020588

~~OFFICIAL USE ONLY~~

POR-2513
(WT-2513)

cir. c.3
DEFENSE NUCLEAR AGENCY
JUL 10 1974
DNA1.940913.012
DTL-020,588

Operation

ROLLER COASTER

PROJECT OFFICERS REPORT—PROJECT 5.1a

SAMPLE PROCESSING FACILITY

A. L. Baietti, Project Officer

A. Zirkes

Tracerlab, LFE
Richmond, California

Issuance Date: July 30, 1965

Qualified requesters may obtain copies of this report from DDC.

~~OFFICIAL USE ONLY~~

Inquiries relative to this report may be made to

Director, Defense Atomic Support Agency
Washington, D. C. 20301

When no longer required, this document may be destroyed in accordance with applicable security regulations.

DO NOT RETURN THIS DOCUMENT

USAEC Division of Technical Information Extension, Oak Ridge, Tennessee

POR-2513
(WT-2513)

OPERATION ROLLER COASTER

PROJECT OFFICERS REPORT — PROJECT 5.1a

SAMPLE PROCESSING FACILITY

A.L. Baietti, Project Officer

A. Zirkes

Tracerlab, LFE
Richmond, California

Qualified requesters may obtain copies of this report from DDC.

This publication is the author(s) report to Director, Defense Atomic Support Agency; Director, Division of Military Application, Atomic Energy Commission; and Director, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority, of the results of atomic weapons experimentation sponsored jointly by the United States - United Kingdom. The results and findings are those of the author(s) and not necessarily those of the Department of Defense, Atomic Energy Commission, or United Kingdom Atomic Energy Authority. Accordingly, reference to this material must credit the author(s). This document is under the control of the Department of Defense and, as such, may only be reclassified or withdrawn from circulation as appropriate by the Defense Atomic Support Agency; Atomic Energy Commission, Division of Operational Safety; or the Atomic Weapons Research Establishment.

DEPARTMENT OF DEFENSE
Washington, D.C. 20301

ATOMIC ENERGY COMMISSION
Washington, D.C. 20545

ATOMIC WEAPONS RESEARCH ESTABLISHMENT
Aldermaston, Berkshire, England

ABSTRACT

A mobile Sample Processing Facility was designed and successfully operated during Operation Roller Coaster to provide: (1) a unified method of processing and packaging samples, (2) onsite counting of selected samples, and (3) a complete record of all samples collected during the operation and their disposition. All of these objectives were achieved with no personnel contamination problems or cross-contamination of samples.

Services provided by this facility (two trailers) included high and low-level counting areas, an instrument repair area, receiving and shipping facilities, and special processing facilities (two 9-foot hoods and 14 glove boxes). The once-through air supply and exhaust system provided 6,000 to 8,000 cfm of conditioned air and made the wearing of special protective equipment unnecessary. Continuous-recording air monitors showed no significant increase in the airborne activity as a result of processing about 20,000 samples. These samples were temporarily stored at Naval Weapons Station (NWS), Concord, California, pending shipping instructions. About 9,000 samples have been shipped for more detailed analysis. The remaining samples are presently stored at NWS and the Sample Handling Records are at Tracerlab/West, Richmond, California. DASA will determine the ultimate disposition of the samples and records after all data has been evaluated and documented.

PREFACE

The authors wish to express their appreciation to the following Tracerlab personnel whose cooperation and untiring efforts contributed immeasurably to the successful operation of the facility: H. Bould, B. Barela, H. Hampton, H. Hardy, R. Mitchell, R. Jones, and M. Schinnerer. We are also indebted to: PFC M. Carawan, Sp/5 L.I. Craven, PFC W. Hartig, PFC A. Kowalczuk, Sgt. M.C. McNeill, PFC D.L. Schultz, Sp/5 R.E. Seviour, Sgt. E.J. Tate, of the 83d Chemical Battalion, 5th Logistical Command, 3d U.S. Army, Fort Bragg, North Carolina, who worked side by side with Tracerlab personnel in processing samples from the operation. A more dedicated group could not be found. We also thank: CWO L.T. Mitchel, J. Herron, and R. Eggenberger, and other Naval Weapons Station personnel (Concord, California) who assisted during the sample storage and shipment phase of the operation.

CONTENTS

ABSTRACT ---------- 5

PREFACE ---------- 6

CHAPTER 1 INTRODUCTION ---------- 11

1.1 Objectives ---------- 11
1.2 Background ---------- 11
1.3 Equipment ---------- 14
1.4 Personnel ---------- 18
1.5 Samples ---------- 19

CHAPTER 2 PROCEDURES ---------- 45

2.1 Operations ---------- 45
2.2 Samples ---------- 51

CHAPTER 3 RESULTS ---------- 66

3.1 Processing ---------- 66
3.2 Monitoring ---------- 68
3.3 Packaging and Shipping ---------- 73

CHAPTER 4 DISCUSSION ---------- 95

4.1 Equipment ---------- 95
4.2 Personnel ---------- 98
4.3 Samples ---------- 102
4.4 Operations ---------- 104
4.5 Contamination Control ---------- 117

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS ---------- 131

APPENDIX A PROCEDURE FOR PROCESSING ANDERSEN IMPACTORS ---------- 134

APPENDIX B PROCEDURE FOR PROCESSING CASELLA IMPACTORS ---------- 143

APPENDIX C PROCEDURE FOR PROCESSING TOTAL AIR SAMPLES ---------- 150

APPENDIX D PROCEDURE FOR PROCESSING TAPES FROM AIR SAMPLERS ---------- 153

APPENDIX E PROCEDURE FOR PROCESSING FALLOUT PLANCHETS ---------- 155

APPENDIX F PROCEDURE FOR PROCESSING FALLOUT SLIDE SAMPLES ---------- 159

APPENDIX G PROCEDURE FOR PROCESSING STICKY PAPER SAMPLES (FILMS) ---------- 161

APPENDIX H PROCEDURE FOR PROCESSING SOIL SAMPLES ---------- 163

APPENDIX I PROCEDURE FOR PROCESSING CONCRETE CORE SAMPLES ---- 165

APPENDIX J PROCEDURE FOR PROCESSING SCRAP METAL SAMPLES ------ 167

APPENDIX K PROCEDURE FOR PROCESSING STICKY WIRES ---------- 170

APPENDIX L PROCEDURE FOR PROCESSING STICKY DISCS ---------- 175

APPENDIX M PROCEDURE FOR PROCESSING VEGETATION SAMPLES ------ 178

APPENDIX N PROCEDURE FOR PROCESSING WATER SAMPLES ---------- 180

TABLES

1.1 Radiation Counters Available ---------- 24
1.2 Detailed Sample Handling Procedures ---------- 25
2.1 Counting Standards ---------- 58
3.1 Sampler Processing Summary ---------- 75
3.2 Sample Counting Summary ---------- 76
3.3 Sample Shipment Summary ---------- 77

FIGURES

1.1 Sample processing facility ---------- 26
1.2 Sample processing facility ---------- 27
1.3 Receiving room ---------- 28
1.4 Sample processing area ---------- 29
1.5 High-level counting area ---------- 30
1.6 Air supply and exhaust system ---------- 31
1.7 Air particulate monitor ---------- 32
1.8 Temporary storage facility ---------- 33
1.9 Low-level counting area ---------- 34
1.10 Packaging Andersen Impactor plates ---------- 35
1.11 Equipment repair area ---------- 36
1.12 Records office ---------- 37
1.13 Storage container ---------- 38
1.14 Andersen impactor ---------- 39
1.15 Casella impactor ---------- 40
1.16 Disassembled total air samplers ---------- 41
1.17 Fallout planchet ---------- 42
1.18 Sticky wire air sampler ---------- 43
1.19 Sticky disc air sampler ---------- 44
2.1 Receiving dock ---------- 59
2.2 Sample handling record ---------- 60
2.3 Receiving room hood ---------- 61
2.4 Processing a Casella prior to disassembly ---------- 62

2.5 Monitoring Casella samples ---------- 63
2.6 Counting data sheet ---------- 64
2.7 Schematic for packaging a Casella ---------- 65
3.1 Double Tracks monitoring results: GZ through Arc B ---------- 78
3.2 Double Tracks monitoring results: Arcs B through R ---------- 79
3.3 Double Tracks monitoring results: Casella impactors on Arc B balloon curtain ---------- 80
3.4 Double Tracks counting results: sticky wires on Arc B balloon curtain --- 81
3.5 Double Tracks monitoring results on UK balloons ---------- 82
3.6 Clean Slate 1 monitoring results: GZ through Arc B ---------- 83
3.7 Clean Slate 1 monitoring results: Arcs B through P ---------- 84
3.8 Clean Slate 1 monitoring results: Casella impactors on Arc B balloon curtain ---------- 85
3.9 Clean Slate 1 counting results: sticky wires on Arc B balloon curtain ---- 86
3.10 Clean Slate 2 monitoring results: GZ through Arc B ---------- 87
3.11 Clean Slate 2 monitoring results: Arcs B through L ---------- 88
3.12 Clean Slate 2 monitoring results: Casella impactors on Arc B balloon curtain ---------- 89
3.13 Clean Slate 2 counting results: sticky wires on Arc B balloon curtain --- 90
3.14 Clean Slate 2 monitoring results: UK balloons ---------- 91
3.15 Clean Slate 3 monitoring results: GZ through Arc B ---------- 92
3.16 Clean Slate 3 monitoring results: Arcs B through L ---------- 93
3.17 Clean Slate 3 counting results: sticky wires on UK balloons ---------- 94
4.1 Sample description form ---------- 124
4.2 Sample receipt ---------- 125
4.3 Suggested sample handling record for future tests, Page 1 ---------- 126
4.4 Suggested sample handling record, monitoring and counting results, Page 2 127
4.5 Facility monitoring form ---------- 128
4.6 Air monitoring results ---------- 129
4.7 Plutonium aerosol MPC based on MPBB of 0.5 μg ---------- 130
A.1 Andersen impactor disassembly drawing ---------- 142
B.1 Casella impactor disassembly drawing ---------- 149

CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES

The objectives of Project 5.1a were to provide (1) a unified method of processing and packaging samples, (2) on-site alpha counting of selected samples, and (3) a complete record of all samples collected during the operation and their disposition.

1.2 BACKGROUND

Operation Roller Coaster was conducted on a portion of the Las Vegas Bombing and Gunnery Range and Sandia Corporation's Tonopah Test Range in southwestern Nevada in the spring of 1963.

This series of tests was conducted to investigate the biological hazards of scattered plutonium and to evaluate the plutonium-scavenging of proposed earth-cover storage structures. Four tests were conducted: Double Tracks, Clean Slate No. 1, No. 2, and No. 3.

The Double Tracks event was designed to investigate the characteristics of plutonium-bearing particulate material formed by a one-point detonation of a device located above a steel-faced concrete surface. The study required measurements

of the duration and intensity of airborne plutonium during its diffusion and settling from the detonation cloud and the corresponding ground deposition pattern. Double Tracks had the additional special intent of exposing animals and air samplers to the same concentrations of airborne plutonium and uranium, the purpose being to determine and correlate the aerosol particle size spectrum with the fallout pattern and the biological uptake, original body deposition, metabolism, and eventual sites of retention of inhaled particles.

The three Clean Slate shots were designed to contrast weapon accidents, with respect to hazard per unit plutonium mass contained, for conditions of open storage, storage in an igloo with 2 feet of earth cover, and storage in an igloo with 8 feet of earth cover.

The sampling program was divided into three major parts: surface deposition, airborne particulates, and animal inhalation studies. Surface deposition studies were concerned with the pattern of fallout that would occur under specified conditions. Samples for this study included slides, films, planchets coated with adhesive, and trays filled with water. Airborne particulate studies were conducted by drawing air through different sized

orifices that separated the material into various particle size ranges and deposited the material on adhesive-covered glass plates. Unfractionated air samples were collected at similar locations for comparison. The animal inhalation studies were used to simulate the effect of an unprotected man breathing in a fallout zone. Particulate samplers next to the animals were used to determine animal exposures. Biological half-life and sites of retention as a function of particle size were studied by using control animals and periodic sacrifices of exposed animals.

Initial estimates of about 20,000 samples to be processed (not including the animal samples) proved amazingly accurate. The time and money saved by eliminating the need for detailed and costly radiochemical analyses of samples that were outside the zone of interest more than covered the cost of the facility and its operation.

The Sample **Processing Facility** (Figures 1.1 and 1.2) was designed to provide a controlled environment and work space where radioactive samples could be processed and packaged for shipment, with a minimum of personnel exposure and cross-contamination of samples.

Many field samples required processing before they could be

shipped to outside agencies for study. These samples, consisting of soil samples, total air (filter) samples, impactor samples, sticky plates and cylinders, were catalogued, counted, and processed prior to shipment according to the requirements of the various Roller Coaster experiments. Special precautions were taken to prevent cross-contamination and particle fractionation of incoming samples. Facilities for decontaminating sampling equipment were also available.

1.3 EQUIPMENT

Trailers. The Sample Processing Facility consisted of two trailers specially equipped to provide the needed field service support. Figure 1.2 shows the High-Level Trailer complete with work benches, hoods, and glove boxes required to provide contamination control in processing samples, and the Low-Level Trailer complete with Low-Level Counting Area, Instrument Repair Area, Records Office, and Shipping Area.

The first section of the High-Level Trailer, the Receiving Room, was sealed off from the rest of the trailer by a dust-tight wall and door and had a separate exhaust system. Two 9- by 3-foot hoods and two glove boxes, with air-lock type access to the other section of the trailer, were located in this room (Figure 1.3). The

hoods were connected to the Receiving Dock by pass-through cabinets. Samplers were passed into the Receiving Room through these cabinets, monitored, and decontaminated as necessary.

A double array of glove boxes (Figure 1.4) was located in the forward part of the second section (the Sample Processing Area). Here, necessary dismantling and packaging operations were carried out. Counting facilities for samples whose contamination level was higher than could be counted in the regular counting area were set up in two of the glove boxes. Alpha monitoring equipment (PAC-1SA's and 3G's) was also available in the glove boxes. Alpha-counting equipment was located in the back part of the second section (High-Level Counting Area) (Figure 1.5). This equipment was to be used for counting samples with high alpha activity.

Separate air control was provided for both sections of the High-Level Trailer. Clean, pre-filtered air was brought in through an evaporative cooler and exhausted through absolute filters (Figure 1.6). The system was designed to provide between 6,000 to 8,000 cfm of heated and cooled air with 4,000 cfm being delivered to the Receiving Room (2,000 cfm being exhausted through each hood) and 2,000 to 4,000 cfm to the Sample Processing

Area. Each glove box was exhausted separately through an absolute filter. The glove boxes had a dual exhaust-filter system. Each box had its own absolute filter and blower and was joined in series to the main absolute filter bank and blower. A series of pressure taps made it possible to measure the pressure drop across each bank of filters and thereby determine the condition of the main exhaust filters at any time. The inside of the trailer was covered with polyethylene sheeting to minimize contamination-decontamination problems. Air inside the trailer was continuously monitored with direct read-out (alpha μc/cc) air particulate samplers (Figure 1.7). The environs surrounding the trailers were monitored periodically as a further check on the contamination control integrity of the facility.

An enclosed and weather-tight walkway was built between trailers to minimize the dust entering the trailers and to facilitate movement of personnel and samples in the facility. Shelving was installed for temporary storage of samples awaiting counting and packaging (Figure 1.8).

The second half of the facility was the Low-Level Trailer. An air conditioning system and other modifications were added to a standard model 50- by 10-foot office trailer.

The work performed in the Low-Level Trailer included low-level sample counting (Figure 1.9), sample packaging (Figure 1.10), maintenance of counting and monitoring equipment (Figure 1.11), and cataloguing and filing of sample records (Figure 1.12). No contamination control was required in this trailer. However, incoming air was pre-filtered and the trailer air-conditioned to provide the proper environment for counting equipment.

A seven-station communication system was installed to make intra-facility communications simpler. This system was especially valuable for Receiving Dock-Receiving Room and Receiving Room-Sample Processing Area operations.

Counting equipment. Thirteen radiation counters were available at the Sample Processing Facility. Their characteristics are shown in Table 1.1. Scintillation probes for detecting beta and gamma radiation were also available. Two side window G-M monitors were available for beta-gamma monitoring.

Packaging and Handling Supplies. Polyethylene bags, various sized cartons, envelopes (for sticky paper), vermiculite (for shipping liquids), foam (for shipping solids), etc., were available for shipping test samples.

Storage Facilities. Samples awaiting shipment were stored

in shelved transportainers (Figure 1.13). Operational supplies were also stored in these containers and in vans.

1.4 PERSONNEL

In the planning phase it was decided that Tracerlab would provide a skeleton staff to operate the facility. Other projects were to provide additional personnel (civilian or military) to process their own samples.

Tracerlab provided 7 people; these included 3 technical people, 3 technicians, and a clerk. The Project Officer was responsible for and supervised all operations in the facility. He also set health and safety standards for use during the operation. The Assistant Project Officer was responsible for designing and equipping the facility. He also set up sample handling procedures and coordinated inter-project activities.

Sample processing was coordinated by a technical man and a technician. A counting technician was responsible for operating the counting rooms and initial review of all counting data. The electronics technician was responsible for instrument maintenance and operation of the ventilation system. In addition, he assisted other projects in modifying their electronic equipment to perform special functions. The records clerk maintained the master

Sample Handling Record file and provided necessary clerical support.

Project 2.2 collected most of the samples and assigned eight soldiers to assist in their processing. It was necessary to permanently assign these personnel to Project 5.1a to meet sampler turn-around schedules. (This was done after the Double Tracks event.)

Various other military and civilian personnel assisted for short periods of time in processing and clerical operations.

1.5 SAMPLES

There were 15 different types of samplers and each required different handling techniques. Detailed step-by-step procedures for each type of sampler (except high-volume air samplers) are included as appendixes to this report. A list of the procedures and appendix numbers is shown in Table 1.2.

Andersen Impactors (Figure 1.14). An Andersen impactor is a multi-stage unit for separating airborne particles according to size. This unit contained five 3-3/8-inch diameter glass plates and a 2-inch filter paper that required counting. In addition, the first perforated plate was also counted. For a step by step method of processing these samples, see Appendix A.

Casella Impactors (Figure 1.15). A Casella impactor is a multi-stage unit for separating airborne particles according to size. This unit contained four 1-inch diameter glass plates and a 47-mm filter paper that required counting. For a step by step method of processing these samples see Appendix B.

Total Air Samplers (Figure 1.16). Three different models of total air samplers (TAS) were used. Mark I and II TAS's were reusable and the samples were removed following each test and the units decontaminated. The third unit was a Gelman disposable plastic air sampler and it required only packaging. For a step by step method of processing these samples see Appendix C.

Tape Air Samplers. Gelman moving-tape air samplers were used during the tests. The tapes and their spools were removed after the test and placed in plastic bags. For a step by step method of processing these samples see Appendix D.

Fallout Planchets (Figure 1.17). 1-3/4-inch diameter planchets with a 1-1/2-inch active surface of sticky material were used to estimate the activity accumulated on a sticky paper and glass fallout slides placed on the same fallout table. Data obtained by counting the alpha activity on the planchets also provided a picture of the cloud's path. Several of the more active samples were also

gamma counted. Planchets with less than 10,000 dpm (α) were discarded after counting; the others were stored for additional study. For a step by step method of processing these samples see Appendix E.

Fallout Slides (Test and Off-Site Samples). Glass fallout slide samples (2 by 3 inches) were delivered in metal boxes and envelopes and required only packaging. For a step by step method of processing these samples see Appendix F.

Sticky Papers (Test and Off-Site Samples). Sticky papers 12 by 12 inches delivered folded in large manila envelopes, required only packaging. For a step by step method of processing these samples see Appendix G.

Soil Samples. Soil samples gathered before and after each test were delivered in plastic bottles and metal cans and required only packaging. For a step by step method of processing these samples see Appendix H.

Concrete Core Samples. Concrete core samples obtained from the concrete pads surrounding ground zero were delivered in plastic bottles and required only packaging. For a step by step method of processing these samples see Appendix I.

Scrap Metal Samples. Scrap metal samples were gathered

from the ground zero area. The larger pieces were dissolved in plastic bags prior to delivery to the facility. For a step by step method of processing these samples see Appendix J.

Sticky Wires (Figure 1.18). Sticky wires were 3/32 by 18-inch brass wires with a 4-inch length of insulation covering each end. The ends of the sticky wires were fitted with aligator clips and bent to 90° angles at approximately 2 inches from either end. This left a 10-inch exposed surface which was coated with a petroleum-base jelly for collecting contamination. The wires were attached to long lines suspended from cables carried aloft by a balloon. These samples were counted in air-ionization chambers, and the data was used to determine the vertical profile of the cloud. For a step by step method of processing these samples see Appendix K.

Sticky Discs (Figure 1.19). Sticky discs were 7-inch diameter plexiglas discs with a petroleum-base jelly on the surfaces and were hung from the balloon curtain by long screws. For a step by step method of processing these samples see Appendix L.

Vegetation Samples. Various forms of desert vegetation gathered before and after the tests were delivered for processing in plastic bags. For a step by step method of processing these samples see Appendix M.

Water Samples. Glass refrigerator trays were filled with water to collect fallout resulting from the tests. These trays were emptied into glass bottles for processing. (Plastic was not used because the Pu might adhere to the walls.) For a step by step method of processing these samples see Appendix N.

High-Volume Air Samplers. Staplex high-volume air samplers with 8- by 10-inch sampling heads were used following the test series to measure airborne radioactivity up and downwind of the test area. The filter paper samples were removed from the units, placed in plastic envelopes, and sent to Project 5.1a for storage. As these samples were not processed further, no additional information is provided.

TABLE 1.1 RADIATION COUNTERS AVAILABLE

Name	Mfg.	Detector	Max. Sample Size	α Counting Efficiency (%)*	Type
A-4	Tracerlab	1.6" crystal	2" diam	21	Automatic
A-6	Tracerlab	1.6" crystal	2" diam	23	Automatic
N-C	Nuclear-Chicago	2" crystal	1-1/4" diam	25	Automatic
NMU-1	Eberline	4" crystal	4" diam	20	Manual
NMU-2	Eberline	4" crystal	4" diam	32	Manual
SDA-1	Eberline	4" crystal	4" diam	45	Manual
SAC-2	Eberline	2" crystal	2" diam	39	Manual
SAC-3	Eberline	2" crystal	2" diam	42	Manual
A-5	Tracerlab	1.6" crystal	2" diam	25	Manual
AC-4	Eberline	6" x 9" gas flow	6" x 9"	24	Manual
English-1	?	2" x 15" air ionization	3/32" x 14" wire	?	Manual
English-2	?	2" x 15" air ionization	3/32" x 14" wire	?	Manual

* Based on 4π counting

TABLE 1.2 DETAILED SAMPLE HANDLING PROCEDURES

Sample Type	Appendix
Andersen Impactors	A
Casella Impactors	B
Total Air Samplers	C
Tape Air Samplers	D
Fallout Planchets	E
Fallout Slides	F
Sticky Papers	G
Soil Samples	H
Concrete Core Samples	I
Scrap Metal Samples	J
Sticky Wires	K
Sticky Discs	L
Vegetation Samples	M
Water Samples	N

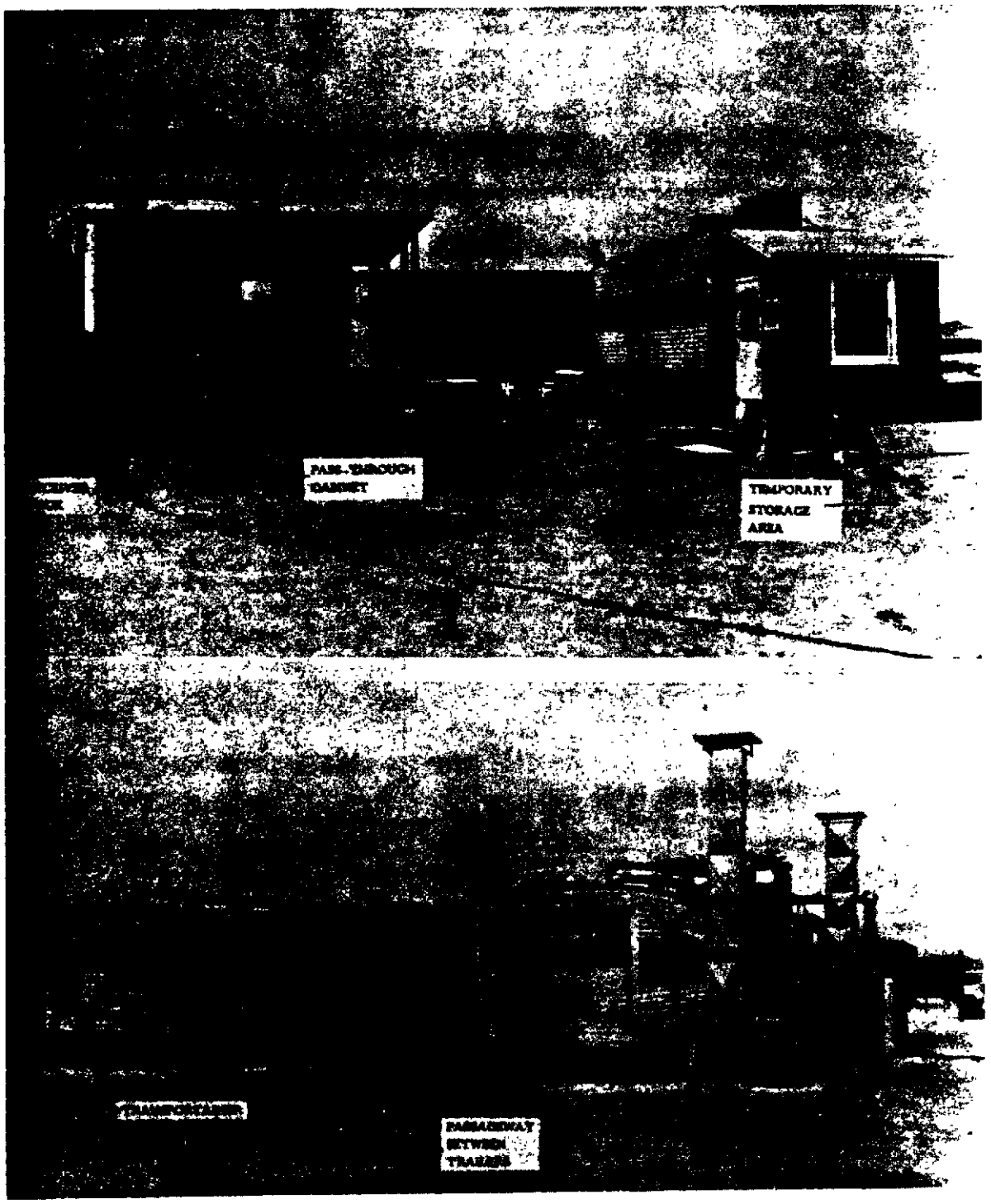


Figure 1.1 Sample processing facility. (Tracerlab photo)

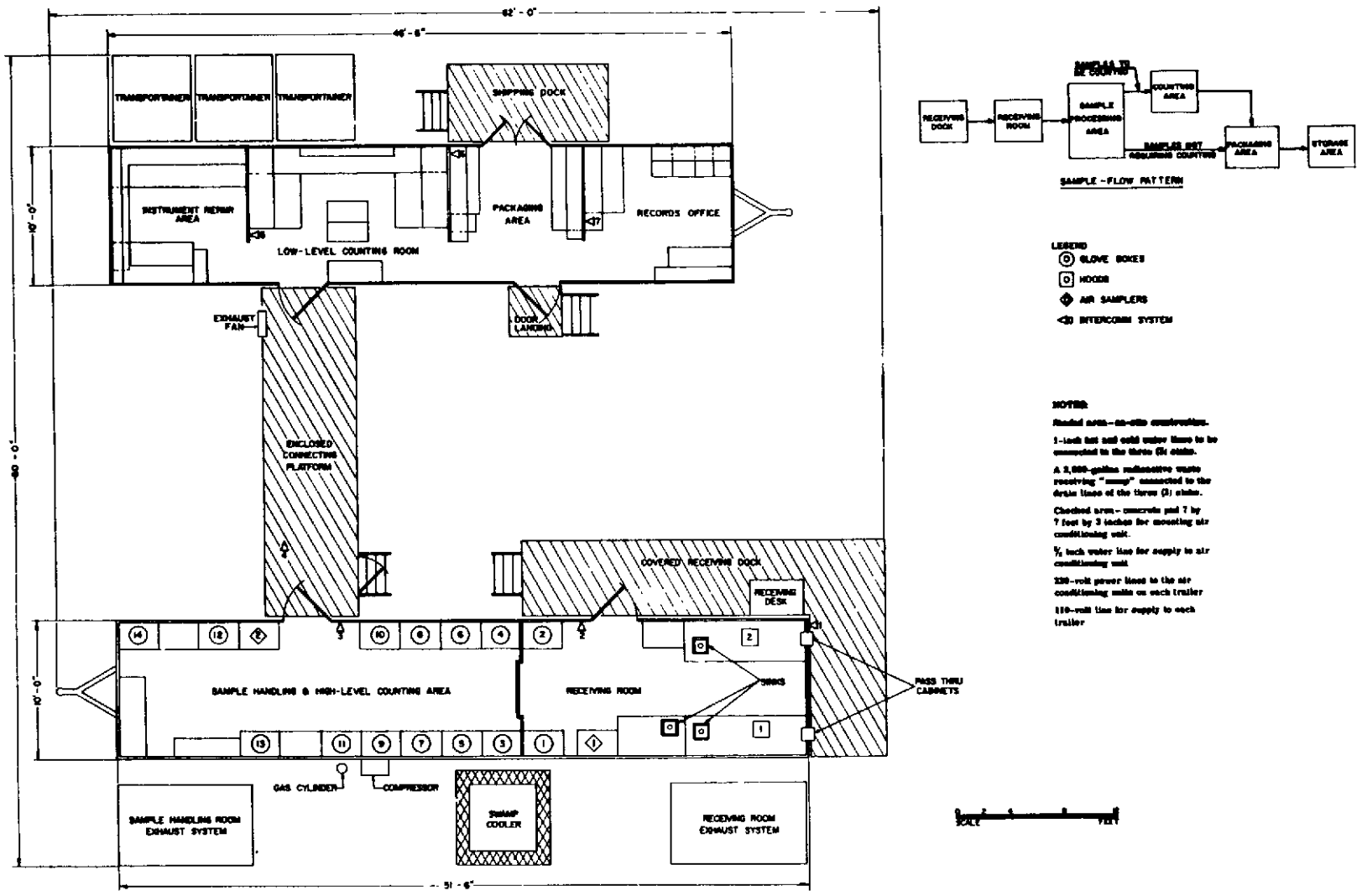


Figure 1.2 Sample processing facility.

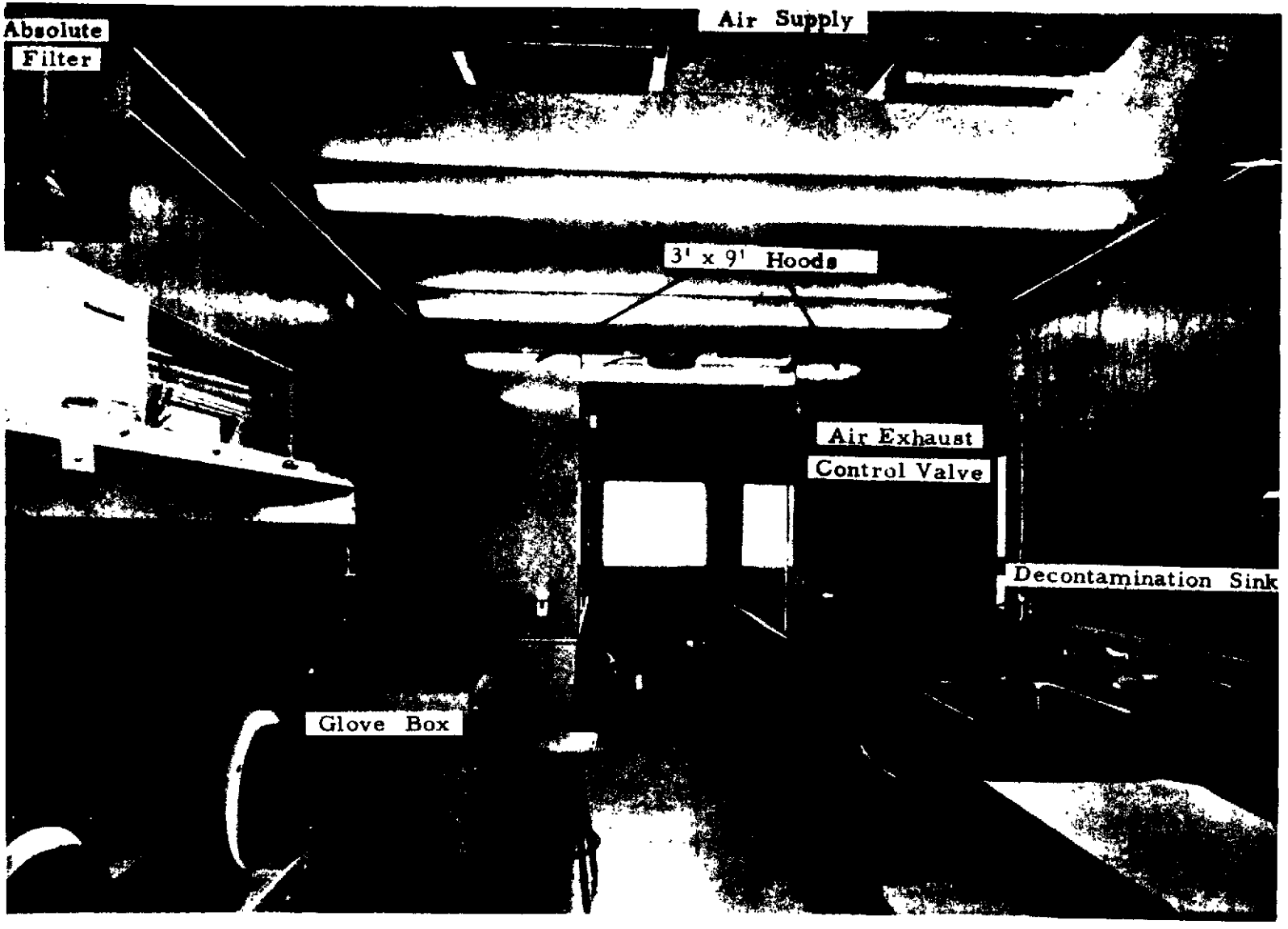


Figure 1.3 Receiving room. (Tracerlab photo)

Figure 1.4 Sample processing area. (Tracerlab photo)

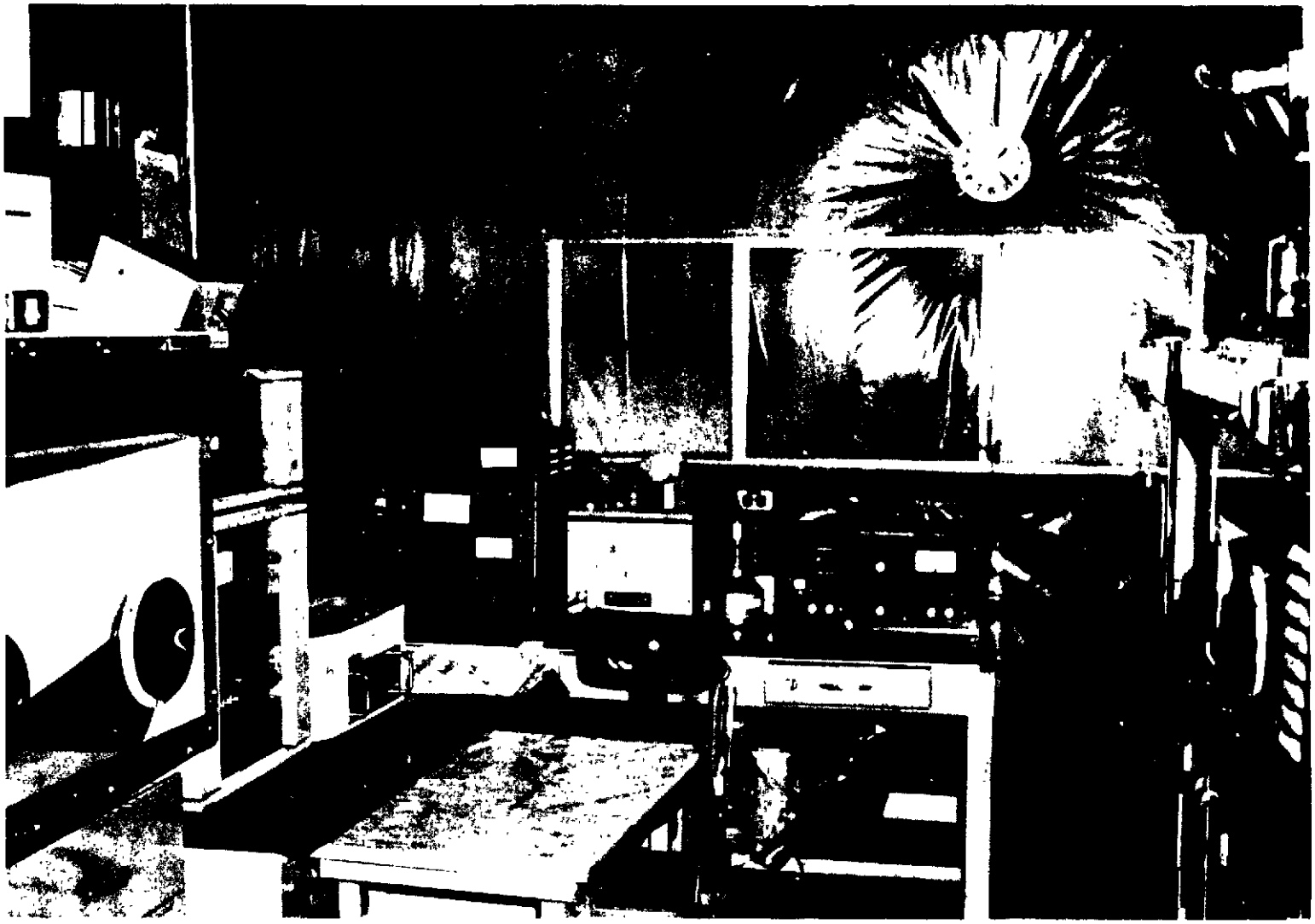


Figure 1.5 High-level counting area. (DASA-122-08-TTR-63)

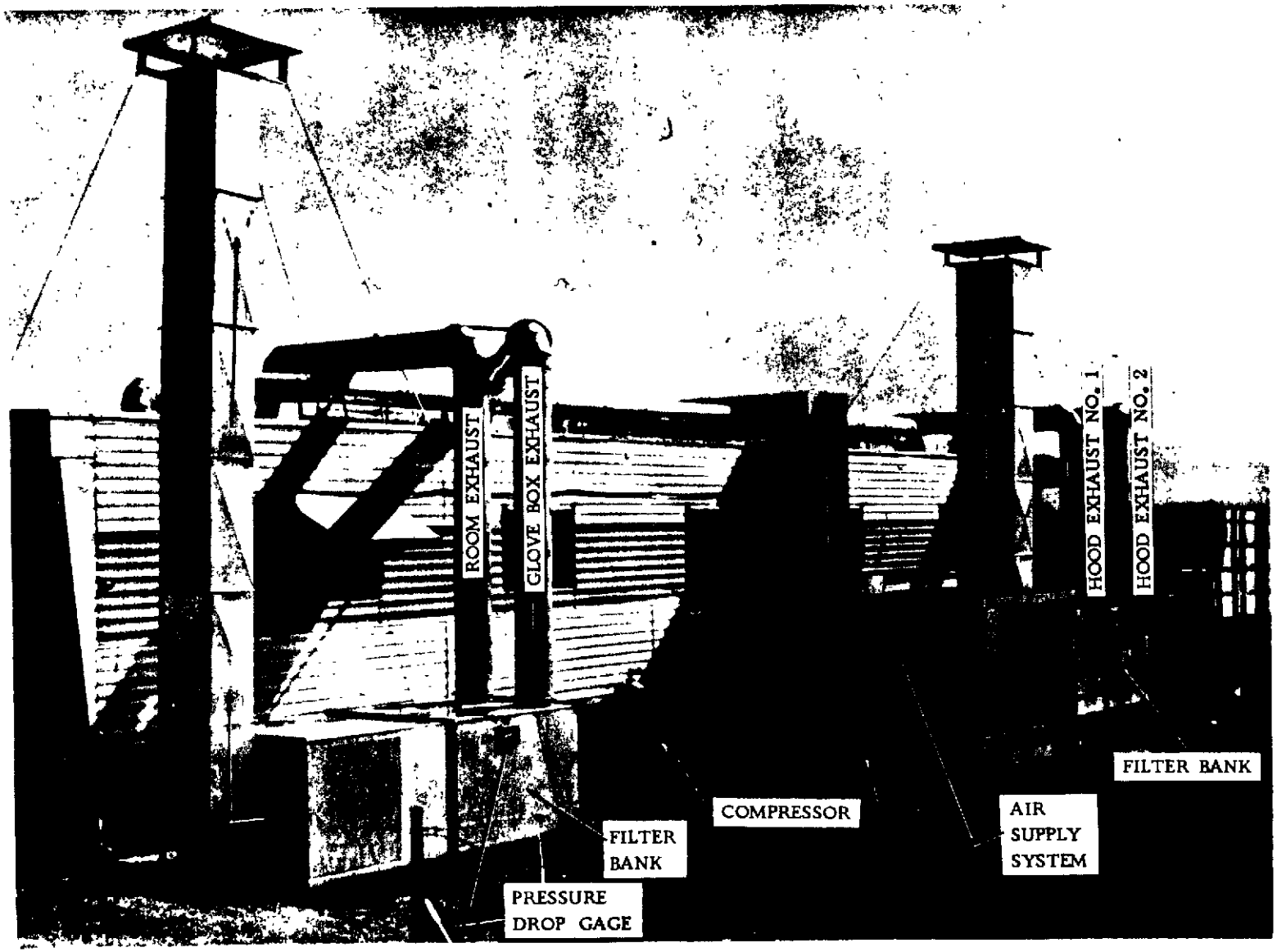


Figure 1.6 Air supply and exhaust system. (DASA-136-18-TTR-63)

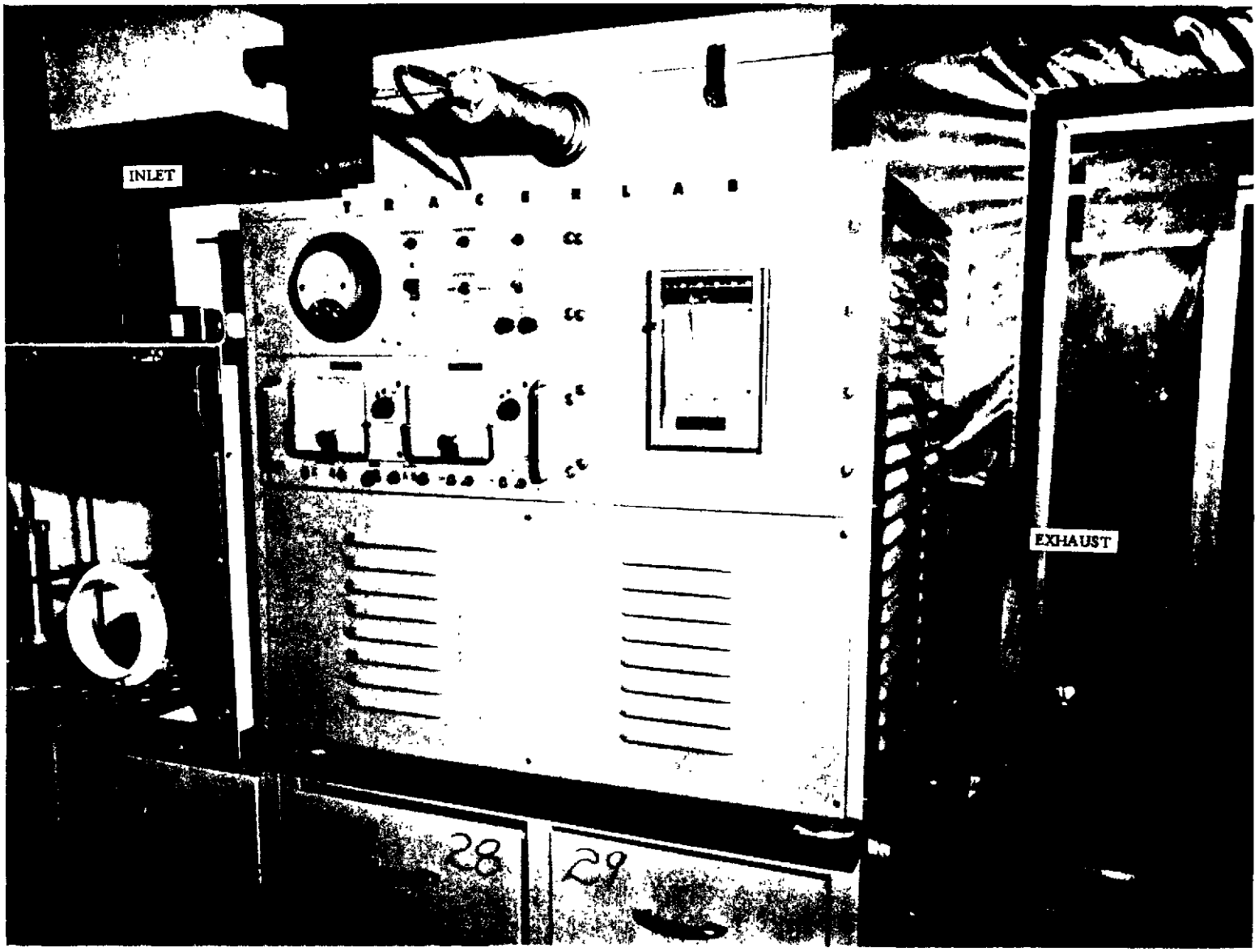


Figure 1.7 Air particulate monitor. (DASA-139-05-TTR-63)

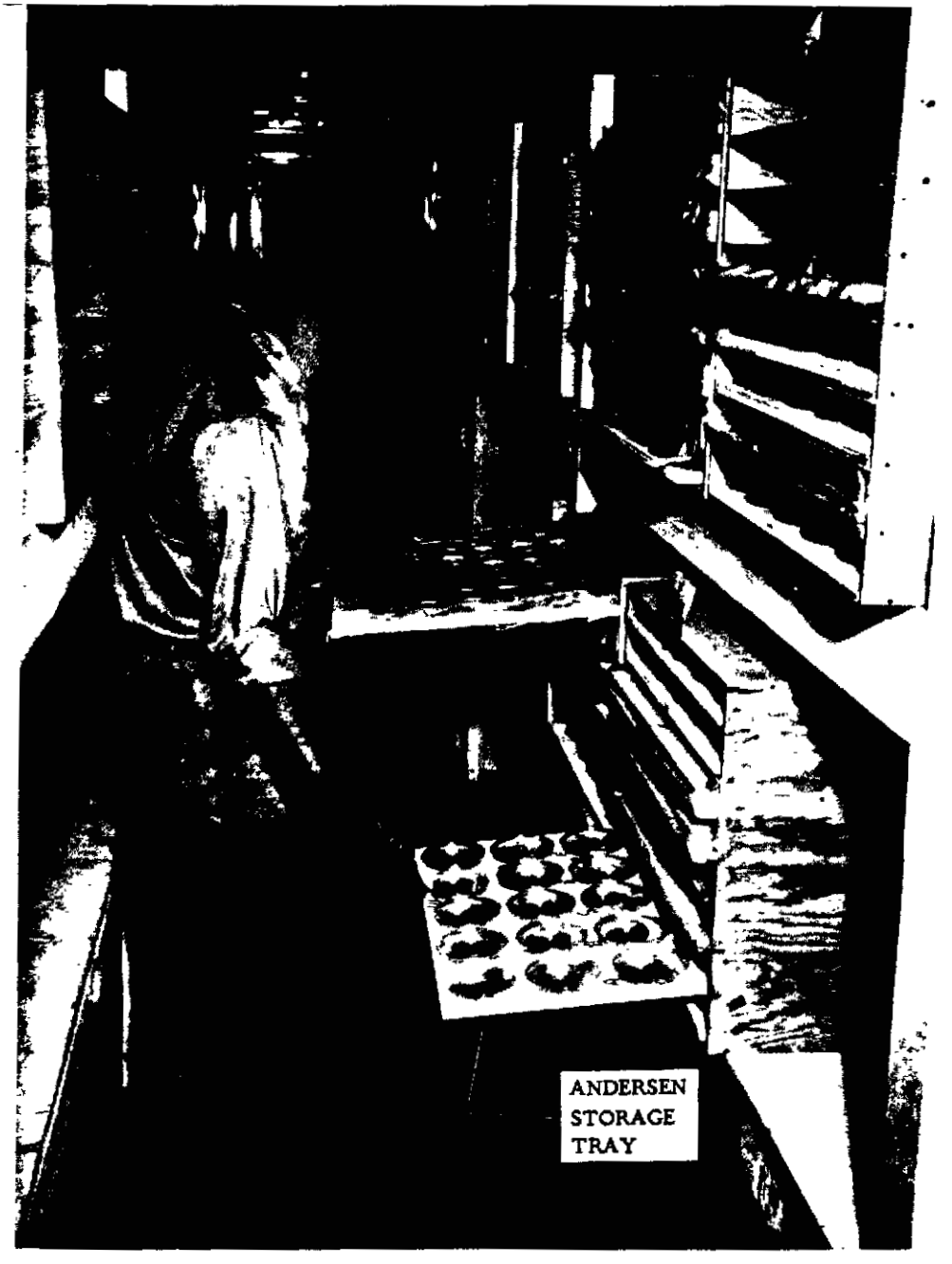


Figure 1.8 Temporary storage facility. (DASA-139-06-TTR-63)

Figure 1.9 Low-level counting area. (DASA-122-07-TTR-63)

Figure 1.10 Packaging Andersen impactor plates. (DASA-139-03-TTR-63)

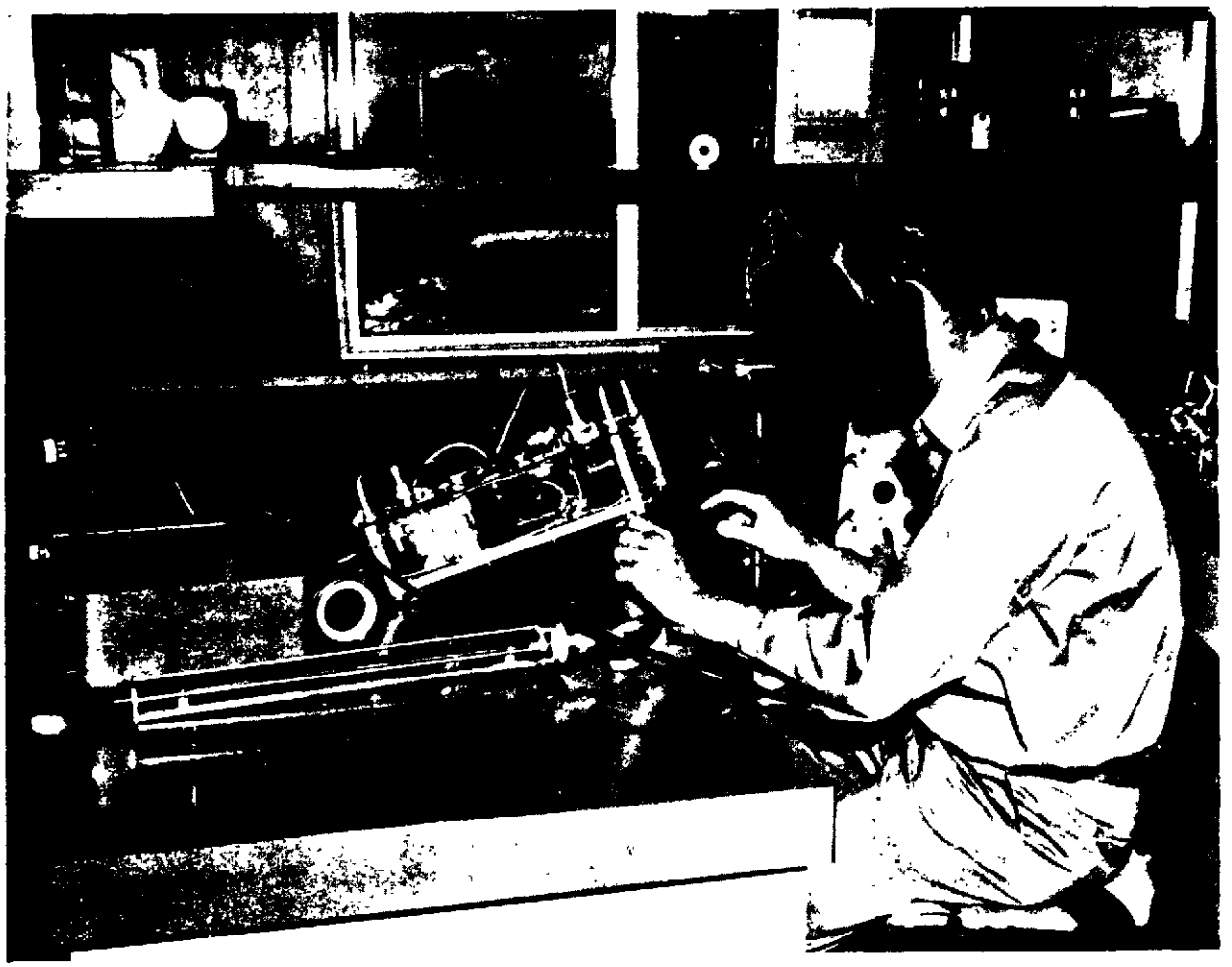


Figure 1.11 Equipment repair area. (DASA-139-01-TTR-63)

Figure 1.12 Records office. (DASA-139-04-TTR-63)

Figure 1.13 Storage container. (DASA-136-19-TTR-63)

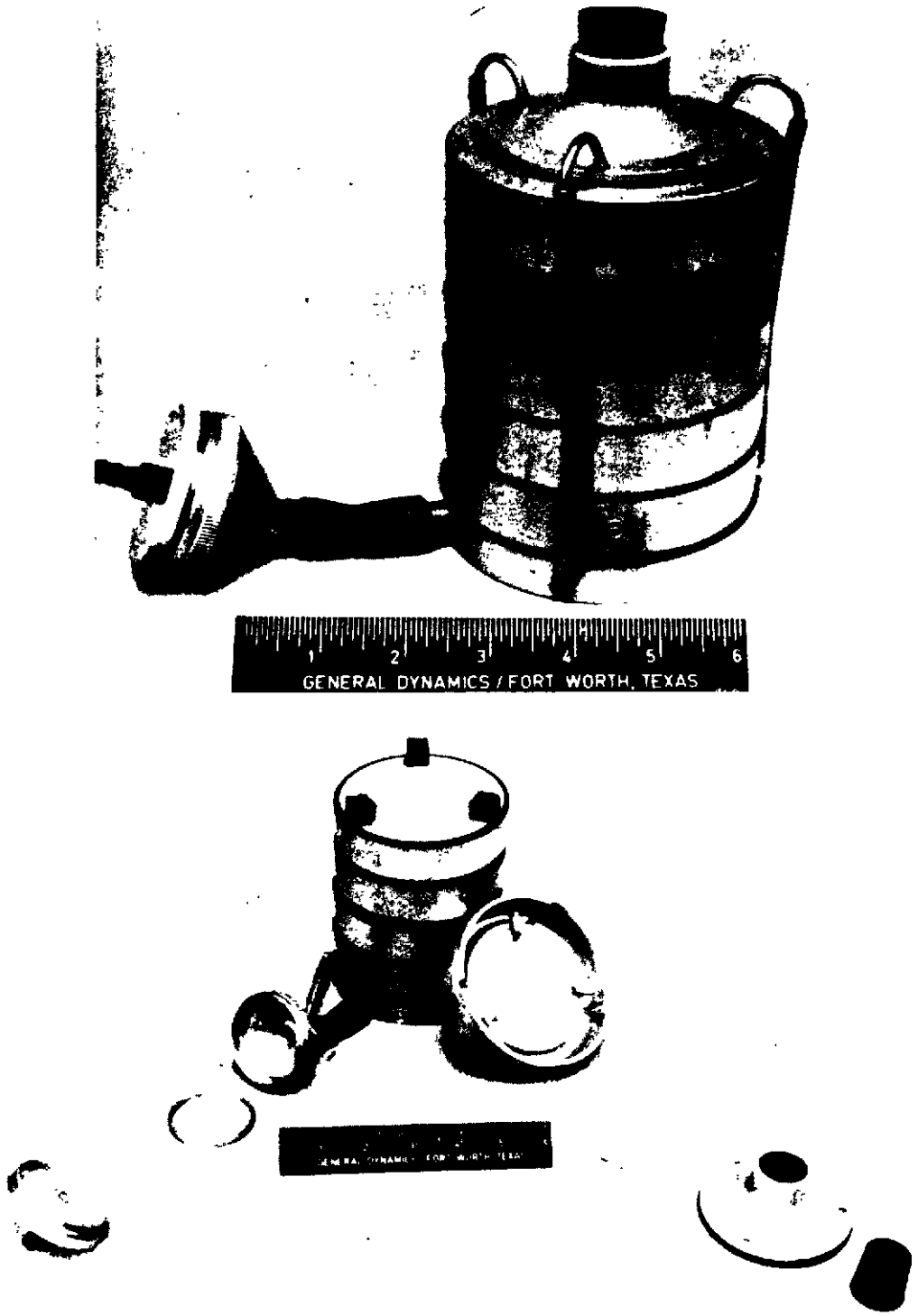


Figure 1.14 Andersen impactor. (General Dynamics photo)

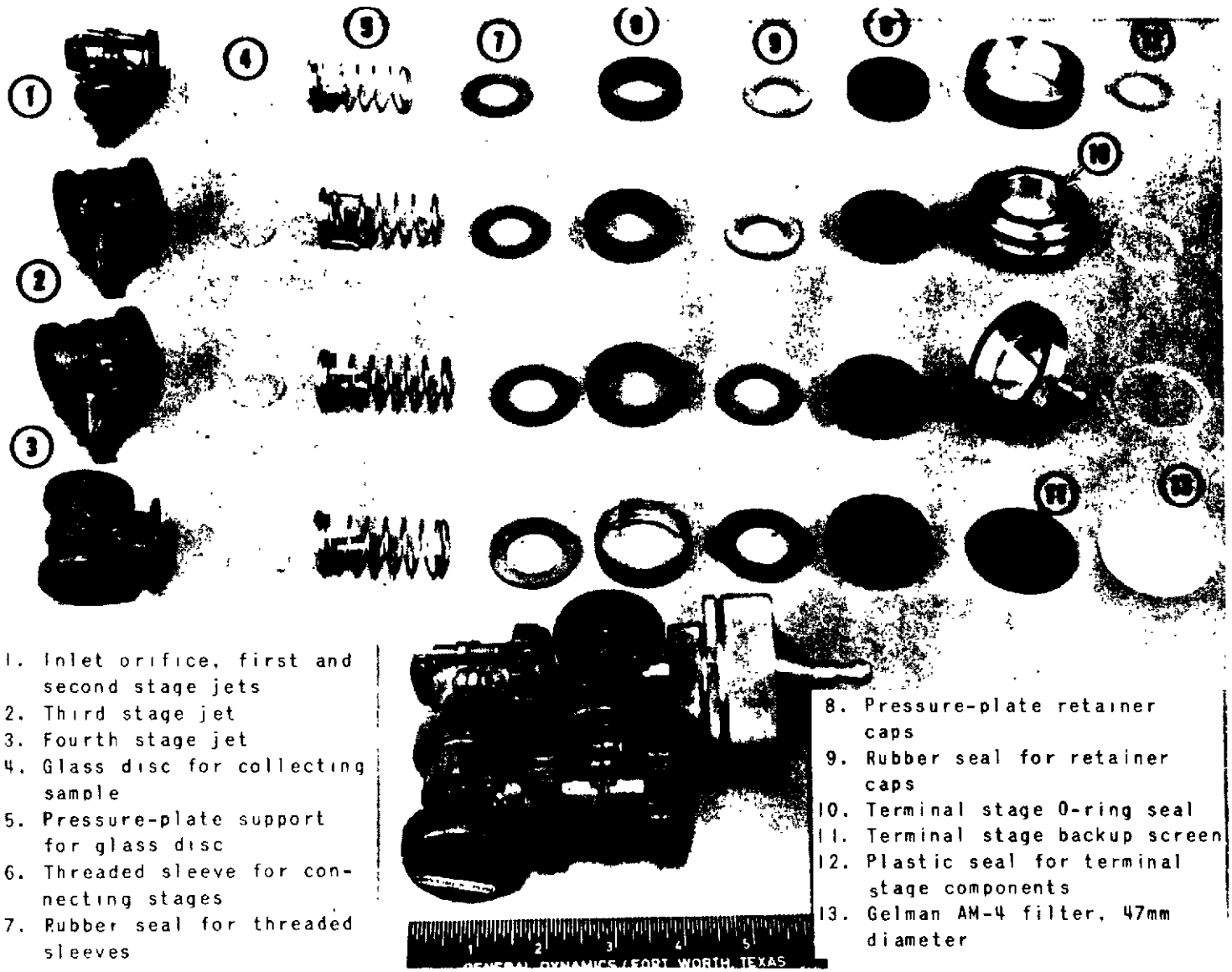
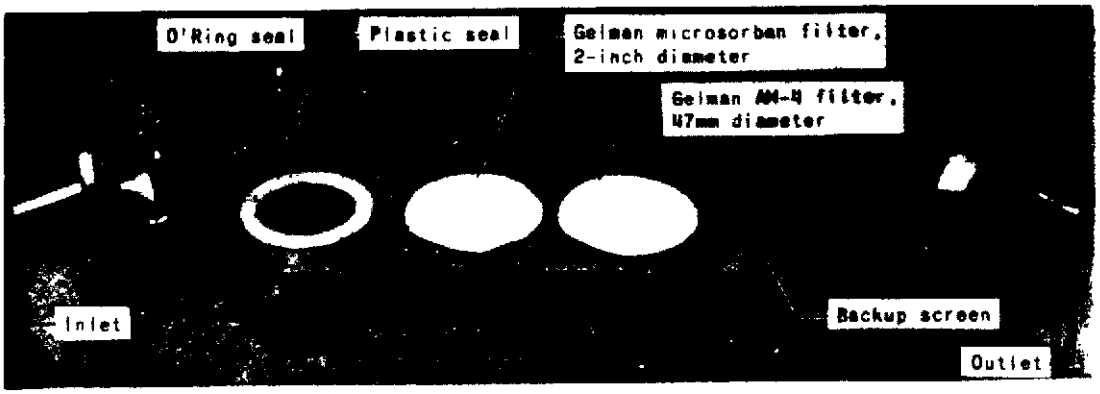
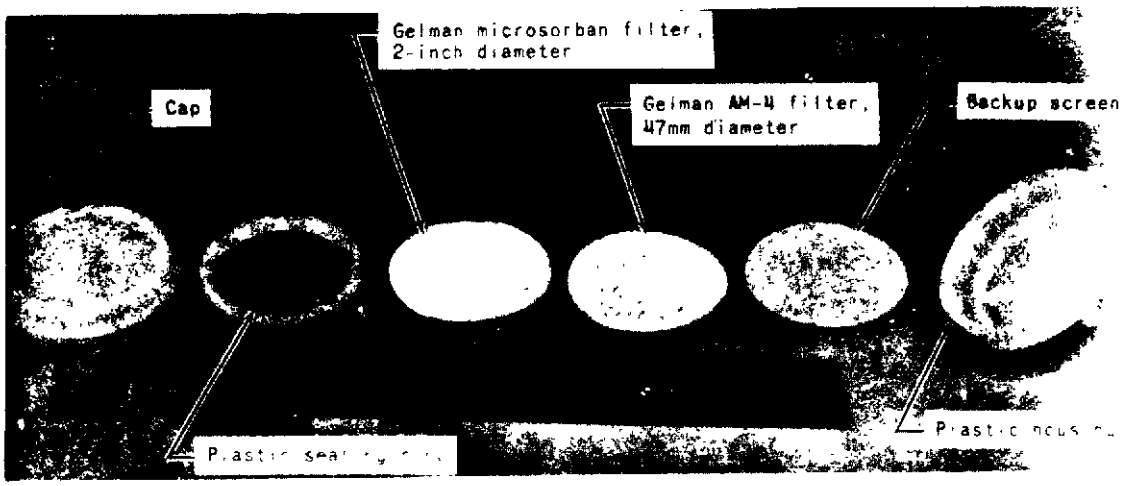


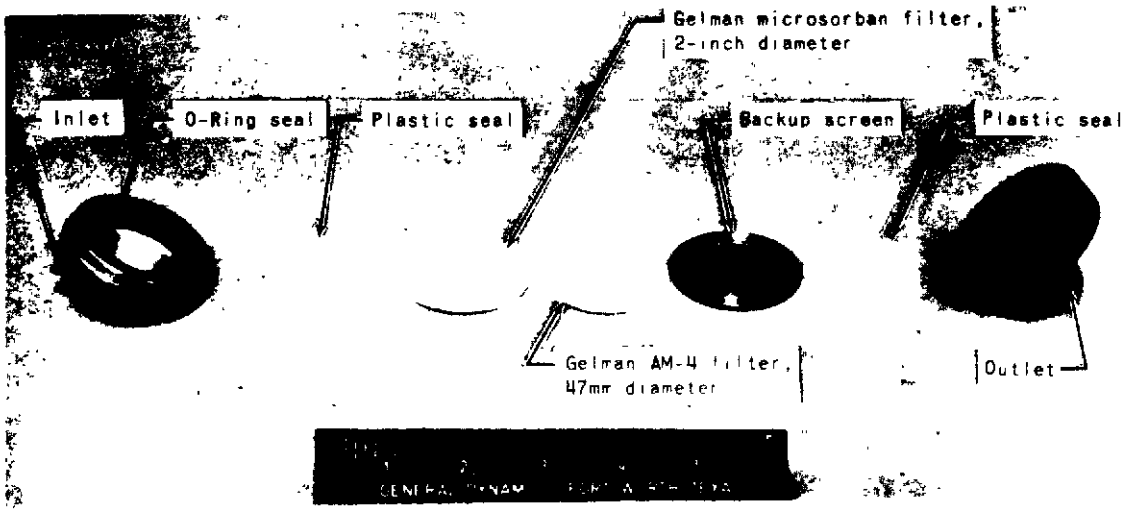
Figure 1.15 Casella impactor. (General Dynamics photo)



Type I



Disposable Type



Type II

Figure 1.16 Disassembled total air samplers. (General Dynamics photo)

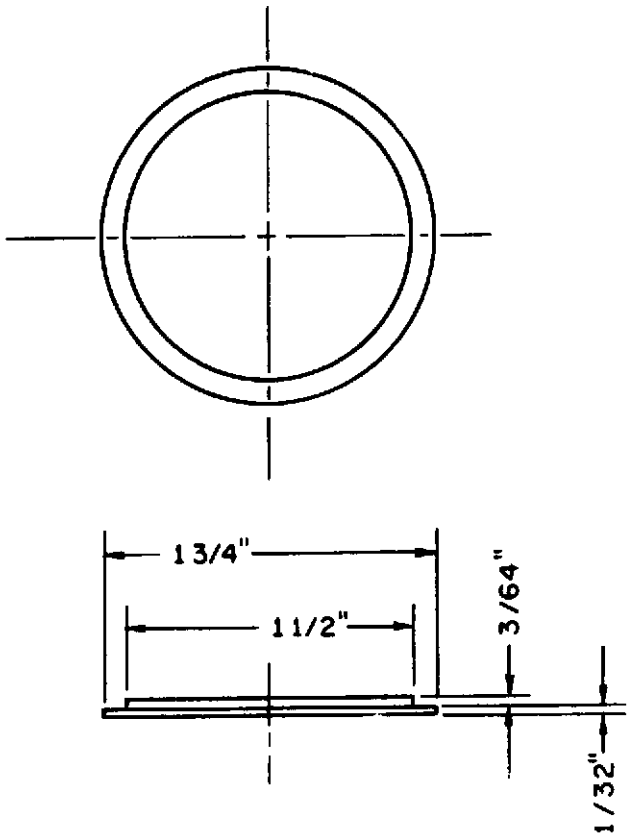


Figure 1.17 Fallout planchet.

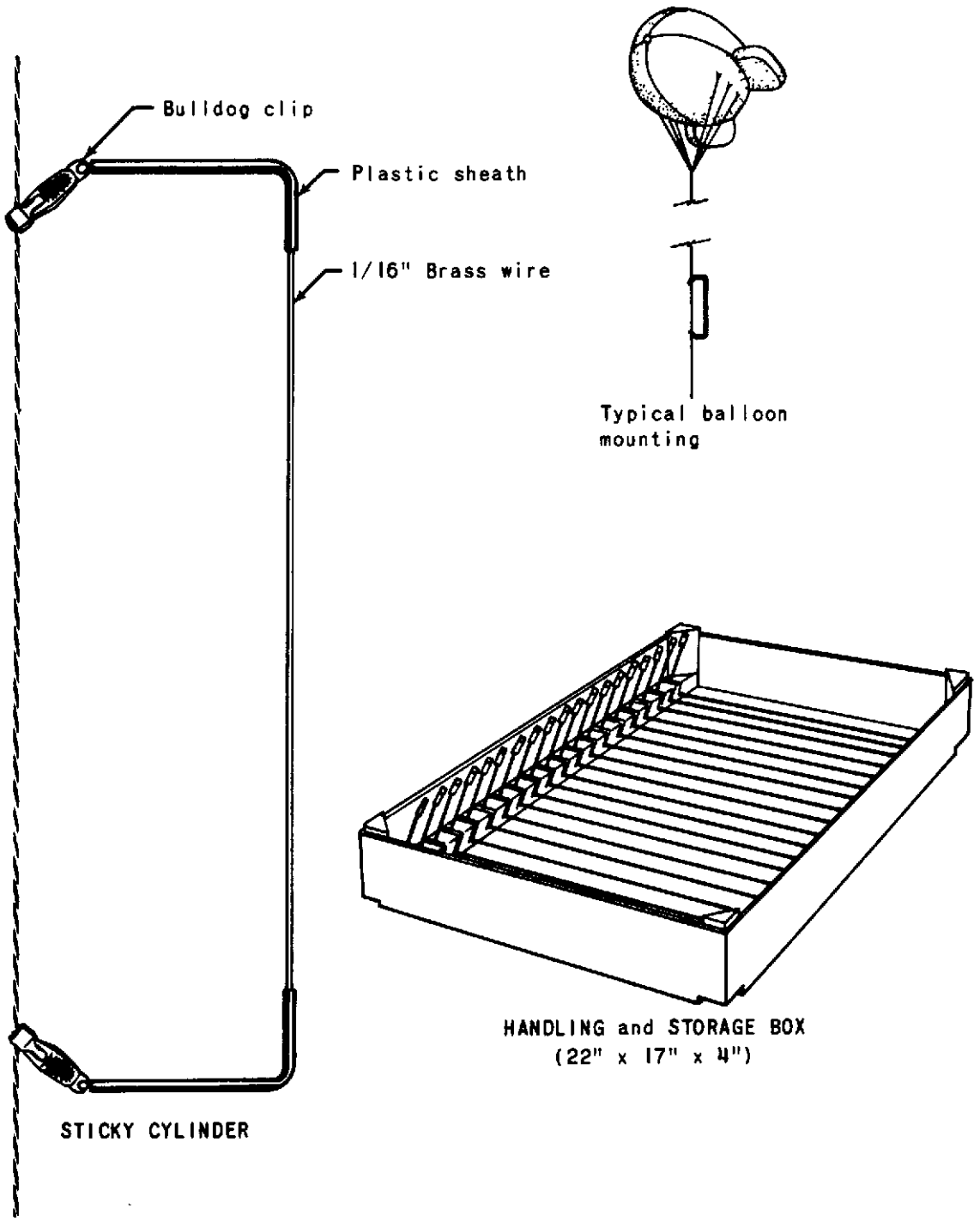


Figure 1.18 Sticky wire air sampler.

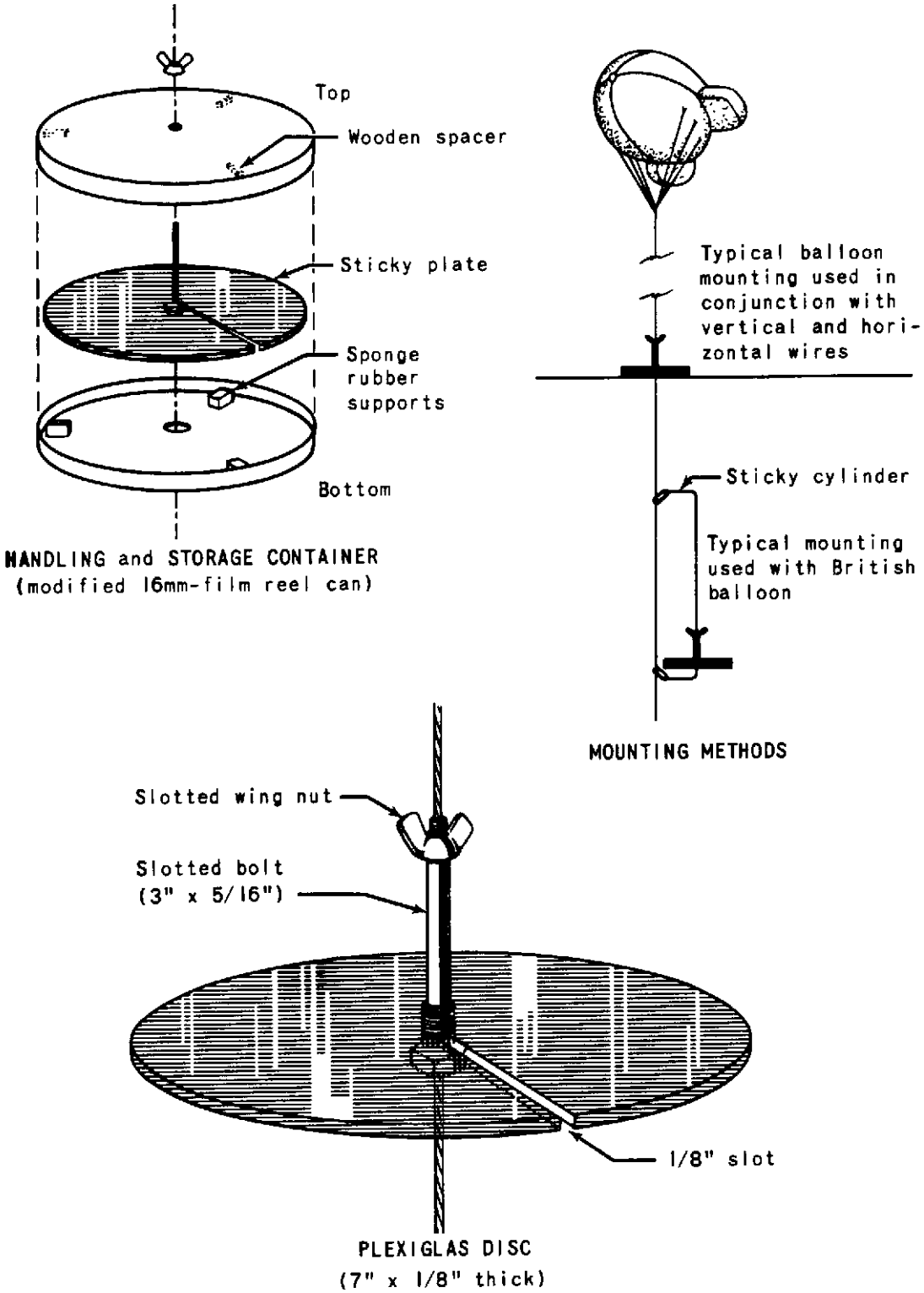


Figure 1.19 Sticky disc air sampler.

CHAPTER 2

PROCEDURES

2.1 OPERATIONS

Operating procedures were established to minimize the contamination hazard to personnel and to avoid cross-contamination of samples while achieving the objectives of the Facility, namely, to provide (1) a unified method of processing and packaging samples, (2) on-site alpha counting of selected samples, and (3) a complete record of all samples collected during the operation and their disposition.

Since the contamination levels were 10 to 100 times less than the expected (initially calculated) values, operating procedures were simplified and personnel regulations regarding dress, eating, drinking, smoking, and passage between areas were relaxed. Handling techniques developed while processing samples resulted in significant changes to operating procedures. Specially built jigs and fixtures were discarded and simpler procedures based on manual dexterity were adopted as personnel handling the samples gained experience. Samples from the last test were processed 2 or 3 times faster than samples from the first test, while contamination control was maintained to the same, or a higher degree.

Pre-Processing Facility Checks. Before sample processing began, operating checks were made on all equipment.

The air supply and exhaust system of the High-Level Trailer was checked to determine that the internal pressure was less than ambient atmospheric pressure and that the Receiving Room was at a greater negative pressure than the Sample Processing Area. Two adjustments of the air supply and exhaust system were used to obtain these conditions. A two-speed motor controlled the air supply to the trailer, while separate pneumatic valves controlled the exhaust rate from the Receiving Room and the Sample Processing Area. These valves controlled the exhaust rate from 0 to 4000 cfm. Checks were made to determine that glove boxes were operating at lower negative pressure than working areas and that air from the Receiving Room was exhausting properly through the hoods. The pressure drop across the absolute filters was measured continually and the drop across the total filter bank was measured periodically on each exhaust system. (Filters were to be changed if the pressure drop was greater than 3 inches of water. However, no reading greater than 1 inch was observed during the operation.)

The responses of the Portable Alpha Counters (PAC-3G and

1SA) were checked daily with calibrated sources. Low PAC-3G readings usually indicated that the gas supply of the instrument was exhausted. The mylar window was checked to see that it was intact and light-tight. This was done by exposing the detecting surface to a strong light and observing meter needle movement. Frequent background checks were made to detect probe contamination. Contamination was removed from probe grids with masking tape. The PAC's were monitored periodically and readings greater than 50 cpm (minimum detectable activity) indicated the presence of contamination. The instrument was returned to the repair facility for decontamination. Very few instances of instrument contamination were observed.

Counting systems were checked daily. Standard sources were counted for pre-set times and count rates compared with calibrated values. Background counts were also made at this time. (The background count was 5 cpm or less in all cases.) Voltage and frequency meters were attached to the trailer power supply to show the magnitude and time of any variations. (This was essential because small changes in these parameters could have a large effect on counting results.) These meters showed that whereas the frequency was fairly constant ($\pm$0.5 cycle per

second), the voltage varied several volts during the day due to changes in power demands of the main camp. In general, small daily fluctuations had little or no effect on counting systems or data they produced. Additional background and standard checks were made periodically to further reduce the effect of these fluctuations. Severe voltage fluctuation occurred twice as a result of generator breakdown. The first outage caused an automatic counting system sample-changer to break down. The second outage burned out an automatic counting system printer. (It was necessary to replace it.)

The thermostats in each trailer were checked and compared to standard thermometer readings. Attempts were made to keep counting areas at 75°F for maximum counting accuracy and instrument stability. However, insufficient heater capacity and persistence of cold weather made it difficult to maintain this temperature. Temperature fluctuations caused maximum variances of about 2% in counting results. This effect was partially corrected for by making more frequent background and standard checks.

Sample processing supplies were conveniently placed at the beginning of each work day.

Receiving Dock and Receiving Room personnel dressed out in

coveralls, shoe covers, caps, and rubber gloves at the Rad-Safe center.

Controls During Processing. Receiving Dock and Receiving Room personnel were restricted to their own areas and the passageway entrance between trailers to control cross-contamination. They were permitted to enter the passageway only after removing their contaminated gloves and putting on clean booties. Hands and feet were monitored with a PAC to preclude contamination of the passageway. (The passageway was the only area in which they were permitted to smoke or drink.) Personnel working in the Sample Processing Area and in the High-Level Counting Room wore normal work clothing. They were permitted access to the Low-Level Trailer after monitoring their shoes at the dutch-door that separated the two units. When no contamination or airborne activity was found in the Sample Processing Area, free access to both trailers was permitted. Smoking and drinking restrictions in this area were also relaxed at such times. Personnel working in the Low-Level Trailer wore normal clothing with no restrictions on smoking, drinking, etc.

Continuous air samplers measured the airborne radioactivity level in the Receiving and Sample Processing areas. Throughout

processing operations, these units recorded the instantaneous concentration and the concentration 6 hours later (to permit ambient radon-thoron to partially decay). Ten PAC's dispersed throughout the facility were used to monitor glove boxes, hoods, and samples. Sample monitoring data plotted on test array maps provided a rapid qualitative picture of the cloud's profile and fallout pattern.

The Project Officer monitored all operations by visiting processing areas, observing handling procedures, and, when applicable, suggesting improvements or revisions in procedures.

Facility Clean-Up. After each processing operation, a general monitoring survey of the work area was made. All hood and glove box protective coverings were removed and disposed of and the bare surfaces monitored with the PAC's. Contaminated units were washed or vacuumed until background readings were obtained. Tools and supplies used during the operation were monitored and either decontaminated or disposed of as contaminated waste. After processing facilities and supplies had been checked and decontaminated or disposed of, the floors and working surfaces were cleaned with a wet vacuum cleaner and monitored with a PAC.

PAC's, distributed around the facility, were used to check personnel contamination. The alpha hand monitor in the Receiving Room was also used. Receiving Dock and Receiving Room personnel returned to the Rad-Safe center after processing operations were completed and were monitored a second time. In only one or two instances was significant contamination found and this was removed easily with soap and water.

After clean-up, the facility was ready to process the next group of samples. Through an effective set of operating procedures, modified with time and experience, it was possible to record and process large numbers of samples in a minimum of time, with minimum hazard to operating personnel, and with minimum cross-contamination of samples.

2.2 SAMPLES

Samples produced by this series of tests can be divided into two types: those resulting from natural deposition of fallout on a surface and those produced by passing air through sampling devices. Natural deposition samples were produced either by placing samples in the field prior to the test and collecting them afterward (fallout planchets and slides, sticky papers and trays with water) or by removing the naturally occurring environment

after the test and comparing it to background samples taken prior to the test (soil and vegetation). These samples provided a qualitative picture of the deposition pattern of the fallout cloud.

Samples produced by drawing air into a sampler were intended to simulate contamination uptake by human breathing in a fallout zone. Some samplers (total air and moving tape samplers) were designed to provide a gross picture; others (Casella and Andersen impactors) separated the inhaled contamination by particle size. After additional analysis, the latter units will also provide a picture of the particle size distribution resulting from a specific test (set of conditions), as a function of distance from ground zero.

Sample Processing. Samples were picked up in the field and transported to the Receiving Dock (Figure 2.1) of the High-Level Trailer. A Sample Handling Record (Figure 2.2) was prepared for each sample(r) or group of samples. Samples (or samplers) were placed into pass-through cabinets attached to each hood. They were removed from the cabinet into the hood. Outer containers (plastic bags, envelopes, cartons, etc.) were removed and a rough alpha monitoring check made by either smearing the outer surface of the samplers or monitoring them with a PAC.

Contaminated units were decontaminated by vacuuming or wiping prior to removal of the samples (Figure 2.3). Samples (or samplers) were placed into clean containers (polyethylene bags, envelopes, etc.) (Figure 2.4) and transferred to glove boxes where samples requiring counting were separated from the rest. Samples that did not require counting or additional processing were placed into clean (uncontaminated) outer containers for temporary storage. Samplers requiring disassembly were processed inside glove boxes. The samples were removed by methods described in **Appendixes A-N.** Monitoring of samples removed from a Casella sampler is shown in Figure 2.5. Each sampler was put back into a polyethylene bag and returned to the originating group for decontamination and reloading. All samples were numbered so that a complete record of samples, and their disposition, would be available.

Counting. The counting facilities were set up so that samples of varying degrees of contamination could be handled safely without cross-contamination. Three counting areas were available: (1) glove boxes for contaminated samples reading greater than 1,000,000 cpm (alpha) or samples whose nature or form made it inadvisable for them to be counted in an uncontrolled atmosphere;

(2) High-Level Counting Room for contaminated samples reading between 10,000 to 100,000 cpm (alpha) and that could be handled and counted in a normal manner; and (3) Low-Level Counting Room for samples with 10,000 cpm (alpha) or less. As samples from Double Tracks were received, it became apparent that nearly all samples were less than 10,000 cpm. It was therefore decided to minimize sample processing time by using available counting equipment in both the Low and High-Level Counting areas.

Counting Data Sheets (Figure 2.6) were prepared to provide a complete record of all variables involved in counting samples. Sample number, sample description, counting area, counter used, and counting time were all recorded on the form. Space to record the type of radiation to be measured and operating voltage were also provided. The gross count was recorded as read off the counter. Uncorrected counts per minute, net counts per minute, and corrected dpm were rounded off to three significant figures for numbers of 100 or more or to two significant figures for numbers less than 100. The background was recorded to the nearest significant whole number (0 to 5) and the standard cpm to dpm conversion factor was recorded to three significant figures.

To process samples from each test in a minimum of time,

samples were normally counted for only three minutes. In instances where projects needed more precise data, longer counting times (10 to 30 minutes) were used.

Forty standards of different dimensions and activity level were prepared and calibrated to $\pm 2\%$. These standards had the same dimensions as samples to eliminate need for a geometry correction factor. Table 2.1 lists all standards.

A background count and standard check were made first thing in the morning and in the afternoon. In addition, periodic background and standard checks were made during the day to control counter-contamination build-up. These checks served to minimize cross-contamination and maximize sample counting accuracy.

Packaging. After counting, the samples were packaged for storage. The guiding principle in packaging samples was to assure that the recipient and his equipment would not become contaminated while removing the sample from its outer shipping container. In addition, great care was taken to prevent cross-contamination of samples. Both objectives were achieved through triple encapsulation. The sample was first placed in a container which, when monitored, was shown to be clean. (This first pack-

aging was sometimes done by the project originating the sample.) Next the container (envelope, plastic bottle, etc.) was placed in another container (envelope, plastic bottle or bag, etc.) which was then placed into a carton. Casella and Andersen impactor samples and liquid samples received special packaging.

The contaminated sides of Casella slides were covered with a plastic hat (to protect the surface) and placed in dissolvable color-coded, cellulose-acetate envelopes. The envelopes were sealed and labeled with the appropriate sample number and stage number. All sample envelopes from one Casella were gathered together and put into a 3- by 5-inch manila envelope marked with the sample handling record number. These manila envelopes were gathered together in lots of about 25 and put into larger manila envelopes. The sample handling record numbers were listed on each envelope. These large envelopes were then put in cardboard cartons for temporary storage. (See Figure 2.7 for diagrammatic representation of Casella processing procedure.)

Normal Andersen impactor slides were also placed in cellulose acetate envelopes (Figure 1.10). Andersen plates with strippable water-soluble films for use in particle studies were placed in specially prepared petri dishes to protect their active

surface. These petri dishes were then packaged in the normal manner.

Bottled liquid samples had their lids sealed with Tuck Tape and cardboard was wrapped around the bottle. The bottle was placed into one plastic bag and then another, with each in turn being sealed with tape. The bottles were placed into cartons for temporary storage.

A shipping log was kept since samples were classified secret restricted data . Initially, a separate book was maintained. After several shipments had been made, it was decided that the signed sample receipt file could serve the same purpose and save one step in the processing cycle. Entry in the logbook was than discontinued. Data in the log, and on the receipts, includes: sample handling record number, sample description, person receiving the sample, and shipment registration number (if the samples were mailed).

TABLE 2.1 COUNTING STANDARDS

Std. No.	Configuration	Standard DPM	Std. No.	Configuration	Standard DPM
1	2" filter paper disc	2300	250	2" platinum disc	3480
2		2.30×10^4	251		3520
3		2300	252		3140
4		2.30×10^4	253		2810
5		2300	254		2.87×10^4
6		2.30×10^4	255		3.23×10^4
124	3-3/8" metal discs	2020	256		3.34×10^4
125		2020	257		3.21×10^4
126		2020	295	1" platinum disc	3800
127		2.02×10^4	297		3800
128		2.02×10^4	298		2360
129		2.02×10^4	299		2610
130	1" x 3" microscope slide	2020	309		2.08×10^4
131		2020	311		2.65×10^4
132		2020	312		3.10×10^4
133		2.02×10^4	313		4.32×10^4
134		2.02×10^4	623		2800
135		2.02×10^4	796		2.23×10^4
201	1" filter paper disc	2720	808		2.72×10^6
202		3060	809		2.25×10^4
203		2.61×10^4	821		3.43×10^5
204		1.51×10^4	839		2200
205		2.45×10^4	880		2.15×10^5
200		2860	883		2.44×10^4
			888		1970
			890		2.96×10^6
			893		3.21×10^6
			897		3.07×10^5

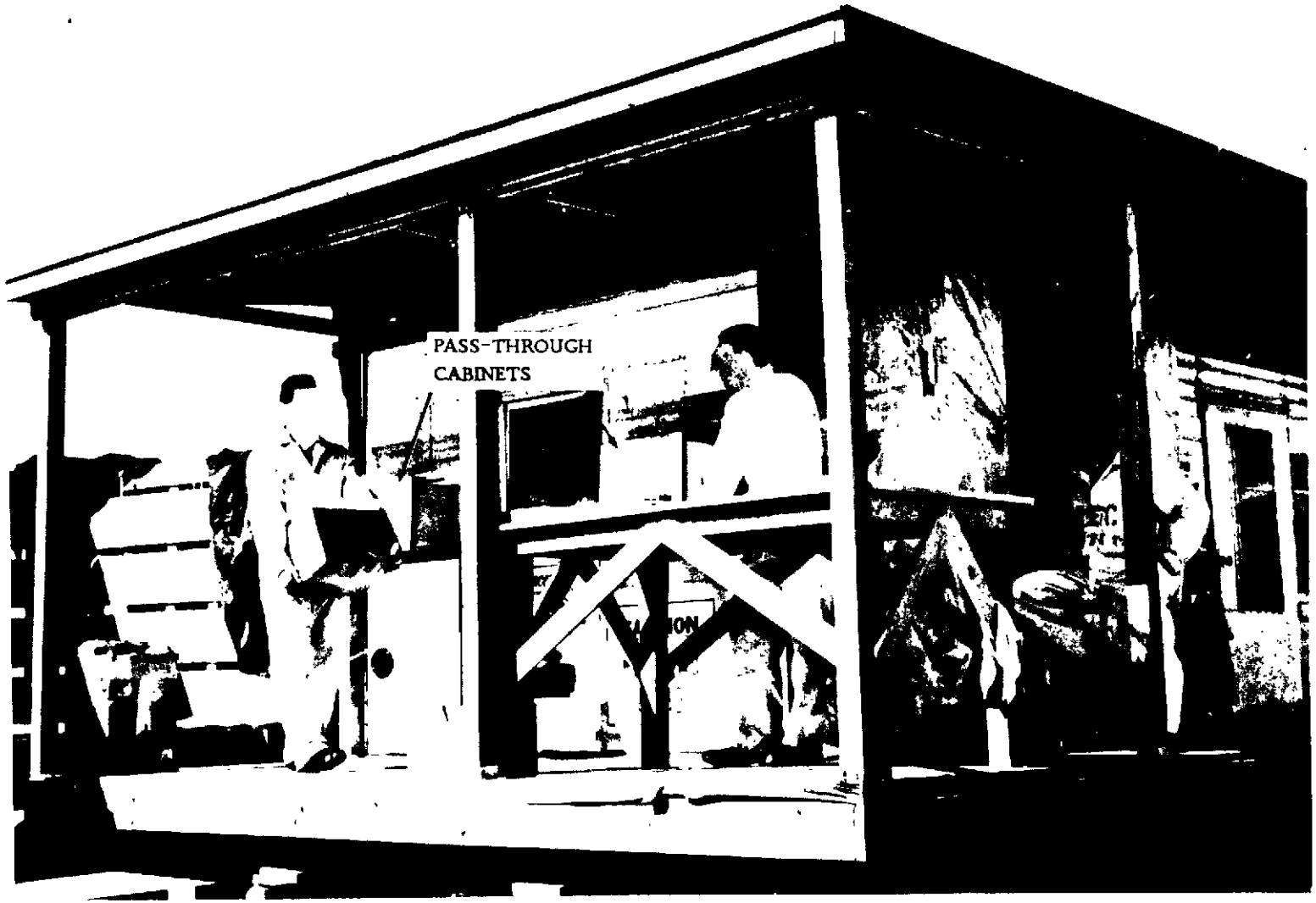


Figure 2.1 Receiving dock. (DASA-139-07-TTR-63)

SAMPLE HANDLING RECORD

Date _____ Sample No. 010154

Submitted by (Company Name) _____
(Project Officer's Name) _____ Project No. _____
Initiators Sample No. _____

SAMPLE HISTORY

1. Type _____
2. Original Location _____
3. Test No. _____

ACCEPTED FOR PROJECT S.IA _____

WORK TO BE PERFORMED

INITIAL AND DATE WHEN EACH STEP IS COMPLETED

A. Receiving Room (SEE DIRECTION SHEET ____) NO ☐ YES ☐ _____
1. Normal Processing of Sample
2. Sample Holder
a. Discard ☐
b. Decontaminate for Re-use ☐
c Wipe Test Result _____
d. Return to: Name _____
Location _____
3. Special Instructions _____

B. Sample Handling Area (SEE DIRECTION SHEET ____) NO ☐ YES ☐ _____
1. Normal Processing of Sample
2. Count ☐
Monitoring Check ☐ Results _____
3. Special Instructions _____

4. Next Station
High-Level Counting Room ☐ Low-Level Counting Room ☐
Shipping Room ☐

C High-Level Counting Room ☐ D. Low-Level Counting Room ☐ _____
1. Alphas Only ☐ Results _____ dpm
2. _____ ☐ Results _____ dpm
3. Counting Time _____
4. Accuracy Desired _____
5 Special Instructions _____

E. Shipping Instructions
1 Samples _____
a. Method
Normal Freight ☐ Air Express ☐ Special Delivery ☐ _____
b. Persons Name _____
c. Company Name and Address _____

2. Data
a. Persons Name _____
b. Company Name and Address _____

3. Special Instructions _____

General Comments _____

Figure 2.2 Sample handling record.

Figure 2.3 Receiving room hoood. (Tracerlab photo)

Figure 2.4 Processing a Casella prior to disassembly. (DASA-120-35-TTR-63)

Figure 2.5 Monitoring Casella samples. (DASA-120-20-TTR-63)

☐ LOW-LEVEL
☐ HIGH-LEVEL

COUNTING DATA SHEET

Sample No. _____

Sample Description _____
Counter to be Used _____
Counting Time _____
Special Instructions _____

Type of Radiation ☐ Alpha ☐ _____
Operating Voltage _____ V

Sample Number	Inst. No.	Date	Time	Gross Count	Counting Time	CPM	Bkgd.	Net CPM	Std. Factor	Corrected DPM	

Figure 2.6 Counting data sheet.

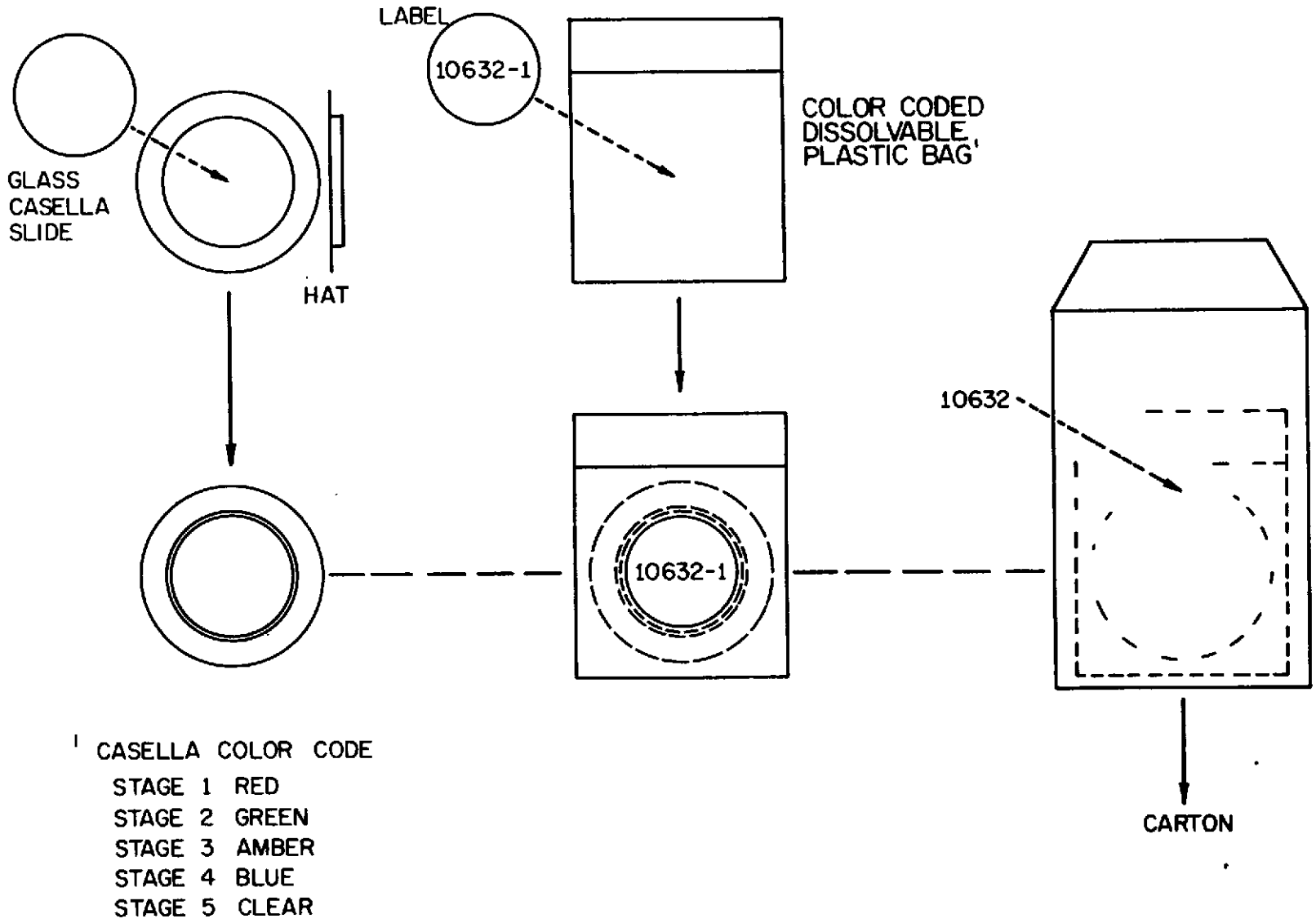


Figure 2.7 Schematic for packaging a Casella.

CHAPTER 3

RESULTS

3.1 PROCESSING

A total of 14,323 samplers were processed by the Sample Processing Facility during Operation Roller Coaster. Of this number, 3,895 were from Double Tracks, 3,292 from Clean Slate 1, 3,840 from Clean Slate 2, 3,239 from Clean Slate 3, and 57 after the conclusion of the test series. Table 3.1 provides a complete listing by type of the samplers processed. The 14,323 samplers contained 20,021 samples requiring processing.

In processing samples, notes were made on the Sample Handling Record on sample condition, omission of samples (example: stage 5 missing), and other pertinent points. A summary of these observations is included in Table 3.1.

The samples processed can be divided into two groups, those counted before packaging and those requiring only packaging. The processing method for Andersen and Casella impactor samples, fallout planchets, and sticky wires was determined by their location relative to the fallout cloud and the PAC monitoring results on each sample. Samples in the path of (and on the fringe of) the cloud were counted; those beyond the cloud were only packaged.

Of the 20,021 samples available, 9,902 were counted by the Sample Processing Facility. Of this number, 2,916 were from Double Tracks, 2,114 from Clean Slate 1, 2,583 from Clean Slate 2, and 2,289 Clean Slate 3. For a breakdown of sample counting statistics, see Table 3.2. A total of 2,334 samples was never counted because of individual location relative to the fallout cloud. Of this number, 687 were from Double Tracks, 909 from Clean Slate 1, 738 from Clean Slate 2, and 0 from Clean Slate 3.

A total of 8,970 other types of samples were packaged without counting. These included sticky papers and fallout slides from on-site and off-site locations, soil and vegetation samples, and total air samples (the non-disposable total air samples had to be removed from their holders). Of these, 2,469 were from Double Tracks, 2,069 from Clean Slate 1, 2,194 from Clean Slate 2, and 2,238 from Clean Slate 3.

Sample processing time steadily diminished as experience in handling techniques was gained. Initially (Double Tracks), 4 Casellas or Andersens per hour were processed per two-man team; by Clean Slate 3, the rate had increased to 12 Casellas or 8 Andersens per hour per two-man team. After samplers were disassembled and the samples removed, the samplers were re-

turned to Project 2.2 for decontamination and reloading. Samples were monitored and counted, data evaluated, and the samples packaged for storage.

Counting data was given to the project that had originally provided the samples (samplers). Samples reading less than 850 dpm (3 min count) were reported as ±10%; those reading greater than 850 dpm were reported as ±5%. The data, and its interpretation, will be found in other Roller Coaster reports.

3.2 MONITORING

Balloon curtain Casellas and selected ground array samples were monitored with Portable Alpha Counters (PAC) to provide a gross picture of the cloud path (ground array samples) and profile (balloon curtain) and to determine which samples should be counted. Sticky wires on the balloon curtain were monitored in air ionization chambers to obtain a more detailed profile of the fallout cloud passing through the balloon curtain. Monitoring results are shown graphically in Figures 3.1 through 3.17. Samples reading background or less are recorded as unshaded symbols, and those reading greater than background have been shaded in. Contamination level contours are drawn on Figures 3.4, 3.9, and 3.13 (sticky wire data) to make visual interpretation of the results

easier.

The data that follows is intended to provide a qualitative picture of the samples individually and the resultant fallout patterns. Air ionization chamber readings are considerably more accurate than the PAC readings because a sample in the air ionization chamber is counted in 4π geometry (all sides of the sample are counted at one time). PAC readings, which are the basis of most of the data, are only qualitative readings, as a small change in distance of the probe from the sample, or the exact position of the activity on the sample relative to the sensitive area of the probe, would have a considerable effect on the reading obtained. Therefore, sophisticated analyses of the data should not be attempted.

Double Tracks. The Double Tracks fallout pattern, as determined by monitoring the samples with PAC's, is shown in Figures 3.1 and 3.2. From these figures we can see that the cloud proceeded due south between Stations B055 and B085, swinging slightly southeast as it proceeded down the array. Considerable spreading out of the cloud seemed to have occurred at Arc R, where positive readings were obtained from Stations 034 to 092. The samples most contaminated were located at BM09 and BO09.

The fallout cloud profile is shown in Figures 3.3, 3.4, and 3.5. Figure 3.3 shows Arc B balloon curtain Casella impactor PAC monitoring results. This curtain was centered on B060 and covered from B040 to B080. Highest monitoring results were obtained on Line 5, located at about B047. All but two of the positive samples were located on the left hand side of the curtain (B040-060).

Figure 3.4 presents sticky wire data from the Arc B balloon curtain. Contamination contour lines were drawn to show different levels of contamination: 5 to 50, 50 to 100, 100 to 200, and greater than 200 μμa. The highest cloud contamination levels were located between Stations 040 and 050 at 400 to 600 feet. The radioactivity does not seem to be uniformly dispersed, as low contamination areas are located next to some of the highest areas.

Figure 3.5 shows Casella impactor and sticky wire monitoring results from UK balloons located on Arc J at positions 034, 040, 046, 052, 058, 064, 070, and 076. Balloons at 046, 058, and 070 had impactors at 350 and 700 feet above ground. The 350-foot impactors at J-46 and J-58 showed positive results. (Lack of readings on the J-70 balloon could have been due to the power failure that occurred sometime during the test.) Sticky wire

data indicates that the highest contamination level occurred at Station 034, 200 to 400 feet above ground. A high contamination area is also evident at Station 046, 400 to 600 feet above ground.

Clean Slate 1. The Clean Slate 1 fallout pattern, as shown from the PAC monitoring results, followed a very narrow southeasterly path between Stations 015 to 035 to arc P, where it passed through Stations 030 to 045 (Figures 3.6 and 3.7).

The balloon curtain centered on Arc B026 indicated that the most active portion of the fallout cloud passed through Lines 19 to 29 (Position B031-B045) with the highest contamination levels at Line 21, Position 9 (B033, 1275 feet from the ground) (Figure 3.8).

Figure 3.9 presents sticky wire data from the Arc B balloon curtain. Contamination contour lines were drawn on this figure to show the 5 to 50, 50 to 100, 100 to 150, and greater than 150 μμa areas. This figure shows that highest alpha concentrations occurred at Stations B028 to 032 at 1425 feet. High contamination levels were also found between Stations 022 and 037 at heights of 1,100 to 1,550 feet above the ground.

The UK balloons did not have any Casellas or sticky wires attached to them during the test.

Clean Slate 2. Ground array sample monitoring results with

PAC's (Figures 3.10 and 3.11) indicate that the fallout cloud was widely dispersed in the ground zero to Arc B area and followed a southeasterly direction as it proceeded down the array. Positive readings were obtained all across the array but showed the highest concentration between Stations 020 and 080. Arc B balloon (B024 to 064) Casella impactor samples showed positive results at only five positions (Figure 3.12). These positions were on the extreme left side of the curtain between Stations B025 and B032 and at heights of 300, 975, and 1,275 feet. (The most active part of the cloud may have missed the balloon curtain.)

Figure 3.13 presents sticky wire data from the Arc B balloon curtain. Contamination contour lines were drawn to show the 0.4 to 1, 1 to 2, 2 to 3, and greater than 3 μμa areas. The extremely low readings obtained on the wires as compared to the previous tests and the location of the most contaminated samples on the extreme left side of the curtain indicates that the most active portion of the cloud missed the balloon curtain.

Sticky wires and Casella impactors (350 and 700 feet) on UK Balloon #1 located southeast of the ground zero bunker had the highest readings of the three ground zero UK balloons (Figure 3.14). The most contaminated wire was located 500 feet above ground.

Clean Slate 3. The fallout pattern, as shown from the PAC monitoring results, was widely dispersed in the ground zero area and proceeded in a southeasterly direction down the array (Figures 3.15 and 3.16). The main portion of this cloud passed between Stations D022 and D040, L038 and L048, though a considerable number of contaminated samples were found to the right of these stations.

Sticky wire counting results on UK Balloons 1 and 2 located at ground zero during Clean Slate 3 (Figure 3.17) indicate that the cloud traveled in a southeasterly direction. The most highly contaminated sample was 700 feet above ground. The Arc B balloon curtain was not used during Clean Slate 3.

The data summarized in this section were used to initially determine the cloud's path and profile and to select samples for additional study.

3.3 PACKAGING AND SHIPPING

About 15,000 samples were packaged for storage during and after Operation Roller Coaster. It was initially planned that samples for additional study would be distributed to participating organizations following each test. This was not possible because

selecting organizations to perform these studies required more time than was originally planned. Therefore, after the samples were processed, they were packaged for temporary storage in two transportainers . Specific packaging procedures for each sample type are described in the appendixes. In general, sample packaging was a function of sample form (liquid or solid), its container (glass, polyethylene), and expected additional processing of the sample (radiochemical analysis, microparticulate analysis). Following the completion of the tests, these transportainers were delivered to the Naval Weapons Station (NWS) at Concord, California, for storage. Upon selection of the organizations to perform the additional studies, lists of samples and their recipients were sent to Project 5.1a. The samples, which had been classified secret restricted data at the conclusion of the field phase, were then sent to the laboratories performing the additional studies. Of the 15,000 samples packaged for storage, 8,919 were selected for additional study. Of this number, 3,207 were from Double Tracks, 1,762 from Clean Slate 1, 3,388 from Clean Slate 2, and 3,542 from Clean Slate 3. A breakdown of samples shipped for additional study can be found in Table 3.3. The remaining samples are in secured storage at NWS Concord awaiting a decision on their disposition.

TABLE 3.1 SAMPLER PROCESSING SUMMARY

	Double Tracks		Clean Slate 1		Clean Slate 2		Clean Slate 3		Total Samplers Processed (by type)
	Bkg	Test[1]	Bkg	Test[2]	Bkg	Test[3]	Bkg	Test[4]	
Andersen	9	102	6	100	0	85	0	97	399
Casella	23	261	8	215	0	256	0	185	948
Total Air Samplers	23	224	5	204	0	223	0	189	857
Tape Air Samplers	1	9	0	1	0	6	0	1	18
Fallout Planchets	48	334	10	389	58	464	10	656	1,969
Fallout Slides	59	1103	9	940	79	563	10	1261	4,024
Sticky Papers	48	634	10	385	48	956	10	667	2,758
Soil	5	33	4	36	11	92	7	84	272
Concrete Core	0	6	0	8	0	7	0	6	27
Scrap Metal	0	35	0	2	0	3	0	3	43
Sticky Wires	0	924	0	924	0	924	0	19	2,791
Sticky Discs	0	12	0	18	0	22	0	0	52
Total Samplers Processed Per Event	211	3684	52	3240	197	3643	46	3193	14,266[5]

1 Open Outlets - 174; Open Inlets - 11; Torn Filter Papers - 3; Missing Stages - 4; Broken Stages - 7; Loose Between Stages - 11

2 Missing Stages - 8; Open Outlets - 6; Loose Between Stages - 3

3 Torn Filter Paper - 4; Open Outlets - 9

4 Open Outlets - 2; Missing Stages - 5; Torn Filter Paper - 1

5 57 Additional samples were collected and processed after conclusion of the test series.

TABLE 3.2 SAMPLE COUNTING SUMMARY

	Double Tracks		Clean Slate 1		Clean Slate 2		Clean Slate 3		Total Samples Counted (by type)
	Bkg	Test	Bkg	Test	Bkg	Test	Bkg	Test	
Andersen	63	581	42	434	0	595	0	679	2,394
Casella	115	1180	40	835	0	1015	0	925	4,110
Planchets	48	334	10	238	58	464	10	656	1,818
Sticky Wires	0	595	0	515	0	451	0	19	1,580
Total Samples Counted Per Event	226	2690	92	2022	58	2525	10	2279	9,902

TABLE 3.3 SAMPLE SHIPMENT SUMMARY

Sampler \ Test	DT	CS1	CS2	CS3	Total
Andersen	410	245	390	445	1490
Casella	800	515	845	760	2920
TAS D	46	20	53	81	200
TAS I & II	95	59	82	73	309
Tape	4		5	3	12
Film	150	154	354	365	1023
Slides	405	484	349	729	1967
Soil	72	196	70	44	382
Debris	23	6	85	1	115
Water		25	38	41	104
Wipes	29	15	7		51
Petrolatum (Soil)	23	34	102		159
Off-Site Films	149		2		151
Sticky Discs		9	6		15
Off-Site Slides	1				1
Total Shipped	2207	1762	2388	2542	8899*

* 20 Calibration Casella samples sent in addition

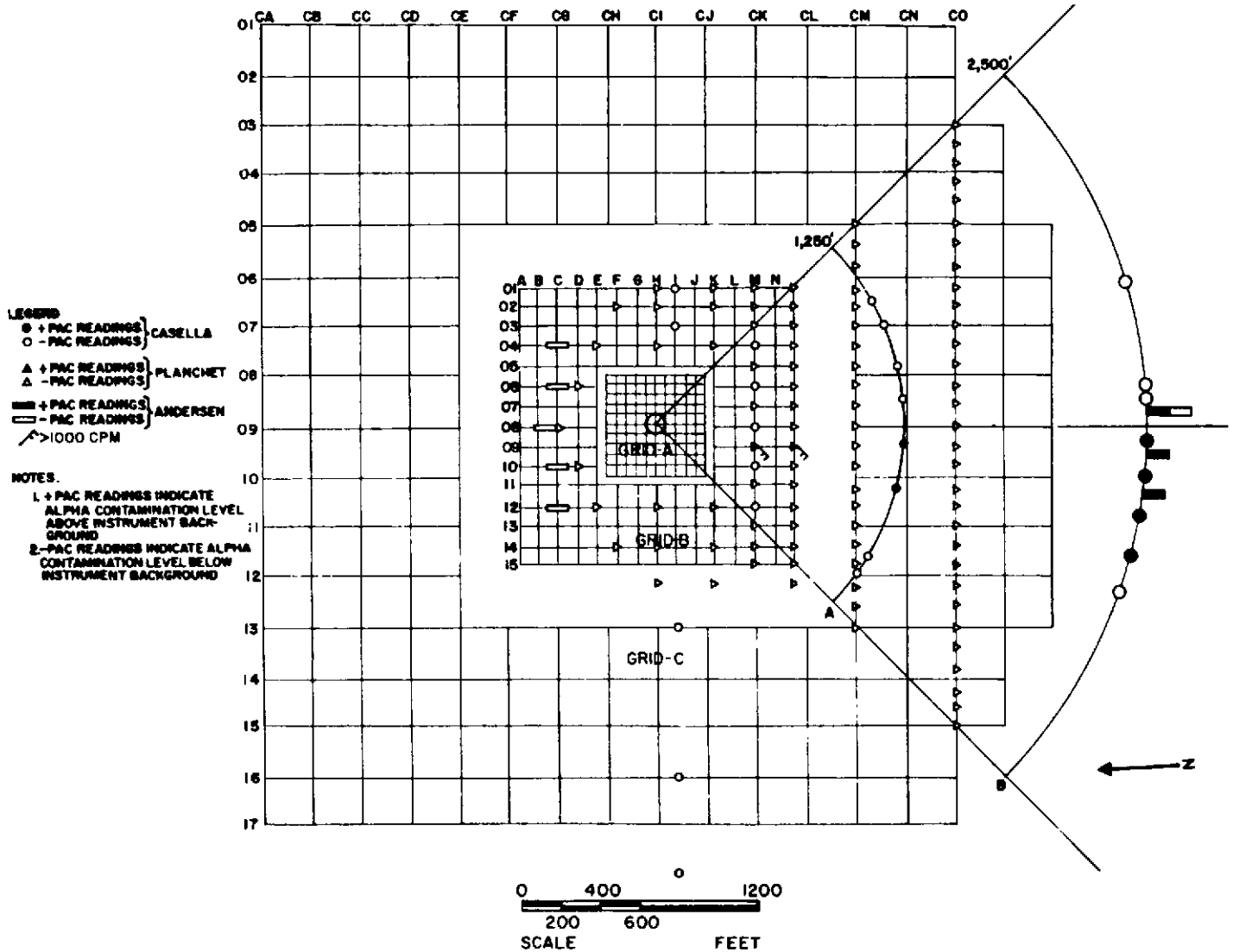


Figure 3.1 Double Tracks monitoring results: GZ through Arc B.

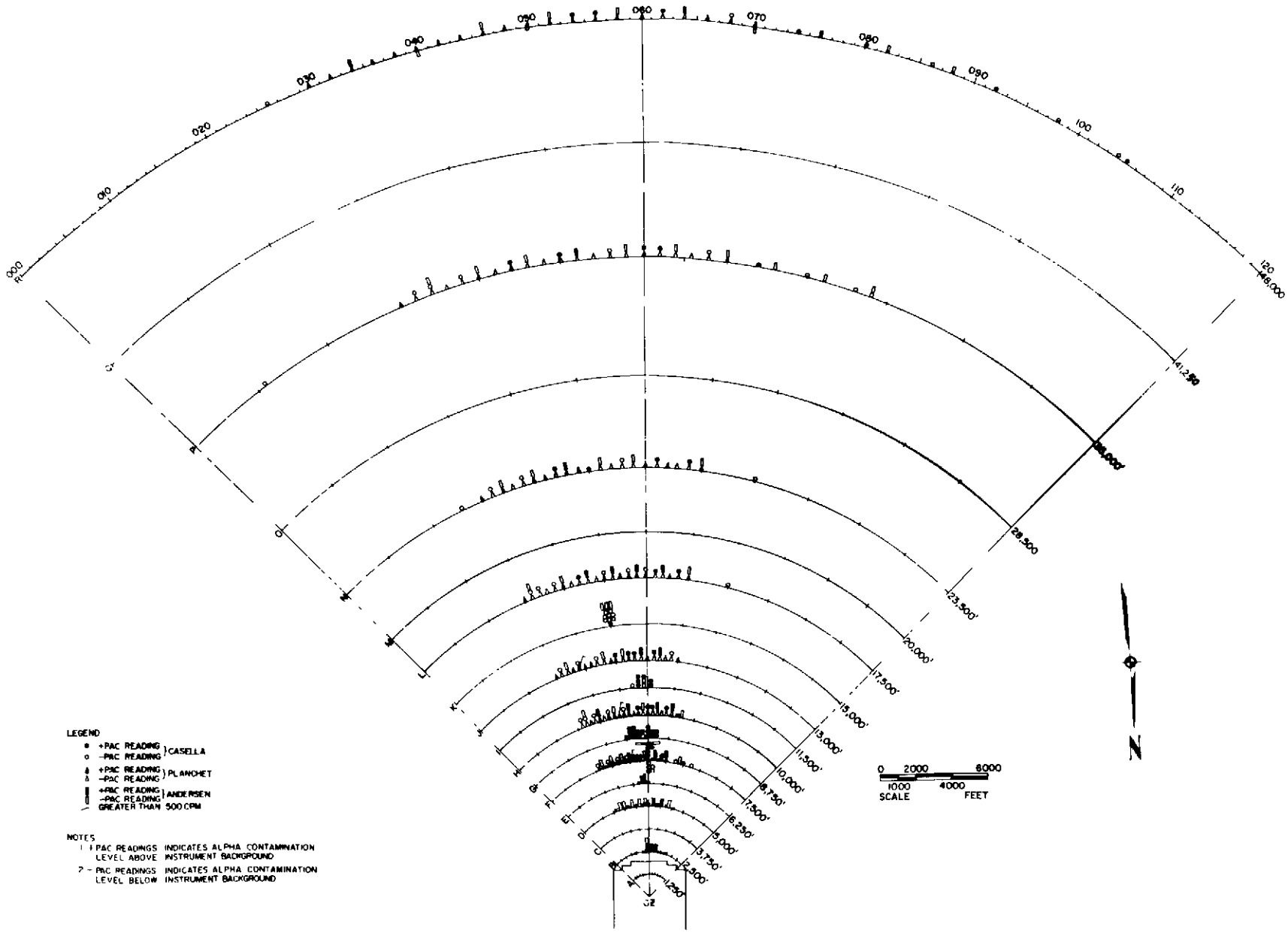


Figure 3.2 Double Tracks monitoring results: Arcs B through R.

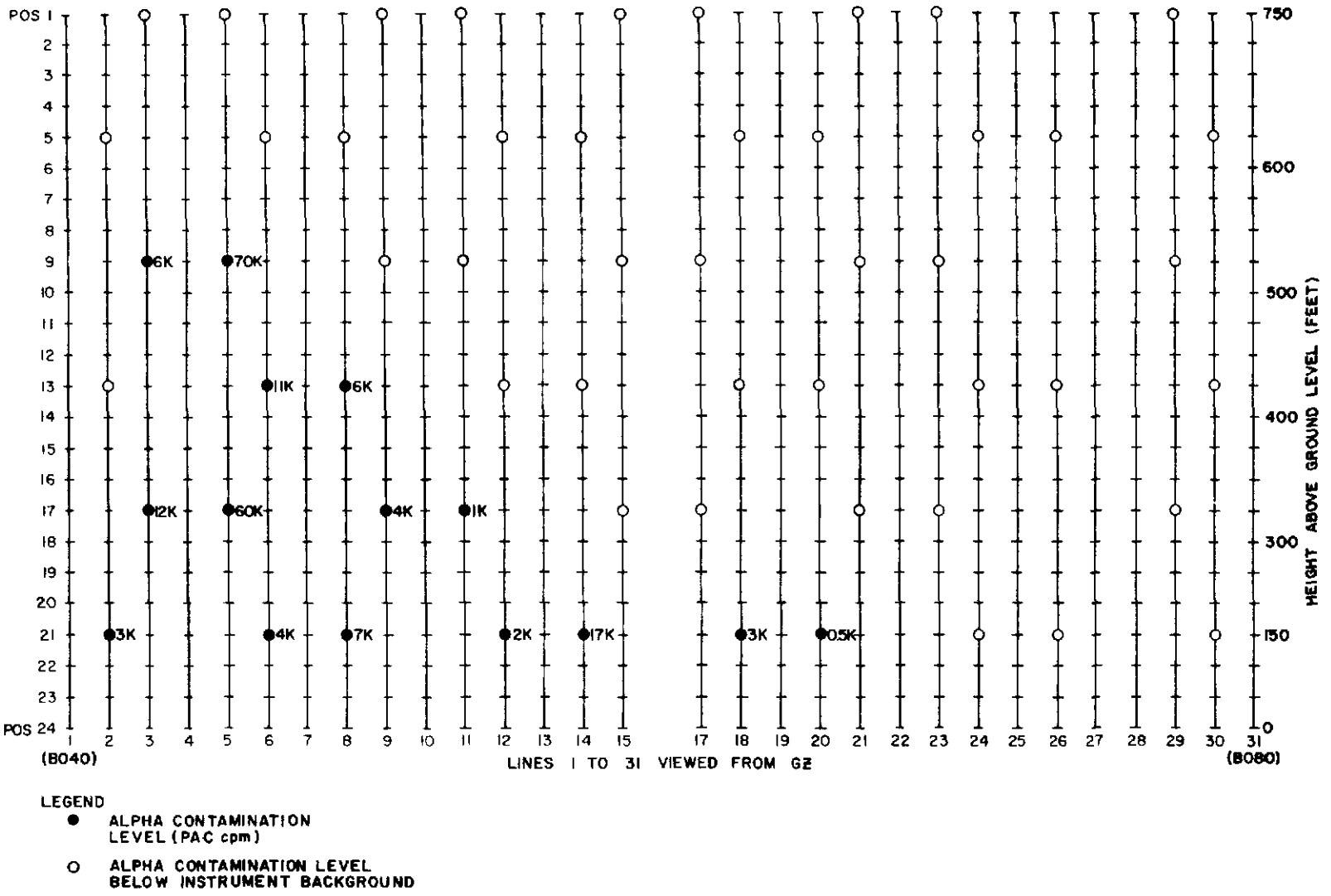


Figure 3.3 Double Tracks monitoring results: Casella impactors on Arc B balloon curtain.

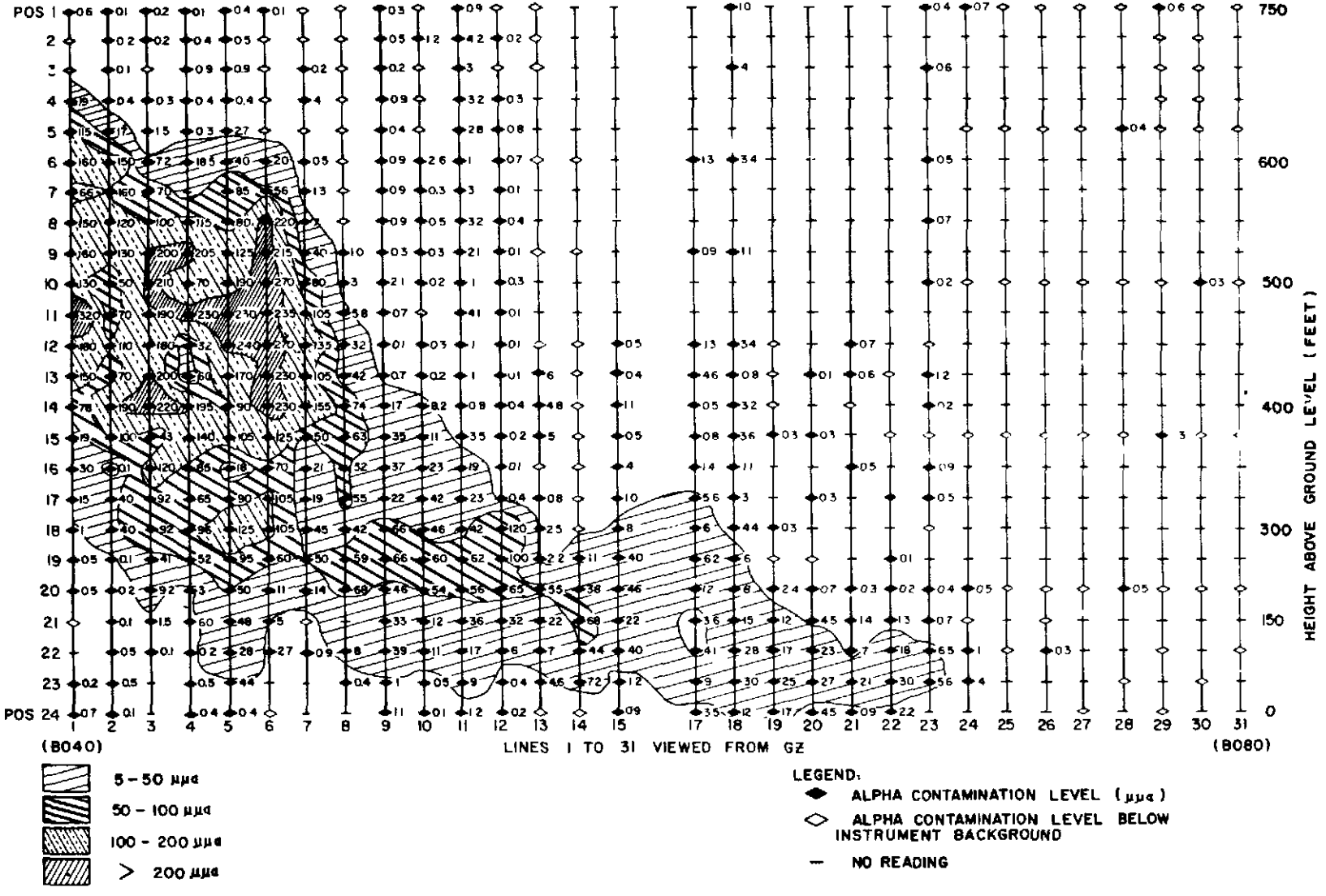


Figure 3.4 Double Tracks counting results: sticky wires on Arc B balloon curtain.

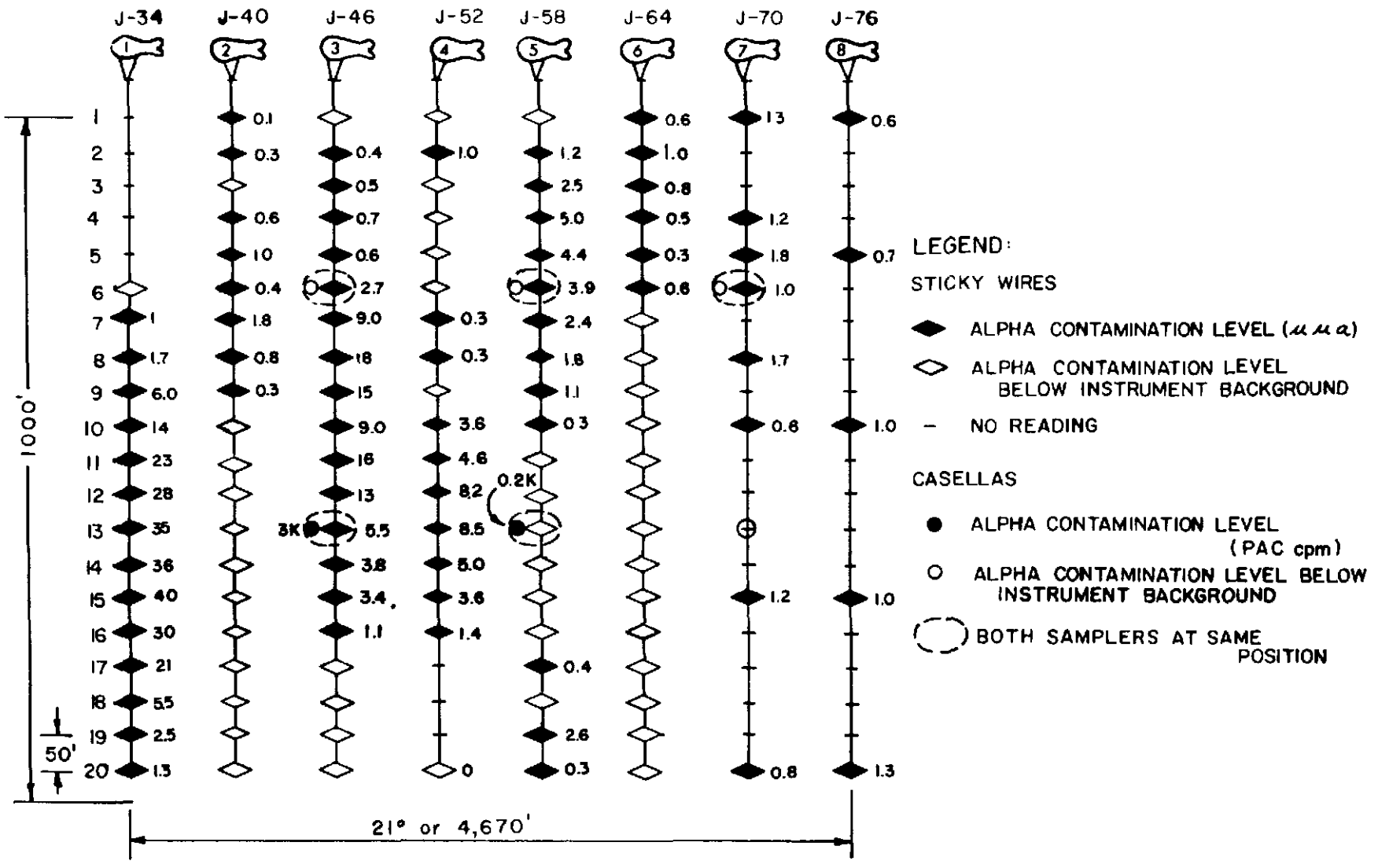


Figure 3.5 Double Tracks monitoring results on UK balloons.

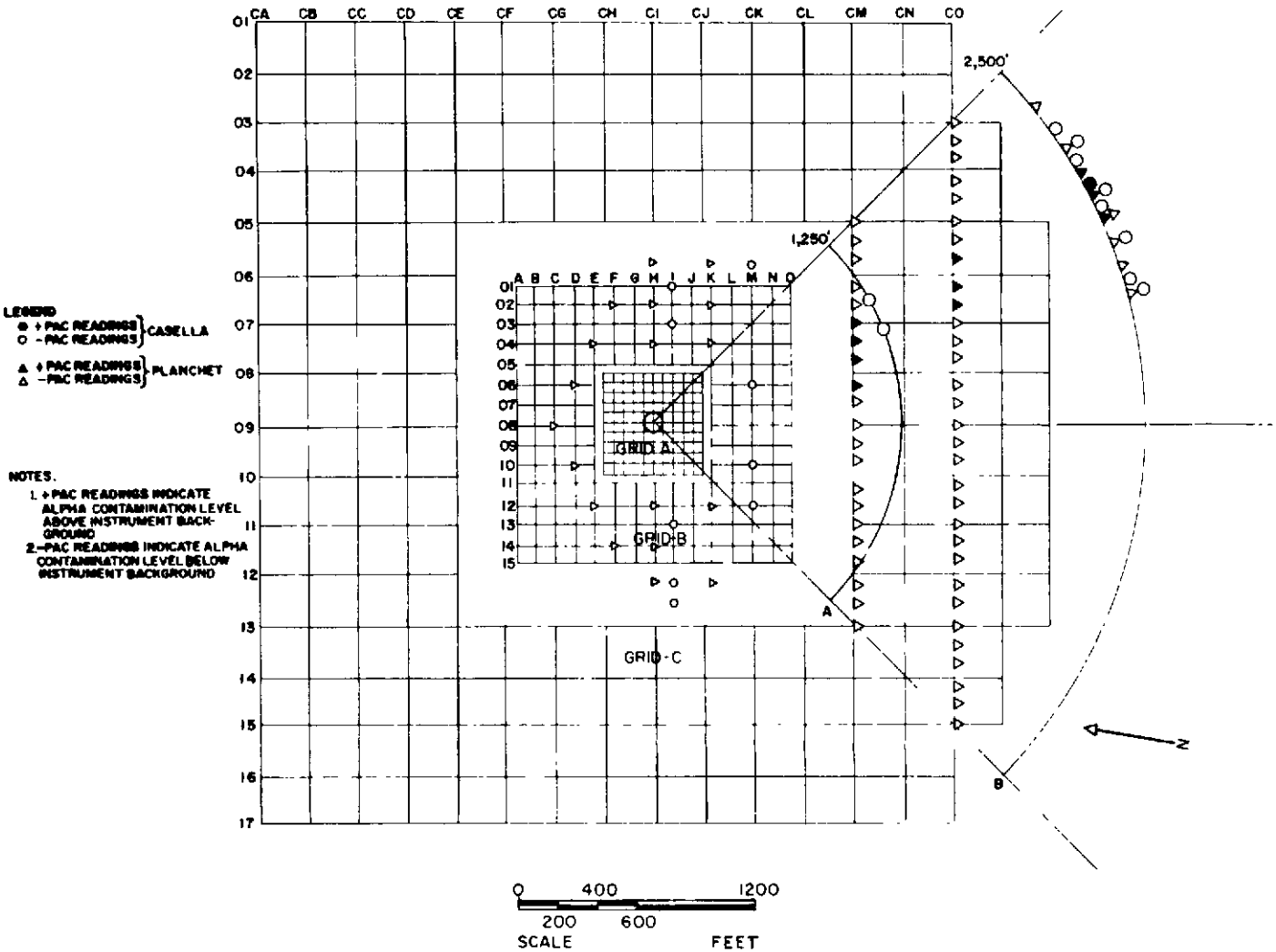


Figure 3.6 Clean Slate 1 monitoring results: GZ through Arc B.

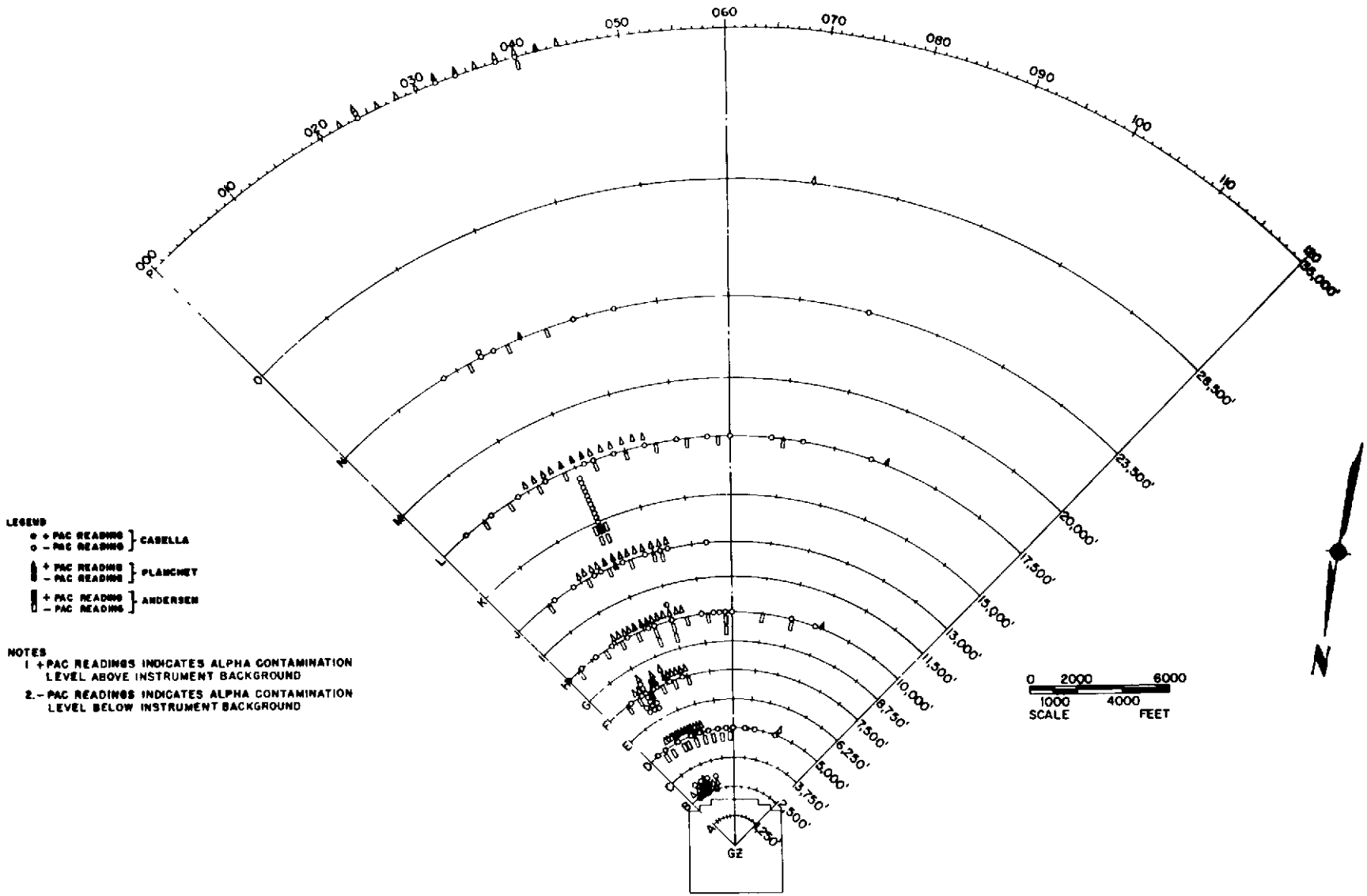


Figure 3.7 Clean Slate 1 monitoring results: Arcs B through P.

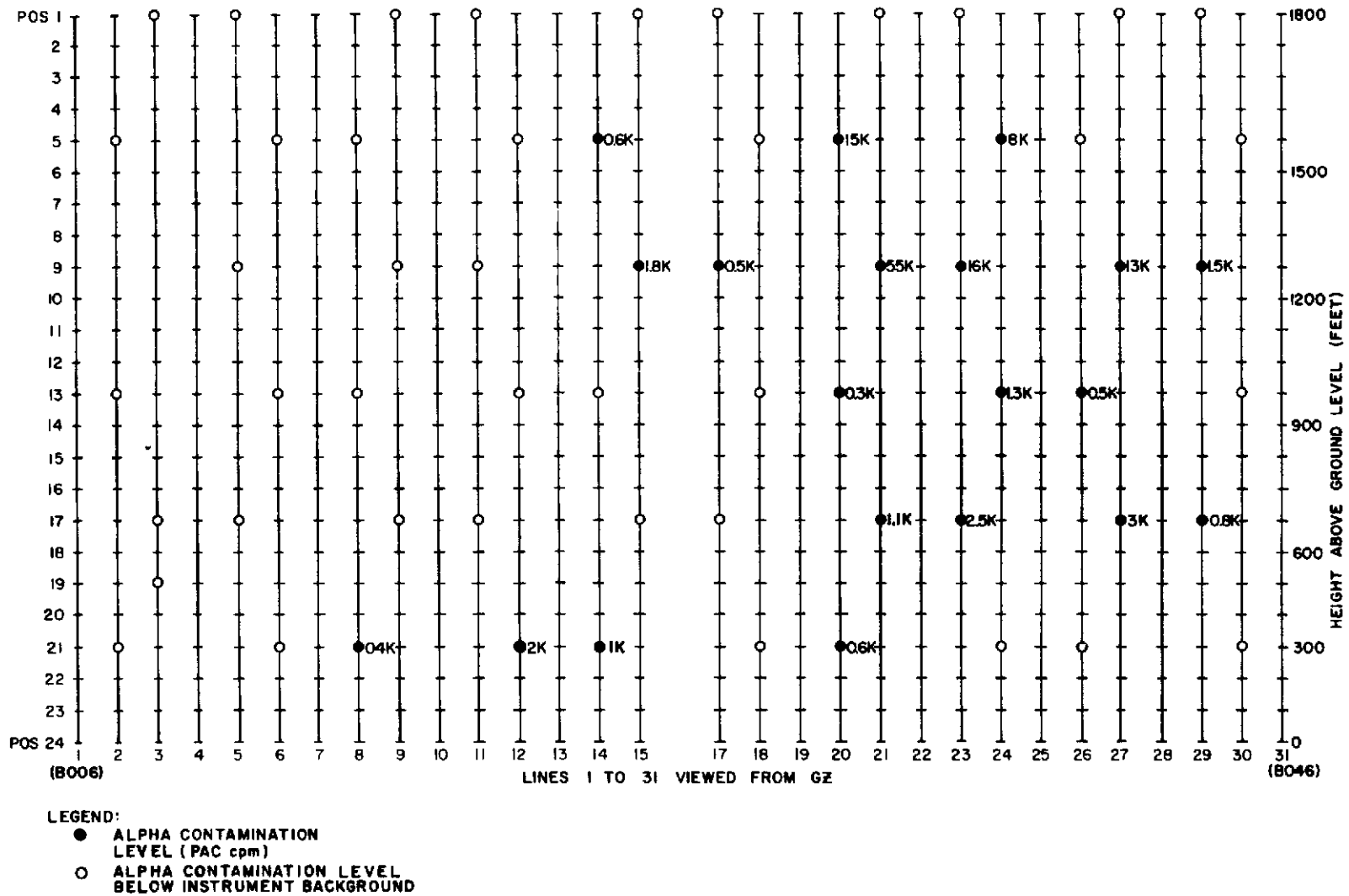


Figure 3.8 Clean Slate 1 monitoring results: Casella impactors on Arc B balloon curtain.

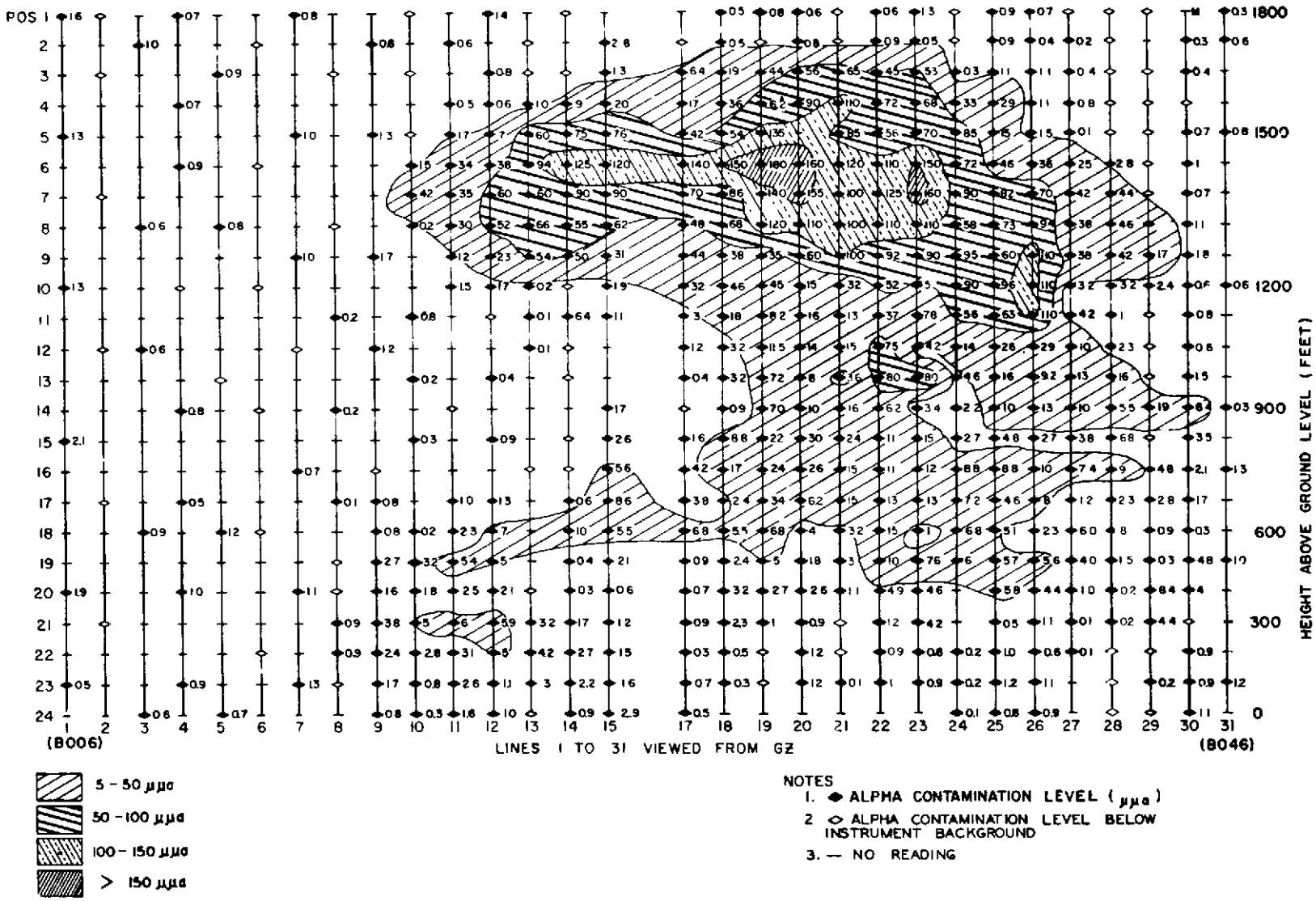


Figure 3.9 Clean Slate 1 counting results: sticky wires on Arc B balloon curtain.

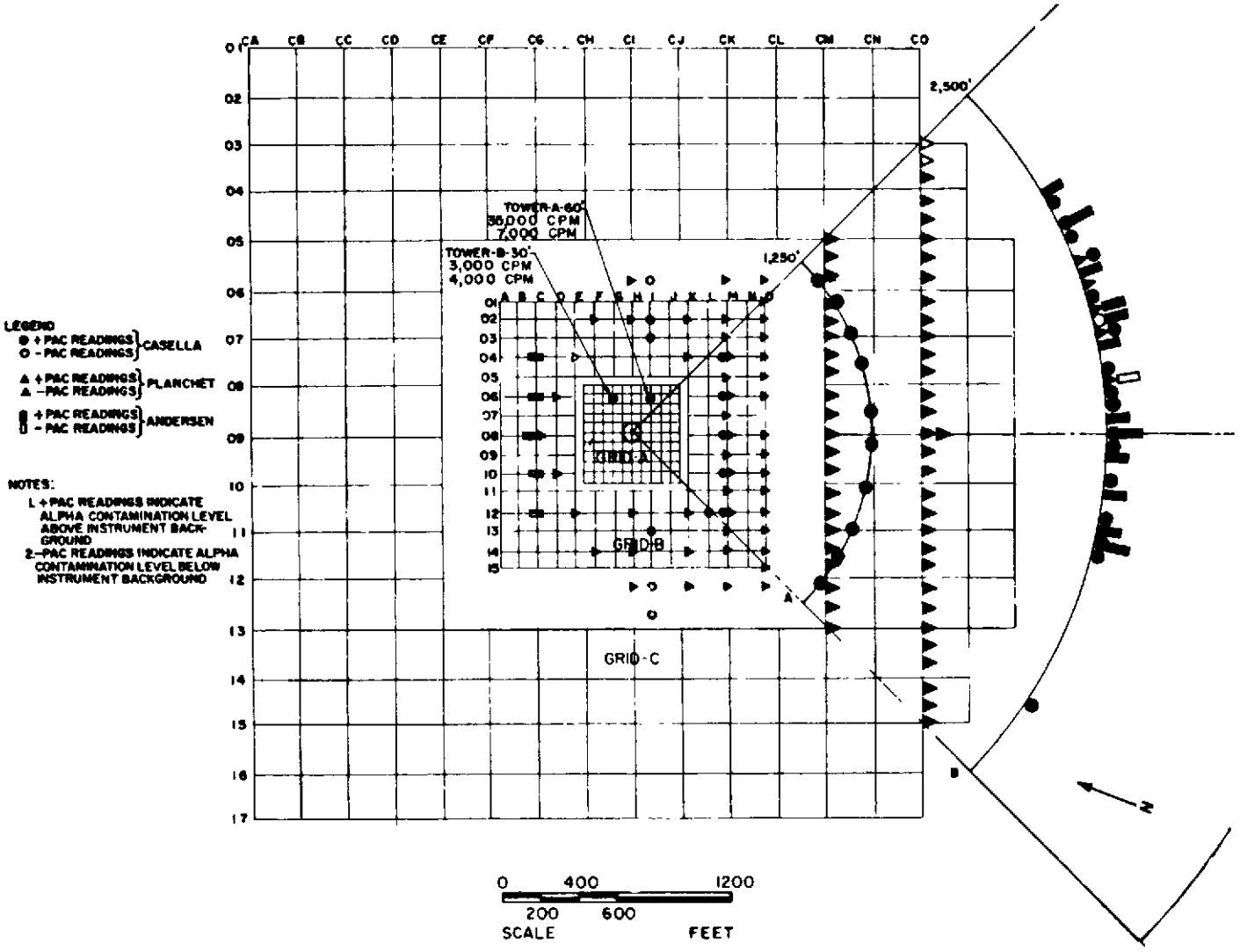


Figure 3.10 Clean Slate 2 monitoring results: GZ through Arc B.

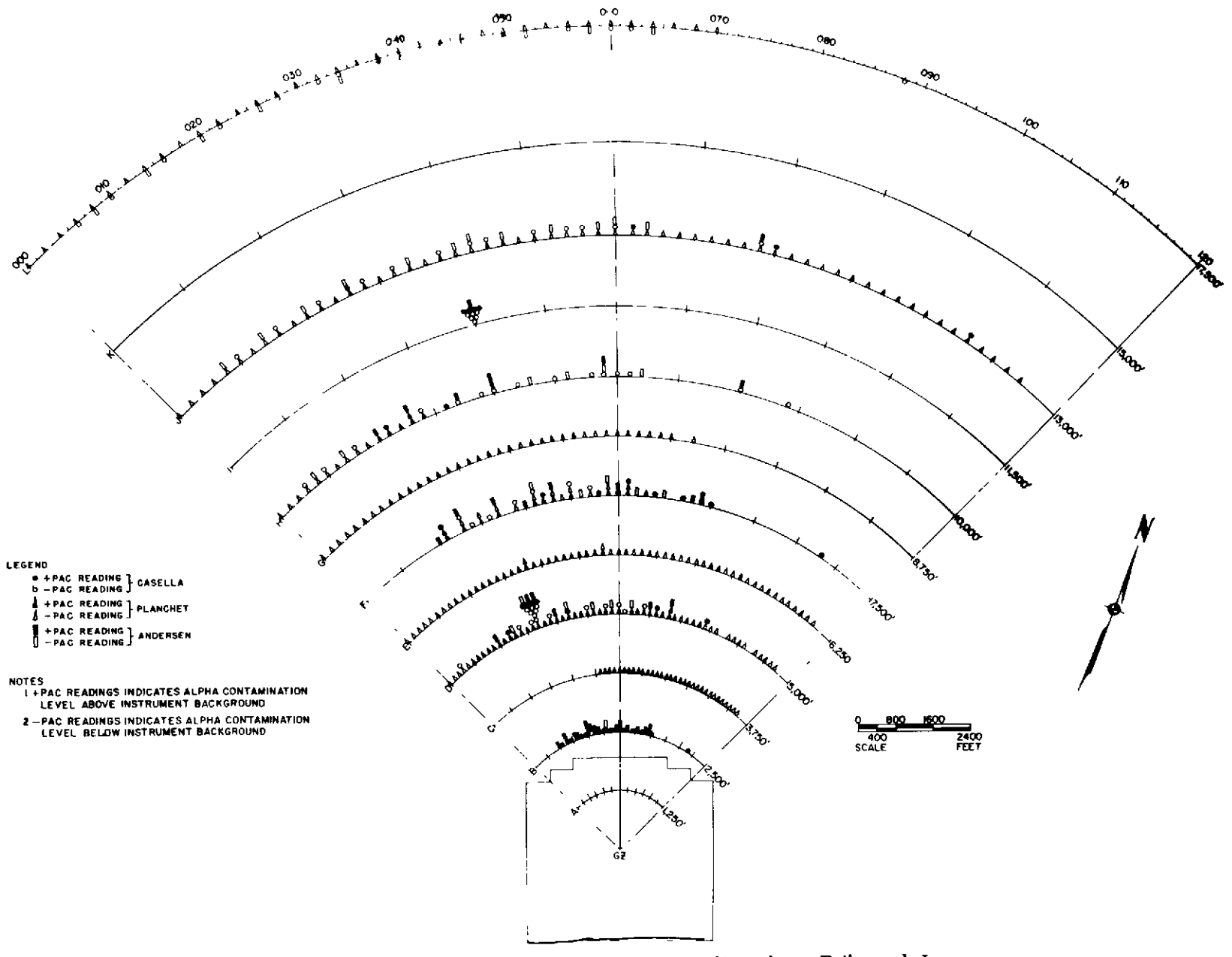


Figure 3.11 Clean Slate 2 monitoring results: Arcs B through L.

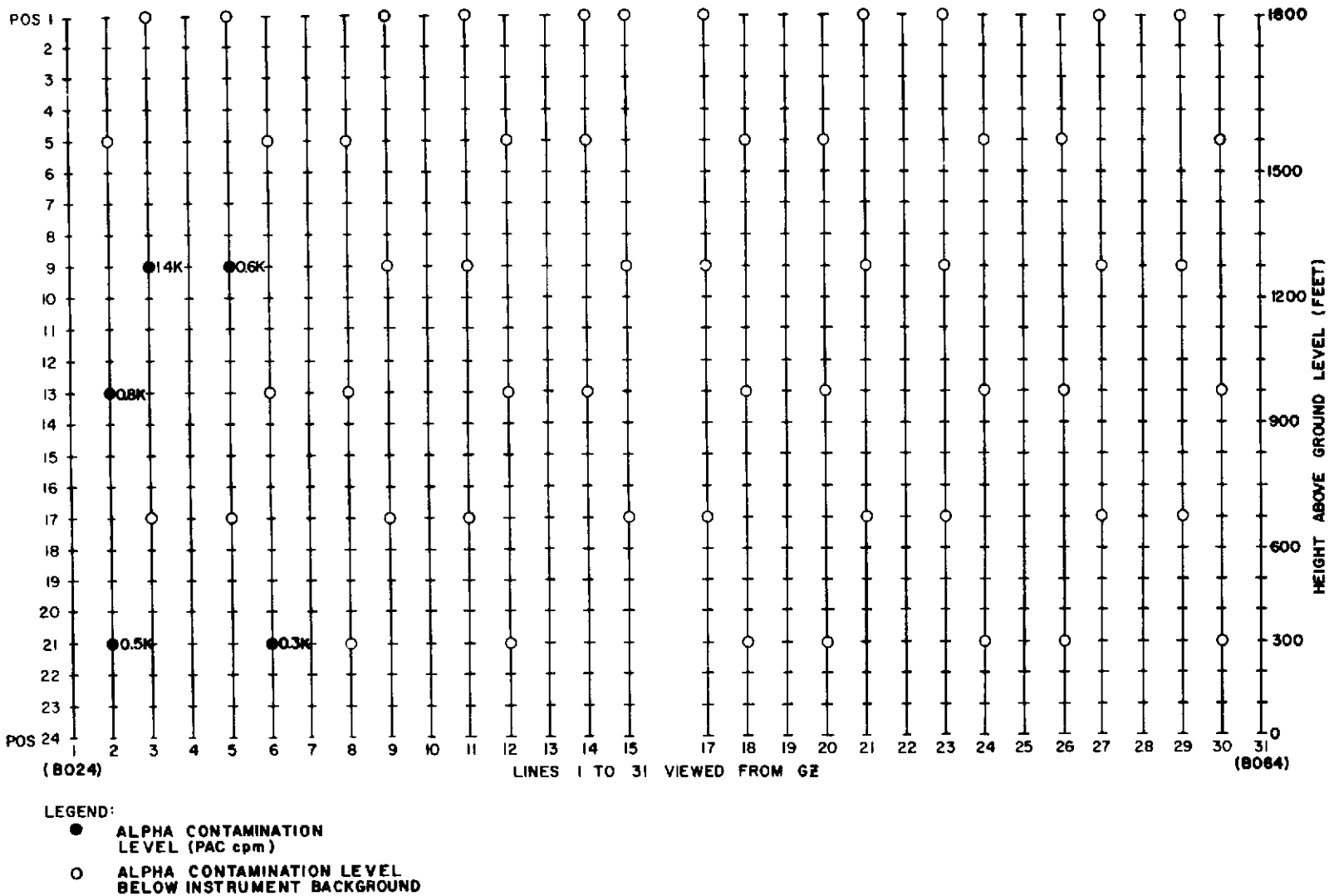


Figure 3.12 Clean Slate 2 monitoring results: Casella impactors on Arc B balloon curtain.

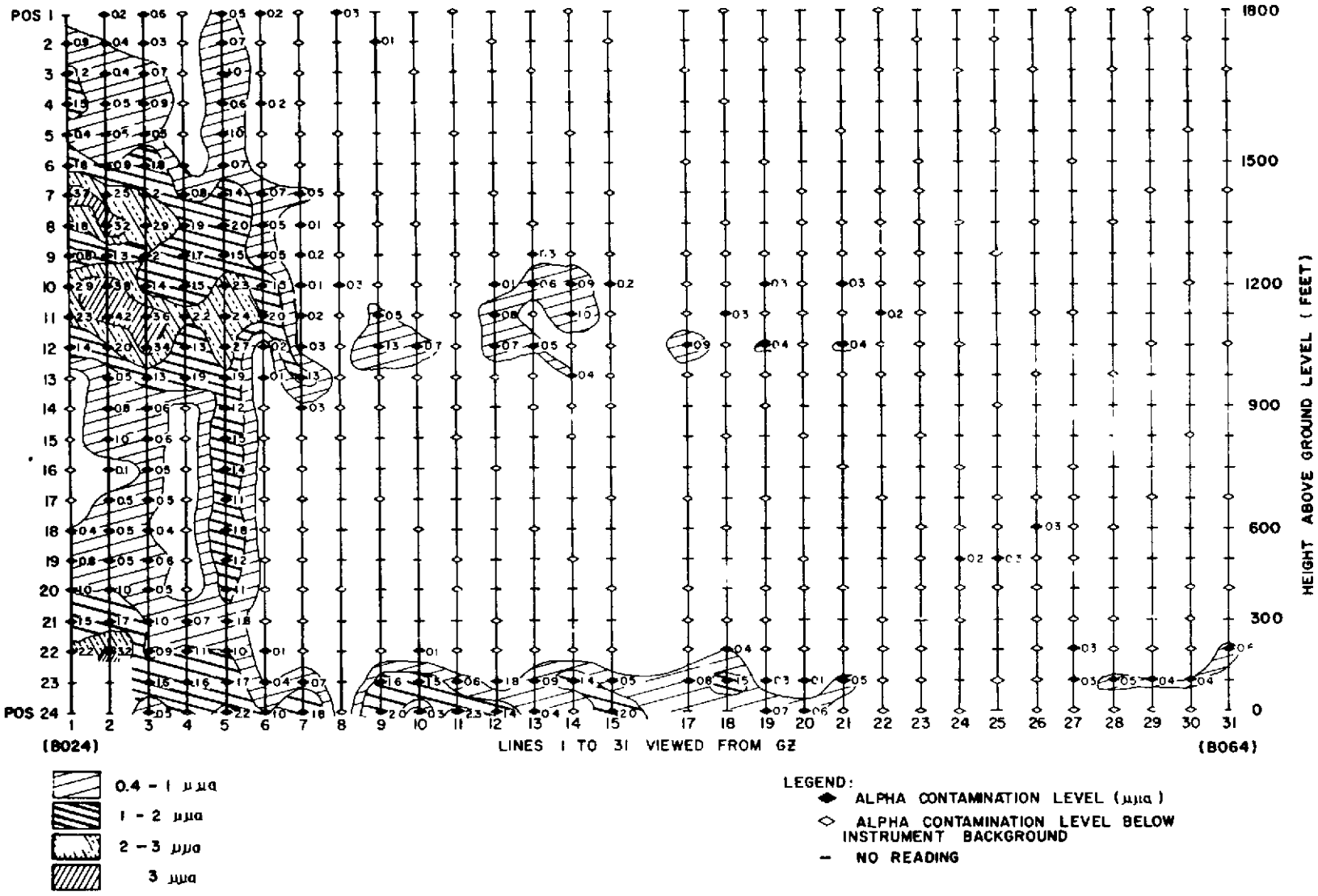


Figure 3.13 Clean Slate 2 counting results: sticky wires on Arc B balloon curtain.

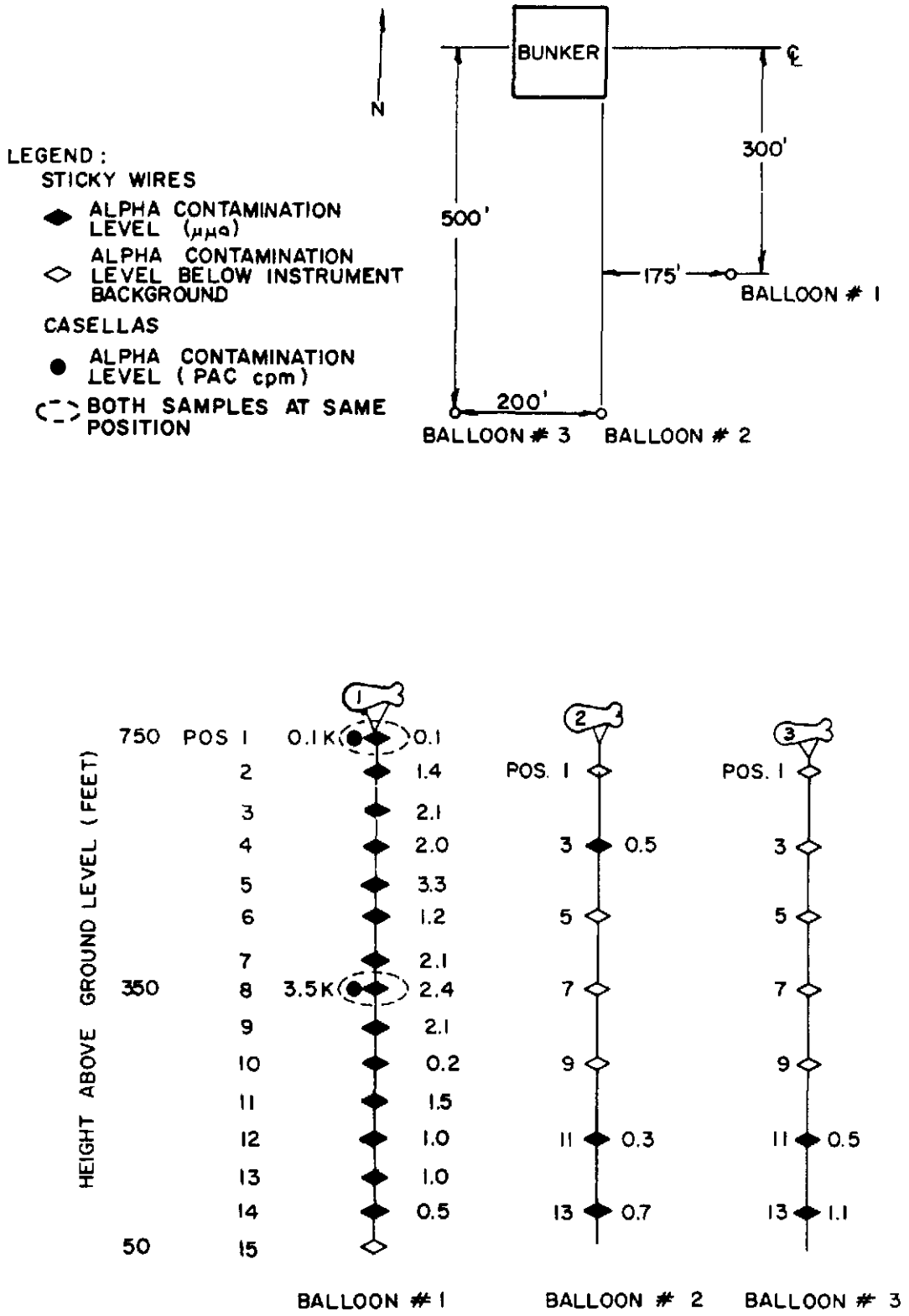


Figure 3.14 Clean Slate 2 monitoring results: UK balloons.

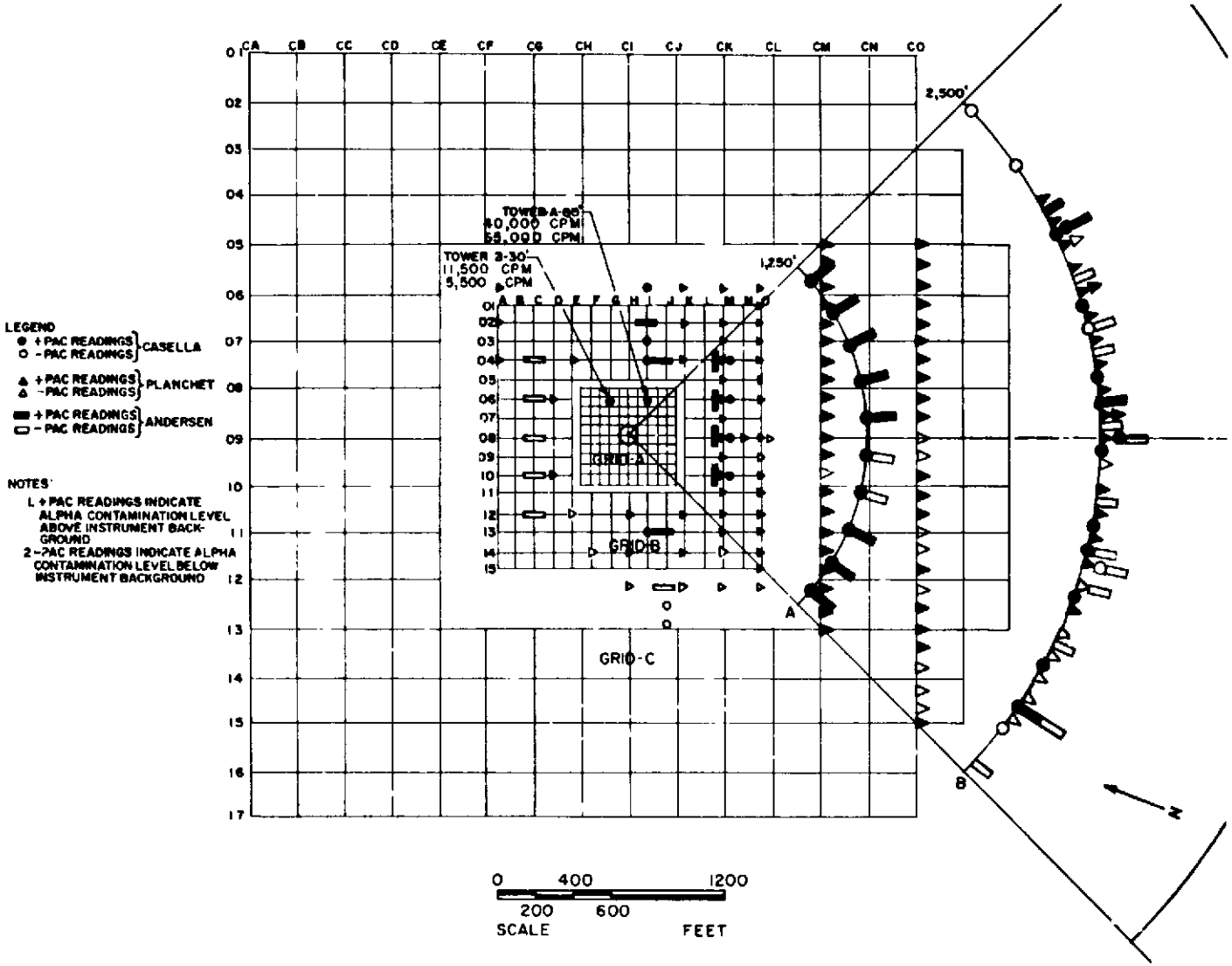


Figure 3.15 Clean Slate 3 monitoring results: GZ through Arc B.

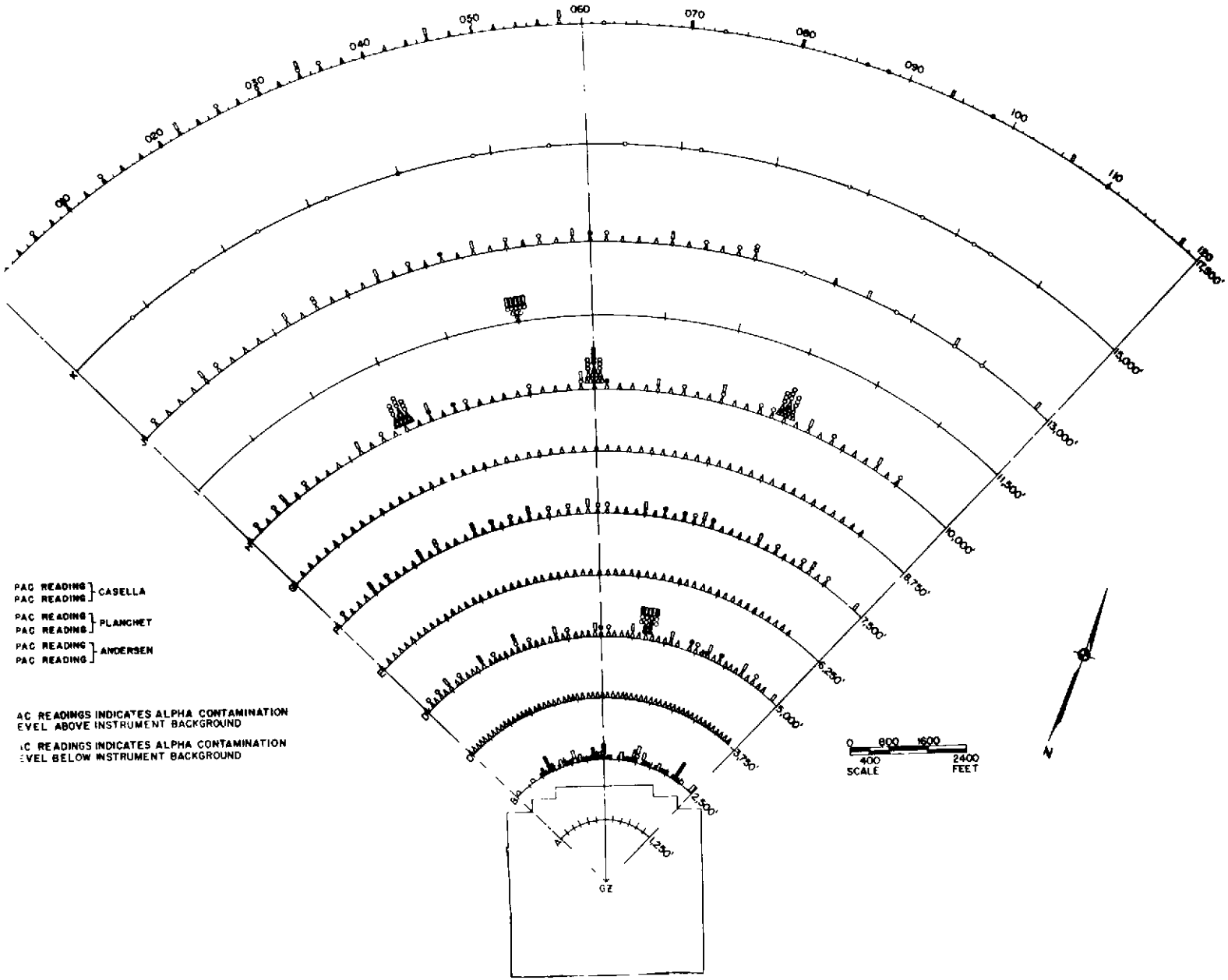


Figure 3.16 Clean Slate 3 monitoring results: Arcs B through L.

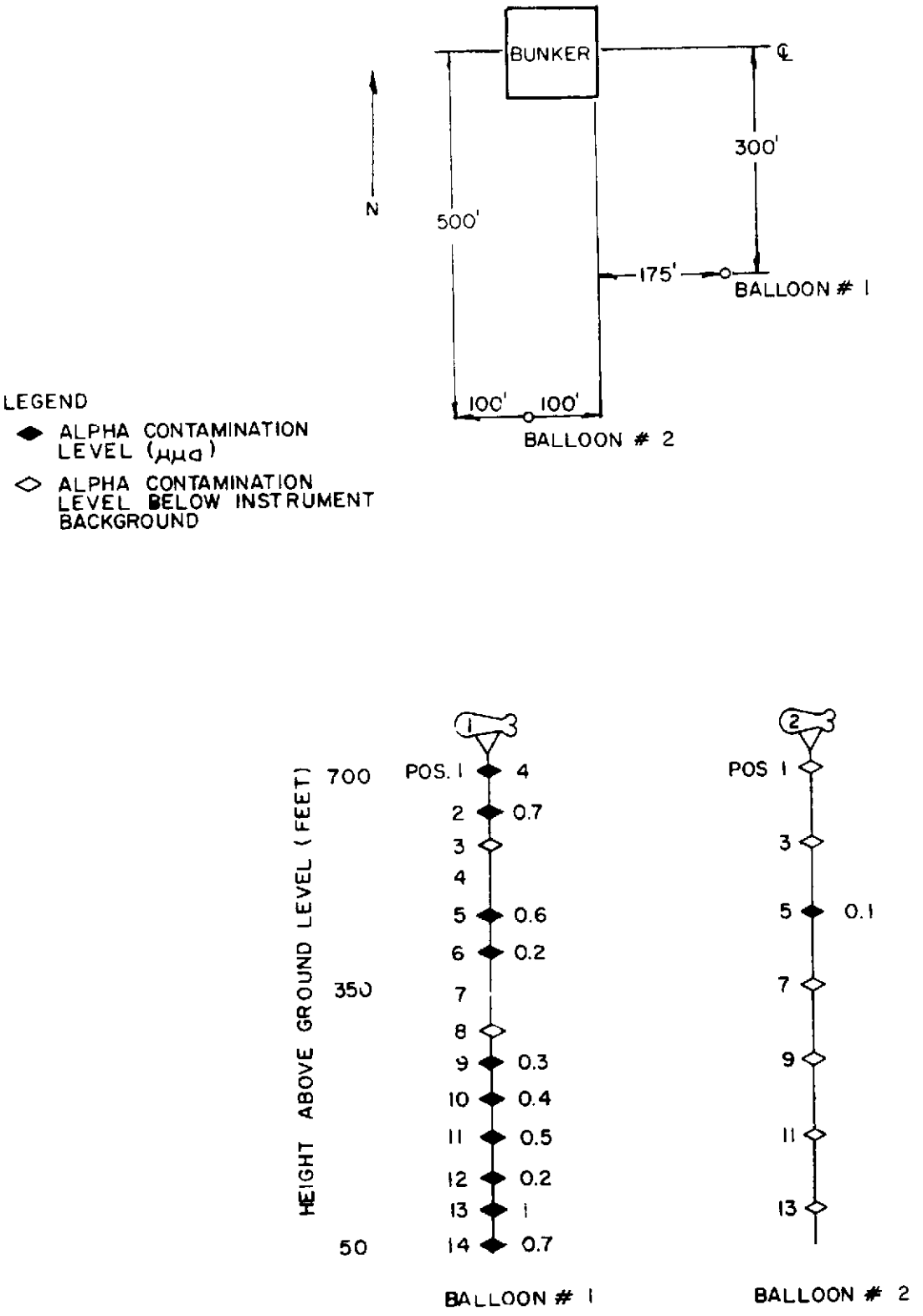


Figure 3.17 Clean Slate 3 counting results: sticky wires on UK balloons.

CHAPTER 4

DISCUSSION

Trailers have been used as field laboratories for many years. In the Sample Processing Facility we tried to overcome the hazards and inconvenience normally associated with handling radioactive and toxic materials by designing contamination control into the hoods, glove boxes, and ventilation systems. In designing the trailers our goals were the efficient handling and processing of samples in a minimum of time and with minimum cross-contamination and personal exposure to contamination.

4.1 EQUIPMENT

All equipment obtained for this operation functioned very well. The only major equipment failure was caused by a severe voltage fluctuation. The damaged equipment was replaced with a new unit. Most other minor operating problems were also due to voltage change. Therefore, it is essential in future operations that a stable voltage supply be available. This can be done one of three ways: a highly-stable generating system can be set up for the entire test site; a voltage stabilizer can be added into the main power line to the Sample Processing Facility; or individual

voltage stabilizers can be obtained for each piece of equipment or circuit. The method selected will depend on relative costs, availability, and general operating capability of the test site.

In reviewing the available counting equipment (see Table 1.1), the Tracerlab Multimatic Counting System, used on all 2-inch smaller samples, showed excellent stability and reproducibility under the adverse conditions imposed during field tests. This equipment served as the mainstay of the counting operations. Of particular advantage was the ability to program both pre-set time and pre-set count. With this equipment we were able to automatically count 50 samples per loading with the data being printed out and available after two and one-half hours. The Eberline NMU detectors[1] and the SDA counter[2] provided a very effective means of rapidly (manually) counting the Andersen impactor glass discs. The English Air Ionization chambers (Figure 1.11) used for counting sticky wires caused considerable problems because insufficient spare parts (connectors, batteries, etc.) were available, and operating personnel were not familiar with the unit. A

---

[1] Borrowed from AFWL

[2] Loaned gratis by the Eberline Corp.

more effective calibration system is needed if ion chamber data is to provide useful field information. The unit was very sensitive and slow to come to equilibrium. Though these are not serious handicaps, they do create operating problems when rapid sample processing is important. Some of the sensitivity to the environment might be eliminated by a better grounding of the unit and through better interconnection of components. The present apparatus works fairly well under laboratory conditions. However, it would be advisable to redesign the unit for future field work. Special emphasis in the redesign should be placed on simplifying the method of introducing the sample and perhaps improving the response time and stability aspects of the readout system. (A sticky wire study (Project 5. 1b) is presently in progress that will provide additional information on this counting system and interpretation of its data.)

Proper selection of the counting equipment is of utmost importance in minimizing counting time. Lessons learned during this operation included: (1) Cost difference between manually-operated equipment versus automatic equipment is not great if one includes the operator's time and the capability of the machine to operate continuously (24 hours a day). It is necessary only to

make spot checks that the automatic unit is functioning properly after each machine loading. (2) Counters that have only pre-set count and not pre-set time are not applicable for field work when a wide range of contamination levels is expected. (3) It is important to differentiate between counting-cup size and sample size. For example, one manufacturer provided a counter that could count one-inch samples, but there was no room for a planchet to hold the sample. (4) The advertised capability of a counter to count a specific-sized sample in no way reflects the crystal size of the detector. The literature of one manufacturer discusses a 2-inch detector which referred to the size of the unit holding the crystal, which in this case was a 1-inch crystal. Counting equipment specifications should therefore be examined carefully or the purchased equipment may not be able to do the desired job without extensive and expensive modifications. (5) It is important to have precise and correct information on the sample size and shape prior to specifying equipment needed to count the sample. (It makes a real difference whether the sample is 2 or 47 mm. Also, does 1 inch really mean 1.00 inch.)

4.2 PERSONNEL

To minimize processing times, available personnel had to

have considerable versatility.

Operating personnel (civilian and military) worked as a flexible unit with the number in any work area changing as sample processing proceeded. Upon receipt of samples, personnel reported to the Receiving Dock and Receiving Room to start processing operations. As processing progressed, some personnel moved to the Sample Processing Area, then to the Counting Rooms, and finally to the Packaging Areas. When processing was completed, they typed and filed data. Extra people were obtained following each test to assist with clerical and typing operations. Shift operations were considered but deemed impractical due to the small number of people available. Automatic counting systems were run 24 hours a day during certain phases of the operation with periodic visits by trained personnel to see that they were functioning properly. The group normally worked 12 to 14 hours daily per 7-day week, and though one would have expected the processing rate to fall off, the rate actually increased because of the experience gained in handling samples. During the last days of the operation, 456 samplers were processed in one day. This number included 111 Andersens, 120 Casellas, 102 disposable total air samplers, 86 reusable total air samplers, and 37 water samples.

The next day, 643 fallout planchets were processed. Only 71 Casellas and 25 Andersens were processed on the first day after Double Tracks.

The use of a mixture of trained and semi-trained personnel to operate the facility was very effective. While on-the-job training was most effective, pre-test training at USA Chemical Center, Edgewood, Maryland, and Sandia Base, Albuquerque, New Mexico, also proved helpful. By the middle of the test operation, military personnel assigned to Project 5.1a became as proficient in most routine operations as the civilian technicians.

Dry runs before Double Tracks were very helpful in firming up operating procedures and familiarizing everyone with operation of the trailers. Operating personnel gained experience in what to do and how to coordinate their efforts, particularly when teamwork was needed. For example, in the disassembly of impactor samples, it was necessary for two men to work as a team in adjoining glove boxes. One man would disassemble a unit, remove a sample, and put it into a prenumbered planchet in the pass-through area between the glove boxes. The second man would be responsible for the planchet being in the pass-through area and after the sample was in it, for monitoring it and placing it into a

counting tray. The second man also provided the data recorder with monitoring information for the Counting Data Sheet.

Passage of samples from the processing area to the counting area, and their counting in a minimum of time, required coordination between the counting and processing groups. This coordination between personnel became more finely tuned as the group became more experienced and resulted in faster sample processing rates.

Personnel operating this facility once again showed that if operating procedures are to be the best possible, they must reflect and include experience gained while using the procedure. It is therefore unwise to plan procedures to the last detail without testing them under actual operating conditions.

A permanently assigned team handling all operations performed in the facility is the most effective way of operating this type of facility. This end product was basically achieved, during this operation, when the eight soldiers were permanently assigned to assist in operating this facility. The higher processing rates that resulted from this assignment demonstrate the increased efficiency of this method of operation. It also permits more effective scheduling of processing time by not requiring that the group

that provides the samples be available in order to process their samples. On several occasions sample processing was delayed when groups were too busy preparing for the next event to assist in processing samples from the previous one. The permanently assigned team form of operation also guarantees that uniform and proper procedures are used in processing all samples. Data so obtained is easier to interpret and analyze.

4.3 SAMPLES

To meet the test objective, it was necessary to determine the fallout cloud's path and profile. On the basis of the monitoring data presented in Figures 3.1 to 3.17, it is apparent that this objective was realized.

Sample counting data were used to determine which samples merited additional study. The samples selected for additional study should have been exposed to the fallout cloud and collected sufficient material to make analysis possible and productive. Since these tests were concerned with the particle size of the resultant airborne debris, samples at varying distances from ground zero must be selected. With impactor samples, not only is the location critical but the selection of the proper stage to be analyzed is equally important. Though a sampler may have been placed in the

right position to obtain a desirable sample, the unit may not have been functioning properly. By reviewing field counting data, good samples can be easily identified. This eliminates needless (and expensive) detailed examination of samples that do not contain sufficient activity to warrant such analyses. Field counting data can also serve as a guide in handling a specific sample so that low-level working areas will not be contaminated by high (activity) level samples.

The key value of field counting data is in assisting scientific personnel in determining immediately after the test which samples can provide the desired data and should therefore be analyzed in more detail.

In discussing samples and counting data obtained from them, it is important to remember that field counting is not the same as laboratory counting. In laboratory counting one can normally control or correct for environmental factors and has more time and elaborate equipment to obtain the data. In field counting, one is interested in obtaining the most significant information in a minimum of time with the available equipment. For example, samples from this operation were counted for three minutes. This did not affect accuracy of data from highly contaminated samples, but it

does mean that data from samples reading close to background should not undergo sophisticated analysis, as statistics of low total counts have large deviations. In addition to statistical uncertainties of low counts, it should be remembered that the voltage and frequency were not constant and that radar and other equipment also provided intermittent spurious counts. Therefore, samples reading less than ten times background should be recounted for longer periods of time, to determine whether the reported count rate is correct, before extensive radiochemical or particulate analyses are performed. Though more accurate field data can be obtained by longer counting times, it is usually not warranted. Field data should be used only to guide future sample studies and for preliminary evaluation of test results.

4.4 OPERATIONS

Building and Equipping the Facility. With operations scheduled to begin April 1, 1963, we had only eight weeks to build and equip the Sample Processing Facility. Only by building the facility and ordering equipment concurrently could it be ready on time. Two used office-trailers were obtained a week after the contract was awarded and while the trailers were being modified, all major equipment was ordered. When the modified trailers were delivered

to Richmond, interior electrical work and furniture installation began. As counting equipment was received, it was assembled and checked. Duct work for the ventilation system was installed while the glove boxes and hoods were being built. Upon receipt, all incoming supplies were checked and repackaged for shipment. Installation of glove boxes and hoods began in the latter part of March. The final component, absolute filters for the glove boxes, arrived on April 1 (by this time the test had been rescheduled for April 15). A checkout of the air supply and exhaust system was conducted at this time. Following this check, the exterior air supply and exhaust systems were disassembled, while the trailers were loaded with the supplies. On Monday morning, April 8, 1963, the trailers left for the test site.

A great amount of coordination and the cooperation of many people were necessary to complete the facility in such a short period of time. Only by various vendors meeting short delivery times, having good weather for outside work on the trailers, and a hard-working crew was it possible to complete the building of the trailers on schedule . A minimum of four to five months should be allotted for future projects of this size. This will greatly reduce procurement, shipping, and labor costs. In order to

complete the building and equipping of the trailers on schedule, it was necessary to pay premium prices for some of the equipment and supplies, to accept second choice materials, to have a considerable number of items air freighted from the East Coast to California, and to pay premium wages to personnel constructing and equipping the facility.

While some things can be done concurrently, the complete unit will be more flexible if more time is allotted for the design and construction phase. Additional time should also be spent on engineering the facility and planning and selecting equipment to be installed. Because of the limited work space available in even a large trailer, studies should be made on the best use of the available space and arrangement of the equipment inside the facility, and what storage arrangement will make supplies available when needed but will not clutter up the facility at other times. We really did not have enough time to do this as thoroughly as we wished.

Siting the Facility. Siting of the facility was very important. In order to operate the facility, 15 gallons per minute of water were needed for the evaporative coolers and decontamination sinks. Both hot and cold water (for decontamination purposes) were required. Since water used in the sinks would likely become contaminated, a dis-

posal site was necessary. By locating the facility next to the Rad-Safe Decontamination Center, a common water supply and evaporative sump for disposal of contaminated liquid waste could be used. This location also expedited receipt of samples from the field because all vehicles delivering test samples had to pass through the Rad-Safe Center before they could deliver samples to the facility. Rad-safe checks were simplified by locating the two facilities in the same general area. This point should be kept in mind in any future test operations.

Temperature and Dust Control. Temperature and dust control are a major problem in operating electronic equipment in the field. The High-Level Trailer's heating and cooling system was designed to maintain interior temperature at $75^{\circ} \pm 5^{\circ}F$ with outside temperatures at 55 to $100^{\circ}F$. Cold temperatures ($35^{\circ}F$) experienced at the start of the operation, and the need to operate the evaporative cooler continually in order to reduce dust in the ventilation system, showed that 25 kw of heaters was inadequate to maintain the desired temperature in the High-Level Trailer. Temperature control in the Low-Level Trailer was also difficult to maintain because the space heaters were not thermostatically controlled. This produced a wide range of temperatures (40° to $95^{\circ}F$). Our

experience shows that the temperature control system must be examined in considerable detail in future mobile laboratory designs, as it caused considerable problems during this operation.

Additional Storage Facilities. During the operation two additional storage areas were made available. A covered, flat-bed trailer was effectively used for storing samples as they were received from the field. Position locations were noted on the sides of the flat-bed and the samples were placed in their appropriate position. This system permitted samples to be delivered directly from the field to a specific area, where they could be safely found and processed. Prior to this, it was necessary to shuffle through all of the samples until the desired ones were found or to spend time arranging samples in alphabetical order according to position location during the test. The covered flat-bed trailer had the additional advantage of protecting samples from weather. This proved of considerable importance when a rainstorm followed delivery of Clean Slate 2 samples. A considerable number of unprotected samples in the field were lost during this storm, while none of the samples in the storage trailer were affected.

Sticky wires were stored in a reconverted ice house because of insufficient time between tests to process them, and existing

storage space was full of other samples in various stages of processing. Separate storage was preferable since these samples were not to be counted until the end of the operation and therefore would not have to be moved or handled until they were to be processed.

This test pointed up the need for flexibility in planning storage facility requirements. The actual facilities needed were almost double pre-operational estimates due to non-shipment of samples and the short period between tests.

Sample Receipt. In receiving samples on the Receiving Dock, a considerable amount of time was spent trying to find the paperwork on the samplers' field position. Many sampler numbers were improperly recorded (601 for 109) and in one case, field data was permanently lost. During future tests it would be advisable if all data were gathered at one point and delivered to the Receiving Dock as a unit. Field personnel should be advised to double check the sampler numbers they record on their sampler location forms. More care should be taken in handling samples in the field to minimize the possibility of cross-contamination of samples during their trip from the field to the Receiving Dock. The effect of this suggestion on Operation Roller Coaster can be seen from the notes at the bottom of Table 3.1; following Double Tracks, 11 inlets and

174 outlets were left open; after Clean Slate 3, 0 inlets and only 2 outlets were left open.

Decontamination of Sample Holders. Originally, plans were to decontaminate all sample holders inside the trailers. However, after the first test it was decided to decontaminate the samplers in the open Rad-Safe area, as there was more room. In addition, the short (1 week) turnaround period between tests meant that neither personnel nor facilities were available for decontamination at the Sample Processing Facility until just before test time. Therefore, the test would have been delayed if sample holders had to be decontaminated inside the trailers. By using the Rad-Safe area, sampler turnaround time was minimized. The processing sequence required to decontaminate and reload sampling equipment must be carefully evaluated if the most effective use is to be made of people and work space.

Shipment of Samples. At the conclusion of the field phase of the operation, the shipment of samples assumed even greater importance with classification of samples as secret restricted data Previous criteria of protecting the integrity of samples through packaging was accentuated and the time required for processing each sample shipment was greatly increased.

The shipping procedure used was based on a series of checks and cross-checks. Upon receipt of the list of samples to be shipped, sample handling records were checked to determine (1) whether the listed information was correct, (2) whether the sample was still available (had not been shipped previously), and (3) the field measurement of the sample (or the planchet field measurement at that location). When mistakes were found, alternate samples were chosen based on desired station location and sample type. Sample description forms (see Figure 4.1) and shipping receipts (see Figure 4.2) were filled out on the basis of the above data. A 3- by 5-inch deck of cards with sample handling record number, type of sample, and company to receive the samples, was prepared to simplify actual removal of samples from storage. After the paperwork was completed, it was rechecked a second time. The desired samples were then collected and repackaged for shipment. The packaging procedure was determined by the type and weight of samples and the related security requirements. Sample description forms and two sample receipts were included inside the shipping cartons and were sent registered mail, return receipt requested, to their designated locations. TWX's notifying recipients of sample shipments were sent and

entries made on sample handling records of the date of shipment and recipient. Upon receipt of the shipment, one copy of the sample receipt was signed and returned to Project 5.1a and became part of the shipping log. Corrected sample shipment lists were then forwarded to Field Command, DASA. Upon completion of initial shipments, an inventory of samples remaining was made and compared with the sample handling records. Complete accord between the two was found.

Wipes taken in the Naval Ammunition Depot, Concord, packaging area at this time were counted. No activity greater than 2 dpm (alpha) per 2- by 2-foot area was observed. Recipients of the shipments reported that in only one case did they find any external contamination on the outer wrapping and it was less than 10 dpm. Some of the manila envelopes containing sticky films were found to contain several dpm on their outer surface. This was expected, since these envelopes were not changed in the field laboratory unless they were found to be contaminated to a level of 50 cpm or greater. Since all reported envelope contamination levels were less than this value, this field procedure was evidently effective in maintaining the desired contamination control.

The shipment of samples brought out with extreme clarity one

major mistake in sample record keeping made in the field, namely multi-listing of samples under one sample handling record number. When the sample handling records were rearranged to determine what samples were available at each position location, it was not possible to do it with the multi-listed sample handling records. Instead, filler sheets had to be typed for each sample, listing original record number, position location, and type of sample. Data recorded on these multi-listed records were also hard to read and contained more errors than the single sample records. In addition, sample shipments could not be conveniently recorded on the original records.

Glass slides proved to be a shipping problem. Originally they were to be shipped as units (boxes); therefore the slide boxes had not been opened at the field laboratory. When the decision to ship individual slides was made, it was found that some of the plastic packing and small inner cardboard boxes had deteriorated and some of the numbers on the slides were illegible or extremely difficult to read. By assuming the slides were packaged in numerical order, this problem was minimized. It was also impossible to directly select the stations desired because the project identification number (and not the position location) was the only marking

on these samples. Converting station locations to identification numbers, both in the field and in shipment of samples, was another potential source of error in the handling and shipping operation.

Record Keeping System. One of the more important functions of the facility was to maintain a complete record of all samples produced by the test and processed by the facility.

Additional clerical and typing help were needed following each test as the amount of work was considerably greater than had originally been anticipated. This was due to the need for the Record Clerk to help in processing operations by recording monitoring data, etc., and the need for typing counting data instead of preparing the original data in triplicate and distributing a penciled copy.

Since the military personnel who did counting and data calculating were not highly trained specialists, all of their work had to be checked for both accuracy and consistency before typing it in triplicate. Even this step caused extra clerical work when it was found that the proofreading was not catching all the errors and a formal proofreading step was inserted into the system before data was released. Without additional help, it would have been impos-

sible to complete processing of the data in time to meet the needs of test personnel. Data was distributed to each project and the Scientific Director's Office following each test. This was done so that data could be reviewed before the next test. The results of this review also determined in what manner certain samples should be packaged. (The Andersen samples to be used for special particulate analysis had to be packaged in a special way; see Appendix A.)

Original copies of the sample handling records and the counting data sheets were gathered together and filed according to test and position location. This file, presently located at Tracerlab/West, Richmond, California, will serve as the permanent record of all samples processed by this facility during Operation Roller Coaster and the data associated with them. Continual referral to this file will be necessary until all samples for additional analysis have been shipped. The file can be used for comparing the field counting data with the more sophisticated data obtained by detailed analysis and used for future reference if additional information as to sample type and location is needed. These files will be given to DASA for final disposition upon completion of all sample shipments.

During this operation, it soon became evident that the Sample Handling Record form should be revised. The form was too detailed and left too much room for unneeded information. A suggested Sample Handling Record form for future tests is shown in Figures 4.3 (page 1) and 4.4 (page 2). Page 1 of the new form includes all of the processing data and the sample history, while page 2 is used for recording the sample monitoring and counting results and the recipient (when it is shipped for additional study). The new form should greatly simplify the collection of needed information and documenting the results without losing the advantages of the present form in compiling a total history of the sample and its processing.

This form will not completely overcome the problems associated with multi-listing of samples on one sample handling record but through forethought and planning it should be possible to minimize them. To find all available samples at a specific location (1) all samples of the same type should be listed for each arc (or portion of an arc) on a separate sample handling record, (2) all sample handling records for the arc in question should be reviewed to find out what samples were actually at that location. (The recording of samples from varied locations on one sample handling

record would make the above determination extremely difficult and would increase the potential error of not finding all of the samples at the desired location.) The alternative, namely a separate sample handling record for each sample, may be impractical, though in cases where a sampler contains more than one sample (example: Andersen or Casella impactors) a separate sample handling record must be completed for each sampler or data handling errors are likely to occur.

4.5 CONTAMINATION CONTROL

Design Criteria. Contamination control is a two-fold problem, first protecting people working in the facility, and second, protecting samples from cross-contamination. To minimize the possibility of cross-contamination of samples and exposure of operating personnel to hazardous quantities of radioactive contamination, it was decided that the High-Level Trailer should have a once-through air circulation system. During the design stage, an additional restriction was placed on the facility, namely, that the Receiving Room had to be a separate entity from the rest of the trailer. (If large amounts of loose contamination were handled, the airborne contamination level in this area might get so high that the whole trailer would become contaminated and therefore

unusable.) An air-tight door was installed between the Receiving Room and the Sample Handling Area. This made it possible to completely isolate the two sections. Two separate exhaust systems were provided. However, the door would allow people (and samples) to pass directly between the two areas if operating conditions permitted. As it turned out, the contamination levels experienced were so low that processing operations could be greatly simplified by permitting people to have direct access to each area rather than going outside and walking around the High-Level Trailer. The sample flow pattern was designed to minimize cross-contamination by having samples move through the facility in one direction, starting at the Receiving Dock and ending at the Storage Area (see Figure 1.2).

Operating Results. It is interesting to note that periodic monitoring of work areas revealed little or no contamination outside of the glove boxes and hoods. A special form to record monitoring results (Figure 4.5) was never used because no contamination was ever found after completing clean-up operations. It was originally planned to periodically change the plastic sheeting on the walls and floors. This was not necessary and the original plastic covering was removed only at the end of the field

phase. Even the kraft paper placed on the Receiving Dock did not become contaminated enough to require changing. (It was changed once because a wind and rain storm tore it.)

The air particulate monitors recorded changes in natural airborne activity. Figure 4.6 shows the monitoring results from our arrival in the field (4/20/63) to the end of the field phase (6/17/63). Attempts to correlate the variation in natural airborne activity with local meteorological conditions were unsuccessful. The concentrations measured during collection (immediate detector levels) ranged between 4×10^{-9} μc/cc and 3×10^{-11} μc/cc with an overall average of 1×10^{-10} μc/cc. Concentrations measured on the downstream detector (after 6 hour delay) ranged between 5×10^{-11} μc/cc and 3×10^{-12} μc/cc (the lower limit of sensitivity of the detector) with an overall average of 5×10^{-12} μc/cc.

The alarm for the immediate detector was set at 10^{-8} μc/cc and at 10^{-9} μc/cc for the downstream detector. The instrument reaches equilibrium with the concentration indicated by the alarm setting in 2 hours. However, it will signal in 6 minutes when collecting at a concentration equal to 10 times the alarm setting and in 54 seconds when collecting at a concentration 100 times the alarm setting. Figure 4.7 is a plot of the Pu aerosol MPC for

various exposure times. Four hours exposure to a concentration of 10^{-8} $\mu c/cc$ of Pu could produce a maximum permissible body burden (MPBB) of 0.5 μg. Four hour exposure to 10^{-9} $\mu c/cc$ of Pu could produce 10% of the MPBB.

Since the average concentration of natural airborne activity was about 1×10^{-10} $\mu c/cc$, a Pu concentration of 10^{-9} $\mu c/cc$ would have been easily detected by the immediate detector. (Natural airborne concentrations of this magnitude were recorded only three times.) On the basis of the average concentration measured at the downstream detector (5×10^{-12} $\mu c/cc$), a Pu concentration of 10^{-11} $\mu c/cc$ would have been easily detected. (Natural airborne concentrations of this magnitude were recorded only twice.) According to Figure 4.7, a 24-hour exposure to 10^{-11} $\mu c/cc$ of a Pu aerosol could produce 1% of the MPBB.

At no time was there an indication of a Pu aerosol. Had the alarm sounded, positive action would have been taken to protect personnel working in the trailer. (Full-face respirators were available for all trailer personnel.) As a further check on the quality of the airborne activity, several samples of the moving paper tape were selected and recounted four days later (allowing for additional decay of the natural activity). No alpha activity

above counter background was measured on any of the tape samples. As no increase in airborne activity inside the trailer was ever noted as a result of processing operations, smoking and drinking controls in the Sample Processing Area were relaxed. The lack of airborne activity from sample processing also confirmed the safety of using the door between the Receiving Room and the rest of the High-Level Trailer to simplify movement of personnel and samples. These actions were possible because adequate planning and forethought had been used in designing the facility and operating experience showed that the sample handling procedures resulted in little or no activity being released into the environment.

Procedures to prevent cross-contamination of samples were completely successful, as evidenced by successive reading of samples reading thousands of counts per minute and then samples reading background.

Processing of the sticky wires is an excellent example of how, through experience in sample-handling, highly contaminated samples can be handled without cross-contamination of samples or contamination of people processing samples. In processing these samples, glove-box gloves were removed for greater

dexterity in arm movement and personnel handling the wires wore surgeon or plastic gloves. Kleenex strips were placed between the thumb and forefinger when handling the wires. (This technique minimized glove contamination.) Special jigs used in cutting off the curved ends of the wires were discarded and cutting was done by holding the wire in one hand and the cutters in the other. It must be remembered that, unlike other samples, these wires were highly contaminated and improper handling would have resulted in the glove box, the person processing the sample, the general working area, and other samples becoming contaminated. No such problems arose.

Care in handling and storing samples during and after each operation was largely responsible for the success in preventing cross-contamination of samples. Frequent cleaning of work areas, continuous checks for personnel contamination, and background checks on counters minimized the potential problem. However, it was the attitude and interest of the operating people in what they were doing that really minimized or eliminated need for extreme contamination control procedures.

In discussing contamination control, it must be realized that the low contamination levels observed on most of the samples con-

siderably eased the control problem. However, if another similar unit were designed, very few contamination control procedures or design concepts should be changed. It is easier to relax personnel restrictions and operating conditions than not to have the capability of operating in a safe, efficient manner if large amounts of contamination have to be handled.

Sample Handling Record _____

Sample Type: _____

Test No. _____

Stage No: _____

Sample Location:

Arc _____

Station _____

Estimate of Sample Activity
(as measured in the field)

☐ 0-1 d/m

☐ 1-10 d/m

☐ 10-100 d/m

☐ 100-10^3 d/m

☐ 10^3-10^4 d/m

☐ 10^4-10^5 d/m

☐ $>10^5$ d/m

_____

Project 5.1A
(Initial & Date)

Comments: _____

_____

_____

_____

Figure 4.1 Sample description form.

10/63

PLEASE SIGN AND RETURN ORIGINAL RECEIPT IMMEDIATELY BY REGULAR MAIL

TO: DATE:

RE: Receipt of Material

Original to be signed personally by the recipient and returned to the sender. Duplicate to be retained by the recipient.

I have personally received from A. L. Baietti, Project Officer 5.1A c/o TRACERLAB, 2030 Wright Avenue, Richmond 3, California, the Operation Rollercoaster sample(s) as identified below.

I assume full responsibility for the safe handling, storage, and transmittal elsewhere of these sample(s) in accordance with existing regulations. The sample(s) is (are) identified as follows:

Sample Number	Description

Registry No. _____

Received By _____ Date _____

Figure 4.2 Sample receipt.

DATE _____ SAMPLE NO. _____

SUBMITTED BY (Company Name) _____

(Project Officer's Name) _____ Project No. _____

INITIATORS SAMPLE NO. _____

SAMPLE HISTORY

1. Type _____
2. Original Location _____ Accepted for Project _____
3. Test Number _____

WORK TO BE PERFORMED

A. Processing

1. NORMAL 2. Special Instructions: _____

B. Counting

1. NORMAL 2. Special Instructions: _____

(See page 2 for data)

C. Packaging

1. NORMAL 2. Special Instructions: _____

_____

Packaged by Date

D. Shipping or Storage

1. Samples

_____

Initial & Date When Stored and Shipped

A. Method

Normal Freight Air Express Special Delivery Store _____ Other

B. Persons Name _____

C. Company Name & Address _____

_____

2. Data

_____

Initial & Date When Shipped

A. Originator

B. Persons Name _____

Company Name & Address _____

_____

OBSERVATIONS & COMMENTS: _____

_____

_____

_____

Figure 4.3 Suggested sample handling record for future tests, Page 1.

Data Recorded By

SAMPLE NO.	MONITORING RESULTS (PAC)-CPM	COUNTING DPM	SHIPPED TO

Figure 4.4 Suggested sample handling record, monitoring and counting results, Page 2.

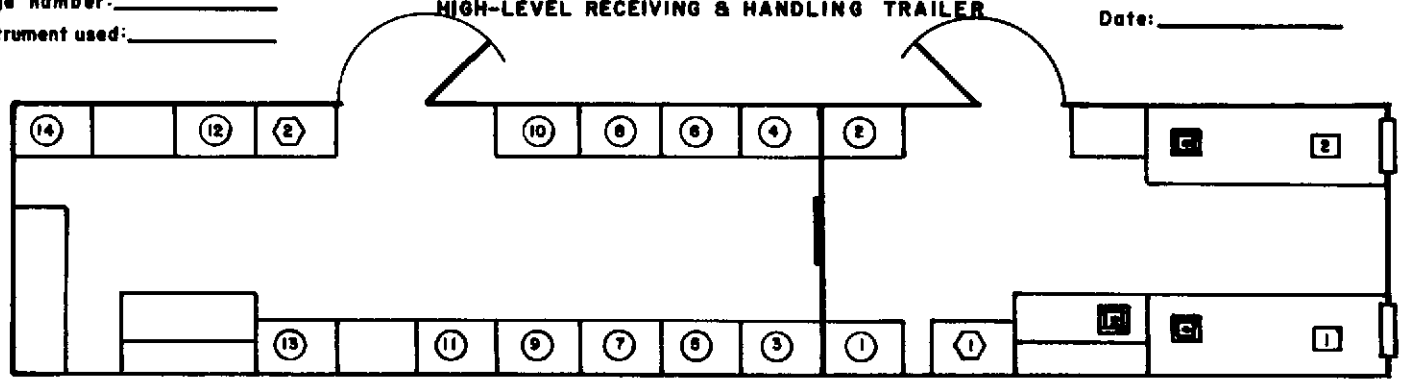
Page number: _____

Instrument used: _____

PROJECT 5.1A MONITORING FORM

HIGH-LEVEL RECEIVING & HANDLING TRAILER

Date: _____



LEGEND: ☐ RECEIVING HOODS — ○ GLOVE BOXES — ⬡ AIR SAMPLERS

RESULTS

Sample No.	Description	d/m	Sample No.	Description	d/m	Sample No.	Description	d/m

Comments

_____

_____

_____
(Signature)

Figure 4.5 Facility monitoring form.

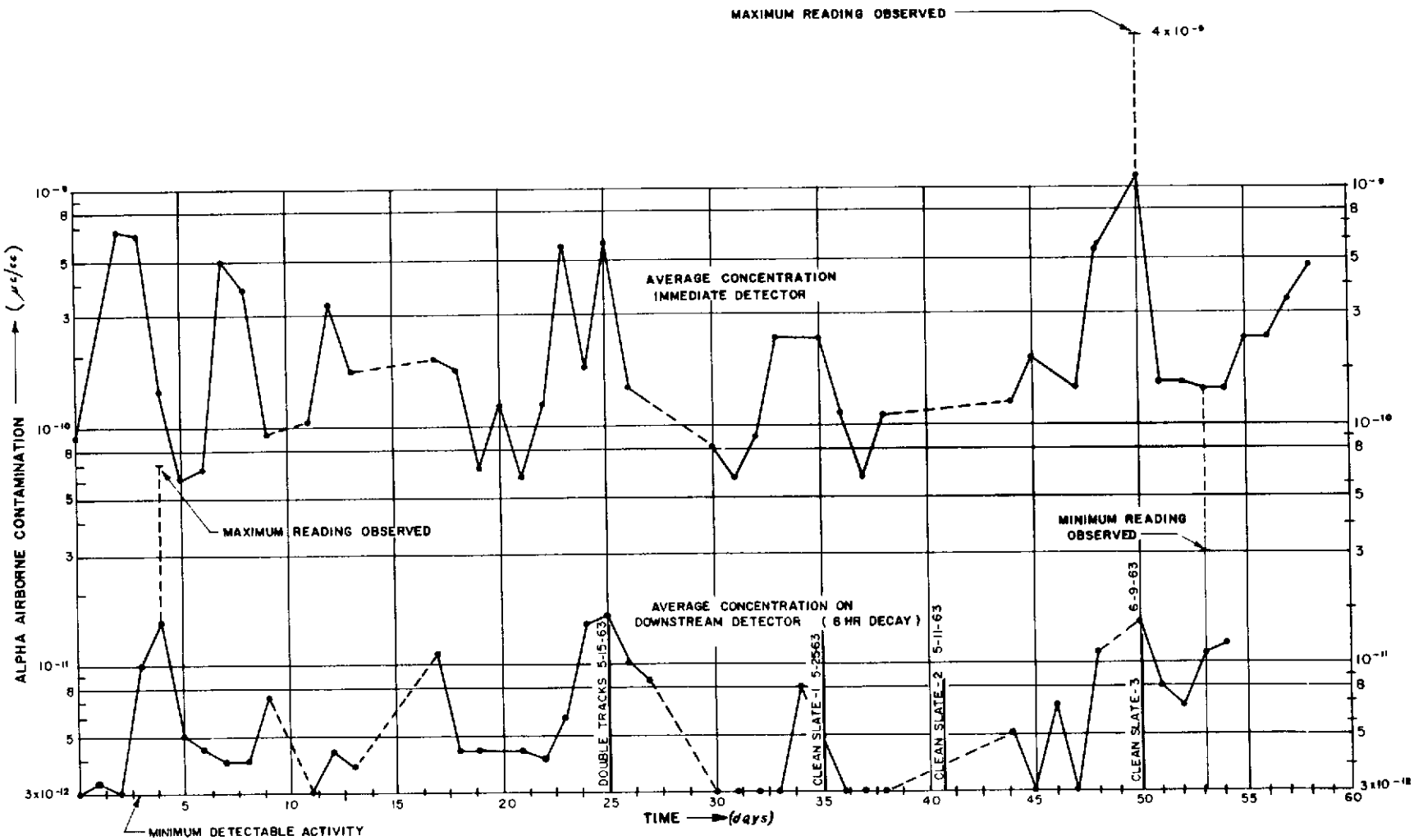


Figure 4.6 Air monitoring results (20 April through 17 June 1963).

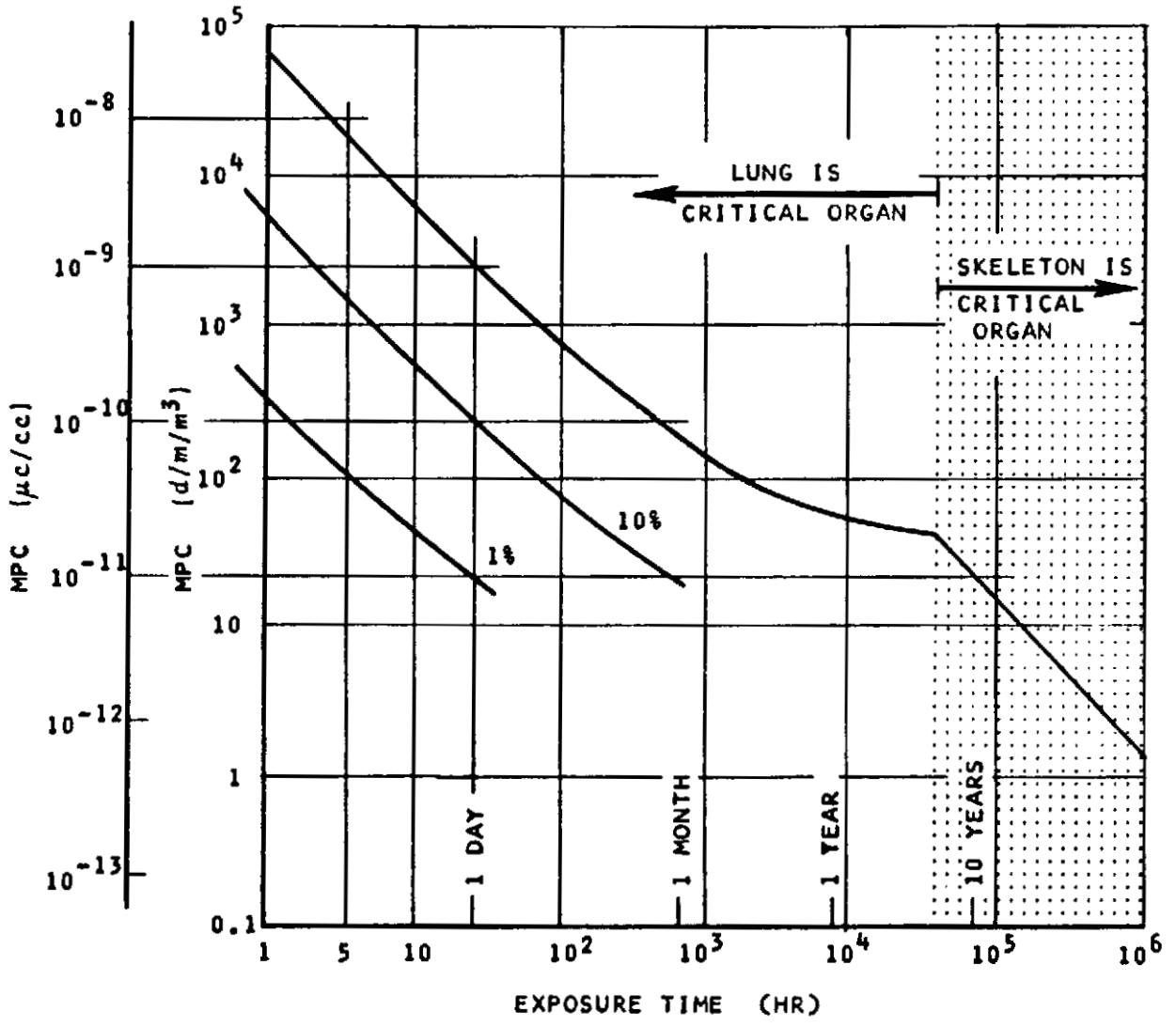


Figure 4.7 Plutonium aerosol MPC based on MPBB of 0.5 μg.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The Sample Processing Facility provided (1) a unified method of identifying and recording all test samples, (2) an on-site facility for alpha-counting selected samples and providing preliminary fall-out data for immediate evaluation, and (3) a method of, and a facility for, packaging and shipping samples that eliminated cross-contamination and health hazards.

Operating experience with this facility proved that hazardous samples can be handled safely without elaborate equipment (respiratory or otherwise) and complicated processing procedures if adequate planning and forethought are used in designing the facility.

Flexibility is the key to designing a facility of this nature. Consideration must be given to (1) the type and amount of equipment (so that one breakdown will not shut down the facility), (2) the number of people available to do the job, (3) the amount of storage space available, and (4) the capability of the facility to process all types of samples. Processing times should never be calculated on a 24-hour per day basis, or 100% utilization of equipment, because breakdowns do occur. There will always be an additional need for more space than originally estimated. Therefore, sufficient time

must be allotted to design and engineer the facility so proper equipment and supplies will be available when and where they are needed. Proper and complete planning will allow the facility to operate in the most efficient manner with a minimum of wasted effort. Very few contamination control procedures or design concepts should be changed if another similar unit were designed. It is easier to relax personnel restrictions and operating conditions than not to have the capability of operating in a safe, efficient manner if large amounts of contamination have to be handled.

Sticky wire field counting results indicate that this sample has a unique capability for determining fallout cloud profiles but that improved techniques and equipment for measuring the activity deposited on the wires will be necessary before the wires become standard fallout model analytical tools. A Sticky Wire Evaluation study (Project 5.1b) presently in progress will attempt to define the problems associated with the use of sticky wires and means of overcoming them. Areas to be studied include accuracy and reproducibility of results, determination of conversion factors for field data, and means of improving instrument stability and simplifying its use. A separate report will be issued when the study is completed.

A permanently assigned team is the most effective way to operate this type of facility. This team should be composed of well-trained individuals familiar with samplers being used and methods for processing them. If insufficient trained personnel are available, then time should be allotted for on-the-job training. Experience of the processing team will greatly affect the processing rate.

The Sample Processing Facility should be maintained in its present form for future use.

APPENDIX A

PROCEDURE FOR PROCESSING ANDERSEN IMPACTORS

An Andersen impactor is a multi-stage unit for separating airborne particles according to size. Air is drawn through plates with different sized holes by a small pump. Particles of a specific size range settle out on 3-3/8-inch glass discs that are covered with adhesive or strippable film and located below the porous plates. In this test a 5-stage unit (Stages 1, 2, 3, 4, 6) was used and a total air sampler (TAS) containing high efficiency filter paper was connected to the outlet to trap smaller particles that would normally be exhausted out of the impactor. (The TAS will henceforth be referred to as Stage 7.) The impactors were covered with a plastic bag (except the inlet and outlet nozzles) before placement in the field to minimize contamination on the outside of the sampler. After the test the samplers, in their plastic bags, were brought to the Receiving Dock of the Sample Handling and Processing Facility for processing.

The following step-by-step procedure begins with the receipt of the sampler on the Receiving Dock and lists the processing steps leading to packaging of the samples for storage.

A. SAMPLES REQUIRING COUNTING

1. Upon receipt of the sampler at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sampler number and arc and position location during the test.

2. Monitor sampler with a Portable Alpha Counter (PAC) to determine whether the outer bag is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sampler reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean outer bag and place sampler into a Receiving Room hood pass-through box.

4. Remove sampler from pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the outer bag.

6. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

7. Place the sampler into a clean plastic bag, seal it, and

mark the Sample Handling Record number on it.

8. Place the bag into one of the two Receiving Room glove boxes.

9. Pass the bag containing the sampler into a glove box in the Sample Handling and Processing Section of the trailer.

10. Remove and save the bag as a container for the disassembled unit. With Figure A. 1 as a guide, proceed to process the sampler.

11. Disconnect **Stage** 7 at **Point** 1 and lay aside the other stages.

12. Unscrew **Stage** 7 at **Point** 2 and remove the filter paper with a pair of tweezers.

13. Place the filter paper into a prenumbered (Sample Handling Record No. - 7) **2-inch planchet in the pass-through between the** glove boxes.

14. Remove the planchet to the adjoining glove box and monitor it with a PAC to determine in which area the sample should be counted.

15. Record the monitoring result in the last column of the Counting Data Sheet (Figure 2. 6).

16. While applying a downward pressure, remove the hooks

holding the impactor together. (Methods successfully used include placing a spatula handle under the hooks and lifting; placing the entire unit under a jig (to keep it from exploding when a hook was removed) and then pulling the hooks off by exerting finger pressure, etc.).

17. Insert a spatula at Point 3 (between the end plate and Stage 6) and remove Sample 6 (a 3/8-inch glass disc).

18. Place the glass disc into a prenumbered (Sample Handling Record No. -6) 4-inch petri dish in the pass-through between glove boxes.

19. Remove the petri dish to the adjoining glove box and monitor it with a PAC to determine in which area the sample should be counted.

20. Record the monitoring result in the last column of the Counting Data Sheet (Figure 2.6). Also record in which area (High-Level or Low-Level) the sample should be counted.

21. Insert a spatula at Point 4 (between Stages 4 and 6) and remove Sample 4 with tweezers.

22. Repeat Steps 18 through 20.

23. Insert a spatula at Point 5 (between Stages 3 and 4) and remove Sample 3 with tweezers.

24. Repeat **Steps 18 through 20.**

25. Insert a spatula at **Point** 6 (between **Stages** 2 and 3) and remove **Sample** 2 with tweezers.

26. Repeat **Steps 18 through 20.**

27. Insert a spatula at **Point** 7 (between **Stages** 1 and 2) and remove **Sample** 1 with tweezers.

28. Repeat **Steps 18 through 20.**

29. Take **Stage** 1, hereafter known as **Sample** A (metal part), to the adjoining glove box and monitor it with a PAC.

30. Record the monitoring result for **Sample A** in the last column of the Counting Data Sheet.

31. Place **Sample A** in the glove box counter and count the sample for three minutes.

32. Record the following data next to **Sample A**: counter being used, counting time, date and time at which the counting was done, total counts, background, and standard factor.

33. Return all Andersen parts to the bag in which it was received and seal it. This bag is then placed with other samplers requiring decontamination.

34. Place the 5 petri dishes and the planchet into one of the counting trays and record the location on the Counting Data Sheet

under counting time . (The final Counting Data Sheet typed at the end of the processing operation excludes this and other miscellaneous information.)

35. When samples are to be counted, remove them from the counting trays.

36. Place the planchet containing the filter paper into a 2-inch sample counter and count the sample for three minutes.

37. Record the following data: counter being used, counting time, date and time at which the counting was done, total counts, background, and standard factor.

38. Remove each impactor plate from its petri dish and place it in one of the 4-inch sample counters and count the sample for three minutes.

39. Repeat Step 37.

40. After all the samples from one Andersen have been counted, place them back into their petri dishes and then into a prenumbered temporary storage tray until the data has been reviewed (note the tray number on the Counting Data Sheet).

41. After the data has been checked and found to be correct, the samples are ready for packaging.

42. Obtain 2-inch and 4-inch magenta dissolvable cellulose acetate

envelopes and yellow disc labels for the normal samples and special modified petri dishes for the glass plates to be used for microparticle analysis. (The modified petri dishes are prepared by sealing small pieces of plastic to the bottom and side of the petri dish at 120° intervals or by bending a piece of wire to fit the interior of the petri dish. In either case, a piece of foam-type material is attached to the cover. The wire or plastic pieces keeps the active surface from touching the petri dish while the foam exerts a stabilizing force that prevents the sample from moving about in the petri dish.)

43. Place the filter papers and the normal glass plate samples into the acetate envelopes and seal the envelopes with the prenumbered yellow disc label (Sample Handling Record No.-Stage No.).

44. Remove the glass plates for microparticle analysis from the counting petri dishes and place them into the modified petri dishes designed to protect the active surface (see 42). Mark the Sample Handling Record No.-Stage No. on the petri dish. Seal the petri dishes with strips of tape.

45. Place all of the samples from an impactor into a plastic bag, mark it with the Sample Handling Record number, and seal it.

46. Place the plastic bags into a labeled (contents and test number) cardboard box for temporary storage.

B. SAMPLES NOT REQUIRING COUNTING

1. Follow Steps 1 through 28 in the above procedure for processing the samples, omitting 14, 15, 19, and 20.

2. Return all Andersen parts to the bag in which it was received and seal it. This bag is then placed with other samplers requiring decontamination.

3. Follow Steps 42 through 46 for packaging these samples.

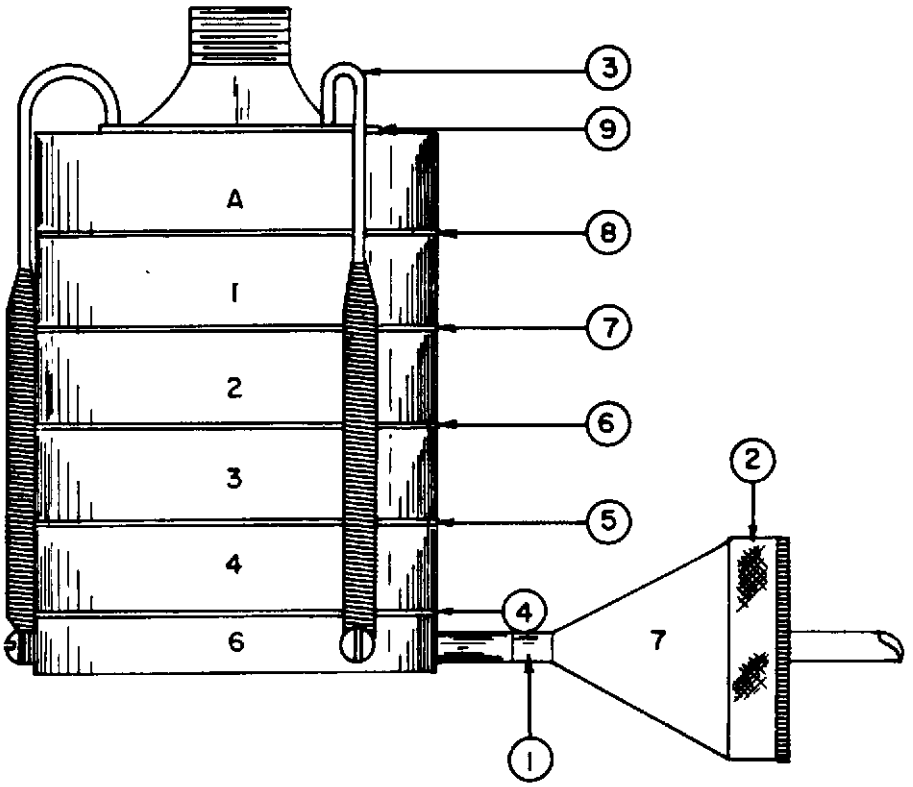


Figure A.1 Andersen impactor disassembly drawing.

APPENDIX B

PROCEDURES FOR PROCESSING CASELLA IMPACTORS

A Casella impactor is a 4-stage unit for separating airborne particles according to size. A small pump draws air through different sized nozzles, which separate out a specific range of particle sizes onto 1-inch glass discs covered with adhesive. A total air sampler (high efficiency filter paper) is connected to the outlet of the impactor to trap the smaller particles that would be normally exhausted out of the impactor. The impactors were placed in the field with a plastic bag over the entire unit, except the inlet and outlet nozzles, to minimize contamination on the outside of the sampler. After each test the samplers, in their plastic bags, were brought to the Receiving Dock of the Sample Handling and Processing Facility for processing.

The following step by step procedure begins with the receipt of the sampler on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

A. SAMPLES REQUIRING COUNTING

1. Upon receipt of the sampler at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) sampler number and arc and position location during the test.

2. Monitor the sampler with a Portable Alpha Counter (PAC) to determine whether the outer bag is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sampler reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean outer bag and place the sampler into a Receiving Room hood pass-through box.

4. Remove the sampler from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the outer bag.

6. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

7. Place the sampler into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

8. Place the bag into one of the two Receiving Room glove boxes.

9. Pass the bag containing the sampler into a glove box in

the Sample Handling and Processing Section of the trailer.

10. Remove and save the bag as a container for the disassembled unit. With Figure B.1 as a guide, proceed to process the sampler.

11. Disconnect Stage 5 at Point 1 and lay aside Stages 1 through 4.

12. Unscrew Stage 5 at Point 2 and remove the filter paper with a pair of tweezers.

13. Place the filter paper into a prenumbered (Sample Handling Record No. -5) 2-inch planchet in the pass-through between the glove boxes.

14. Remove the planchet to the adjoining glove box and monitor it with a PAC to determine in which area the sample should be counted. Place the sample in a numbered and color-coded sample-handling tray (red: High-Level Counting Room; yellow: Low-Level Counting Room).

15. Record the monitoring result in the last column of the Counting Data Sheet (Figure 2. 6).

16. Unscrew cap at Point 3 of the Casella and remove sample No. 4 (1-inch diameter glass disc).

17. Place the disc into a prenumbered (Sample Handling Record No. -4) 1.25-inch planchet in the pass-through between the

glove boxes.

18. Proceed as in 14 and 15.

19. Unscrew cap at Point 4 to remove Sample No. 3 and then proceed as in 17, 14, and 15.

20. Unscrew cap at Point 5 to remove Sample No. 2 and then proceed as in 17, 14, and 15.

21. Disconnect impactor at Point 6 in order to remove Sample No. 1.

22. Unscrew cap at Point 6 to remove Sample No. 1 and then proceed as in 17, 14, and 15.

23. Return all Casella parts to the bag in which it was received and seal it. This bag is then placed with other samplers requiring decontamination.

24. The sample handling tray and location is then noted on the Counting Data Sheet under counting time . (The final Counting Data Sheet, typed at the end of the processing operation, excludes this and other miscellaneous information.)

25. When the samples are to be counted, remove them from the sample handling trays.

26. Place the 1.25-inch planchets containing the glass discs into the special planchet holders.

27. Place the planchets containing the discs and filter paper into an automatic counter, recording their location in the counter in the counting time column of the Counting Data Sheet. The following data should be recorded on the Counting Data Sheet: counter being used, counting time, date and time at which the counting was done.

28. After counting has been completed, the following should be recorded on the Counting Data Sheet: total counts, background, and standard factor.

29. Remove the samples from the counter and place them into a prenumbered temporary storage tray until the counting data has been reviewed.

30. After the data has been checked and found to be correct, the samples are ready for packaging.

31. Obtain color-coded, dissolvable cellulose acetate envelopes (Red - Stage No. 1; Green - Stage No. 2; Amber - Stage No. 3; Blue - Stage No. 4; and Clear - Stage No. 5), plastic hats, yellow disc labels, and manila envelopes.

32. Place the glass disc into the plastic hat in such a manner as to prevent the contaminated surface from being disturbed by future handling, and then insert the sample into the proper color-

coded acetate envelope.

33. Seal the envelopes with a prenumbered yellow disc label (Sample Handling Record No. -Stage No.).

34. Remove the filter paper (Sample No. 5), put it into the clear dissolvable cellulose acetate envelope, and seal it with a prenumbered yellow label.

35. Gather all 5 acetate envelopes and place them into a manila coin envelope and seal it.

36. Mark the Sample Handling Record number on the outside of the envelope.

37. Place the coin envelopes into a large manila envelope in lots of approximately 25.

38. Place the manila envelopes in a labeled (contents and test number) cardboard box for temporary storage.

B. SAMPLES NOT REQUIRING COUNTING

1. Follow Steps 1 through 23 in the above procedure for processing these samples.

2. Follow Steps 31 through 38 for packaging these samples.

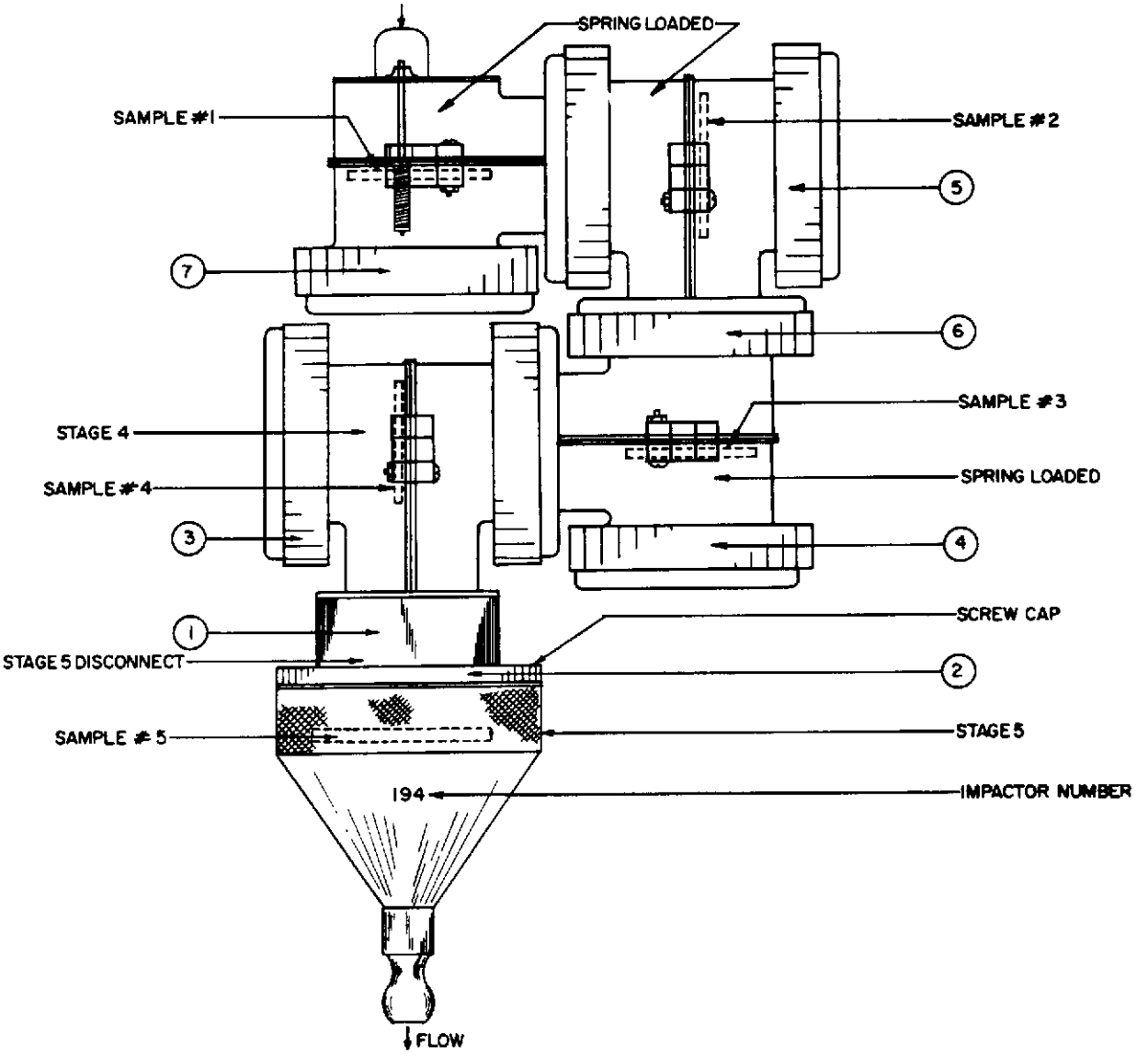


Figure B. 1 Casella impactor disassembly drawing.

APPENDIX C

PROCEDURE FOR PROCESSING TOTAL AIR SAMPLES

A total air sampler (TAS) is a single-stage unit for removing particulate matter from the air. The size of the particles that can be removed is a function of the specific paper used. The air is drawn through the sampler inlet by a pump through 2-inch filter papers and exhausted through the outlet. Three model TAS's were used (see Figure 1.16). The Mark I and II units were metal and were decontaminated and reused. The third unit was a Gelman disposable plastic model. The Mark I and II's were placed in the field with a plastic covering over all but the inlet and outlet. The disposable units were left uncovered. After the test, the sampler's inlet and outlet was sealed and the units were brought to the Receiving Dock of the Sample Handling and Processing Facility for processing.

The following step-by-step procedure begins with the receipt of the sampler on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sampler at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sampler number and arc and position location during the test.

2. Monitor the sampler with a Portable Alpha Counter (PAC) to determine whether the outer bag or exterior surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sampler reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean outer bag and place the sampler into a Receiving Room hood pass-through box.

4. Remove the sampler from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the outer bag (for Mark I and Mark II only).

6. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

7. Place the sampler into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

A. MARK I AND MARK II TAS's

1. Place the bag into one of the two Receiving Room glove boxes.

2. Pass the bag containing the sampler into a glove box in the Sample Handling and Processing Section of the trailer.

3. Unscrew the sampler.

4. Remove the filter papers with a pair of tweezers or with dissecting needles.

5. Place the sample in a clear dissolvable cellulose acetate envelope and seal it with a prenumbered (Sample Handling Record number) label.

6. Place the acetate envelope in a coin envelope, seal it, and mark the Sample Handling Record number on the outside.

7. Place the coin envelopes into a large manila envelope in lots of approximately 25.

8. Place the manila envelope in a labeled (contents and test number) cardboard box for temporary storage.

B. DISPOSABLE TAS's

1. Gather all units from one test and separate into lots of about 25. Seal each lot in a plastic bag and mark the Sample Handling Record numbers on the outside of the bag.

2. Place plastic bag in a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX D

PROCEDURE FOR PROCESSING TAPES FROM AIR SAMPLERS

Gelman moving-tape air samplers were used to collect a continuous sample of the airborne contamination. The filter tapes, on their spools, were removed and placed into plastic bags following each test.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and arc and position location during the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the outer bag is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean

outer bag and place the sample into a Receiving Room hood pass-through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the plastic bag.

6. Place the sampler into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Gather all of the tapes from the test and place them into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX E

PROCEDURE FOR PROCESSING FALLOUT PLANCHETS

Fallout planchets (Figure 1.17) were designed to give a rapid rough estimate of the amount of activity that might be expected to be found on the films (sticky papers) and microscope slides sharing the fallout tables. The planchets were removed from the tables and placed in boxes especially designed to protect their adhesive surface. The boxes were gathered together and placed into rectangular telescope-type cartons with approximately 30 samples per carton.

The following step-by-step procedure begins with the receipt of the samples on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

A. SAMPLES REQUIRING COUNTING

1. Upon receipt of the sample container at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample numbers and arc and position locations during the test.

2. Monitor the sample container with a Portable Alpha Counter (PAC) to determine whether it is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample container

reading more than 500 cpm is discarded and the samples placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted on the Sample Handling Record form.

3. Mark the Sample Handling Record number on the sample container and place it into a Receiving Room hood pass-through box.

4. Remove the sample container from the pass-through box into the hoods. (This is done by personnel inside the Receiving Room.)

5. Remove the sample boxes from the sample container.

6. Monitor the exterior surface of the sample boxes and, if contaminated, vacuum or wipe them off until a background reading is obtained.

7. Place the sample boxes into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

8. Place the bag into one of the two Receiving Room glove boxes.

9. Pass the bag containing the samples into a glove box in the Sample Handling and Processing Section of the trailer.

10. Remove the boxes containing the samples from the bag

one at a time to minimize cross-contamination of samples.

11. Remove the planchet from the sample box and place it in a prenumbered (Sample Handling Form number and project identification number)2-inch planchets in the pass-through between the glove boxes.

12. Remove the planchet to the adjoining glove box and monitor with a PAC to determine in which area to count the sample. Place the sample in a numbered and color-coded sample handling tray (red: High-Level Counting Room; yellow: Low-Level Counting Room).

13. Record the monitoring result in the last column of the Counting Data Sheet (Figure 2. 6).

14. The sample handling tray and location is then noted on the Counting Data Sheet under counting time . (The final Counting Data Sheet, typed at the end of the processing operation, excludes this and other miscellaneous information.)

15. When the samples are to be counted, remove them from the sample handling trays.

16. Place the planchets into an automatic counter, recording their location in the counter in the counting time column of the Counting Data Sheet. The following data should be recorded

on the Counting Data Sheet: counter being used, counting time, date and time at which the counting was done.

17. After the counting has been completed, the following should be recorded on the Counting Data Sheet: total counts, background, and standard factor.

18. Remove the samples from the counter and place them into a prenumbered temporary storage tray until the counting data has been reviewed.

19. After the data has been checked and found to be correct, all planchets except those reading above 10,000 dpm are discarded. Samples reading above 10,000 dpm are packaged for storage.

20. Cover the 2-inch planchet containing the sample with another 2-inch planchet.

21. Tape the cupped planchets together.

22. Place the unit into a plastic bag, mark the Sample Handling number and project number on the box and seal it.

23. Gather all of the planchets and place them into a plastic bag, labeled as to contents and test number, and seal it.

24. Place the plastic bag in a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX F

PROCEDURE FOR PROCESSING FALLOUT SLIDE SAMPLES

Slides from various field and off-site locations were collected and placed in metal slide containers or manila envelopes following each test.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

A. On-Site Samples

1. Upon receipt of the samples at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and arc and position location during the test.

2. Monitor the sample container with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample container reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the sample Handling Record number on the outer

surface and place the sample into a Receiving Room hood pass-through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Place the metal slide container into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Gather all the metal slide containers from the test and place them into a labeled (contents and test number) cardboard box for temporary storage.

B. Off-Site Samples

1. Upon receipt of the samples at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and position location during the test.

2. Transfer the samples delivered in the manila envelopes into clean plastic bags, labeled as to contents and test number.

3. Gather all of the slides from the test and place them into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX G

PROCEDURE FOR PROCESSING STICKY PAPER SAMPLES (FILMS)

Sticky papers used to determine the fallout pattern were collected from various field and off-site locations and placed in manila envelopes following each test.

The following step by step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and arc (for on-site samples) and position location during the test.

2. Monitor the envelope with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the outer

surface and place the sample envelope into a Receiving Room hood pass-through box.

4. Remove the sample envelope from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained. (If unsuccessful, place the sample into a clean envelope labeled as to contents, location, and test number.)

6. Gather all of the envelopes included under the Sample Handling Record number and place them into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Place the plastic bags into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX H

PROCEDURE FOR PROCESSING SOIL SAMPLES

Soil samples from various field locations were collected and canned or placed in polyethylene bottles or tubes before and following each test.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2. 2) the sample number and arc and position location during the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and on the bag itself.

3. Mark the Sample Handling Record number on the outer surface and place the sample into a Receiving Room hood pass-

through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Place the sample into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Samples were combined into effective groups (as a function of the number produced by a specific test) and placed into a plastic bag labeled as to contents and test number.

8. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX I

PROCEDURE FOR PROCESSING CONCRETE CORE SAMPLES

Concrete core samples were put into individual plastic bottles in the field.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of a concrete core sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and its arc and position location following the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record and the bag itself.

3. Mark the Sample Handling Record number on the exterior surface and place the sample into a Receiving Room hood pass-through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Place the sample into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Gather the concrete core samples from the test and place them into larger plastic bags, labeled as to contents and test number, and seal them.

8. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX J

PROCEDURE FOR PROCESSING SCRAP METAL SAMPLES

Scrap metal samples were put into plastic bags in the field. The larger samples were dissolved in a field laboratory and delivered in plastic bottles for processing. The smaller samples were delivered in the plastic bags to the Sample Handling and Processing Facility.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

A. SOLID SAMPLES

1. Upon receipt of a scrap metal sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2. 2) the sample number and its position location following the test.

2. Monitor the plastic bag with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record and the

bag itself.

3. Mark the Sample Handling Record number on the exterior surface and place the sample into a Receiving Room hood pass-through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Place the sample into a second plastic bag, seal it, and mark the Sample Handling Record number on it.

7. Gather the scrap metal samples from the test and place them into larger plastic bags, labeled as to contents and test number, and seal them.

8. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

B. LIQUID SAMPLES

1. Follow **Steps** 1 through 5. The plastic bottle containing the liquid sample will either be inside a larger plastic bottle or sealed inside a plastic bag.

2. Place the bottle (or bag) in a clean plastic bag and seal it.

3. Place the sealed plastic bag into a larger plastic bag and

seal it.

4. Mark the Sample Handling Record number on the exterior bag surface.

5. Place the bottles into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX K

PROCEDURE FOR PROCESSING STICKY WIRES

Sticky wires (3/32-inch thick by 18-inch long) were coated with adhesive and fastened to the balloon curtain by means of alligator clips attached at each end of the wire (Figure 1.18). There were 24 sticky wires per balloon line and 30 active balloon lines per American balloon curtain. As the cloud passed through the balloon curtain, the radioactive particulates adhered to the sticky wires. At the end of each test, the wires were unclipped from the curtain and placed in special wooden boxes. The boxes were then placed into clean plastic bags for delivery to the Sample Handling and Processing Facility.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the samples at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the balloon number and line and position location during the test.

2. Monitor the outer bag with a Portable Alpha Counter (PAC) to determine whether it is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving

Room hoods and pass-through boxes.) Any plastic bag reading more than 500 cpm is discarded and the sample placed into a clean plastic bag prior to being put into the pass-through boxes. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean outer bag and place the sample container into a Receiving Room hood pass-through box.

4. Remove the sample container from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the bag before placing the sample container into the glove box.

6. Place the sample container into one of the two Receiving Room glove boxes.

7. Pass the sample container into a glove box in the Sample Handling and Processing Section of the trailer.

8. Remove the desired wire (the box is labeled as to line number and test, and the wires are marked to show line number and position) into the next glove box.

9. Hold the sample in the gloved left hand and have a plas-

tic bag located below the left hand to catch the wire when it is cut. This is to prevent the glove box from becoming contaminated. In handling the wires, it was found that it is advisable to have a tissue between the wire and the glove in order to reduce the contamination and replacement of gloves.

10. Snip one end of the wire just above the 90° angle and remove the insulation. Then snip the other end just below the 90° angle and remove the insulation. (This will result in one straight end and one curved end.)

11. Place the wire on the holding jig and monitor with a Portable Alpha Counter (PAC).

12. Record the monitoring result in the last column of the Counting Data Sheet (Figure 2.6).

13. Pass the sample into the next glove box for insertion into the ionization chamber.

14. Place the straight end of the wire into the anode clip and the curved end into the holder by the cap. Screw the cap on the unit. Switch the instrument to the appropriate scale setting and wait for equilibrium to be reached. Record the $\mu\mu$ ampere reading, date counted, counter, etc., on the Counting Data Sheet.

15. Three different types of processing can occur at this

point.

a. The wire is disposed of. (This occurs most of the time.)

b. The wire is wiped with a piece of filter paper until all of the adhesive is removed and an insignificant amount of activity remains on the wire. (This is confirmed by making another measurement in the ionization chamber after wiping.) Wipe enough wires to obtain representative samples for the range of instrument readings. (The wipe samples will be analyzed radiochemically and the results used to calibrate the ionization chamber.) Place the wipes into dissolvable cellulose acetate envelopes and seal them with prenumbered (wipe number, line, and position) yellow disc labels. All samples for each line are than gathered and placed into a plastic bag, labeled as to contents, and sealed. The plastic bags are then placed into one large plastic bag, labeled as to contents. The bag is placed in a cardboard box, labeled as to contents, for temporary storage.

c. Some of the wires with high instrument readings and representing a cross section of the balloon curtain are retained for future studies. In this case, cut off the turned end of the wire and stick each end into a cork. Put the corked sample into a cardboard tube and seal the ends with tape. Mark the Sample Handling

Record number and the line and position location on the outside of the tube. Gather all of the tubes from the test and place them in a plastic bag labeled as to contents and test number. Place the plastic bags into a labeled (contents and test number) cardboard box for temporary storage.

ANNEX L

PROCEDURE FOR PROCESSING STICKY DISCS

Sticky discs were 7-inch diameter plastic plates that were coated with an adhesive on both sides and fastened to the balloon curtain by means of long bolts (see Figure 1. 19). As the cloud passed through the balloon curtain, the radioactive material adhered to the sticky discs. At the end of each test, the bolts were loosened and each disc was placed in a movie-film can with the screw protruding through a hole in the bottom and top of the can.

The following step-by-step procedure begins with the receipt of the sampler on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2. 2) the sample number and arc and position location during the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the sample container is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any container reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination

value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the film can and place the sample into a Receiving Room hood pass-through box.

4. Remove the sampler from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the sample container and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Remove the bolts from the sample. Place into a plastic bag and return to Project 2.2 for decontamination and re-use.

7. Place the sample container into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

8. Place the bag into one of the two Receiving Room glove boxes.

9. Pass the bag containing the sample into a glove box in the Sample Handling and Processing Section of the trailer.

10. Remove the bag and open the film can.

11. Take the sample out of the can with large tweezers or handling tongs.

12. Monitor the disc by making two measurements on each

side with a PAC.

13. Record the results in the last column of the Counting Data Sheet (Figure 2. 6).

14. Dispose of all samples reading less than 2,000 cpm.

15. Return any sample reading greater than 2,000 cpm to the original film can.

16. Seal the container with tape and then place it into a clean plastic bag.

17. Seal the bag, noting the marking and the Sample Handling Record number on the outer surface.

18. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX M

PROCEDURE FOR PROCESSING VEGETATION SAMPLES

Field vegetation samples were collected before and after the test. The samples were put into individual plastic bags in the field and then gathered into a large clean plastic bag at the Rad-Safe control point.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and arc and position location during the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the outer bag is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the clean outer bag and place the sample into a Receiving Room hood pass-

through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Remove the outer bag.

6. Monitor the inner bag and, if contaminated, vacuum or wipe it off until a background reading is obtained.

7. Place the sample into a clean plastic bag, seal it, and mark the Sample Handling Record number on it.

8. Gather the vegetation samples from the test and place them into larger plastic bags, labeled as to contents and test number, and seal them.

9. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

APPENDIX N

PROCEDURE FOR PROCESSING WATER SAMPLES

Glass trays were filled with water and dispersed throughout the array prior to each test. Upon completion of the test, the trays were emptied into clean glass bottles and delivered to the Sample Handling and Processing Facility.

The following step-by-step procedure begins with the receipt of the sample on the Receiving Dock and lists the processing steps leading to the packaging of the samples for storage.

1. Upon receipt of the sample at the Receiving Dock, note upon the Sample Handling Record (see Figure 2.2) the sample number and arc and position location during the test.

2. Monitor the sample with a Portable Alpha Counter (PAC) to determine whether the outer surface is grossly contaminated. (This is done in order to prevent gross contamination of the Receiving Room hoods and pass-through boxes.) Any sample reading more than 500 cpm is placed into a clean plastic bag prior to being put into the pass-through box. The exterior contamination value is noted both on the Sample Handling Record form and the bag itself.

3. Mark the Sample Handling Record number on the sample

and place it into a Receiving Room hood pass-through box.

4. Remove the sample from the pass-through box into the hood. (This is done by personnel inside the Receiving Room.)

5. Monitor the exterior surface and, if contaminated, vacuum or wipe it off until a background reading is obtained.

6. Tape the bottle cap to the bottle in such a manner that it cannot come loose.

7. Place a layer of cardboard around the exterior of the bottle.

8. Place the bottle in a clean plastic bag and seal it.

9. Place the sealed plastic bag into a larger plastic bag and seal it.

10. Mark the Sample Handling Record number on the plastic bag.

11. Place the plastic bag into a labeled (contents and test number) cardboard box for temporary storage.

Military sites, installations, and contractors requesting changes of address or distribution requirements should forward their requests through established channels to the Chief, Defense Atomic Support Agency, Washington, D. C. 20301.

DISTRIBUTION

ARMY ACTIVITIES

1 CHIEF OF RESEARCH & DEV. D/A ATTN ATOMIC DIV.
1 ASST.CHIEF OF STAFF FOR FORCE DEV.
2 CHIEF OF ENGINEERS D/A ATTN ENGMCEM
3 THE SURGEON GENERAL D/A
2 COMD. GEN. US ARMY COMBAT DEV.
1 COMD. OFFICER US ARMY CDC NUCLEAR GR.
2 COMD. OFFICER,US ARMY NUC.DEF.LAB.ATTN J.C.MALONEY
1 CHIEF,US ARMY NUC.WEAPONS SYSTEMS SAFETY GR.
3 COMD.GEN. US ARMY MATERIEL COMD.
1 COMD.OFFICER,PICTINNY ARSENAL
3 COMD.GEN. US CONTINENTAL ARMY COMD.

NAVY ACTIVITIES

1 CHIEF OF NAVAL OPERATIONS ATTN OP-75
1 CHIEF OF NAVAL OPERATIONS ATTN OP-40
1 CHIEF,BUREAU OF NAVAL WEAPONS ATTN CP-3
1 CHIEF,BUREAU OF NAVAL WEAPONS ATTN FWAM-4
1 CHIEF,BUREAU OF YDS.&DOCKS ATTN CODE 42.330
3 CHIEF,BUREAU OF MED.&SURGERY D/N ATTN CODE 74
1 COMD.OFFICER & DIR.,US NAVAL CIVIL ENG.LAB.
2 COMD. OFFICER US NRDL
1 COMD. OFFICER US NRDL ATTN ROSS K. FULLER
1 COMMANDANT HDQ. US MARINE CORPS
1 COMD.-IN-CHIEF,ATLANTIC
1 COMD.-IN-CHIEF,PACIFIC,C/O FLEET P.O.
1 COMD.-IN-CHIEF,US NAVAL FORCES,EUROPE

AIR FORCE ACTIVITIES

1 HDQ.,US AIR FORCE ATTN AFRNEA
1 HDQ.,US AIR FORCE ATTN AFIIS
1 HDQ.,US AIR FORCE ATTN AFSSSAE
1 HDQ.,US AIR FORCE ATTN AFRSTA
1 HDQ.,US AIR FORCE ATTN AFMSPA
1 COMD. AIR FORCE SYSTEMS COMD. ATTN SCGB
1 COMD. BOLLING AIR FORCE BASE ATTN RTNW
1 HDQ. AIR DEFENSE ENT AFB
1 COMD. AIR FORCE LOGISTICS COMD.
1 COMD.AIR TRAINING COMD.
1 COMD.STRATEGIC AIR COMD.
1 COMD.TACTICAL AIR COMD.
5 AIR FORCE WEAPONS LAB. ATTN WLL-3
1 AIR FORCE WEAPONS LAB. ATTN LT.COL. J.L.DICK WLP
1 AIR FORCE WEAPONS LAB. ATTN COL.I.J.RUSSELL WLRB
2 COMD.OGDEN AIR MATERIEL AREA
2 COMD.SAN ANTONIO AIR MATERIEL AREA

OTHER DEPARTMENT OF DEFENSE ACTIVITIES

20 DIR. DEFENSE ATOMIC SUPPORT AGENCY ATTN OAPA
30 DIR.DEFENSE ATOMIC SUPPORT AGENCY ATTN JAIEG
1 COMD.FIELD COMD. DASA,SANDIA ATTN FCTG5
1 CHIEF,WEAPONS TEST DIV. SANDIA ATTN STWT
1 CHIEF,WEAPONS TEST DIV. SANDIA ATTN WTOP
1 CHIEF,WEAPONS TEST DIV. SANDIA ATTN WTOP-P
3 CHIEF,WEAPONS TEST DIV. SANDIA ATTN WTOP-P2
1 CHIEF,WEAPONS TEST DIV. SANDIA ATTN WTWT-TI
40 DEFENSE DOCUMENTATION CENTER
1 CHAIRMAN,ARMED FORCES EXPLOSIVES SAFETY BOARD

CIVILIAN DISTR

1 COL.SCHOOL OF MINES RES.FOUND.ATTN DR.F.L.SMITH
1 COL.SCHOOL OF MINES RES.FOUND.ATTN MR.J.K.PERRY
2 HAZELTON NUCLEAR SCIENCE CORP ATTN MR.H.E.MENKER
1 TRACERLAB INC. ATTN MR.A.L.BAIETTI
1 TRACERLAB INC. ATTN MR.WILLIAM MAJOR
1 TRACERLAB INC. ATTN MR.CHARLES D. DUNN
1 EBERLINE INSTRUMENT CORP ATTN MR.ROBERT GALLAGHER
1 EBERLINE INSTRUMENT CORP ATTN MR.WM.S.JOHNSON,SR.
1 EBERLINE INSTRUMENT CORP ATTN MR.JACK C.BENTLEY
1 EBERLINE INSTRUMENT CORP ATTN MR.ERIC GEIGER
2 LOVELACE FOUNDATION ATTN DR.SAM WHITE
2 ISOTOPES INC.ATTN PHILIP W.KREY
2 ISOTOPES INC.ATTN MR.REX D. SHERWOOD
2 ISOTOPES INC.ATTN DR. JAMES P. FRIEND
2 ISOTOPES INC.ATTN MR.RALPH E. FRIED
1 HANFORD ATOMIC PROD.OPERATION ATTN DR.WM.J.BAIR
2 US PUBLIC HEALTH SERVICE ATTN MR.JOHN COOGAN
2 UNIV. OF ROCHESTER AEP ATTN PROF.ROBERT H.WILSON
2 US WEATHER BUREAU USAEC ATTN R.W.TITUS
1 GEN.DYN.CORP.NUC.DESIGN & OPER.DIV.ATTN W.T.PRICE
1 GEN.DYN.CORP.NR&D,NAR FACILITY ATTN DR.N.H.GODBOLD
1 GEN.DYN.CORP.NR&D,NAR FACILITY ATTN MR.ROY HENRY
1 GEN.DYN.CORP.NR&D,NAR FACILITY ATTN MR.J.C.COUCHMAN

ATOMIC ENERGY COMMISSION ACTIVITIES

5 DIR.OF MILITARY APPLICATION USAEC
5 USAEC ATTN DIV.OF OPERATIONAL SAFETY
2 USAEC ATTN DIV. OF BIOLOGY AND MEDICINE
2 USAEC ATTN DIV. OF RADIATION PROTECTION STANDARDS
5 USAEC,NEVADA OPERATIONS OFFICE
5 USAEC SAN FRANCISCO OPERATIONS OFFICE
5 USAEC ALBUQUERQUE
1 USAEC ALBUQUERQUE.ATTN.E.R.MATHEWS,DIV.OPER.SAFETY
1 ASST.TO THE SEC.OF DEFENSE ATOMIC ENERGY
1 CHICAGO OPERATIONS OFFICE,DIV.HEALTH & SAFETY
1 HEALTH AND SAFETY LAB.USAEC,ATTN DR.J.H.HARLEY
1 INDUSTRIAL HYGIENE & SAFETY ANL ATTN DR.J.SEDLET
1 GE CO.HANFORD ATOMIC PROD.ATTN DR.J.M.NIELSEN
3 PRES.SANDIA CORP
1 PRES.SANDIA CORP.ATTN DR.J.D.SHREVE,5414
1 PRES.SANDIA CORP.ATTN DR.B.F.MURPHEY,5410
1 PRES.SANDIA CORP.ATTN MR.H.W.CHURCH,5414
1 PRES.SANDIA CORP.ATTN DR.T.B. COOK,5400
1 PRES.SANDIA CORP.ATTN MR.L.C.GUYNES,3415
1 RADIOACTIVITY SECTION NBS ATTN L.A.CURRIE
2 SANDIA CORP.LIVERMORE
5 DIR.LAWRENCE RADIATION LAB.
5 DIR.LOS ALAMOS SCIENTIFIC LAB.
1 DIR.LOS ALAMOS SCIENTIFIC LAB.ATTN DR.M.F.MILLIGAN
30 DIV.OF TECH. INFORMATION EXTENSION