DNA1.940930.101

AG CENTRAL FILES

[redacted]

FILE # 998

VOLUME I

MONTH Jan - Dec 62

SUBJECT: ROLLER COASTER

C E R T I F I C A T E

I certify that I have had access to the attached file on the days indicated below, and that no papers or other material were removed from the file while in my possession.

NOTE: This is to be certified by each person using this file.

SIGNATURE	DATE OUT	DATE RETURNED

HRE-0800

RETURN THIS FILE TO AG CENTRAL FILES WITHIN TWO (2) WORKING DAYS.

[redacted]

1962

[redacted]

[redacted]

HEADQUARTERS FIELD COMMAND
DEFENSE ATOMIC SUPPORT AGENCY
SANDIA BASE, ALBUQUERQUE, NEW MEXICO

971

ADDRESS REPLY TO:
COMMANDER, FIELD COMMAND
DEFENSE ATOMIC SUPPORT AGENCY

27 DEC 1962

FCWT

SUBJECT: Formal Proposal for Operation ROLLER COASTER (U)

TO: Chief
Defense Atomic Support Agency
Washington 25, D. C.

1. References:

a. Letter, Ch DASA, DASATP/960 TG-63, subject: Test Program for Evaluation of Storage, Handling and Transportation Criteria for Plutonium Bearing Weapons, dated 20 August 1962, with Inclosure 1, subject: Concepts and Objectives of Proposed Plutonium Scattering Tests.

b. Letter, FC DASA, FCWT, same subject, 16 November 1962.

2. In response to reference 1a and guidance contained in the inclosure thereto, a formal proposal for Operation ROLLER COASTER is forwarded for review and approval by the Planning and Policy Committee and subsequent approval at higher levels.

3. There are several significant changes in the scientific program that have evolved since the submission of the preliminary proposal (reference 1b). They are as follows:

a. Detonation of the biophysical shot on a steel plate resting on a concrete pad. This change is contemplated in an effort to keep the cloud as free of the dirt soil as possible and thus permit a more accurate and effective study of the plutonium particulate.

b. The use of one plutonium containing weapon in each of the three CLEAN SLATE shots. This will minimize the expenditure of plutonium, and the distribution of the contaminant. If the plutonium containing weapon is located in the center of the storage array, it should be quite possible to differentiate between the plutonium associated with the cloud coming out the door and that going through the earth cover. Levels of concentration should still be well above detection limits.

Declassified by DNA; Chief, ISTS
WITHOUT INCLOSURE
Date: 2/28/90

When separated from inclosures, this document may be downgraded to ~~CONFIDENTIAL~~ UNCLASSIFIED.

[redacted]

DASA 6 5 0 0

9253

HRE - 0800

c. The biological studies are now planned to include sheep and burros as well as dogs. The addition of these animals should permit an increased capability in the biological measurements and the subsequent interpretation and evaluation of the data.

4. An analysis of estimated costs for the operation based upon guidance from AEC/NVOO for support and cost quotations for the research program show that the total cost of the program will approach $4.9 million, of which the AEC share will be $2.2 million and the DOD portion, $2.7 million. This is approximately $1.8 million in excess of the originally proposed budget of $3.1 million. The primary reasons for these higher costs are: the expense of operating in a remote area; NVOO is not budgeting for any of the support that is normally provided in a test program; and a charge of approximately $300,000 is being made for special device modification. Since ALO and FC DASA are presently developing a Memorandum of Understanding that will form the basis of the division of cost between the two agencies, it is not yet possible to have a formal concurrence by both parties on the breakout shown in Section J, Inclosure 1. This section is presented only as a forecast estimate of the cost.

5. Since the United Kingdom is a joint participant in this operation, a requirement exists to ship samples containing plutonium to Aldermaston, England, for analysis at the Atomic Warfare Research Establishment (AWRE) laboratories. Request that authority be obtained to ship up to 1,000 samples containing not more than a total of 1 gram of plutonium to the AWRE laboratories for chemical and physical analysis.

6. As of this date the availability of Stonewall Flats for the DOUBLE TRACKS event is pending. Requests for this area have been forwarded by NVOO to DMA, AEC, Washington and by FC DASA to Ch DASA for appropriate action. Resolution of problems is becoming increasingly urgent with the approaching dates for finalized planning and preparation of long lead time purchases and installations.

7. Several important actions are being held in abeyance pending approval of the final program. These include placing a request with AEC for the special devices and entering into contractor negotiations for the necessary scientific support. It is hoped that suggestions and modifications made by the Planning and Policy Committee can be incorporated in the plan at an early date and approval granted by 15 January 1963.

8. Lt Col James Dick and Mr. Darwin Palmer will be in Washington during the week of 7 January 1963 to discuss details of the formal proposal as required with the Planning and Policy Committee. Mr. Palmer is acting as an alternate for Dr. Shreve as the latter is confined to the hospital with pneumonia and is not expected to be available for the conference. It is suggested that Lt Col J. S. Ivesson, UK,

[redacted]

27 DEC 1962

FCWT
SUBJECT: Formal Proposal for Operation ROLLER COASTER (U)

be invited to Washington during this period for consultation as required by the Committee. Colonel Iveson made extensive contribution to the scientific program during its formulation.

H. C. Donnelly

H. C. DONNELLY
Major General, USAF
Commander

1 Incl
as (7 cys)

Copies furnished (w/Incls):
Chief, DASA, Washington 25, D.C., for United Kingdom w/3 cys Incl
Director, Division of Operational Safety, USAEC, ATTN: Dr. Gordon Dunning, Washington 25, D.C. w/3 cys Incl
Director, Division of Military Application, USAEC, ATTN: Lt Col D.L. Schmucker, Washington 25, D.C. w/1 cy Incl
Manager, Albuquerque Operations Office, USAEC, ATTN: Mr. Everett Mathews, Albuquerque, New Mexico w/1 cy Incl
Manager, Nevada Operations Office, USAEC, P. O. Box 1676, Las Vegas, Nevada w/1 cy Incl
President, Sandia Corporation, ATTN: Dr. J.D. Shreve, Sandia Base, Albuquerque, New Mexico, w/1 cy Incl

[redacted]

~~Secret~~

Research Program for Evaluation of Storage, Handling, and Transportation Criteria for Plutonium Bearing Weapons

Operation ROLLER COASTER

21 December 1962

Declassified WITH DELETIONS by
DNA, Chief, ISTS
DATE 9/28/94

SECRET UNCLASSIFIED CONFIDENTIAL TOP SECRET 1963 DASA

Sec A, E-H
Sec 412
513

~~EXCLUDED FROM AUTOMATIC REGRADING;~~
~~DOD DIR 5200.10 DOES NOT APPLY~~

Upon ~~approval~~ of ~~Appendix D,~~
this ~~document may~~ be down-
~~graded~~ to CONFIDENTIAL ~~or S/RD~~.

~~Secret~~ DASA Cy 4 of 10 cys, 47 pages

~~RESTRICTED DATA~~
~~Atomic Energy Act 1954~~

Dissem

[redacted]

TABLE OF CONTENTS

SECTION A. Background 1

SECTION B. Purpose and Objectives 3

SECTION C. Organization 4

SECTION D. Site Selection 5

SECTION E. Experimental Concept 6

SECTION F. Weapons Requirements and Modifications 8

SECTION G. Evaluation of Safety Hazards to On-Site or Off-Site Population 9

SECTION H. Support 10

SECTION I. Planning Schedule 13

SECTION J. Fiscal Structure 14

SECTION K. Security and Classification 16

SECTION L. Scientific Program 17

Program 2. Physical Measurements . . . . . .

Project 2.1 Soil Deposition Measurements 18

Project 2.2 Air Sampling Measurements 19

Project 2.3 Fallout Sample Collection 21

Project 2.4 Micro-meteorological Measurements 22

Project 2.5 Alpha Survey 28

Project 2.6 Special Particulate Characteristics 30

Project 2.7 Balloon Array 31

Project 2.8 Off-Site Survey 33

[redacted]

9253

[redacted]

Program 4 Biomedical . . . . . .

Project 4.1 Biomedical Studies 34

Program 5 Laboratory Analysis . . . . . .

Project 5.1 On-Site Laboratory 39

Project 5.2 Radiobiological Analysis 40

Project 5.3 Radiochemical and Physiochemical Analysis . . . 42

APPENDICES

Appendix	Title	Page
A	ROLLER COASTER Organizational Chart	A-1
B	Field Experiment Area	B-1
C	Instrumentation Arrays	
	Figure 1 - Fixed Surface Instrument Array (-2000 to +2500 feet)	C-1
	Figure 2 - Fixed Surface Instrument Array (+2500 to +50,000 feet)	C-2
	Figure 3 - Mobile Surface Instrument Array (+2500 to +50,000 feet)	C-3
	Figure 4 - Mobile Biological Sampling Array .	C-4
	Figure 5 - Mobile Balloon Supported Instrument Array	C-5
	Figure 6 - Details of Balloon Curtain at 2,500-foot Radius	C-6
	Figure 7 - Details of Balloon Curtain at 13,000-foot Radius	C-7
	Figure 8 - Details of Balloon Curtain at 50,000-foot Radius	C-8

[redacted]

APPENDICES (Cont'd)

Appendix	Title	Page
D	Device Designs	
	Figure 1 - Type I Device (Pu bearing)	D-1
	Figure 2 - Type II Device (non-Pu bearing). .	D-2
	Figure 3 - WR [redacted] HE Sphere	D-3
E	Device Arrays	
	Figure 1 - Device Array (Open)	E-1
	Figure 2 - Device Array (Closed)	E-2
F	Igloo Structures	
	Figure 1 - Igloo with 2' Earth Cover	F-1
	Figure 2 - Igloo with 8' Earth Cover	F-2

[redacted]

FORMAL PROPOSAL

SECTION A. Background

With the advent of the manufacture of plutonium at Hanford in 1944, concern for its biological effect has been foremost in the minds of individuals responsible for the health and safety of personnel working with the material. Physical and biomedical programs were carried out and subsequently, radiological standards in the form of maximum permissible levels (MPL) were established for body organs considered critical and maximum permissible concentrations (MPC) in air and drinking water. Plutonium is an alpha emitter and therefore constitutes an internal hazard only. It can enter the body via ingestion, inhalation or through cuts or abrasions. The mode of entry into the body of greatest concern is by inhalation since past research programs have indicated that insoluble plutonium oxides are not distributed by the intestine nor are they transported to any degree by the body fluid. Any particle small enough to reach the lower respiratory tract has an excellent chance of clinging to alveolar surfaces with a half life of approximately one year and causing local radiation damage. Some of the finer particulate matter so captured may be taken directly into the blood stream over a period of several days. This material stays as blood burden until its trace solubility allows eventual assimilation to the extent of some 70 percent of the material carried. This 70 percent is distributed principally in the bone where it remains indefinitely as far as the human life span is concerned since the radiological half life of plutonium is of the order of 20,000 years.

With the development and employment of "sealed-pit" or "optimized" plutonium bearing weapons, a situation arose wherein potential accident conditions existed in conjunction with transportation, storage and operational readiness that could subject not only research and industrial workers but localized segments of the general public to plutonium exposure. This could result if the device burned or underwent a one-point detonation. Extensive safety studies conducted in conjunction with the design of the new type weapon demonstrated that the destruction would be entirely non-nuclear.

The first tests to determine estimates of the plutonium contamination problem were carried out at the Nevada Test Site in November 1955 and January 1956. These studies were followed by a second field experimental program known as Project 57, Operation PLUMBOB. This was accomplished in April 1957.

The results of the above studies were used as a basis of storage and transportation criteria of plutonium bearing weapons throughout the United States. However, when overseas storage sites were established where population densities in the vicinity of the stockpiles were considerably greater than in this country and further, permissible levels of concentration were somewhat more restrictive, it became apparent that additional delineation of the exposure problem was necessary.

[redacted]

These factors led to a meeting on 12 July 1962 of representatives of the United Kingdom, the U. S. Atomic Energy Commission, and the U. S. Department of Defense. This meeting resulted in the formulation of a paper entitled "Concepts and Objectives of Proposed Plutonium Scattering Tests" in which the basic objective was, "to investigate the biological hazard of scattered plutonium and to evaluate the plutonium-scavenging effects of the earth covered storage structures".

The research program Operation ROLLER COASTER outlined in the following sections is in response to the Concept Paper.

[redacted]

SECTION B. Purpose and Objectives

The principal purpose of Operation ROLLER COASTER is to investigate the biological hazard of scattered plutonium resulting from the non-nuclear destruction of a nuclear device. Other primary purposes are to characterize the "plutonium" particulate, to determine the hazard reduction effects attributable to earth-covered nuclear storage structures, and to refine fallout forecasting techniques.

The objectives of the research program are:

a. Obtain by physical and biological measurements necessary data on the plutonium airborne particulate to permit an assessment of the acute (inhalation) hazard.

b. Measurement of the distribution of plutonium on the ground to permit detailed accountability of the amount involved.

c. To evaluate the total effectiveness of the structures, including varying thicknesses of earth cover as a scavenging material, in reducing the radiological hazard which would arise in the event of an accidental non-nuclear explosion.

d. Obtain meteorological data on this test which can be used in conjunction with a cloud model to forecast the radiological hazard to man under other weather conditions.

[redacted]

SECTION C. Organization

Operation ROLLER COASTER is a joint U. S. Atomic Energy Commission, U. S. Department of Defense, United Kingdom (AEC/DOD/UK) research program. The detailed organizational structure is contained in Appendix A. Key personnel selected are as follows:

Research Group Director - LtCol James L. Dick, USAF

Scientific Director - Dr. James Shreve, Sandia Corp.

Deputy Scientific Director - LtCol J. Stuart Iveson, UK

ALOO Coordinator - Mr. Everett Mathews

CH DASA Program Advisor - LtCol Jack C. Bentley

Scientific Planning & Policy Group:

Dr. Gordon Dunning, AEC

Dr. William Otting, DOD

Dr. Kenneth Stewart, UK

As this is a joint program with the United Kingdom, their representatives are considered an integral part of the scientific team. The UK will be represented by 12 to 15 personnel who will be integrated into the field activities. Subsequently, UK laboratory personnel will perform chemical analyses and participate in the evaluation and interpretation of the experimental results.

SECTION D. Site Selection

The shot locations for Operation ROLLER COASTER will be located in the Cactus and Stonewall Flats areas approximately twenty miles east of Goldfield, Nevada. The coordinates of Stonewall Flats are 37°33'N to 37°50'N and 116°46'W to 117°05.5'W. Ground zero has been tentatively selected as 37°45.5'N, 116°58'W. The coordinates for Cactus Flats are 37°33'N to 37°50'N and 116°30'W to 116°46'W with the three ground zeros as follows: 37°41.4'N, 116°36.4'W; 37°42.7'N, 116°37.7'W; 37°44.2'N, 116°39.4'W.

Requests for control and utilization of the subject areas have been initiated. At the present time Stonewall Flats is controlled by the Air Force and Cactus Flats is controlled by Sandia Corporation. The portion of a map including the proposed field experiment area is shown in Appendix B.

[redacted]

SECTION E. Experimental Concept

Operation ROLLER COASTER will consist of four shots:

1. DOUBLE TRACKS (biophysical and physical measurements).

One-point detonation of a modified [redacted] containing plutonium and contained in a MK 25 case. This device will be placed in a cradle 1 foot above a one-inch thick steel plate measuring 8' X 8'. The plate will rest on a 1 foot thick reinforced concrete pad, 20' X 20'. The surface soil will be statilized with oil to a radius of 50 feet.

2. CLEAN SLATE - Open (physical measurements). One-point propagation detonations of 9 modified [redacted] one of which contains plutonium. Devices will be mounted 1 foot above a pad of reinforced concrete, 24' X 24' X 6" thick.

3. CLEAN SLATE - 2' Earth Covered Igloo (physical measurements). One-point propagation detonations of 19 modified [redacted] one of which will contain plutonium. Devices will be placed in a standard storage igloo covered with two feet of earth.

4. CLEAN SLATE - 8' Earth Covered Igloo (physical measurements). Same as #3 except for 8' of earth cover and the addition of instrumented acceptor igloo.

The DOUBLE TRACKS shot is a research study designed to investigate the particulate characteristics of plutonium subjected to a one-point detonation, the acute exposure problem measured by both physical and biophysical techniques and to refine the "cloud model" and associated fallout pattern. An extensive array consisting of air samplers, fallout collectors, and animal stations extending 10 miles downwind and encompassing an area of 50 square miles or more will be set up to delineate the distribution of the plutonium. A schematic of the array is shown in Appendix C. The sampling arrays will possess maximum mobility.

The three CLEAN SLATE studies represent conditions of open storage, storage in a DASA type igloo with two feet of earth cover and a DASA type igloo with 8 feet of earth cover. As described above, 9 [redacted] one of which will contain plutonium, will be arranged (see Appendix D) on a 6" thick reinforced concrete pad measuring 24' X 24'. These devices will be detonated in sequence similar to that expected if propagation took place. Extensive physical measurements will be made. The array will be approximately 5 miles in length and 3 miles wide at the distant arc. A diagram of the array is shown in Appendix C. The arrangement of the weapons on the pad is shown in Appendix E.

The hazard reduction by earth scavenging will be determined in two experiments conducted in igloos covered by 2 feet and 8 feet of earth, respectively. Each igloo will contain 19 devices. One device in each igloo will contain plutonium. The arrays for making appropriate

[redacted]

[redacted]

physical measurements will be approximately 3 miles in length and 2 miles wide at the distant arc. A diagram of the array is shown in Appendix C. The arrangement of the weapons is shown in Appendix E. Details of the igloos are given in Appendix F.

[redacted]

[redacted]

SECTION F. Weapons Requirements and Modifications

The following devices, modified as indicated, are required:

1. DOUBLE TRACKS: One [redacted] contained in a MK 25 case and suitable for one point detonation at any detonator well. All [redacted] will be removed and replaced with depletalloy (D_{38}) of similar mass and configuration. The device will not contain any form of an initiation system.

2. CLEAN SLATE:

a. Igloo Events: (Two events). Each event will require [redacted] modified as outlined in paragraph 1. In addition, for each event, 18 HE spheres will be required which contain depletalloy similar in mass and configuration to equal the total [redacted] No device will contain any type of initiation system.

b. Open Storage Event: One [redacted] modified as outlined in paragraph 1, and 8 H E Spheres modified as outlined in paragraph 2a will be required for this event. No device will contain any type of initiation system.

Diagrams of modifications are contained in Appendix D.

[redacted]

[redacted]

SECTION G. Evaluation of Safety Precautions to On-Site or Off-Site Population

Basic criteria for site selection included a relatively flat area, for instrumentation purposes, located remotely in regard to populated area and bordered downwind by sufficient Government controlled unpopulated territory to maximize off-site safety. It is anticipated that the amount of plutonium distributed beyond the site and adjacent Government land will be negligible. The devices to be used in the program will be modified to insure no nuclear yield.

De-dudding operations will be required for both Stonewall Flats and Cactus Flats since both areas have been used as gunnery and bombing ranges. FC/DASA is initiating action to have military explosive ordnance disposal teams clean out the area.

Appropriate radiation control points will be required for Stonewall and Cactus Flats. More detail is given in the section on support.

Following the completion of the operation, adequate decontamination and/or reclamation of the area will be accomplished in accordance with presently established criteria.

SECTION H. Support

The following support will be required:

1. Arming and firing as described below:

a. One-point side detonation of a modified [redacted] located one foot above a steel pad.

b. One-point detonation of 9 [redacted] to simulate propagation. These weapons will be arranged on a concrete pad (See Appendix E).

c. One-point detonation of 19 [redacted] to simulate propagation. These weapons will be located in an earth covered igloo (See Appendix E).

d. One-point detonation of 19 [redacted] to simulate propagation. These weapons will be located in an earth covered igloo (See Appendix E).

2. Housing & Office Space: A camp site capable of housing a maximum of 300 technical and operational personnel will be required because of the remote location of the program site. Office space for approximately 100 personnel will be required from 1 April to 1 May. It is suggested that the main camp be located at 37°53'N, 116°47'W. Camp competent to serve 100 people by 15 March.

Build-up of personnel is as follows:

1 Mar 63 - 25 personnel	15 May 63 - 150 personnel
15 Mar 63 - 100 personnel	30 May 63 - 150 personnel
1 Apr 63 - 200 personnel	15 Jun 63 - 50 personnel
15 Apr 63 - 300 personnel	30 Jun 63 - 0 personnel
30 Apr 63 - 150 personnel	

In addition, two forward camp sites will be required, one located to support Stonewall Flats at 37°43.3'N and 116°49'W with alternate site at 37°47.8'N and 116°58'W and the other to support Cactus Flats at 37°43'N and 116°35'W.

These will provide office space for a maximum of 75 personnel at Stonewall and 45 at Cactus Flats, respectively, and noon messing facilities for a peak load of 250 personnel at Stonewall Flats and 150 at Cactus Flats. The period of maximum utilization of Stonewall Flats will be from 1 April to DOUBLE TRACKS shot D+15, hopefully April 30. It is anticipated that the advanced camp for Stonewall will not be required beyond D+15. The maximum utilization of the

advanced camp site in Cactus Flats will be during the period April 15 to D+3 for the 3rd CLEAN SLATE, estimated to be 2 June 1963. The relative positions of the installations are shown in Appendix B.

3. Health Physics: Access control points will be required at each area. Provisions for "suiting out" prior to entering the field and decontamination on return are required. This capability will be required at Stonewall Flats from 15 April to D+30 days. Peak load is anticipated to be 200 personnel from D-day to D+3. A similar capability with a peak of 100 personnel will be required at Cactus Flats from 30 April to D+5 days following the 3rd shot, approximately 4 June 1963.

4. Construction & Road Network:

a. Road network will be required to improve the accessibility to the experimental areas and to permit emplacement and some degree of mobility to the instrumentation array. Access roads requiring improvement will include the road that connects Goldfield to Mellan via Cactus Springs. Widening and resurfacing will be required from a point where the road intersects the 117°05'W meridian east through Cactus Springs to Mellan. A second main road will be require from the Camp Site south along the eastern edge of Cactus Flats in the vicinity of the 116°40'W meridian to the forward camp site area for CLEAN SLATE. A third main road is contemplated as a north entrance to Stonewall Flat. The main road complex is shown in Appendix B. Total distance for the main roads will be approximately 75 miles. In addition approximately 300 miles of bladed roads throughout the arrays will be required.

b. The main installation construction requirements will include the following:

(1) One 1-foot thick concrete pad 20'x20' with a 1-inch thick steel plate measuring 8'x8' placed on the concrete pad. This will be located at the GZ for DOUBLE TRACKS.

(2) One 6-inch thick reinforced concrete pad 24'x24'. This pad will be located at CLEAN SLATE GZ #1.

(3) One DASA type storage igloo measuring 12'x25'

covered with 2 feet of soil located at CLEAN SLATE GZ #2.

(4) One DASA type storage igloo measuring 12'x25' covered with 8 feet of soil located at CLEAN SLATE GZ #3.

Sketches of the igloos are contained in Appendix F.

5. Other Support: Other support will be required including photography; power including generators, wiring networks one mile downwind on each array, communications, transportation, animal shelters, and meteorological measurements. The animal shelters will be required to have a capability to house approximately 75 dogs, 140 sheep and 50 burros. The facility will be required from 15 March through 30 June. Another support item of considerable magnitude will be the procurement and handling of approximately 2,500,000 cubic feet of helium. Storage for 500,000 cubic feet will be required at any one time. This requirement will extend during the period 20 March to 15 June.

Complete details pertaining to support requirements will be worked out jointly between FC/DASA WET staff and NVOO support personnel.

FC/DASA WET staff includes:

Deputy for Operations - Lt Col Harry H. Elmendorf, USAF

Deputy for Support - Lt Col Boggs A. Robinson, USA

SECTION I. Planning Schedule

The following is a chronological sequence of events envisioned for Operation ROLLER COASTER.

25 Aug 62 - FC/DASA receives Concept Paper and is directed to prepare research plan jointly with AEC & UK.

12 Oct 62 - Acceptable organizational concept is formulated between AEC (Sandia Corp.) and DOD (FC/DASA).

19 Oct 62 - Preliminary plan is represented to CH/DASA and AEC.

25 Oct 62 - Preliminary plan is coordinated with UK representatives.

2 Nov 62 - Potential contractors are invited for a technical briefing on operation.

5 Dec 62 - Proposals from prospective contractors are received.

21 Dec 62 - Formal plan is forwarded to CH/DASA for subsequent distribution to AEC and UK.

15 Jan 63 - Approval of plan by AEC/DOD/UK.

1 Mar 63 - Meteorological measurements resumed.

15 Mar 63 - Initiate construction of igloos and shot pads.

15 Mar 63 - Camp installation to accomodate 100 personnel.

15 Mar 63 - Begin installation of scientific array.

1 Apr 63 - All scientific equipment and personnel on site and in place. Camp installation at full capacity of 300 personnel.

15 Apr 63 - Shot DOUBLE TRACKS

1 May 63 - Shot CLEAN SLATE #1 (Open Shot)

15 May 63 - Shot CLEAN SLATE #2 (Igloo - 2' cover)

30 May 63 - Shot CLEAN SLATE #3 (Igloo - 8' cover)

30 Jun 63 - Terminate field experiment and submit interim reports.

31 Dec 63 - Complete physical and chemical analyses.

15 Apr 64 - Submit final reports.

SECTION J. Fiscal Structure

The funding for Operation ROLLER COASTER is a joint venture in which the AEC will support the DOUBLE TRACKS studies and the DOD will support the CLEAN SLATE studies plus a portion of the DOUBLE TRACKS studies. The UK will provide for the travel, per diem, shipping charges and costs of expendable supplies in support of their equipment.

The current budget allocated to this operation is $3,100,000; $1,600,000 from DOD and $1,500,000 from AEC. An analysis of estimated costs forthe operation based upon guidance from AEC/NVOO for support and cost quotations for the research program indicates that the total budget required will be approximately $4,932,350 of which $2,707,100 is DOD costs and $2,225,250 is AEC costs. The detailed breakdown is as follows:

Program 2 - Physical Measurements

Project No.	Item	AEC	DOD	TOTAL
Proj 2.1	Soil Deposition Measurements	$25,000	$50,000	$75,000
Proj 2.2	Air Sample Measurements	75,000	75,000	150,000
Proj 2.3	Fallout Collection	50,000	50,000	100,000
Proj 2.4	Micromet Measurements	35,000	35,000	70,000
Proj 2.5	Alpha Survey	50,000	50,000	100,000
Proj 2.6	Special Particulate Characteristics	100,000	100,000	200,000
Proj 2.7	Balloon Array	75,000	100,000	175,000
Proj 2.8	Off-Site Survey	30,000	30,000	60,000
Program 2 Sub Total		$440,000	$490,000	$930,000

Program 4 - Biomedical Studies

Proj 4.1	Biomedical Studies	$370,000		$370,000
Program 4 Sub Total		$370,000		$370,000

Program 5 - Laboratory Analysis

Proj 5.1	On-Site Laboratory	$50,000	$50,000	$100,000
Proj 5.2	Radiobiological Analysis	200,000		200,000
Proj 5.3	Radiochem & Physiochem Analysis	150,000	150,000	300,000
Program 5 Sub Total		$400,000	$200,000	$600,000

[redacted]

Program 9 - Support

Proj 9.2,3&5	Photography	$40,000	$100,000	$140,000
Proj 9.4	Tech Info (Reports)	5,000	5,000	10,000
Proj 9.61	Road Construction	120,000	280,000	400,000
Proj 9.61	Pad & Igloo Construction		100,000	100,000
Proj 9.61	Animal Shelters	37,000		37,000
Proj 9.62	Camp Operating Costs	100,000	200,000	300,000
Proj 9.62	Camp Installation Cost	110,000	210,000	320,000
Proj 9.62	Trailers & Office Space	12,000	12,000	24,000
9.64	Rollup & Extended Control	100,000	150,000	250,000
	Radiation Safety	50,000	50,000	100,000
	Consultants	40,000	40,000	80,000
Proj 9.8	Assembly & Device	5,000	85,000	90,000
	Security	45,000	45,000	90,000
	Device Preparation	6,000	282,000	288,000
	Communications	25,000	25,000	50,000
	Transportation	20,000	20,000	40,000
Program 9 Sub Total		$725,000	$1,664,000	$2,389,000
	TOTAL	$1,935,000	$2,354,000	$4,289,000
	+15% Contingency	290,250	353,100	643,350
	TOTAL	$2,225,250	$2,707,100	$4,932,350

Since ALO and FC/DASA are presently developing a Memorandum of Understanding that will form the basis of the division of cost between the two agencies, it is not possible to have formal concurrence by both parties on the breakout shown here. This section is presented only as a forecast estimate of the cost.

[redacted]

[redacted]

SECTION K. Security and Classification

Classification guidance will be in accordance with the existing AEC/DOD Continental Classification Guide and subsequent messages on ROLLER COASTER. The term ROLLER COASTER and the fact that United Kingdom personnel are participating is unclassified.

Security requirements for admittance to the Test Site and badging of project personnel will be in compliance with AEC requirements. Specifically, requests for access to the Test Site for DOD and DOD contractor personnel will be submitted to the Security Officer, Weapons Effects and Tests, Field Command, DASA, Sandia Base, New Mexico.

Physical security at the Test Site including special weapons security will be provided by FSI Security in accordance with "Memorandum of Agreement AEC/DOD Use of Nevada Test Site Facilities, 14 January 1961.

Detailed coordination of security matters are presently underway between the Director of Security, NVOO and the Security Officer, FCWT, Field Command, DASA.

[redacted]

SECTION L. Scientific Program

The Operation ROLLER COASTER research program consists of twelve projects under the supervision of the Scientific Director, Dr. J. D. Shreve (AEC) and his Deputy, Lt Col J. S. Iveson (UK). Dr. Shreve's staff is also augmented by assistants for specialized scientific areas and a "Referee Team" for evaluating analytical procedures.

[redacted]

PROGRAM 2

1. PROJECT TITLE: Soil Deposition

2. PROJECT NUMBER: 2.1

3. PROJECT SPONSOR: AEC - DOD

4. PROJECT FUNDING: AEC $25,000 - DOD $50,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. PROJECT OFFICER: Undetermined

7. OBJECTIVE: To determine the amount, characteristics and distribution of plutonium in and around the crater, blast area, and throw-out area.

8. EXPERIMENTAL PROCEDURES:

a. This project will determine the amount, characteristics and distribution of small amounts of plutonium mixed with very large amounts of soil and debris to evaluate the scavenging effects of storage structures.

b. Prior to detonation, throw-out "catchers" will be positioned and anchored so that they will not be disturbed by blast. These catchers will be of metal construction close in and may be of heavy plastic sheeting at more distant points from GZ. The purpose of the "catcher" is to obtain samples containing only structure soil and plutonium, and thereby simplify the separation chemistry. It is estimated that the radius of significant throw-out will be about 400 feet from GZ.

c. After detonation, a preliminary radiac survey will be made to delineate the iso-deposition contours of plutonium. This survey will be from the GZ out to the limit of the significant throw-out or "massive fallout" area (greater than 1/32-inch soil deposition) which is estimated to be within a 400 foot radius of GZ. Following or concurrent with the initial survey, throw-out "catchers" will be retrieved and soil samples may be taken. Soil samples will be of two types, shallow (depth less than 15") and cores (depth of 3 feet or greater) dependent on the sampling location and depth of throw-out at a particular radius. All soil samples will be evaluated for total plutonium content and the vertical distribution of plutonium within the sample. Vertical distribution in "catchers" will be determined by sequential "sticky planchet" technique. "Catcher" samples and soil samples will be analyzed chemically for total plutonium content versus mass of debris.

[redacted]

PROGRAM 2

1. PROJECT TITLE: Air Sampling Measurements

2. PROJECT NUMBER: 2.2

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $150,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. PROJECT OFFICER: Undetermined

7. OBJECTIVES:

a. To determine the size and activity of plutonium bearing particles and their spatial distribution in the cloud and near the surface.

b. To determine the time variability of these measurements.

c. To provide a sample collection service for other projects.

d. To refine existing cloud models and, where applicable, generate new cloud models.

8. EXPERIMENTAL PROCEDURES:

a. Air sampling will be accomplished by placing cascade and Anderson impactors for particle size discrimination and lo-vol millipore samplers for total accountability throughout the predicted downwind path of the cloud. Vertical sampling of the cloud will be accomplished by mounting cascade impactors, total air samplers and "sticky" cylinders on the balloon curtains described in Project 2.7. Sixty cascade impactors, 33 total air samplers and 744 "sticky" cylinders will be mounted on the first curtain, located approximately 2,500 feet downwind. The arrangement is illustrated in Appendix C, Figure 6. A second curtain (Appendix C, Figure 7) at 13,000 feet downwind will be equipped with 44 total air samplers and several hundred "sticky" cylinders. These two curtains will be used on all four shots. On the DOUBLE TRACKS shot, a third curtain (Appendix C, Figure 8) comprised of 10 individual balloons spaced at 3° intervals, will be located 50,000 feet downwind from GZ. Each of the balloons will support 2 cascade impactors and 20 "sticky" cylinders.

b. A near-surface fixed air sampling array consisting of 57 cascade impactors and 78 total air samplers is shown in Appendix C, Figures 1 and 2. This array is supplemented by a mobile array consisting of 90 Mark II cascade impactors, 99 total air samplers, and

90 other particle sizing impactors shown in Appendix C, Figure 3. The latter array will allow greater definition of the concentration gradients in the areas of highest concentration.

c. In addition, time resolved measurements of the aerosol will be made at two radii - (7500 feet and 23,500 feet for DOUBLE TRACKS) and (7500 feet and 17,500 feet for CLEAN SLATE). At each of these radii 9 fixed stations will be distributed over a 60° arc and one mobile station will be moved to intercept the center of the cloud in the best manner practicable.

d. Project 2.2 will be concerned primarily with defining the particulate size and activity as a function of position and time. These data will be used to refine existing cloud models. Certain of the samples collected by Project 2.2 will be assigned to Project 2.6 for special characteristics analysis. In addition Project 2.2 will place and recover special collectors required by Project 2.6.

PROGRAM 2

1. PROJECT TITLE: Fallout Sample Collection

2. PROJECT NUMBER: 2.3

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $100,000

5. RECOMMENDED PROJECT AGENCY: Eberline Instrument Corporation
Santa Fe, New Mexico

6. PROJECT OFFICER: Mr. Bill Johnson

7. OBJECTIVE: The objective of this project is to make collections of the plutonium fallout to determine the total plutonium deposited on the ground, the concentration per unit area, concentration versus time of deposit, and the particle size distribution.

8. EXPERIMENTAL PROCEDURES:

a. The locations of fallout sample collectors are shown in Appendix C, Figures 1 and 2. Approximately 580 sticky plates, each containing a sticky planchet to allow quick removal and rapid on-site counting, will be placed for DOUBLE TRACKS. Soil samples will be taken as required at selected stations out to a distance of 50,000 feet. For the CLEAN SLATE structure events approximately 400 sticky plates and planchets will be placed out to a distance of 17,500 feet. Similar measurements will be made for the CLEAN SLATE open shot out to a distance of 35,000 feet for a total of 520 stations. Soil samples will be taken at selected stations. Plywood sample stands 2' x 2' in area and 2' high will be fabricated and positioned as indicated on the grid. Prior to shot time, sticky trays will be exposed, along with planchets and other sampling devices. The time of arrival and build up rate of plutonium will be determined by 30 stations distributed throughout the grid.

b. Fallout trays and soil samples will be analyzed by Project 5.2 for plutonium content as described by standard laboratory procedures. Planchets will be counted by the on-site laboratory for a "quick-look" evaluation of fallout deposition. Caution will be exercised by sample collection teams to keep cross-contamination to a minimum.

c. Selected planchets will be subjected to radioautography for particle size determination.

PROGRAM 2

1. PROJECT TITLE: Micro-meteorological Measurements

2. PROJECT NUMBER: 2.4

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $70,000

5. RECOMMENDED PROJECT AGENCY: U. S. Weather Bureau
Nevada Operations Office
Las Vegas, Nevada

6. PROJECT OFFICER: Mr. Robert Titus, USWB

7. OBJECTIVES:

a. Define meteorological parameters in the proposed test area sufficiently to place technical equipment and structures for most effective use of probable weather for cloud development, travel, and the fallout process, to minimize weather delays, and to provide an estimate of the meteorological problems for planning and forecasting.

b. Provide meteorological support including observations and forecasts for pre-event technical operations and for the safety program.

c. Document for each event the immediate pre-event and sufficient post-event winds and temperatures both surface and aloft to provide time and space detail for correlation with measurements of cloud dimensions and disposition.

8. EXPERIMENTAL PROCEDURE:

a. Discussion. It is logical to attempt to extrapolate surface-deposited particulate radiation patterns from one explosion to another explosion only using knowledge of the wind and other meteorological conditions affecting each. For example, low wind speed shortens the distribution pattern, shear in wind direction widens it, and thermal inversions can reduce cloud height and possibly shorten the pattern. With only small clouds in prospect in this operation, the meteorological elements must be measured in much greater detail and over a smaller area than is normally done. The detail is important because local variations are frequent in the terrain of southern Nevada. Complete circulations are often observed in about the same scale as the expected clouds. Measurements in sufficient detail to identify and describe fully the possible variations of this scale would involve an instrument grid spacing of about 500 feet horizontally and 50 feet vertically in the downwind direction, over an area as far as the cloud might be of interest. Since not enough instrumentation of all kinds will be available to have this close grid

spacing, all available instrumentation will be used and a strong attempt will be made to insure that the explosions occur in conditions of relatively smooth and continuous flow without smaller perturbations than can be measured.

b. Operational Procedures: The operations needed to accomplish the objectives may be readily divided into three phases:

(1) Phase I, Climatological, will involve collection of data from the event areas, primarily for statistical analysis to assist in the design of the experiments. Observing teams began this phase in October, taking data in the field starting October 23rd and continuing through November. Analysis of data will continue through January.

(2) Phase II, Climatological and Support, will be a continuation of the climatological observations in support of pre-event operations such as tethered balloons and weather forecasting studies.

(3) Phase III, Event Phase, will include installation and checkout of measurement systems and their operation through the events themselves. Weather and radiation briefings will be provided by forecasting teams and the on-site weather observational program will be enlarged.

Data obtained will be of three general types: surface winds, winds aloft, and temperatures surface and aloft:

(1) Surface wind data will be collected from 9-foot and 30-foot wind towers by continuous recording equipment which gives a record of wind speed and direction. In Phase III a telemetered network will give spatial variations. Phase III surface wind information will relate the distribution of fallout to the observed motion of the air in the shallow layer near the earth interface. Wind variability in time and space will be recorded for correlation with curvature of the fallout patterns.

(2) Winds aloft will be obtained by tracking slowly rising balloons and recording the elevation and azimuth angles of them at regular intervals, using single theodolites for optical tracking and M-33 radar for electronic tracking. The elevation and azimuth angle data are used with manual plotting and calculating methods to obtain wind speeds and directions for 500 foot increments based upon mean sea level (MSL) as reference. For most stations in the Cactus Flats-Stonewall Flats areas, the first standard winds aloft level will be 5,000 feet above mean sea level, with consecutive levels at 500-foot intervals above. In Phase III the wind increments will be attempted by 100 foot layers. Detailed sounding of the winds aloft will be made from several locations near each event using slowly rising balloons from remote releases within the array to relate larger scale air motion within the area of maximum interest to the observed fallout. Spatial wind profiles in time sequence will show short term and long term wind variability. Pilot balloon observations

will relate the lower level wind structure to the gross profile of the winds aloft at greater heights and will add data to the lower level wind profiles. Additional winds aloft data in the first three thousand feet above the surface will be obtained by means of a device which automatically and at regular intervals inflates and releases a balloon carrying a marker which is jettisoned after a short flight period. The marker is aerodynamically configured to drop straight down. The effect of the flight thus marked is to integrate the wind speed and directions in a shallow layer through which the balloon passed as would be done by a falling particle. By measuring the bearing and distance of the marker from the point of origin a mean layer wind is produced with simple calculations.

(3) Temperatures aloft will be obtained by using a modified radiosonde instrument carried aloft by balloon. The modification permits continuous temperature recording through electronic receiving and display equipment on the ground. Detailed soundings of temperature versus height will be made prior to and during each event. These soundings will establish the thermal structure of the atmosphere in the layers above the event area and produce criteria for evaluation of the vertical stability of the air. This will relate cloud rise with atmospheric temperature equilibrium.

<u>Approximate Observational Program</u>. Cactus Flats and Stonewall Flats

Phase I: 1 December 1962 to 15 February 1963

A. Surface Winds
   1. Frequency: continuous recording
   2. Location: Cactus Flats
      a) Two 9 ft. towers - coordinates Mellan 766308 & 654332
      b) One 30 ft. tower - coordinates Mellan 709279

      Stonewall Flats
      a) Two 9 ft. towers - coordinates Cactus Springs 591932 & 035700
      b) One 30 ft. tower - coordinates Cactus Springs 011703 to be shifted to 000628 when clear

B. Single theodolite observations
   1. As required

Phase II: 1st Period, 15 February to D-4 weeks

A. Winds Aloft - Single theodolite observations
   1. Frequency: Hourly, 0500-1100 PST, Monday through Friday alternate weeks at each site
   2. Location: One in each flat
   3. Height: To 10,000 ft. above the surface
   4. Additional observations as required by support operations

2nd Period, D-4 weeks to D-1 week

A. Winds aloft - Radar observations
   1. Frequency: Daily 0700, 1000, 1600 and 1800 PST.

2. Location: Two locations upwind and to either side of GZ; dependent upon chronological order of events as to site.

3. Height: To 10,000 ft. above surface

B. Surface winds
1. As in period 1 Dec-15 Feb
2. Installation of two anemometers vicinity of each event GZ to be telemetered to CP weather trailer. After event shift to next event GZ area. Continuous recording, 9 ft. above surface.

C. Temperature sounding
1. Frequency: Daily at 0600 and 1400 PST
2. Location: Mobile trailer, as required
3. Height: To 5,000 ft. above surface

D. Mean Layer winds
1. As in periods 15 Feb to D-4 weeks

Phase III: 1st Period, D-1 week to D-2 days (Each event)

A. Winds Aloft - Radar observations
1. As in period D-4 weeks to D-1 week

B. Surface winds
1. As in period D-4 weeks to D-1 week

C. Temperature soundings
1. Frequency: Hourly 0400-1000 PST daily
2. Location: Mobile trailer as required
3. Height: To 5,000 ft. above surface

D. Mean Layer winds
1. As in period 15 Feb to D-4 weeks

2nd Period D-2 days to H-4 hours

A. Winds Aloft - Radar observations
1. Frequency 0400, 0600, 0800, 1600 PST daily additional run 1900 PST D-1 day
2. Location - Two locations upwind and to either side of GZ
3. Height - To 10,000 ft. above the surface

B. Surface winds
1. As in period D-4 weeks to D-1 week

C. Temperature Soundings
1. As in period D-1 week to D-2 days

D. Mean Layer winds
1. As in period 15 February to D-4 weeks

3rd Period, H-4 hours to H hour (Each event)

A. Winds Aloft - Radar observations
1. Frequency - Hourly plus additional observation at H-30 minutes
2. Location - Two locations upwind and to either side of GZ
3. Height - To 10,000 ft. above the surface

B. Surface Winds
1. As in period D-4 weeks to D-1 week

C. Temperature Soundings
1. Frequency - Hourly
2. Location - Mobile trailer, as required
3. Height - To 5,000 ft. above the surface

D. Mean Layer Winds
   1. As in period 15 Feb to D-4 weeks, to be read as area becomes available after event
E. Single theodolite observations
   1. Frequency - Hourly commencing H-2 hours
   2. Location - Three sites located downwind for documentation
   3. Height - To 10,000 feet above the surface

4th Period, H hour through documentation period (Each event)

A. Winds aloft - Radar observations
   1. Continuation of hourly observations as previously
B. Surface winds
   1. Continuous recording
C. Temperature Soundings
   1. Hourly observations to H+1 hour
D. Mean layer winds
   1. As in period 15 Feb to D-4 weeks, to be read as area becomes available.
E. Single theodolite observations
   1. Continuation of hourly observations

The above schedule will be subject to change depending on availability and performance of instruments, availability of manpower, and conflict with other test programs. Although not included above, this office is prepared to operate meteorological instrumentation furnished by other agencies and governments.

United Kingdom Studies

The measurements outlined by the USWB are to be supplemented by measurements in the micro-meteorology field by the United Kingdom. These measurements will commence 6 weeks pre-shot and will consist of:

a. The temperature profile.
b. The turbulence profile.
c. Attempts to determine the "length of scale" of the turbulence.
d. The wind speed profile.

These measurements are made:

a. From two towers 600 feet apart and in a line upwind of ground zero, the nearer tower as close to GZ as safety permits.

b. From two balloons in the general area of the towers.

TEMPERATURE

a. From balloon (tethered). Ten thermistor devices will be mounted at 100 ft increments to 1,000 ft. A continuous record will be obtained.

b. From one 120 ft tower. Ten thermistors at 12 ft intervals continuously recorded.

TURBULENCE PROFILE. Lateral and vertical turbulence will be measured at 30 ft, 80 ft, and 120 ft from the two towers and at 250 ft and 730 ft from a tethered balloon.

The length scale of the turbulence will be investigated from the two towers separated by 600 ft. Further data will be obtained from the USWB stations.

The wind speed profile will be measured from one of the towers at five heights and from the tethered balloon at the heights of the turbulence meters.

PROGRAM 2

1. PROJECT TITLE: Alpha Survey

2. PROJECT NUMBER: 2.5

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $100,000

5. RECOMMENDED PROJECT AGENCY: U. S. Army Nuclear Defense Laboratory
Edgewood Arsenal, Maryland

6. PROJECT OFFICER: Capt Burton J. Conway
U. S. Army Nuclear Defense Laboratory
Edgewood Arsenal, Maryland

7. OBJECTIVES:

a. To provide large area radiac survey of the plutonium contaminated area and establish contamination level contours.

b. To correlate, by chemical analysis, plutonium radiac meter readings with absolute surface levels of plutonium deposition.

c. To provide data concerning distribution and concentration of plutonium on the ground in support of other projects, and provide a higher sampling density than is practicable by radiochemistry alone.

8. EXPERIMENTAL PROCEDURES:

a. The alpha survey grid will be established in conjunction with other sampling grids. It will be contained primarily within the grid layout area established for Projects 2.1, 2.2, and 2.3. Some deviation from these grids is required in order that close-in surveys as indicated on Appendix C, Figure 1 (Fixed Surface Instrument Array, -2000' to +2500') can be accomplished most expeditiously. Dimensions and layout of the alpha survey grid are shown as part of said figure. Brushed concrete pads will be placed at each grid line intersection from minus 2000 feet extending through GZ up to plus 2500 feet. From plus 2500 feet through the remainder of the downwind array up to 50,000 feet (see Appendix C, Figure 2), brushed concrete pads will be placed on 16 arcs, with 3/4° separation as a minimum, plus some possible augmentation between established arcs as desired. Clusters of similar blocks will be placed at suitable locations downwind to determine the uniformity of distribution of plutonium over a given area as compared to a single block.

b. The radiac survey will be conducted by several two-man teams equipped with Eberline PAC-3G survey meters, Eberline PAC-1SA survey meters, Eberline PG-1 plutonium probe, and other suitable portable radiac instruments. All members of the survey teams will wear protective

clothing and those surveying within 200 feet of GZ will be required to wear self-contained breathing apparatus until the contamination levels can be well-defined.

c. Each survey team will enter the grid area at designated entry points as soon as practicable after the contamination has been deposited. Each team will proceed in a crosswind direction relative to the array on a designated path and will monitor and record readings at each concrete pad. The monitoring survey must be accomplished as rapidly as possible, consistent with accuracy and the prevention of excessive cross-contamination caused by resuspension.

PROGRAM 2

1. PROJECT TITLE: Special Particulate Characteristics

2. PROJECT NUMBER: 2.6

3. PROJECT SPONSOR: AEC - 50%, DOD - 50%

4. PROJECT FUNDING: $200,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. RECOMMENDED PROJECT OFFICER: Undetermined

7. OBJECTIVES: The objective of this project is to provide a capability to investigate special characteristics of plutonium compound particles formed during a one-point detonation of a plutonium bearing nuclear weapon.

8. EXPERIMENTAL PROCEDURES:

a. The complex nature of chemical reactions involving plutonium is not well known, particularly when these reactions occur in a non-homogeneous environment, and are influenced by many variables which cannot be predetermined.

b. In order to define some of the more important characteristics of the plutonium particulate, special collection techniques, such as water-filled collection vessels, electrostatic precipitators, and other diversified collection equipment will be used in limited numbers at specific locations to obtain samples other than those collected in the normal grid array. These samples will be analyzed by very rigorous scientific techniques to provide data concerning solubility, chemical reaction selectivity, plutonium distribution within the particle, size and shape, frangibility, and others. Laboratory techniques to be employed in these intricate characterization studies will include radioautography, investigations by high powered optical and electron microscopy, high density liquid flotation and rate of fall studies, solubility studies under varying pH conditions, electron diffraction studies, and neutron activation analysis.

c. A referee team will review continuously the work of the various laboratories throughout the analysis program to ensure that the very best techniques are used in the chemical analyses and the highest degree of accuracy and consistency are maintained throughout the program.

PROGRAM 2

1. PROJECT TITLE: Balloon Array

2. PROJECT NUMBER: 2.7

3. PROJECT SPONSOR: AEC - DOD

4. PROJECT FUNDING: AEC - $75,000, DOD - $100,000

5. RECOMMENDED PROJECT AGENCY: Sandia Corporation

6. PROJECT OFFICER: Mr. H. G. Laursen

7. OBJECTIVES:

a. To provide a mobile vertical support mechnaism suitable for positioning cloud sampling instrumentation to intercept the cloud at several locations downwind from the source.

b. To provide a vertical support for meteorological instrumentation at two fixed locations in each experimental area.

8. EXPERIMENTAL PROCEDURES:

a. The balloon curtains will provide for a vertical array of instruments for sampling of the particulate in the clouds of the respective shots. In DOUBLE TRACKS, a mobile balloon curtain consisting of a 6000 pound lift balloon with a cable rack 750 feet high and 1500 feet wide will be located approximately 2500 feet downwind from GZ. A similar curtain 750 feet high and 7500 feet wide will be located at 13,000 feet downwind. A third curtain, to be used for DOUBLE TRACKS only, consisting of ten (10) small individual balloons, each to support a single string of instruments, will be located at 50,000 feet downwind from GZ. The mobile array is illustrated in Appendix C, Figure 5. For the CLEAN SLATE events, only the first two curtains will be used, the close-in at 2500 feet and the second at 13,000 feet, both elevated to 1800 feet. Details of the balloon curtains are shown in Appendix C, Figures 6, 7, and 8.

b. The mobile balloon curtains will be designed to move at approximately 2 MPH. Arrays beyond 5000 feet from GZ may be moved continuously. Arrays less than 5000 feet from GZ cannot be moved after H-20 minutes. The balloons for supporting meteorological instruments will be rigged similarly as shown in Appendix C, Figure 8, with the exception that anchors will be fixed, not mobile.

c. The project officer will be responsible for all phases of procuring and operating all balloons, rigging, associated power distribution systems, and safety throughout all phases of balloon array operations.

The responsibilities for placing and recovering all instrumentation associated with these balloon arrays shall remain with the appropriate instrumentation project.

[redacted]

PROGRAM 2

1. PROJECT TITLE: Off-site Survey

2. PROJECT NUMBER: 2.8

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $60,000

5. RECOMMENDED PROJECT AGENCY: U.S. Public Health Service
Las Vegas, Nevada

6. PROJECT OFFICERS: Mr. Jack Coogan, USPHS
Mr. John McBride, USPHS

7. OBJECTIVES:

a. To provide data on the low-level distribution of plutonium beyond the limits of the experimental grid used in Operation ROLLER COASTER.

b. To insure that the off-site population is not exposed to significant plutonium contamination.

c. To provide additional scientific input that will allow a more accurate accounting procedure for total plutonium distribution.

8. EXPERIMENTAL PROCEDURES:

a. Off-site locations to a 100 mile radius from the ROLLER COASTER grids will be instrumented with fallout collection media and air sampling equipment which will be oriented toward very low level detection and sampling. These sampling locations will be established on existing roads and will be concentrated near populated areas. In addition, the regular off-site PHS network will provide samples from each station around the test site. Samples collected at these off-site locations will be analyzed in a manner similar to that described for Project 5.3. This information and data will be used to evaluate any potential exposure of off-site personnel to plutonium particulate. In addition, this data will be available to the scientific personnel responsible for on-site survey as an adjunct to refine total plutonium accountability and distribution.

b. If work load permits, airborne air samplers will traverse the cloud area after it is beyond the test array to determine off-site airborne cloud concentrations and particle size distribution.

[redacted]

PROGRAM 4

1. PROJECT TITLE: Biomedical Studies

2. PROJECT NUMBER: 4.1

3. PROJECT SPONSOR: AEC

4. PROJECT FUNDING: $370,000

5. RECOMMENDED PROJECT AGENCY: Biophysics Division
Air Force Special Weapons Center
University of Rochester
Rochester, New York

6. PROJECT OFFICER: Mr. Robert Wilson, University of Rochester

7. OBJECTIVES:

a. To determine the lung burden and early clearance of deposited inhaled plutonium in three species of animals.

b. To determine the translocation throughout the animal's body of inhaled plutonium and elimination as influenced by time following exposure.

c. To relate the uptake and retention of the aerosol by animals to sampling by physical measurements.

d. To evaluate by biophysical measurements the radiation exposure to man resulting from the accidental non-nuclear detonation of a plutonium bearing weapon.

8. EXPERIMENTAL PROCEDURE:

a. General Information.

It is proposed that three species of animals (burros, sheep and dogs) be exposed to the plutonium cloud from a one-point detonation. The burro is selected because its submacroscopic respiratory anatomy very closely approximates that of man. The second is chosen because the sheep is comparable to man in size and breathing rate; its pulmonary anatomy is quite similar; and the probability of plutonium intake by ingestion is low. The dog is chosen because of its previous use in such work and because of the considerable amount of data on inhalation by dogs of plutonium aerosols. Careful correlation of results from these animals will make the problem of extrapolation to man simpler and estimates of hazard more defensible. Determinations will be made of lung clearances at early times for all three species, and this will be extended sufficiently long in time to permit measurements of the lung burden of long-residence-time plutonium. Translocation of plutonium will be studied in

detail in sheep to determine not only plutonium deposition in and removal from the lung but also what other sites, if any, tend to accumulate plutonium over extended periods of time. These parallel studies thus consist of a lung burden determination in three species and a translocation or distribution-excretion determination in one species (sheep).

A study will be initiated at the AFSWC Radiation Effects Laboratory to determine lung changes in X-ray exposed animals. Thirty dogs will be given known X-ray dosages to the lungs approximating the α -radiation dosages that the plutonium-exposed dogs will receive. These animals will be maintained for the same length of time as the long term plutonium animals. They will be examined for any pulmonary or physiological changes. At sacrifice, pathological examination will be made to determine any changes. The eventual aim of this study is to determine a Relative Biological Effectiveness of alpha radiation to the lung.

The air sampling requirements for the biological program will be met by the physical program. Requirements for the information needed will be developed, and the choice of numbers and kinds of instruments needed to provide this information will be left to the discretion of the physical measurements program.

There is a need to develop quartering facilities for these animals. The dogs present the greatest housing problem since they are not normally desert dwellers and will need protection against the rigors of the desert climate. It is therefore proposed to obtain trailers to house the dogs. These can be located at a convenient point on the site, thereby minimizing time lost and hazard presented as a result of excessive travel. Pens and shelters against dust are needed for the larger animals. The latter takes on particular emphasis since this is an inhalation study, and inordinate lung burdens of inert dust may jeopardize good results from a plutonium inhalation study.

Since it is intended to maximize the exposures of the animals, somewhat restrictive weather requirements have been posed. An inversion is needed to limit cloud rise; winds should not exceed 5-10 knots and steady in direction; and shear must be less than 30°.

A time table has been formulated which represents absolute deadlines for the various aspects of test implementation. If this experiment is to be performed as planned, it is absolutely essential that no single date on this time table be allowed to slip. It will be noted that the time table calls for a ready date of 15 April 1963.

b. Pre-test Studies.

Procurement of animals according to the established time-table is essential in order that those animals from other climates and elevations can become adjusted to the climatology at the Stonewall Flats Site. This is less of a problem with sheep and burros because their location of origin can be selected to correspond with the Test Site. Dogs will be procured from non-desert locations near sea level, and a period of acclimatization is required.

In addition to acclimatization, it is necessary to have base line data on all animals in order to establish norms and variances for these particular populations if any valid deductions are to be made from the data obtained. Such studies require:

(1) Physical examination and history development.

(2) Three blood counts (RBC and WBC).

(3) Body weight on receipt and prior to exposure.

(4) Lung X-rays.

(5) De-worming (sheep only).

(6) Establishment of normal respiratory parameters on as many animals as possible.

(7) Coding and randomization of animals to insure statistical validity of data obtained.

(8) Development of an effective system for recording and processing data.

At least two weeks prior to the scheduled detonation, all personnel and animals are to be transported to the Test Site. Dry runs will be performed to evaluate animal loading, handling, and wrapping procedures.

c. Animal Exposures.

It is proposed that 70 Beagles, 50 burros, and 140 sheep be exposed to the plutonium cloud at several ranges downwind. The planned distances are 500' down-range (A); at one-half the predicted distance to maximum airborne concentration at ground level (B); at this predicted distance (C); and at twice the predicted distance (D). It should be recognized that there is no intent to use animals as samplers for determining this distance; rather, this array represents recognition that there is some error in prediction possible. Greatest emphasis is placed on location C, since it is not practicable to populate all ranges to the same extent, and it is believed that the meteorological conditions set down for detonation will permit adequate exposure of animals at all ranges.

The animals will be placed on hay racks or some similar mobile platform to permit rapid and accurate location (or relocation) on the array. Range A will have only 10 sheep for determination of lung burden at this distance. Range B will have 10 dogs and 10 sheep, also for lung burden determination. Range C will have 50 dogs, 50 burros, and 110 sheep. Range D will have 10 dogs and 10 sheep for lung burden determination. The dogs and burros will be used to determine initial respiratory tract deposition and early-time lung clearance. The sheep will provide information on these parameters and also on tissue redistribution. Figure 4, Appendix C illustrates the mobile biological sampling array.

During cloud passage an effort will be made to monitor respiratory rates on some animals. As soon as possible after cloud passage, the animals will be recovered and decontaminated.

d. Sacrifice.

As soon as possible after recovery, 10 animals of each species will be sacrificed from Range C. These will be autopsied and lung and both femurs will be collected. At the time of collection a sample of lung tissue and one femur will be set aside for pathology and autoradiography. The latter study will be done only if chemical analysis indicates the presence of plutonium. This sacrifice will give an indication of initial lung deposition. On D+1, 10 animals of each species from Range C will be sacrificed, and the same tissues taken. In addition, liver, hilar lymph nodes, and GI tract and contents will be taken from the sheep. On D+3, 10 animals of each species from Range C will be sacrificed and tissue collection will duplicate that on D+1, except that sheep will be sacrificed, and lung and femurs will be taken. On D+5, 10 sheep and 10 dogs from Range B will be sacrificed, and lung and femurs will be taken. On D+6, 10 sheep from Range A will be sacrificed and the same tissues taken. On D+7, 10 of each species from Range C will be sacrificed, and the same tissues will be taken. D+14 will duplicate D+7.

At this time, 60 sheep from Range C will remain, all other animals having been sacrificed. The remaining animals will be sacrificed, 10 at a time, 30, 90, and 180 days, and 1, 2, and 3 years post-exposure. Lung, liver, hilar lymph nodes, and femurs will be taken. At each sacrifice point one control animal for each species represented will be sacrificed and autopsied at the same time and in the same manner as a measure of contamination control. When tissue collection for pathological examination is specified, an additional control animal will be sacrificed for pathological control samples.

e. Elimination Studies.

As soon as possible after removal from the field and decontamination, the sheep scheduled for the 3-year sacrifice will be placed in metabolism cages and urine and feces will be collected for the first eight days. Thereafter, 5-day collections will be made on these same sheep at the same times that the other long-term sheep are sacrificed. [redacted]

f. Chronic Inhalation Studies.

It is recognized that an evaluation of the hazard attributable to the inhalation of resuspended plutonium can probably be accomplished as satisfactorily and with much less effort by using appropriate sampling instruments as by using animals. Therefore, no chronic inhalation studies with animals are proposed, but it is urged that the physical measurement program undertake an instrumental investigation of this aspect.

g. Operational Time Table.

1 - 7 March 1963	Receive animals
1 March 1963	Completion of facilities at Test Site
1 March 1963	Personnel and animals arrive at Test Site
15 April 1963	First Ready Date

PROGRAM 5

1. PROJECT TITLE: On-Site Laboratory

2. PROJECT NUMBER: 5.1

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $200,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. PROJECT OFFICER: Undetermined

7. OBJECTIVES:

a. To provide for sample collector preparation.

b. To provide for on-site calibration of instrumentation.

c. To provide for sample retrieval and packaging.

d. To provide for on-site instrumentation repair and maintenance

e. To provide for on-site counting of selected samples.

f. To provide for on-site chemical analysis of selected samples.

g. To provide for decontamination of instrumentation for subsequent experiments.

h. To provide for sacrifice of the animals and collection of appropriate biological specimens.

8. EXPERIMENTAL PROCEDURE: The on-site laboratory is designed to provide a capability to prepare sample collectors, calibrate and maintain instrumentation, store and package samples, and make preliminary measurements of the radioactivity of the samples by physical and chemical means. The facility will consist of 10 trailers with specialized equipment as required and located in the immediate vicinity of the control point. Following the Stonewall shot the laboratory will be moved to the Cactus Flats control point. Trailers for use in handling the biological specimens will remain at Stonewall Flats control point as long as required.

PROGRAM 5

1. PROJECT TITLE: Radiobiological Analysis

2. PROJECT NUMBER: 5.2

3. PROJECT SPONSOR: AEC

4. PROJECT FUNDING: $100,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. PROJECT OFFICER: Undetermined

7. OBJECTIVES:

a. The primary objective of this project is to provide accurate laboratory analysis of animal tissue, bone material, feces, urine, and other animal associated samples for plutonium content in support of the biological measurements portion of the DOUBLE TRACKS event.

8. EXPERIMENTAL PROCEDURE:

a. Radiobiological and radiochemical analysis of various organs and components of the 3 biological species will be a complex, time consuming and exacting process. The importance of accuracy and proper sample handling, processing, and care cannot be overemphasized. In many cases, proper preparation, handling, and sacrifice procedures, and sampling techniques are more vital than actual laboratory procedures. Analyses which may be required for each animal of each species may consist of one or all of the following types of samples:

(1) Bone content - femur

(2) Tissue content

(a) lung

(b) liver

(c) hilar lymph nodes

(d) GI tract

(3) Metabolism products

(a) GI tract contents

(b) feces

(c) urine

b. Laboratory procedures for determining plutonium content will necessarily vary with the type of biological sample. Basically, the

plutonium will be isolated from the sample by leaching, ashing, washing, fusion, anion exchange, solvent extraction, sedimentation or any other procedure particularly suited to the type of sample. After separation and purification, the plutonium will be deposited on platinum discs and counted in 2 pi geometry with a low background alpha counter to determine total plutonium content. In the case of very low level samples, alpha sensitive emulsions may be used in conjunction with the discs and an appropriate exposure time period to produce radioautographic records which can be counted with a microprojector. A tracer such as Pu_{236} may be incorporated in the laboratory procedure to verify and check the percentage loss of plutonium during laboratory processing.

c. A referee team will be formed to review continuously the work of the various laboratories throughout the analysis program to ensure that the very best techniques are used in the chemical analyses and the highest possible degree of accuracy and consistency are maintained throughout the program.

PROGRAM 5

1. PROJECT TITLE: Radiochemical and Physiochemical Analysis

2. PROJECT NUMBER: 5.3

3. PROJECT SPONSOR: AEC 50% - DOD 50%

4. PROJECT FUNDING: $300,000

5. RECOMMENDED PROJECT AGENCY: Undetermined

6. PROJECT OFFICER: Undetermined

7. OBJECTIVES: To provide laboratory analysis of soil, filters, collection media, and other debris for plutonium content for other projects of Operation ROLLER COASTER.

8. EXPERIMENTAL PROCEDURES:

a. Other projects in Operation ROLLER COASTER will collect many plutonium bearing samples by a variety of methods utilizing diversified sample collection media. These samples will be returned to a laboratory and analyzed to provide the following data:

(1) Total Plutonium content.

(2) Plutonium concentration per unit of area or volume.

(3) Particle size distribution.

(4) Chemical composition.

b. Sample collection, preparation and handling techniques will be carefully established for each type of sample to be processed so that minimum deviation from a "standard field sample" is achieved. The laboratory will perform analyses on the following types of samples which will be collected in Operation ROLLER COASTER:

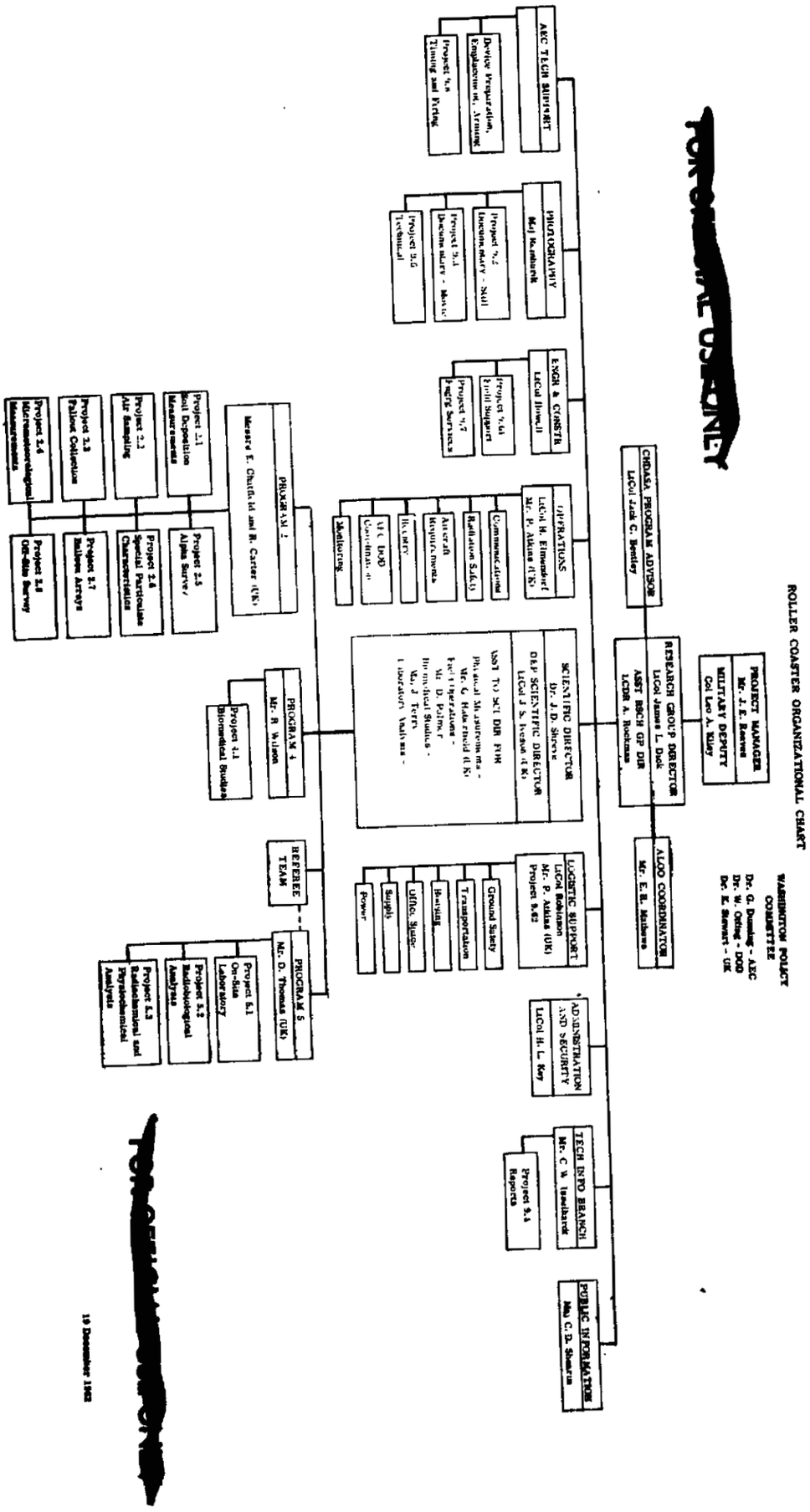
(1) Air Samples - Volumes of air passed through glass, paper, liquid or other filter material will be analyzed for data as previously outlined. The plutonium may be mixed with dirt or debris and collected as a total sample or incremental portions.

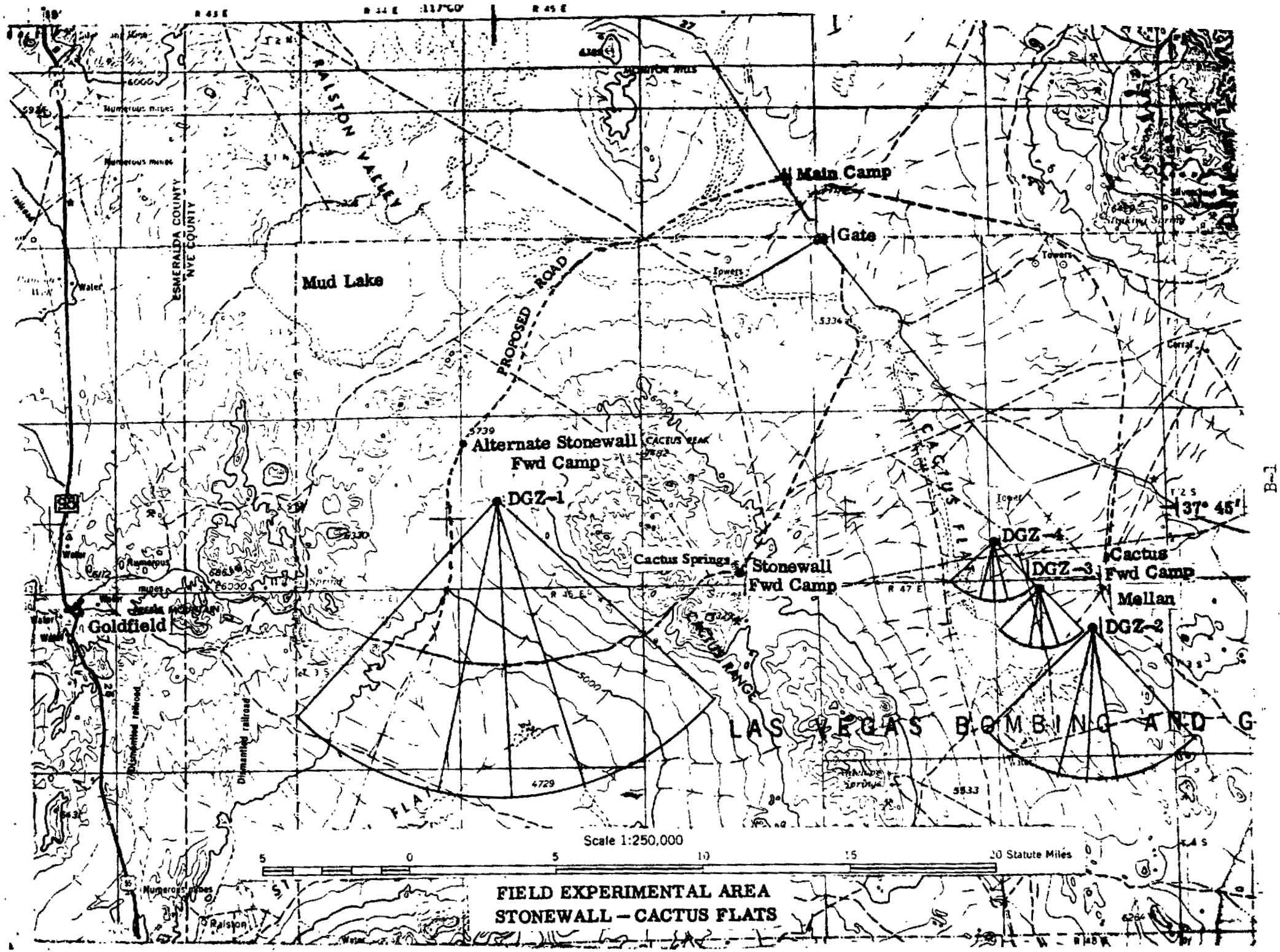
(2) Deposition and Fallout Samples - Debris containing plutonium will be deposited on or mixed with soil or collection media over an extended grid array. Analyses for data as previously outlined will be accomplished on samples mixed with soil, organic resins, paper and other collection media.

c. Standard laboratory procedures established for plutonium analysis and radioactive particle sizing will be used.

d. A referee team will be formed to review continuously the work of various laboratories throughout the analyses program to insure that the very best techniques are used in the analyses and the highest possible degree of accuracy and consistency are maintained throughout the program.

APPENDIX A


ROLLER COASTER ORGANIZATIONALL CHART
PROJECT MANAGER
Mr. J. E. Reeves
MILITARY DEPUTY
Col Leo A. Kiley
WASHINGTON POLICY COMMITTEE
Dr. G. Dunning - AEC
Dr. W. Offing - DOD
Dr. E. Stewart - UK
CHDASA PROGRAM ADVISOR
LtCol Jack C. Bentley
RESEARCH GROUP DIRECTOR
LtCol James L. Dock
ASST RSCH GP DIR
LCDR A. Rockman
ALOO COORDINATOR
Mr. E. B. Mathews
AEC TECH SUPPORT
Device Preparation, Emplacement, Arming
Project 4.8 Timing and Firing
PHOTOGRAPHY
Maj Nussbaum
Project 4.4 Instrumentary - Still
Project 3.1 Instrumentary - Motion
Project 3.6 Technical
ENGR & CONSTR
LtCol Howell
Project 4.6 Drill Support
Project 4.7 Bldg Services
OPERATIONS
LtCol H. Ellenwood
Mr. P. Atkins (UK)
Communications
Radiation Safety
Aircraft Requirements
Security
SAC DoD Coordination
Meteorology
SCIENTIFIC DIRECTOR
Dr. J.D. Shreve
DEP SCIENTIFIC DIRECTOR
LtCol J. S. Irvine (UK)
ASST TO SCI DIR FOR
Physical Measurements - Mr. G. Hakenfield (UK)
Facility Operations - Mr. D. Palmer
Biomedical Studies - Maj J. Ferry
Laboratory Analysis -
LOGISTIC SUPPORT
LtCol Robinson
Mr. P. Atkins (UK)
Project 5.62
Ground Safety
Transportation
Housing
Utilities Support
Supply
Power
ADMINISTRATION AND SECURITY
LtCol H. L. Kay
TECH INFO BRANCH
Mr. C. W. Isenhardt
Project 5.4 Reports
PUBLIC INFORMATION
Maj C. D. Shearin
PROGRAM 2
Meserve E. Chaffee and R. Carter (UK)
Project 2.1 Soil Deposition Measurements
Project 2.2 Air Sampling
Project 2.3 Fallout Collection
Project 2.4 Microseismographical Measurements
Project 2.5 Alpha Survey
Project 2.6 Special Particulate Characterization
Project 2.7 Balloon Arrays
Project 2.8 Off-Site Survey
PROGRAM 4
Mr. R. Wilson
Project 4.1 Biomedical Studies
REFEREE TEAM
PROGRAM 5
Mr. D. Thomas (UK)
Project 5.1 On-Site Laboratory
Project 5.2 Radiobiological Analysis
Project 5.3 Radiochemical and Physicochemical Analysis
19 December 1962


Main Camp
Gate
Mud Lake
RALSTON VALLEY
PROPOSED ROAD
ESMERALDA COUNTY
NYE COUNTY
Alternate Stonewall
Fwd Camp
DGZ-1
Cactus Springs
Stonewall
Fwd Camp
DGZ-4
DGZ-3
Cactus
Fwd Camp
Mellan
DGZ-2
Goldfield
CACTUS RANGE
LAS VEGAS BOMBING AND G
37° 45'
Scale 1:250,000
5 0 5 10 15 20 Statute Miles
FIELD EXPERIMENTAL AREA
STONEWALL – CACTUS FLATS

B-1

APPENDIX C

[redacted]

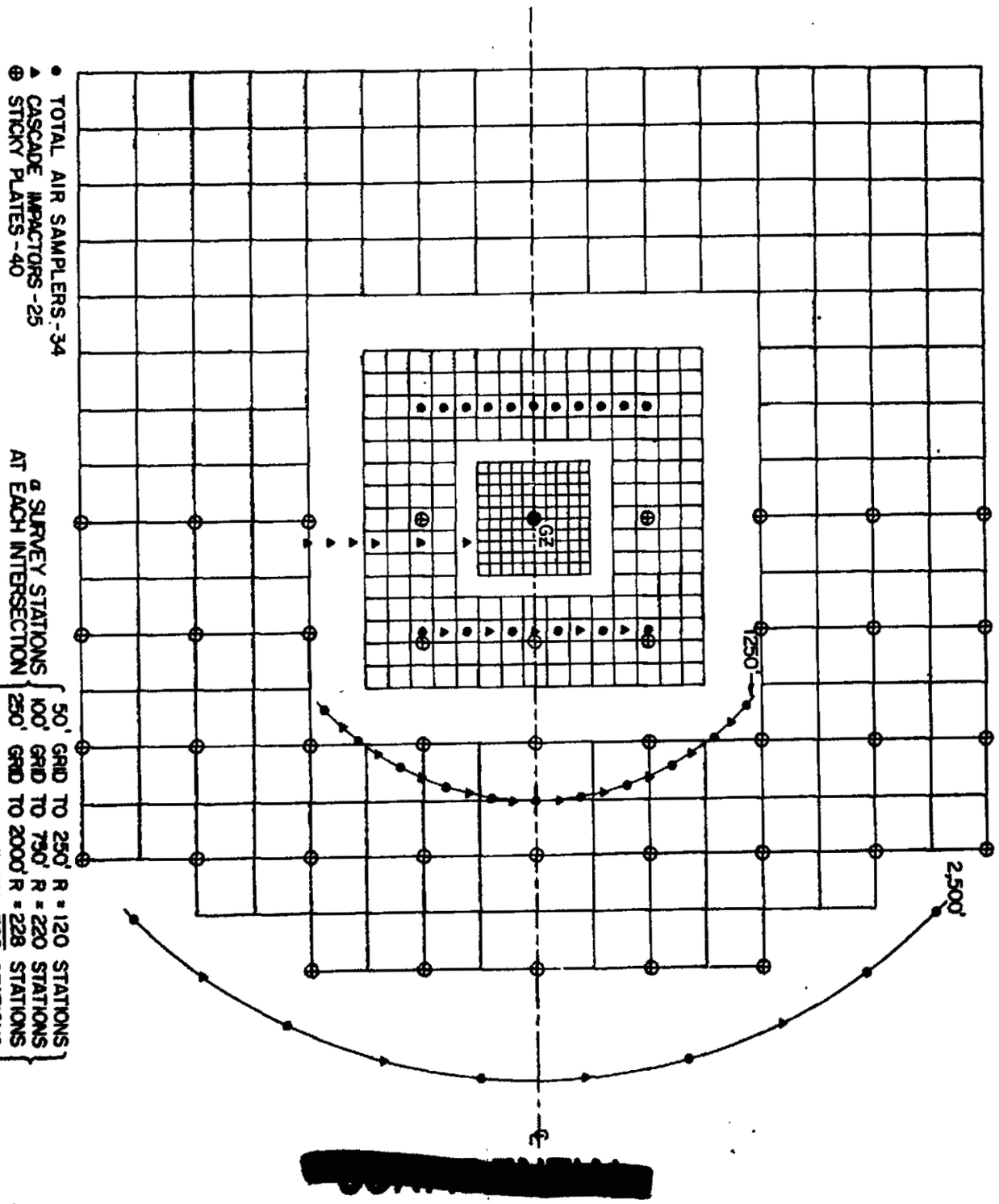


Figure 1. Fixed surface instrument array (−2,000 to +2,500 feet).

[redacted]

APPENDIX C

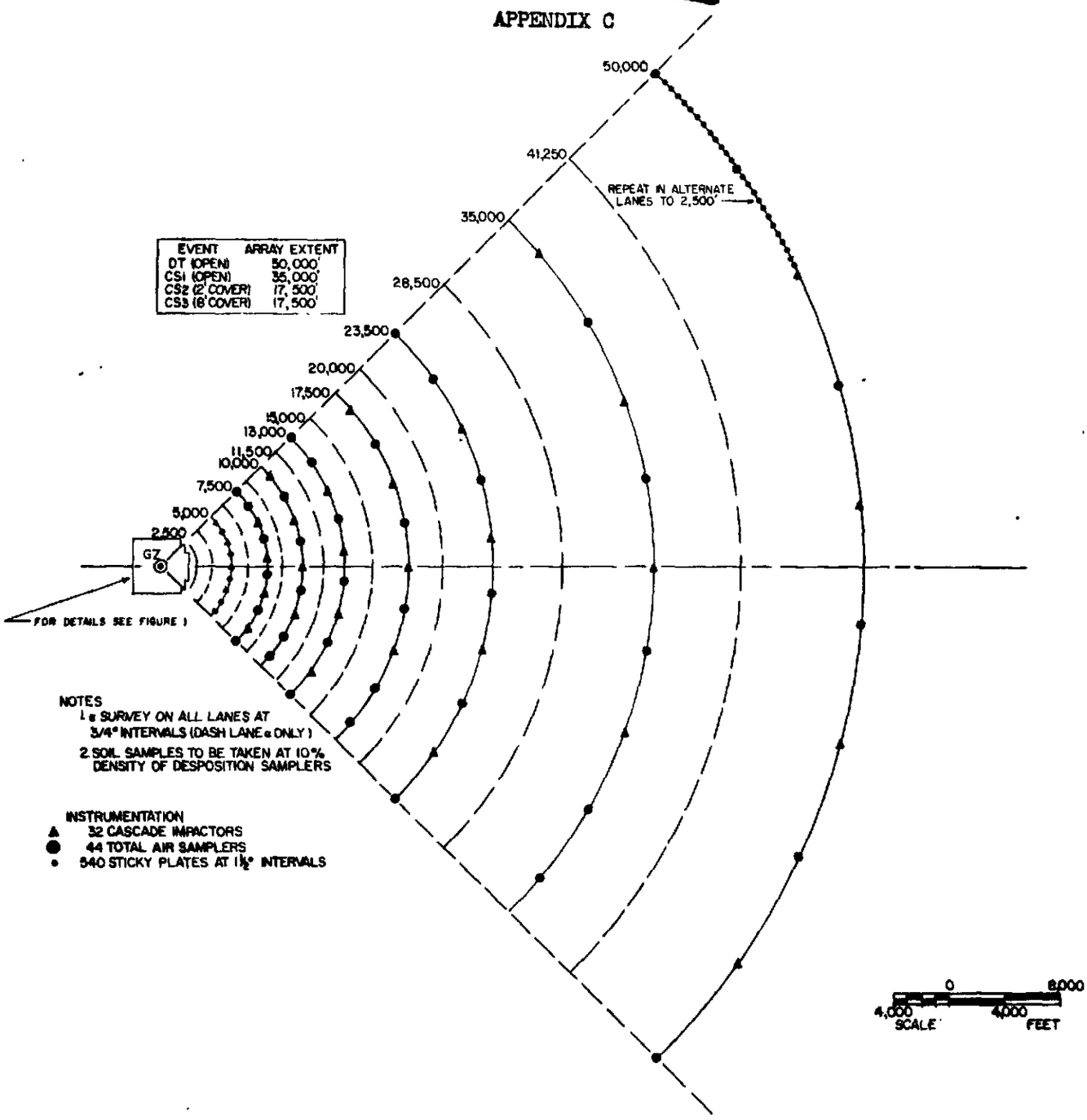


Figure 2. Fixed surface instrument array (+2,500 to +50,000 feet).

[redacted]

APPENDIX C

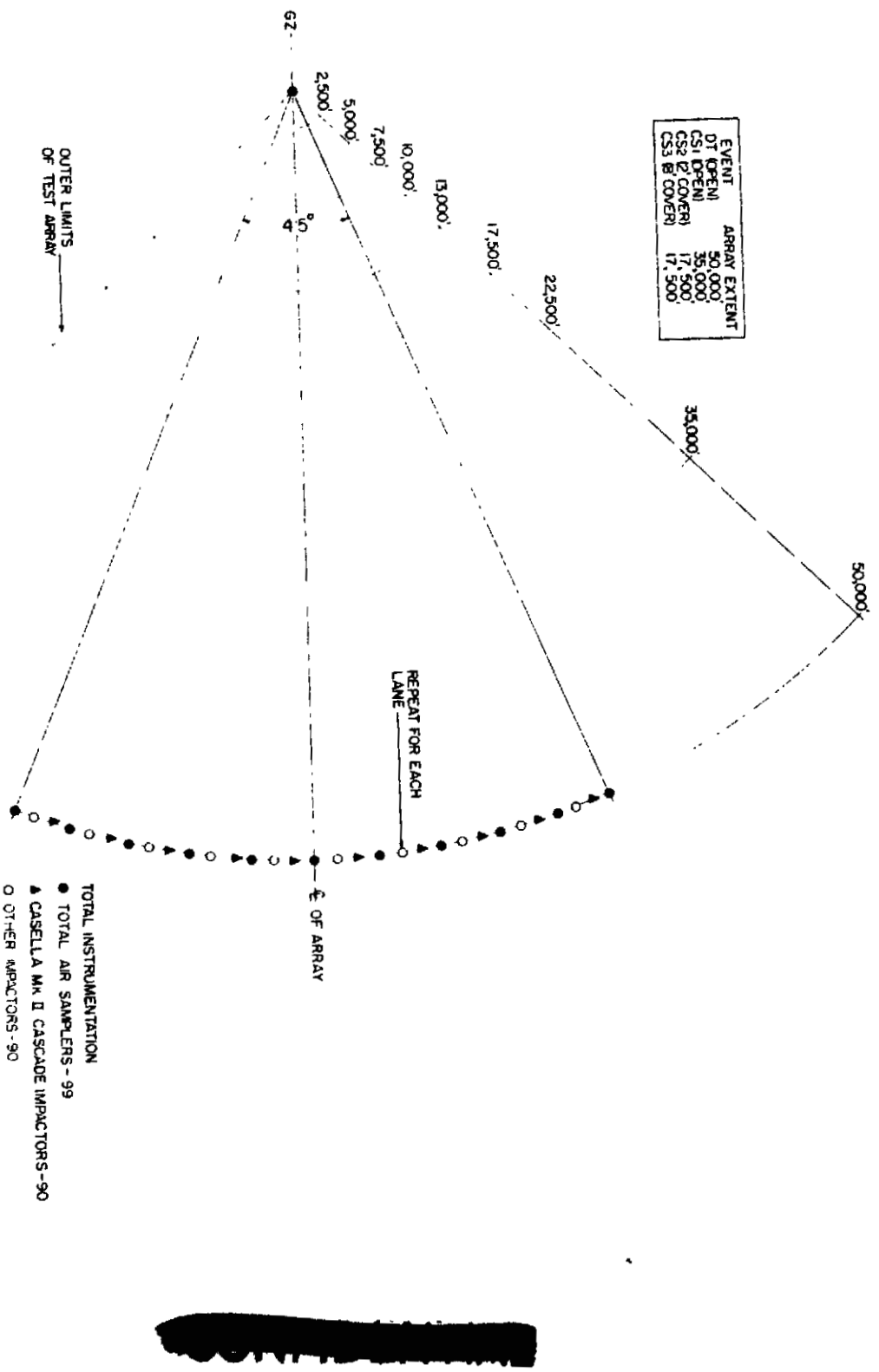


Figure 3. Mobile surface instrument array (+2,500 to +50,000 feet).

[redacted]

APPENDIX C

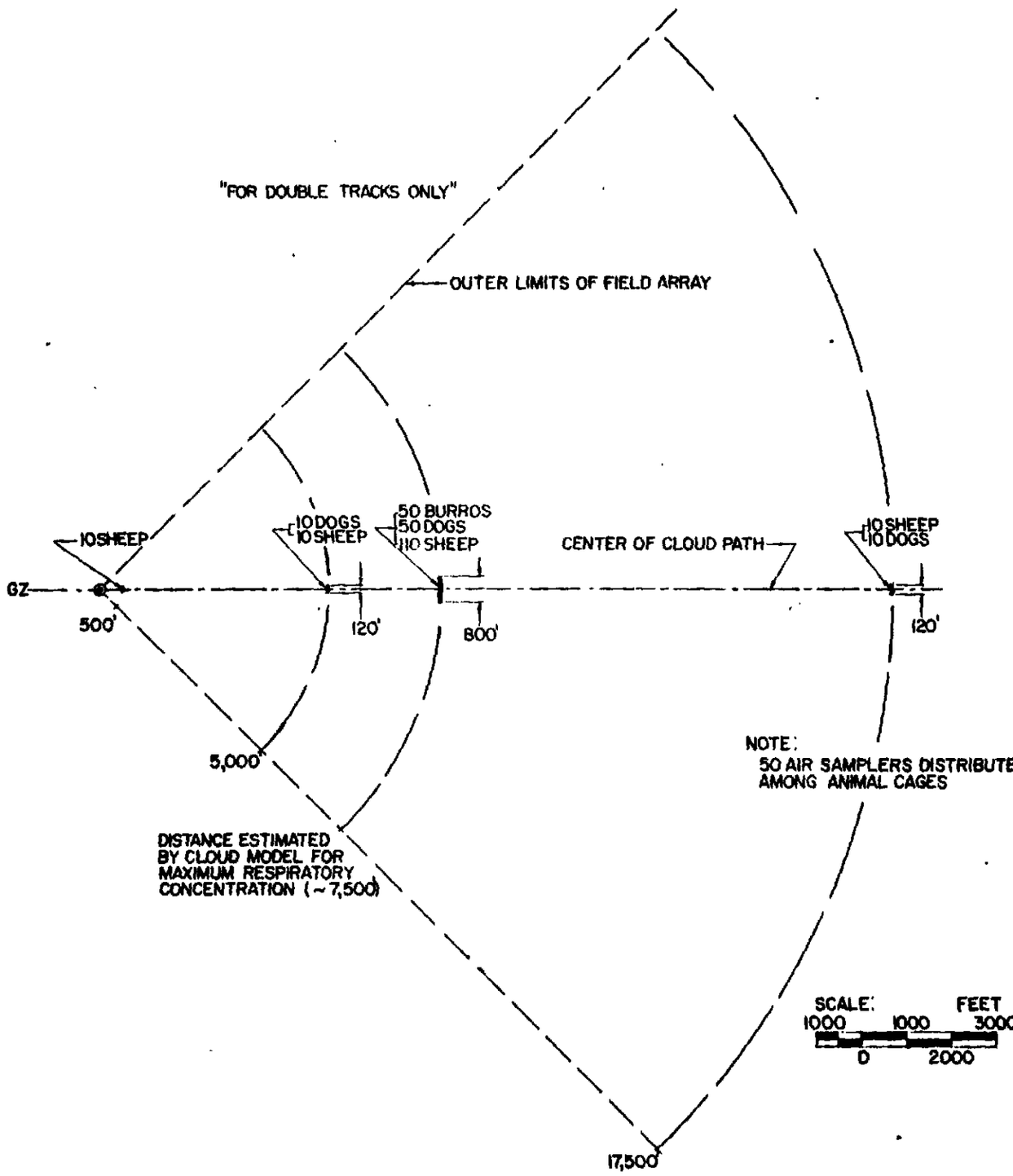


Figure 4. Mobile biological sampling array.

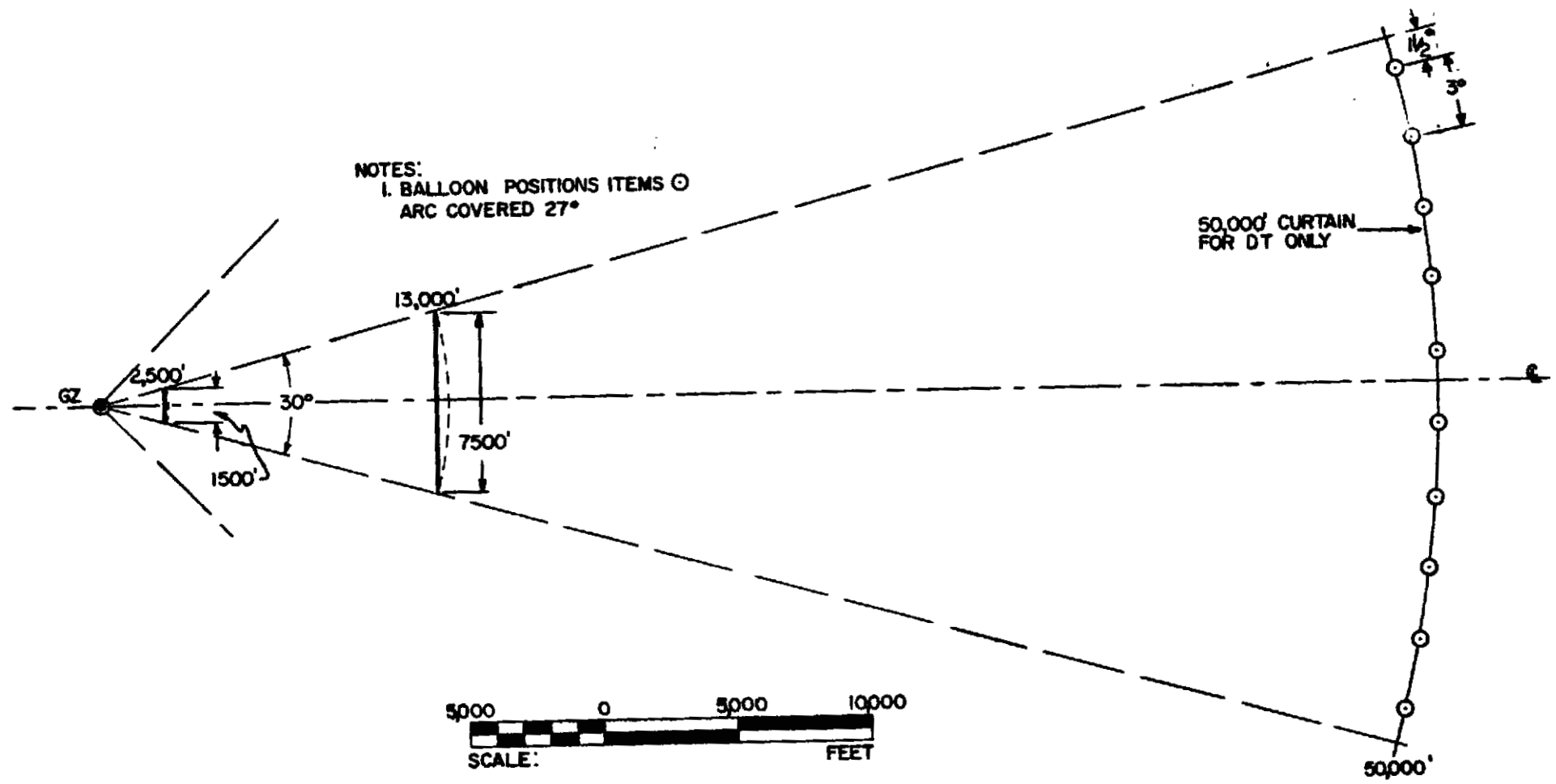


Figure 5. Mobile balloon supported instrument array.

APPENDIX C

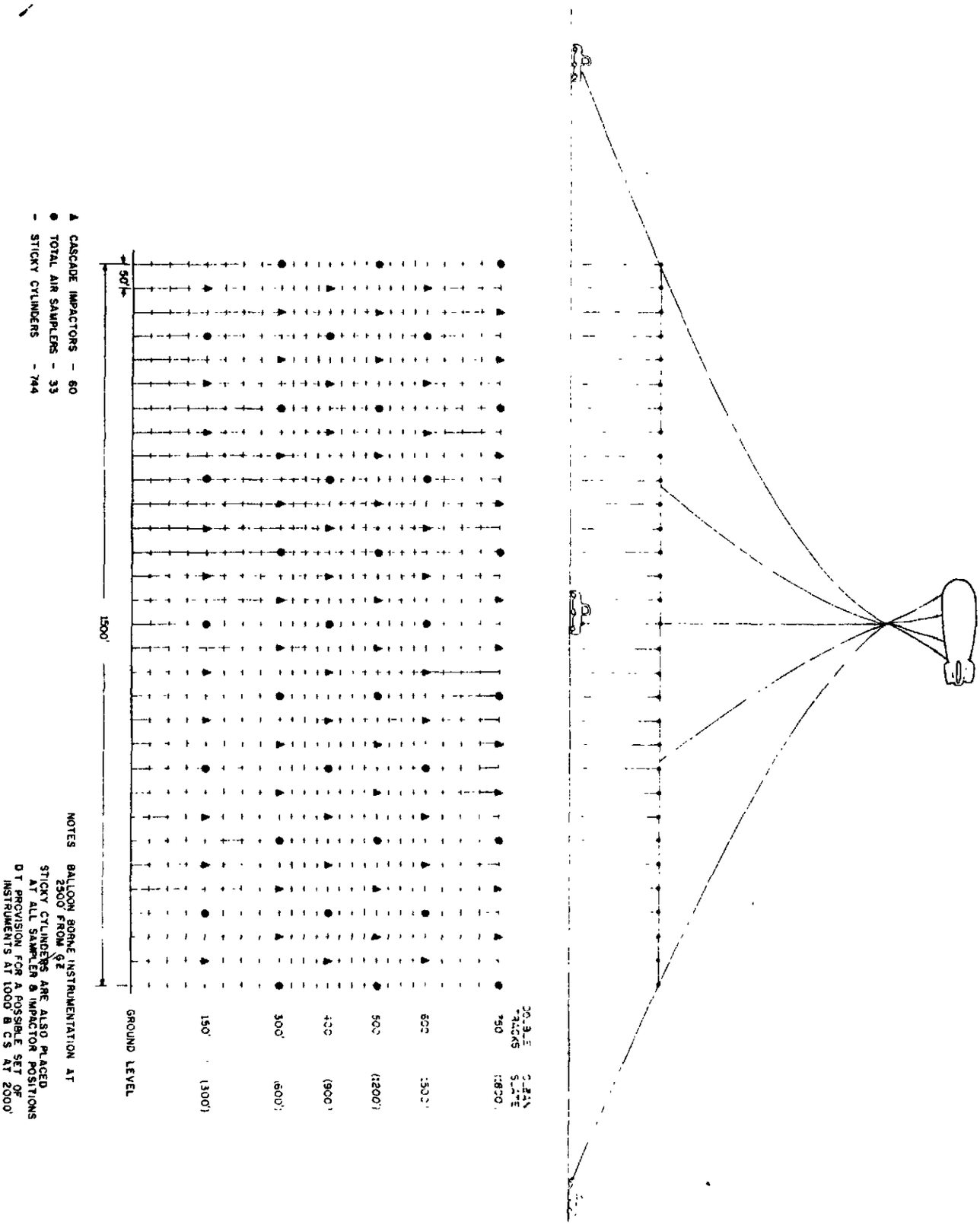


Figure 6. Details of balloon curtain at 2,500-foot radius.

APPENDIX C

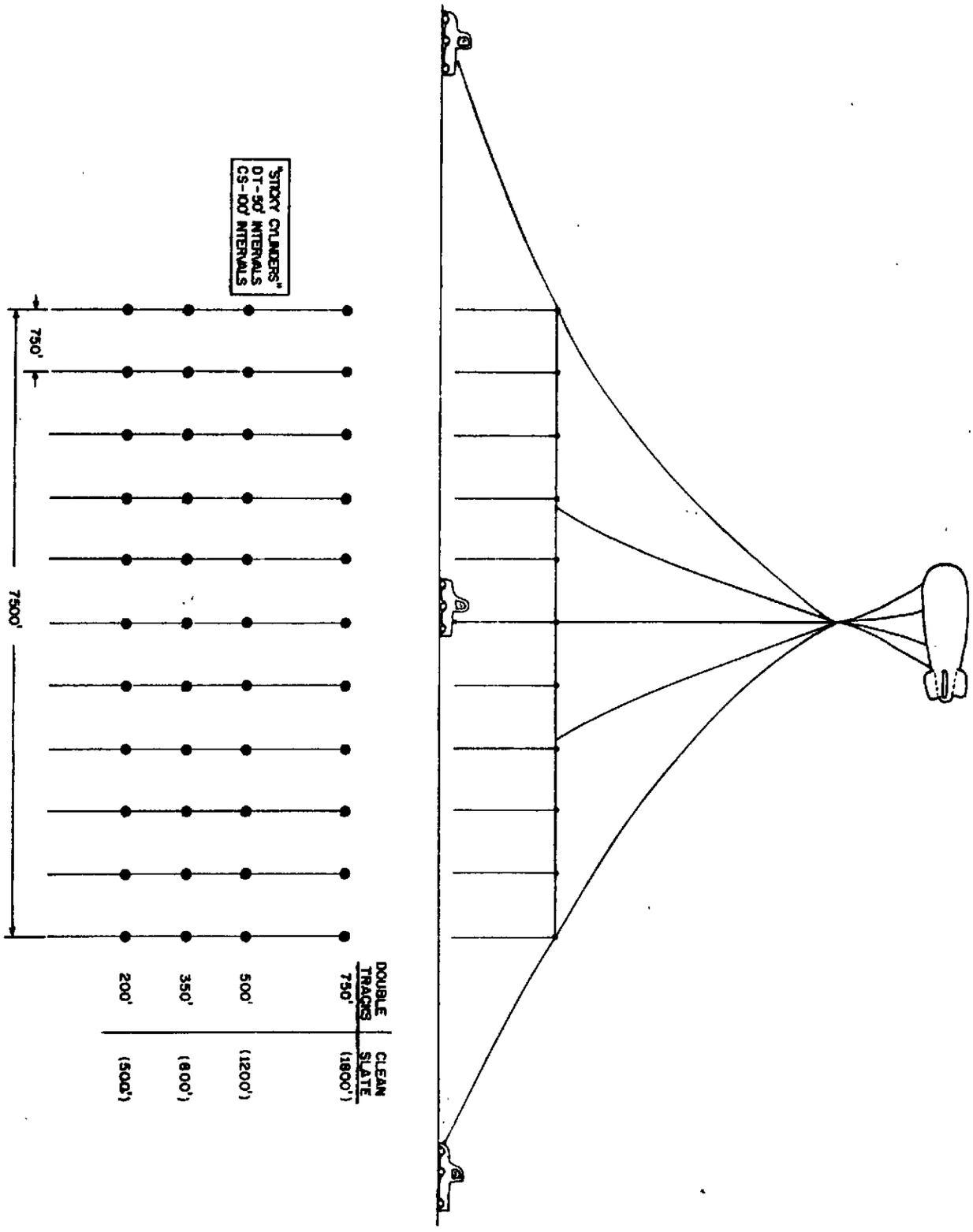


Figure 7. Details of balloon curtain at 13,000-foot radius.

● TOTAL AIR SAMPLERS-44

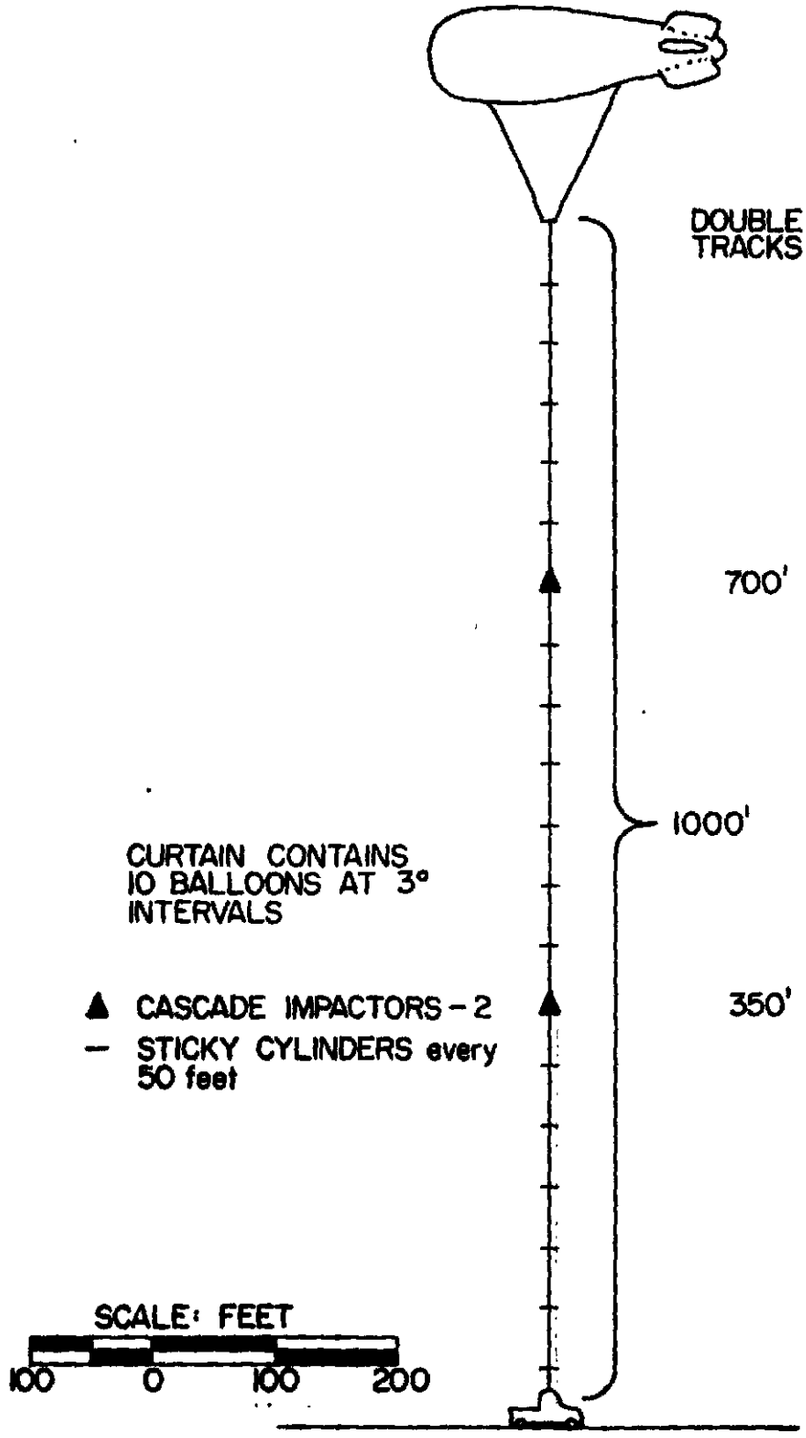


Figure 8. Details of balloon curtain at 50,000-foot radius.

[redacted]

APPENDIX D

Double Track
and
Clean Slate

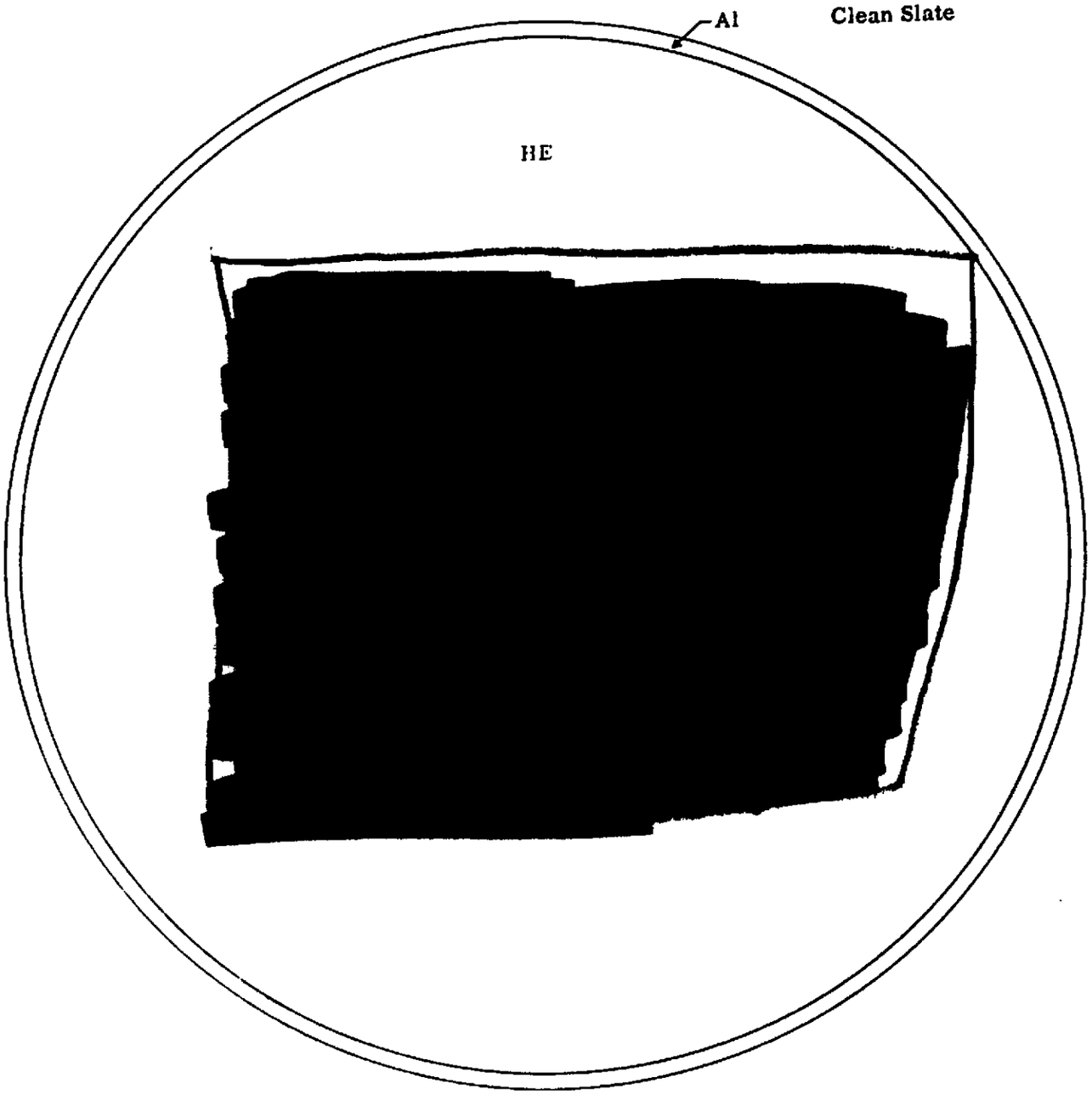


Figure 1. Type I device (Pu bearing).

[redacted]

[redacted]

FC/12620695

THIS DOCUMENT CONSISTS OF 5 PAGES
NO. 4 OF 13 COPIES, SERIES 4

5

[redacted]

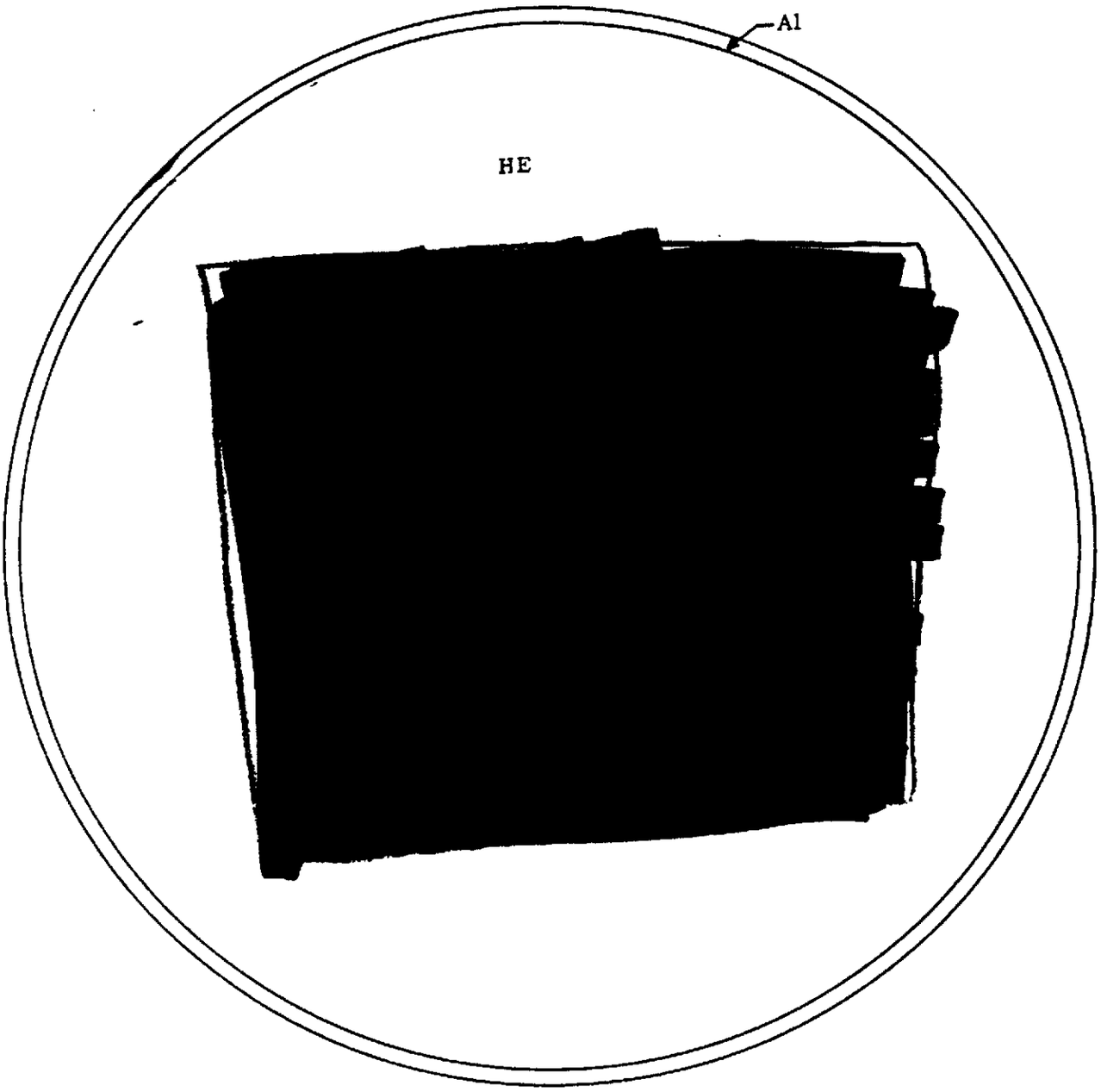


Figure 2. Type II device (non-Pu bearing).

[redacted]

[redacted]

[redacted]

FC/12620695

[redacted]

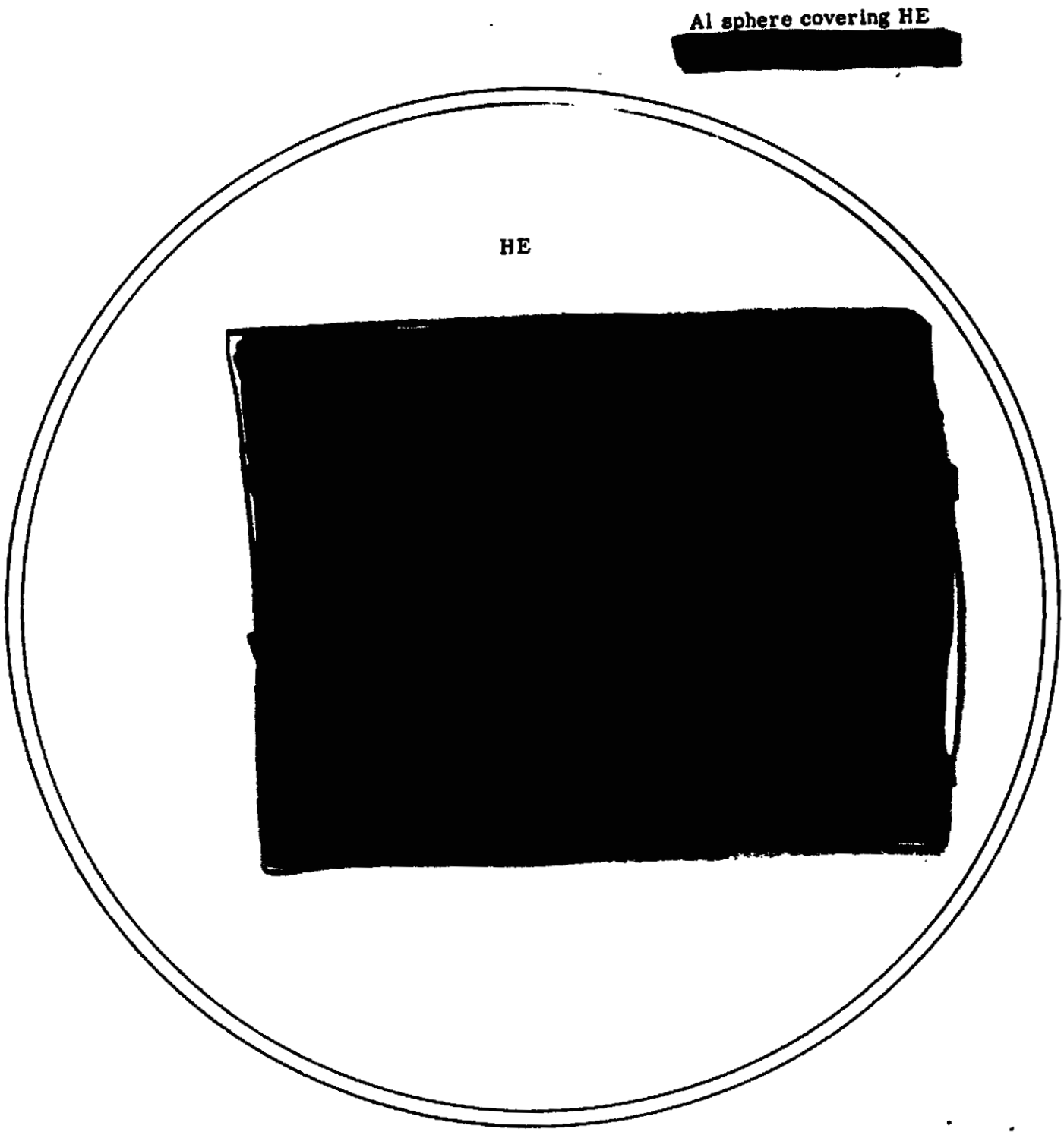


Figure 3. WR [redacted] HE sphere.

[redacted]

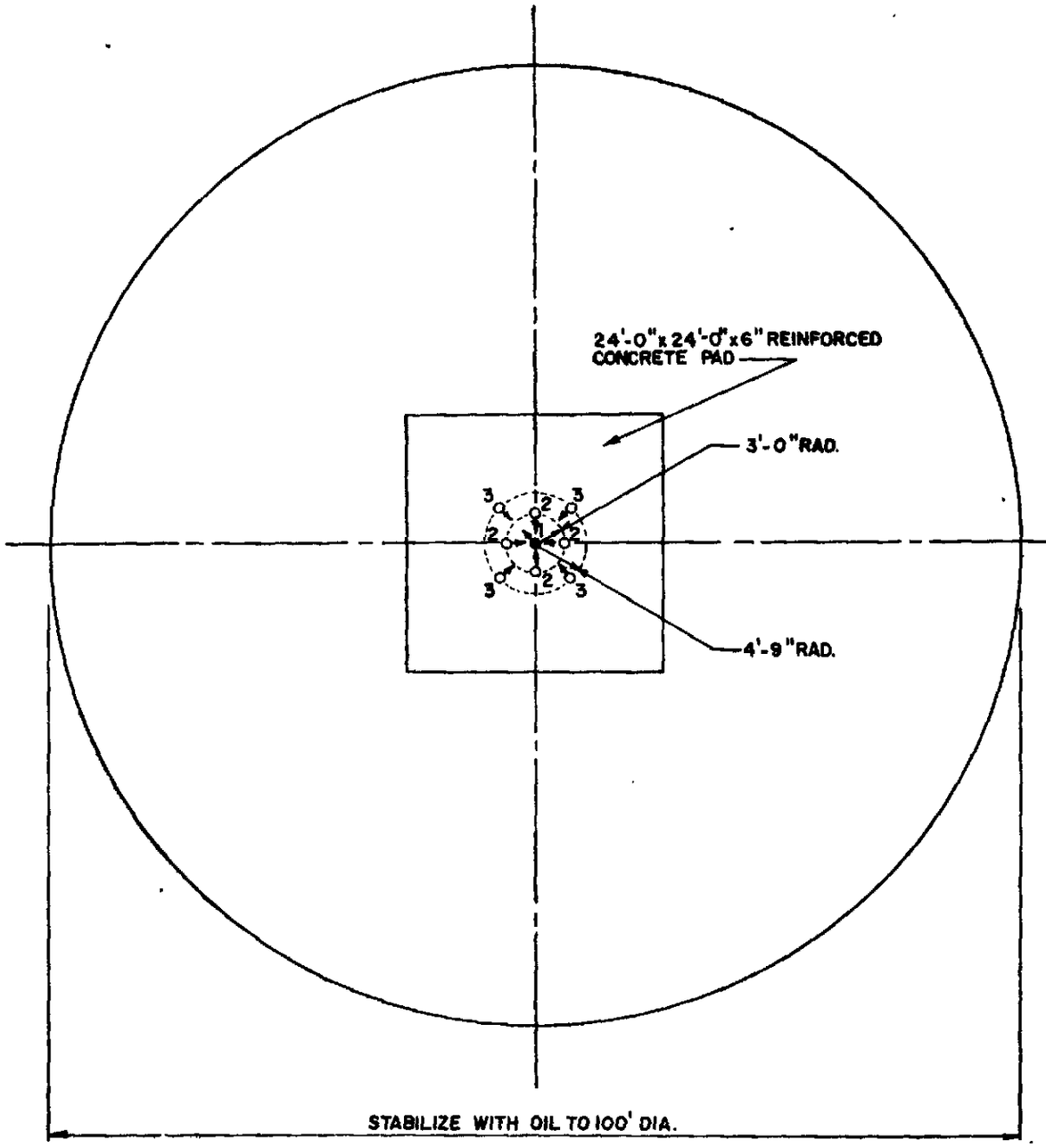
[redacted]

[redacted]

FC/12620695

[redacted]

APPENDIX E. Figure 1 - Device Array (Open)

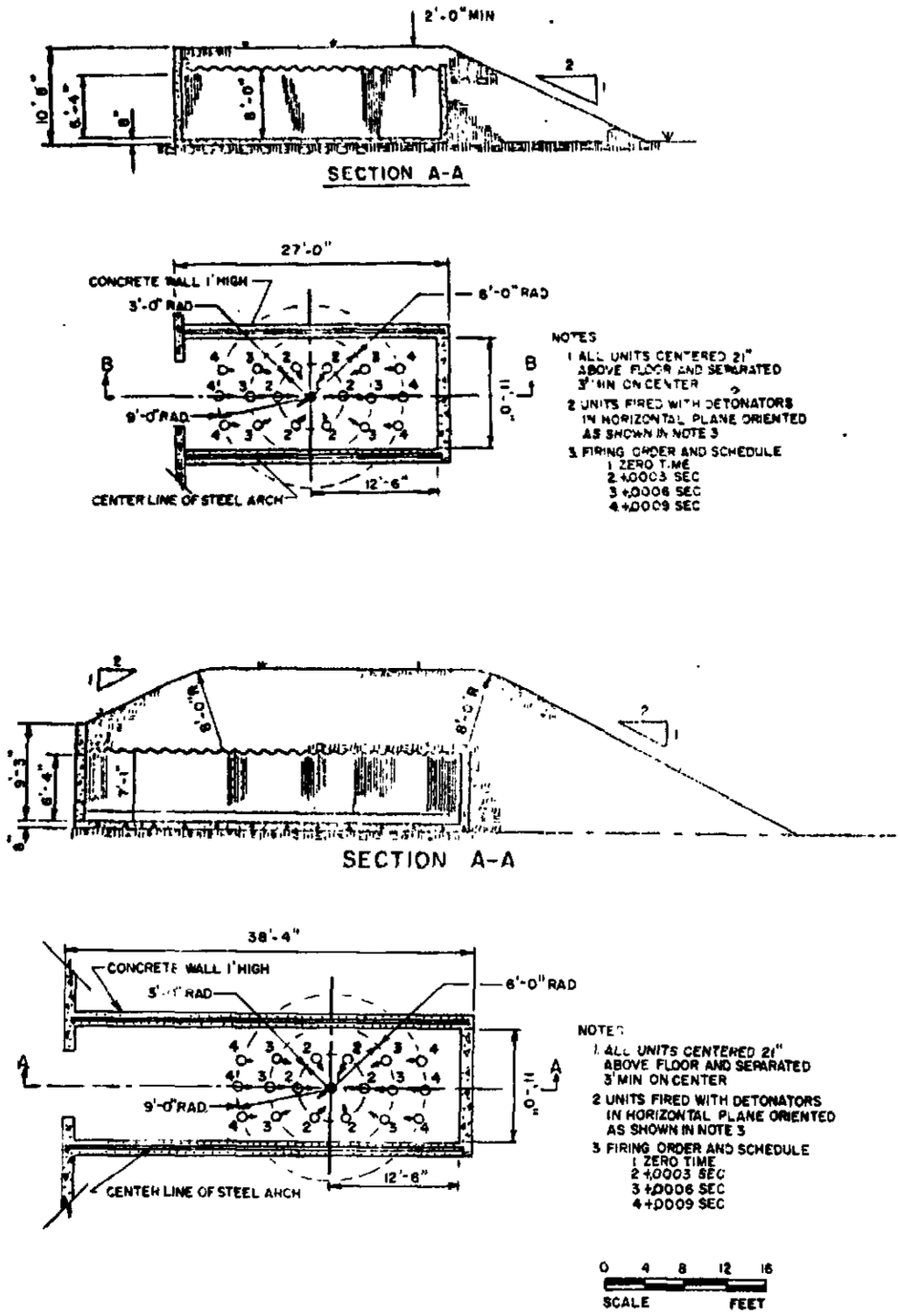


ROLLER COASTER - CLEAN SLATE - RESEARCH DEVICES ARRAY (OPEN
[redacted]

4 0 4 8 12
SCALE: FE

[redacted]

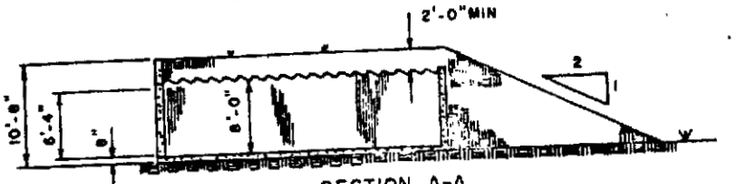
APPENDIX E. Figure 2 - Device Array (Closed)



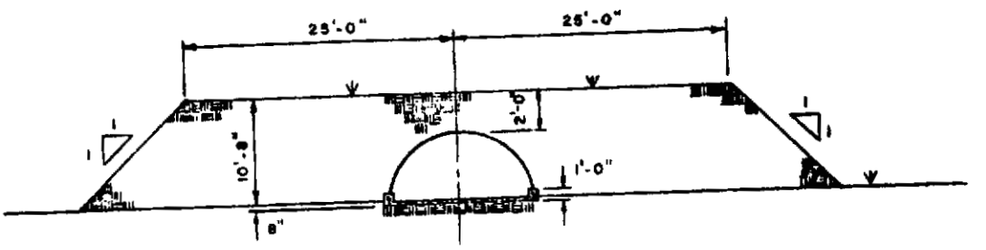
ROLLER COASTER - CLEAN SLATE - RESEARCH DEVICES ARRAY (CLOSED)

[redacted]

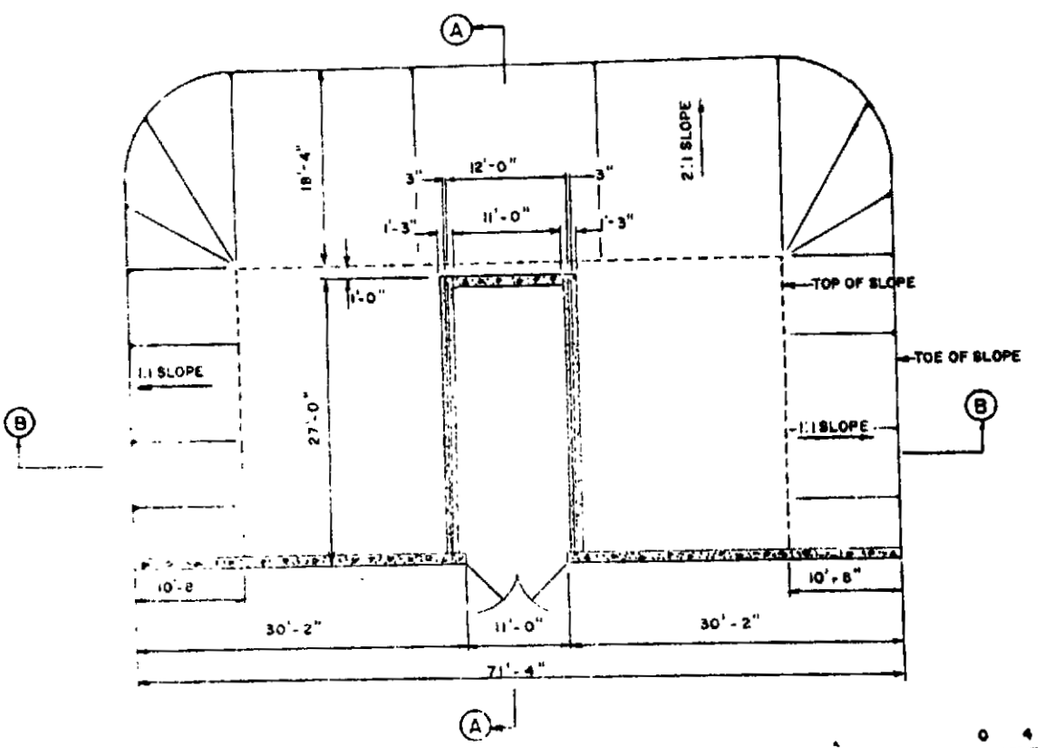
APPENDIX F. Figure 1 - Igloo with 2' Earth Cover



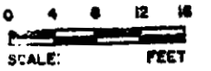
SECTION A-A



SECTION B-B



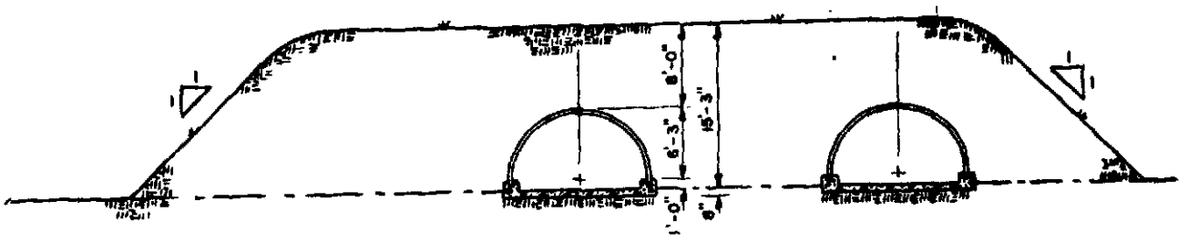
PLAN



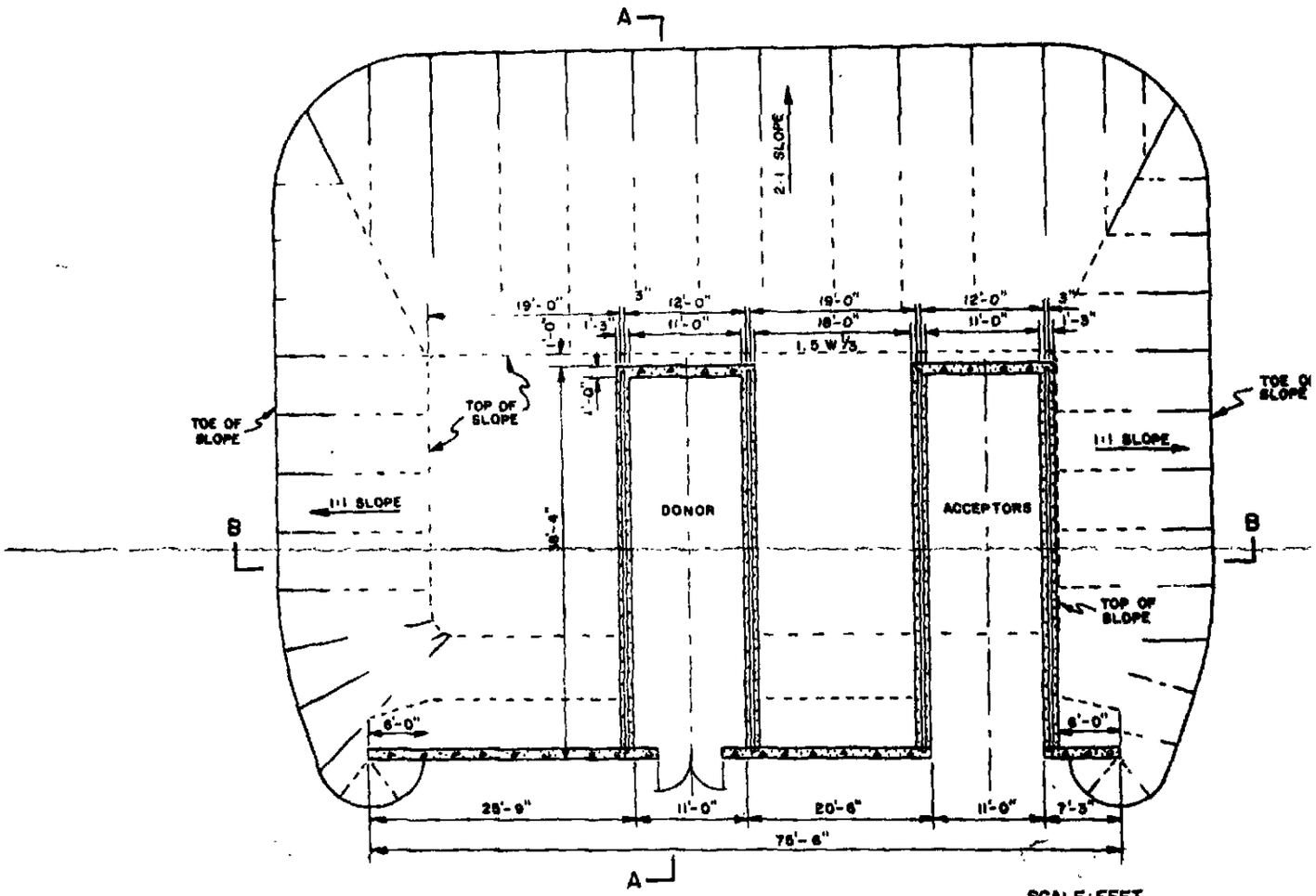
[redacted]

APPENDIX F. Figure 2 - Igloo with 5' Earth Cover

SECTION A-A
SCALE: 1/16" = 1'-0"



SECTION B-B
SCALE: 1/16" = 1'-0"



PLAN
SCALE: 1/16" = 1'-0"

SCALE: FEET
0 4 8 12 16

[redacted]