons in the ZI and subsequent coupling to the base at the island test site is the only way to bring the two together. Assembly of the test articles to the pylons would make an unwieldly heavy, bulky item to handle and ship. Further complications would arise in balancing the system and establishing correct angle of attack. Therefore, the assembly of the test articles to the pylons will be performed at the test sites. All personnel listed under part IV will be engaged in assemblying of pylons to bases, test articles to pylons and/or instrumentation at the test site.

D. There are two types of instruments which require calibration in the field: strain gauges and pressure gauges. Jacks, weights (sand bags) and chord beam clamps will be used for calibrating the strain gauges in bending, torsion, and shear. Air pumps will be used for calibrating the pressure gauges. An equipment trailer will be used to check the frequency response of the pressure gauges.

E. One each instrument room is to be constructed on islands E, S, Q, and P. This room will be used to protect instruments necessary for the rigid, structural, and swept wing models. It will be 8' x 10' x $6\frac{1}{2}$' high and will house amplifiers, recorders, etc. The room will probably protrude 3 to $3\frac{1}{2}$ feet above the ground and will most probably be placed 30 to 35 feet behind the test articles. Forty-eight wires form the intelligence channels from the

[redacted]

with the prime contractor, Holmes and Narver, Engineers, Inc. All drawings have been furnished for this work.

C. Purchase Requests have been prepared for the following and negotiations with prospective contractors are in process.

1. A procurement of the required recorders, that is, 10 each Webster 24 channel records. The contractor will most probably be Webster-Chicago Corporation. Desired delivery date - September 1950 or before.

2. The procurement of the design and fabrication of the "Rigid Models", "Structural Straight Wing Models", "Structural Swept Wing Models", the vented and unvented cylinders and airfoils. MIT is the expected contractor. Delivery of all articles is requested by 1 October 1950.

D. Everything planned is in some stage of development and, therefore, comes under E below. Temperature measuring devices are being investigated for this project but no specific development is in process.

[redacted]

VII. Logistics

A. Sea Lift

1. 287 measurement tons. It is desired to point out that the great majority of material being shipped for this project is Air Force type construction and will be lighter per cubic foot than normal. As an example, the crated swept wing model will occupy approximately 50 cubic feet and will probably weigh 200 pounds.

2. 71 measurement tons. Return of shipment can commence within 4 to 8 days.

[redacted]

[redacted]
Sixteen (16) can commence return in approximately six days after Easy shot. (E + 6).

E. No logistic problem envisioned.

VIII. There is collaboration with Los Alamos Scientific Laboratory on the pressure versus time measurements ("Buck Gages").

IX. A. Mr. D. L. Grimes, Project Officer for 8.2.

B. Mr. D. L. Grimes

Official Address: Commanding General
Wright-Patterson Air Force Base
Dayton, Ohio
Attention: Mr. D. L. Grimes
MCREXA-82

X. <u>Funds</u> - See attached fiscal chart for this information.

XI. Facilities

A. Power.

It is understood that 110V power will be available for Project 8.2 on test sites "E" and "S". It is also understood that electrical power will not be available on test site "Q" and "P". Project 8.2 will be able to operate satisfactorily on Q and P without electrical power being provided. However, it would be desirable to have 110V power on Q and P if possible as otherwise it will be necessary to provide power by a putt-putt driven generator on each island.

B. Communications.

1. Of the time signals available, (d) - 30s ± 0.1s and (f) - 1s ± 0.05s will be utilized by Project 8.2 on all four island test sites "E", "S", "Q", and "P". It is requested that a -30 min. ± 1 min. time signal be provided on all four island test sites "E", "S", "Q", and "P" for Project 8.2. This 30 minute time signal is urgently required in order to turn on the amplifiers (which is part of the recording system) which need a 30 minute warm-up period.

   The recorder tape will be activated at -30 seconds. The -1 second signal will cause a time blip on the recording tape. It is planned that the -1 second signal will also start the tape if the -30 second signal has failed. One second will allow sufficient time for the unit to attain full speed.

2. It is understood that intra-island telephone communication will be available at the four island test sites. This is the only known communication requirement at this time.

C. Laboratory Space and Facilities.

The exact requirements are unknown at this time. It is expected that some type of temporary shelter should be provided on all project 8.2 test sites to protect the instruments and instrument crews while performing installation and calibration.

D. It is expected that the normal boat transportation from the main island of Eniwetok to Engebi will be adequate. It is also expected that normal methods of procuring transportation for distributing the large test articles to the four island test sites will be adequate.

[redacted]

Table of Specimens

Attachment A

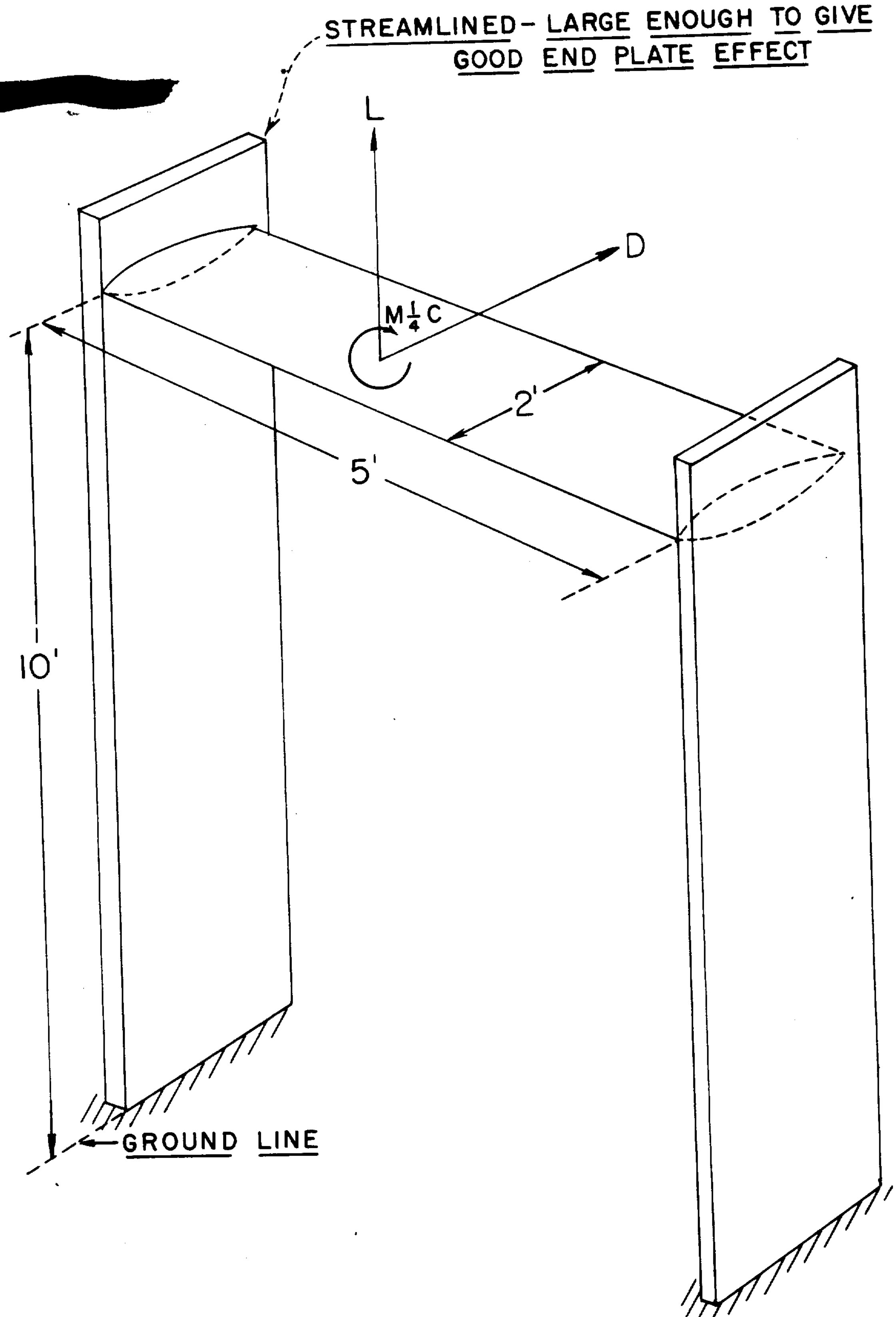
Island Test Site / Approx. Range	Engebi "E" 1347 Yds	Muzinbaarikku "S" 2310 Yds	Teiteirpucchi "Q" 4030 Yds	Bokojaarappu "P" 5507 Yds
Rigid Wing Model	2 ea	2 ea	2 ea	2 ea
Structural Wing Model	2 ea	2 ea	2 ea	2 ea
Swept Wing Model	1 ea	1 ea	1 ea	1 ea
Unvented Cylinder	6 ea	6 ea	6 ea	6 ea
Vented Cylinder	"	"	"	"
Unvented Airfoils	"	"	"	"
Vented Airfoils	"	"	"	"
F-47 Wing				
With flaps & ailerons unvented	1 ea	1 ea	1 ea	1 ea
F-47 Wing				
With flaps & ailerons vented	1 ea	1 ea	1 ea	1 ea
F-80 Fuselage	1 ea	1 ea	1 ea	1 ea
Experimental Structure	1 ea	1 ea	1 ea	1 ea
Control Surface	1 ea	1 ea	1 ea	1 ea

[redacted]

ATTACHMENT B

RIGID MODELS SPECIMEN

[redacted]

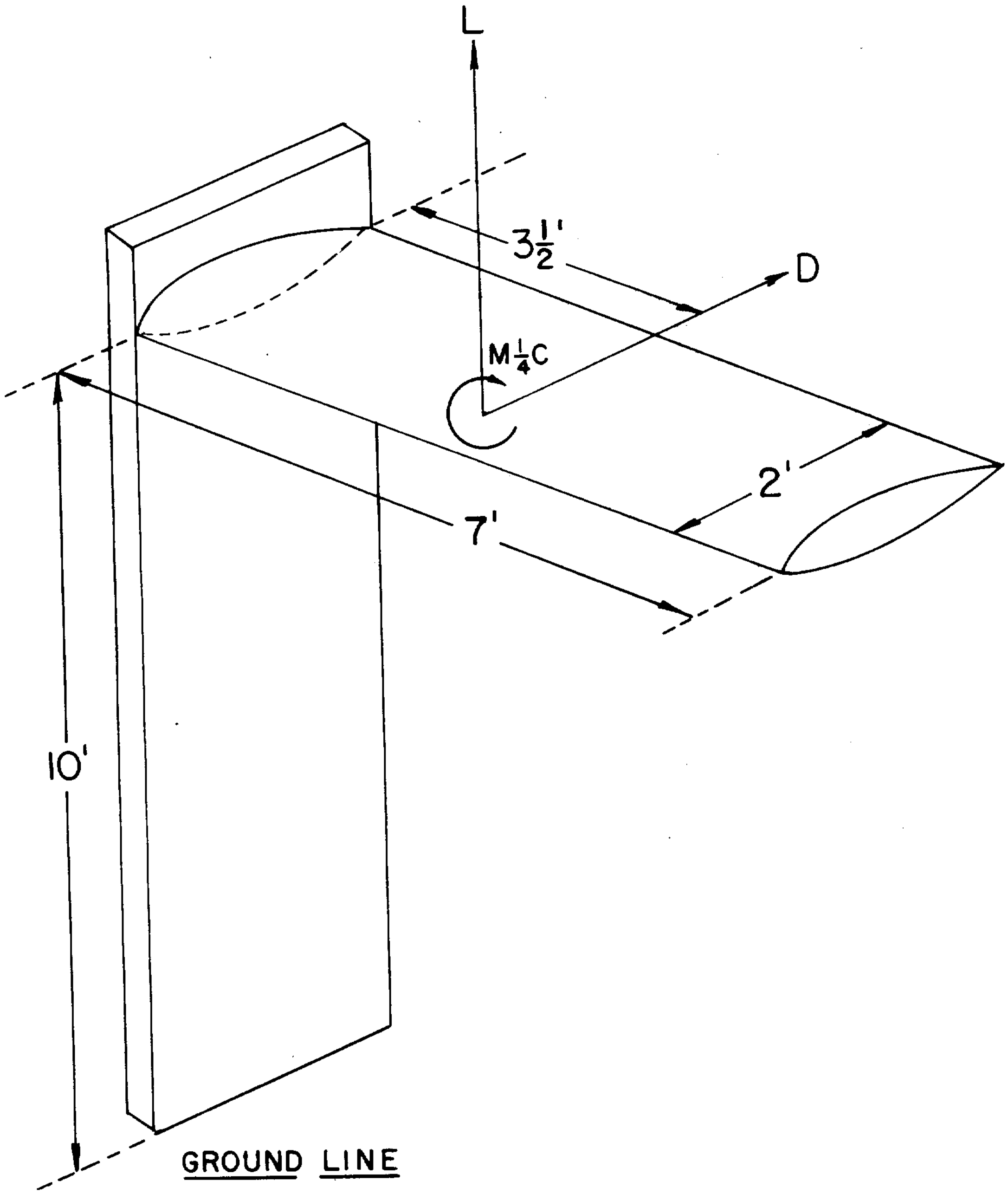


[redacted]

ATTACHMENT C

STRUCTURAL STRAIGHT WING MODEL

[redacted]

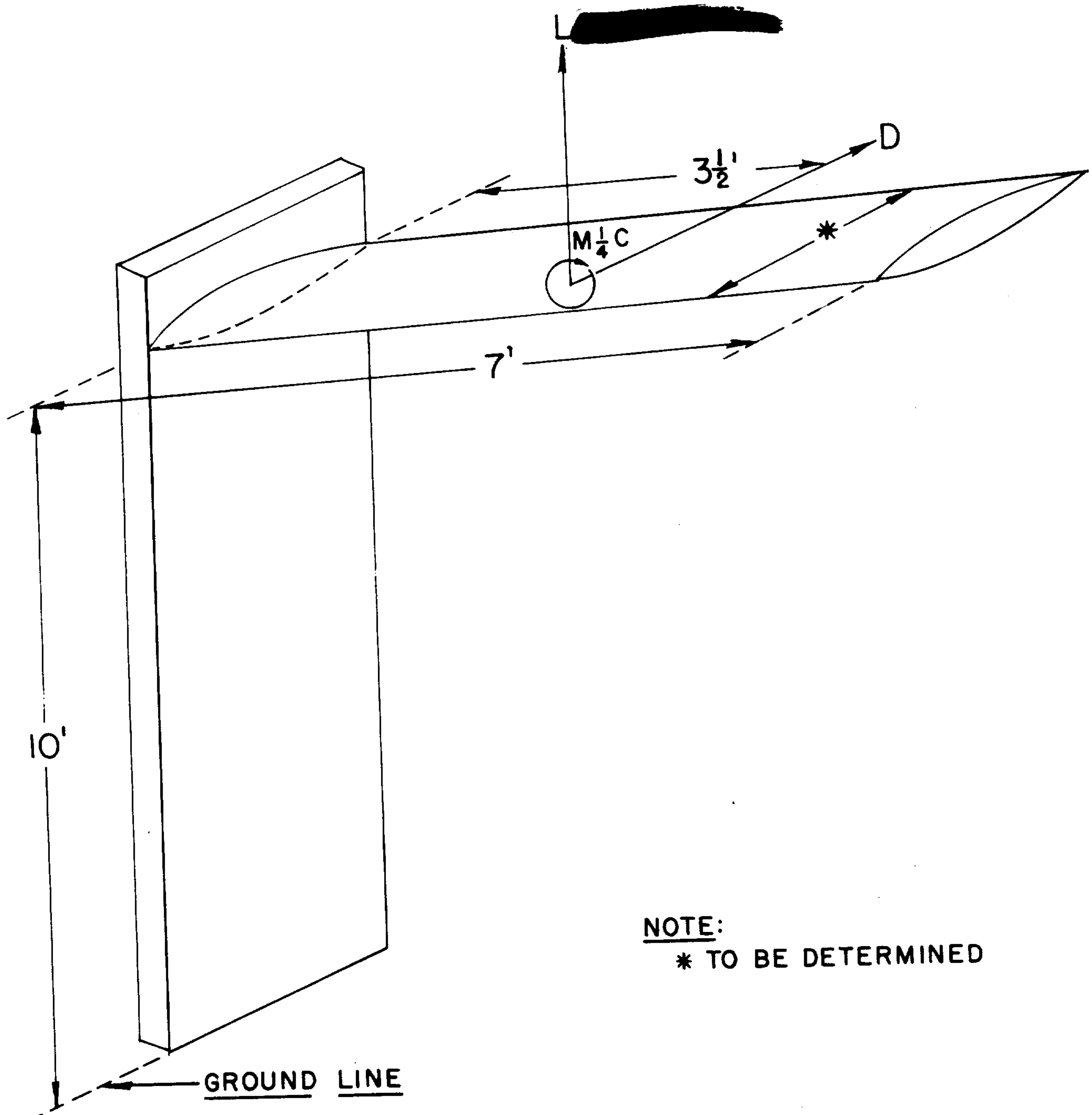


[redacted]

SWEPT MODEL SPECIMEN

ATTACHMENT D

[redacted]

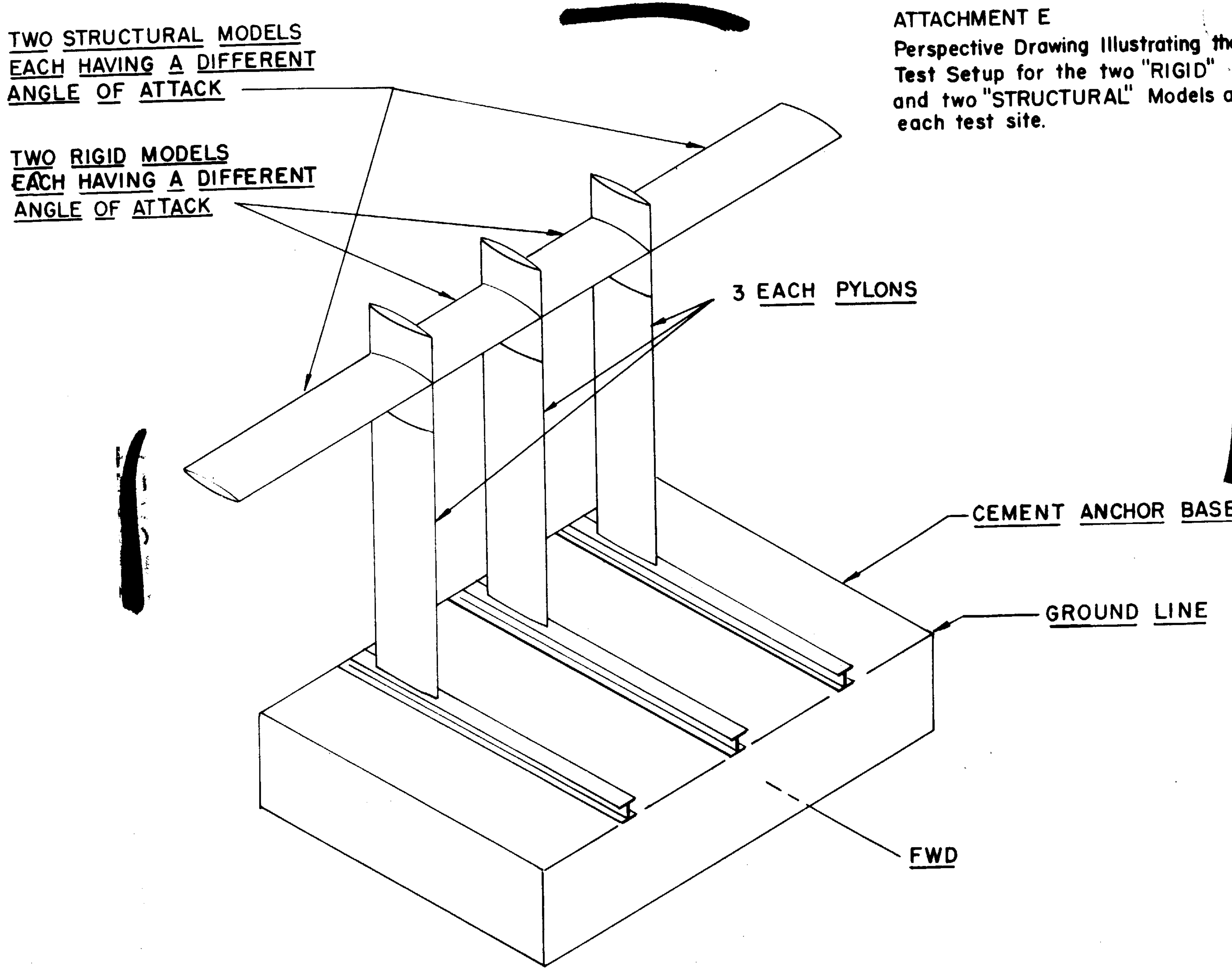


[redacted]

[redacted]

ATTACHMENT E

Perspective Drawing Illustrating the Test Setup for the two "RIGID" and two "STRUCTURAL" Models at each test site.



[redacted]

B. The information received on site E will furnish a check on the same information obtained by a different method. It will also serve to evaluate this new type of a pressure gage. The primary purpose of this measurement is to provide these data for the 8.2 program. This will be done on all the sites listed above.

II. Method

A. This method of pressure measurement utilizes the principle of the interference bands of light produced on the mirrored surfaces of a quartz diaphragm. As the pressure on the diaphragm varies the thickness of the film of air which separates the plates, the interference fringes are displaced. This displacement is a direct measure of the pressure on the diaphragm.

B. This measurement is divided into two parts. On site E, in conjunction with part of Program 3, eight gages are to be placed as follows:

No. of Gages	True Bearing to the Shot Tower	Range in Yards
2	315	950
2	315	1270
2	295	950
2	275	1165

To furnish the required information for Program 8.2 the remaining gages are located as follows:

On site E: 2 gages, bearing approx. 295 T, distance 1323 yds.

On site S: 6 gages, bearing approx. 315 T, 2 at 2250 yds., 2 at 2350 yds., and 2 at 2480 yds. from shot.

On site P: 4 gages bracketing station 8.2.4, bearing approx. 310 T, distance approx. 5500 yds.

On site Q: 4 gages bracketing station 8.2.3, bearing approx. 100 T, distance approx. 3500 yds.

[redacted]

[redacted]

[redacted]
system appears to be adequate for the test. Sufficient data is in hand to enable the experimental work to advance to its final stages. There are no foreseeable difficulties in the present plans.

IV. <u>Personnel Requirements</u>

A. Required at Test Site

1. Officers - 1 LCDR, USN.

LCDR John E. Kirk, USN, is now on duty at the Los Alamos Scientific Laboratory and has been designated project engineer for this project. The duties consist of administration of personnel and money, supervision of the installation and operation of the gages, interpretation and collection of the data

Civilain - 1 Staff Member Los Alamos Scientific Laboratory

R. W. Newman has been assigned by the Los Alamos Laboratory for this duty. His duties are in general the same as listed above for the one officer.

2. Technicians

Enlisted men - 5 Instrument men whose duties will be the installation, calibration, and operation of the gages for the test. These men have already been requested as part of Program 8.2.

3. No unskilled help required.

B. Project Work in Continental United States

1. Scientific Personnel

Require one officer and one civilian staff member. These men are now assigned to this project at the Los Alamos Scientific Laboratory. Their duties consist of doing the experimental work required, collecting the instruments for shipment, and drafting the plans of this project for the test.

2. Technicians

No technicians are required until the Fall of 1950. They are required at Los Alamos at this time in order to indoctrinate them in the use of the gage. At that time, the 5 technicians will be required for a period of about one month.

V. Instrumentation and Equipment Requirements

A. The following is a list of the instruments and equipment required for this project:

26 interferometer gages

75 small relays

18 precision time delay relays

1 calibration kit for the interferometer gages

B. All instruments and equipment can be assembled in ZI.

C. At the test site the instruments need only to be tested and installed.

D. The calibration which is to be done at the test site is the damper setting. This requires the use of a small shock tube, some cellophane diaphragms, and a small bottle of compressed air or some similar gas.

E. No protective equipment is needed.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. About 30% of the equipment is in hand.

B. The gages have been ordered from the Los Angeles shops of the Los Alamos Scientific Laboratory. Delivery of the first of the gages is expected on 27 April 1950 with the delivery completed by the end of May 1950. The order for the time delay relays has been placed with the Haydon Timing Corp. of Waterbury, Conn. Delivery is promised by the end of May 1950.

C. The only orders which remain to be placed are for the dry cell batteries

[redacted]

and film. Those orders will be placed sometime in June for delivery sometime in November. Those delivery dates can easily be met.

D. Some work remains to be developed on the timing system to be built into the gages. This system is not available commercially in the size and price range desired. Work is progressing satisfactorily and the present indications are that this work will be completed by the time the gages arrive so the system can be installed.

E. See D above.

F. See C above.

G. No Armed Forces equipment required.

H. The timing units for each gage are yet to be built. Approximate time required is one month.

I. All decisions on the instruments to be used and the materials required have been made.

VII. <u>Logistics</u>

A. Sea Lift

1. Will have about 3 M/T to reach the test site by D-60.

2. About $2\frac{1}{2}$ M/T will be ready for return on H + 10.

B. Air Lift

1. None

2. None

3. None

C. Sea Lift (Personnel)

1. None

2. None

D. Air Lift (Personnel)

1. Two to arrive about D-60 plus the technicians which are being provided in Program 8.2.

[redacted]

2. Two to leave about I + 10.

E. No particular logistics problem.

VIII. Collaboration

This project will collaborate with the AMC Program 8.2. It will furnish the pressure vs time measurements for the 8.2 stations, and at the same time will provide check points for measurements made under AEC Program 1.0.

IX. Responsibility

A. LCDR John E. Kirk, USN, of J Division, Los Alamos Scientific Laboratory is responsible for carrying out this experiment, collecting the data, and reporting it, through the Program Director, to the Scientific Director.

B. LCDR John E. Kirk
Room 105, J Division,
Los Alamos Scientific Lab.,
Los Alamos, N. M.

X. Funds

A. Fiscal Year - 1950

1. The total cost of this project is $42,000.00. $30,000.00 is to be furnished by Program 3 and $12,000.00 will be furnished by the AEC.

B. Fiscal Year - 1951

No funds required for this year if all material requested is obtained from the 1950 budget.

XI. Facilities

A. No power required. Each gage has its own power supply in the form of a bank of dry cells enclosed within the mounting box.

B. Communications

1. Two timing signals are required at each gage location:

- 5 minutes
- 1 second

These signals have been requested from Dr. J. C. Clark of LASL.

2. No special communications requirements.

[redacted]

C. The laboratory space required is one work bench about 9' x 4' on the working surface. No special equipment needed for this laboratory space.

D. The transportation requirements for the forward area are included in Program 8.2.

XII. Remarks

None

[redacted]

[redacted]

S[redacted]

[redacted]

TEST PROPOSAL

PROJECT 8.3 - PHASE A

RADAR SCOPE PHOTOGRAPHY

I. Object of the Experiment

A. Photographs of radar scopes during atomic explosions are to be obtained.

B. Detailed analysis of radar scope data available from Crossroads and Sandstone indicates that proper use of radar scope photography may furnish a direct measurement of bombing accuracy and an estimate of bomb damage. (See Operations Analysis Section, Special Report No. 3, title "Airborne Radar Strike Photography of Atomic Explosions".)

II. Method

A. Radar Set AN/APQ-24 as installed in B-50 type aircraft used in Project 8.1 will be adequate as basic radar equipment.

B. A special "A" type scope is required in addition to the basic radar set for each aircraft participating. This scope (Dumont Type 294 or equivalent) will have high light intensity output and will be photographed by a high speed camera (General Radio). For each of the two (2) aircraft participating in this project one (1) "A" type scope, one (1) high speed camera and one (1) 35 mm movie camera will be needed plus necessary spares.

This equipment can be located at the radar operator's station and in the space vacated upon removal of forward top gun turret. There will be no other instrumentation points.

C. Details of Part IIA and B are not critically dependent on the expected yield of the weapon, the date and time of the tests.

[redacted]

[redacted]

III. Details of Progress to Date in Experimental and Theoretical Work

A. The above-mentioned report by Operational Analysis Section establishes the desirability of obtaining further data of this type. This Laboratory is undertaking to develop instrumentation to obtain this data on the present project. Preliminary studies are being made of pulse to pulse photography and "A" scope motion pictures on standard oscillographs to establish detailed equipment requirements.

Any quantitative data on ionization and pressure distributions at shot time will be of value to make a more complete analysis of the recorded data. Requirements for associated circuitry for timing and control are being determined.

IV. Personnel Requirements

A. Required at Test Site

1. Scientific personnel

1 each civilian engineer (AMC representative) - Project Officer W. R. Boario

1 each JTF-3 officer, Assistant Project Officer, Capt. C. W. Abbitt

1 each civilian engineer (Western Electric technical representative) for maintenance and application of Radar Set AN/APQ-24

AMC will furnish all of the above.

The civilian engineer (AMC representative) and the JTF-3 officer are now on hand. The Western Electric representative will be procured by AMC when funds are available.

2. Technicians

2 each Radar Repairmen (airmen), airborne equipment, SSN 955 for Radar Set AN/APQ-24 maintenance

AMC is in the process of procuring these airmen.

B. Project Work in Continental United States

1. Scientific personnel

1 each civilian engineer (AMC representative) - Project Officer, W. R. Boario

1 each JTF-3 officer, Assistant Project Officer, Capt. C. W. Abbitt

1 each civilian engineer (Western Electric technical representative) for maintenance and application of Radar Set AN/APQ-24

1 each civilian engineer (AMC representative) - Engineering Services, T. J. Gibbons

1 each civilian engineer (AMC representative) - Photographic Services, George Taylor

AMC will furnish all of the above. All of the above are now on hand except the Western Electric representative.

2. Technicians

Same as Part IV.A.2

V. Instrumentation and Equipment Requirements

A. Following is a list of instruments and equipment required for the experiment (not including standard laboratory items):

3 each test oscilloscopes
3 each high speed scope cameras
3 each 35 mm movie cameras
5 each spare cathode ray tubes
25,000 feet 35 mm film

B. The instruments and equipment will be installed in the ZI in the aircraft in which the tests are being performed.

C. No assembly or construction is planned at the test site.

D. No calibrations are involved except those on the photographic oscilloscope in the aircraft.

E. No protective equipment or construction is required for experimental equipment.

VI. Present Status of Equipment and Instruments Required to Perform the Experiment

A. No equipment has been procured for this project. This will be done when funds are available.

B. Order was placed this month for one (1) Dumont Type 294 Cathode Ray Oscilloscope.

C. The following orders will be placed when funds are available:

2 each test oscilloscopes (Dumont)
3 each high speed cameras (General Radio)
3 each 35 mm movie cameras (possibly standard stock items)
5 each spare cathode ray tubes (Dumont)
25,000 feet 35 mm film (possibly standard stock items)

The earliest possible delivery date is desired on this equipment.

D. All special equipment other than Part VI.C will be developed by this unit.

E. There are no contractors or outside agencies doing any development and procurement for this project.

F. Commercially available equipment not yet procured or on order and estimate of number of months in which delivery can be expected:

Scope:	Dumont, Type 294 CRO	45 days
Camera:	General Radio	45 days

G. Armed Forces equipment not yet obtained: None

H. The using experimental group can build scope triggering devices, range markers, racks and time indication markers in approximately 45 days after purchase of scopes and cameras.

[redacted]

I. No technical advice and/or data are lacking and no procurement assistance is needed for this project at this time.

VII. Logistics

A. Sea Lift

1. No material involved before test.

2. No material involved after test.

B. Air Lift

1. All material will be installed in experimental aircraft in ZI.

2. The only material requiring immediate return after test is the processed film (estimated 12,000 feet 35 mm). It is not known by the experimental group what organization is to evaluate this data; therefore, its destination is not known at this time.

3. No other material after test is involved.

C. Sea Lift (personnel)

1. Two (2) airmen will be involved who should reach the forward area D-45.

2. Two (2) airmen involved in roll-up who should commence return to ZI on George plus 10.

D. Air Lift (personnel)

1. Project officer should arrive D-15 days. JTF-3 officer and Western Electric technical representative should arrive D-30 days.

Above personnel should have air transportation, since it is anticipated that the instruments and equipment to be installed for this project will be completed at a rather late date and it is necessary that these people arrive at the indicated times.

2. Personnel as outlined in Part VII.D.1 should commence return at George plus 5 days.

[redacted]

[redacted]

E. Experiment at test site will present no other logistics problems not covered above.

VIII. Collaboration

The data collected by this experiment is in the behalf of Operations Analysis Section, USAF.

IX. Responsibility

A. The person who has the responsibility for carrying out this experiment, collectiong data and reporting it is:

W. R. Boario, Air Materiel Command

B. Official address of Project Officer responsible for 8.3 project is:

Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio

Attention: W. R. Boario, MCREER-44

X. Funds

			FY 1951
01	Personnel		$ 15,000
02	Travel		2,000
04	Communications		400
09	Equipment:		
	3 Each Test Oscilloscopes	$ 4,500	
	3 Each 35 mm Movie Cameras	1,500	
	3 Each High Speed Cameras	4,500	
	5 Each Spare Cathode Ray Tubes	500	
	25,000 ft 35 mm Film	1,500	12,500
		TOTAL	$ 29,900

These funds are needed early in FY 1951 for obligations.

[redacted]

[redacted]

XI. Facilities

A. Power

Power facilities at test site are not required. Power sources (27 V DC) will be required to ground check radar equipment at the aircraft ground base.

B. Communications

1. The following time signals are required in the test aircraft:

i - $-5s \pm 0.05s$
k - $0s \pm 0.05s$

This requirement is being coordinated with personnel involved in Project 8.1.

2 None.

C. Laboratory Space and Other Facilities

Normal radar maintenance facilities are required at the aircraft base. Facilities for processing 35 mm film are also required at the aircraft ground base.

D. Forward Area Transportation

No special transportation in the forward area is required.

XII. Remarks by Project Officer

This proposal is based on the operation and maintenance of equipment for radar scope photography for two (2) B-50 aircraft only

Any photographs by O-15A radar scope cameras of standard radar plan position indicators on other aircraft in the test area should be made a part of this data.

Final circuit design and installation of any part of this equipment cannot proceed until funds are made available for this project. It is therefore requested that the funds be made available at the earliest possible date.

[redacted]

This project will require the services of one (1) Aircraft Observer (Bombardment) SSN 1037 per aircraft during tests. It is requested that this be coordinated with Headquarters furnishing crew members. One member of the Laboratory will also accompany each aircraft during tests.

[redacted]

[redacted]

27 April 1950

LAB-J-1204

[redacted]

TEST PROPOSAL

PROJECT 8.3 - PHASE B

MEASUREMENT OF EFFECTS OF ATOMIC EXPLOSIONS ON RADIO PROPAGATION

I. Object of the Experiment

A. Data are to be obtained. The effects of blast, radiation, and ionization from the explosion on the transmission and reception of radar and radio waves both direct and reflected.

B. Application of the data. Considerable differences of opinion exist as to influences or effects on the propagation and reception of radio and radar waves in the vicinity of atomic blasts. An analysis of the data from this experiment will provide basic knowledge on these phenomena for application in future planning and design. The data from this experiment and that from radar scope photography will be complimentary and each will aid in the analysis and interpretation of the other.

II. Method

A. It is proposed to cause radar and radio transmitters on selected sites to transmit on frequencies spaced throughout the spectrum and be received or reflected through the blast and be recorded on magnetic tape for subsequent measurement and analysis.

B. Plans involve the use of radar and radio on patrol ships; radio at existing stations in Japan, Guam, Okinawa, etc. and on JTF-3 sites in the Pacific and on ships assigned to TG 3.3.

C. Extent to which details of Part II.A and B are dependent on an estimated yield of the weapon, etc. The results of VHF and higher frequencies are little affected by the time of day and date. On other frequencies the resulting effect will be predicted by study of propagation charts and the [redacted] these tests the results will confirm or deny the affect of yield.

III. Details of Progress in Experimental and Theoretical Work

A. It was originally proposed to conduct this test by aural means as Project 4.4; however, it is considered that the human error would render any results inconclusive and of little value. The Signal Officer, Joint Task Force THREE, proposes the recording and subsequent analysis of data for this experiment. The data from these recordings and from radar scope photography will be complimentary and each will aid in the analysis and interpretation of the other; it is considered that they can be performed under the same project. There are no data at present for a theoretical attack of the problem. In previous tests there appears to have been noted some effects such as are proposed for recording, but the extent and nature of the effect has not previously been recorded nor measured.

IV. Personnel Requirements

A. Required at the Test Site

1. Scientific personnel

No special personnel will be required since assigned communications personnel will be utilized. Therefore, at times when message communications are silenced, the Signal Officer, JTF-3 will arrange details and instructions for the utilization of the personnel.

2. Technicians

Same as Part IV., A. 1

B. Project Work in Continental United States

1. Scientific personnel

Same as Part IV., A. 1

2. Technicians

Same as Part IV., A. 1

V. Instrumentation and Equipment Requirements

A. Following is a list of instruments and equipment required for the experiment (not including standard laboratory items):

2 Stancil-Hoffman 15 Channel Magnetic Tape Recorders with active channel indicators, time change-over mechanism and playback.
2 Stancil-Hoffman MINITAPE playbacks.
15 Stancil-Hoffman MINITAPE recorders.
3 Estroline-Angus recording type volt meters.
Accessories and Supplies for the above.

B. The instruments and equipment will be installed in the ZI.

C. Installation will be by JTF-3 personnel supervised by one engineer from Stancil-Hoffman Corporation.

D. No calibrations are to be made at the test site.

E. No protective equipment or construction is required for experimental equipment.

VI. Present Status of the Equipment and Instruments Required to Perform the Experiment

A. All equipment except recorders and playback and certain military transmitters and receivers has been obtained from Bureau of Ships and AFAMC for this project.

B. No orders were placed during month.

C. It is anticipated that orders should be placed by 15 June with the Stancil-Hoffman Corporation and the Estroline Company for the above enumerated equipment with a delivery date of not later than 15 October 1950.

D. No equipment yet to be developed.

E. No equipment partially developed.

[redacted]

F. Same as in Part VI., C.

G. S and X-band receivers and transmitters from BuShips and AFAMC in addition Signal Corps equipment already on order.

H. Installation will be by JTF-3 with a time requirement estimated to be 30 days.

I. Authority and the allotment of funds as set forth are the only requirement.

VII. Logistics

A. Sea Lift

1. Estimate 15 MT's to reach site by 15 October 1950.

2. 5 MT's, two weeks after last test.

B. Air Lift

1. No material except emergency supplies involved before test.

2. No material involved after test.

C. Sea Lift (personnel)

1. No additional personnel involved.

2. No additional personnel involved.

D. Air Lift (personnel)

1. No personnel involved.

2. No personnel involved.

E. Experiment at test site will present no other logistics problems.

VIII. Collaboration

The program will be executed by JTF-3 personnel without anticipated

[redacted]

[redacted]

Attention: Col. Leland H. Stanford

X. <u>Funds</u>

All funds will be furnished by the department.

XI. <u>Facilities</u>

A. Power

It is estimated that 3 kva 110 volt 60 cycle single phase will be required at Eniwetok. The requirements at other sites are none and within the available power normally supplied at those sites. There are no special power frequency requirements.

B. Communications

1. -15m, -5m, and -1m timing signals will be required at all sites. They will be distributed by the Communications system of JTF-3 in implementing this test program.

2. Description of the exact communications requirements will be made after the general program has been approved and after an exact analysis

of the situation. They will not exceed the frequency bands assigned to JTF-3 and will not utilize, except as already described herein, any equipment not utilized for normal communications in the tests.

C. No special requirement as this entire program will be conducted in structures assigned to and utilized by communication facilities.

D. It is contemplated that no special vehicles nor boats nor aircraft will be required for this program; however, it is contemplated to utilize aircraft and boats assigned to elements of JTF-3.

XII. Remarks by Project Officer

None

[redacted]

[redacted]

SD- 8663

6 February 1951

LAB-J- 2104

This [redacted] pages
No. [redacted] Series A

TEST PROPOSAL

PROJECT 8.3 PHASE C

AERIAL PHOTOGRAPHY DAMAGE STUDY

I. Object of Experiment

The direct damage interpretation from aerial photographs will be checked for accuracy against the actual damage determined by examination of ground photographs and inspection of the structures.

II. Method

A. It is necessary that the following be accomplished on Easy Shot only:

1. Vertical photographs will be required from an altitude of 12,000 ft. with scales of 1/6000, 1/12,000 and 1/24,000, with overlays of 53-65%, and side laps of 10-20%. Both pre-shot and post-shot coverage is desired. The photographs may be made on any convenient day, satisfactory for photography, within a few days before and after the shot.

2. Oblique photographs from an altitude of 1500 ft. at a distance of 1/4 mile and will be required for each structure grouping. Both pre-shot and post-shot coverage is desired. The photographs may be made on any convenient day, satisfactory for photography, within a few days before and after the shot.

3. Photographs taken at the time of the blast are also desired to evaluate possibility of using such photographs for bomb damage assessment.

[redacted]

[redacted]

4. Proposed flight line necessary to accomplish the photography is being furnished TG 3.4.

B. Plan of Operation

1. TG 3.4 has confirmed that one of the Program 8 B-17's will be available for the missions listed in paragraphs A.1. and A.2. above. Installation of cameras will be accomplished just prior to mission. Project Officer will be on air missions to supervise the photography.

2. Requirement of paragraph A.3. will be met by selecting photographs from pictures now scheduled to be shot at blast time.

3. Upon completion of missions, film will be couriered to Lookout Mountain Laboratory for processing, classifying and indexing. Two prints of each picture will be forwarded to Bomb Damage Assessment Section of Intelligence, Headquarters, USAF for analysis. One print of each oblique picture will be forwarded to Director, Program Three for information.

III. Personnel Requirements

A. Required at Test Site:

1. Scientific Personnel -- None

B. Technicians:

1. Project Officer -- Mr. Eugene E. Furnish, to arrive at test site about 25 March, 1951 via air transportation.

IV. Instrumentation and Equipment Requirements

Cameras required for the above photography are one (1) K-17 with 6" lens, one (1) K-17 with 12" lens, and one (1) K-18 with a 24" lens. These are being furnished by Air Materiel Command and will be ready for air shipment by 1 March, 1951. Estimate 100 lbs. weight and 15 cu. ft.

V. Responsibility

Project Officer -- Mr. Eugene E. Furnish

VI. Funds -- None required.

[redacted]