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EXPERIMENTAL DESIGN

for

Aerosol Characterization Study

Prepared for

Air Resources Board

State of California

Contract No. ARB-358

Not for Public Release Without Approval of Air Resources Board

APPROVED BY:

T. L. Loucks
Program Manager
Science Center

January 31, 1972

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1. Introduction

In this report, the experimental design plan for the aerosol characterization experiment is described in accordance with work scheduled under Air Resources Board Contract No. 358. The investigations outlined essentially fulfill the first phase of our planning for this project, as outlined in the North American Rockwell Science Center proposal SC2120T. The program discussed here is the result of intensive efforts by the experimenters to develop a plan compatible with the objectives of the study and the rapidly expanding knowledge of aerosol chemistry. The key ingredients in the plan were (a) the aerometric evaluation results coming from work in the first phase of this study, (b) experience gained by the University of Minnesota group operating a mobile laboratory in Denver, Colorado during the fall of 1971, and (c) continuing research on aerosol behavior by all investigators through the past several months.

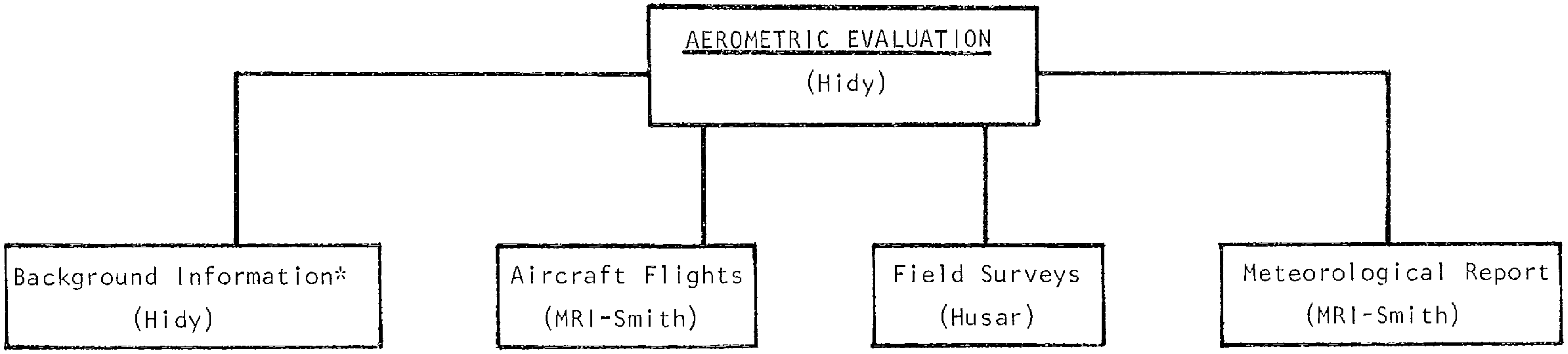
The aerometric evaluation of the three major basins of interest in California was conducted in four parts, as indicated schematically in Fig. 1. Each element of this portion of the study provided important information for planning the intensive field experiment. The results of the aerometric evaluation will not be described here but will be summarized later in a Progress Report as part of the documentation for Phase I of the program.

This report approaches the experimental design by covering first the goals of the study and their inputs on the measurement requirements. Then the plan for the intensive experiment and the data management system are discussed. Finally, the operational procedures and implementation plans are described, as they complete our ideas for phase II (Preparations).

2. Experimental Design Criteria

At the outset, it is worthwhile to restate the objectives of this experiment and repeat the fact that this study is designed to be an experiment focused on these objectives and not a pollution monitoring program. The objectives are:

(1) To characterize the aerosol in the South Coast, the San Francisco Bay Area, and the San Joaquin Valley Basins in terms of its physical and



Background Information* (Hidy)

1. APCD's
2. ARB
3. NASN-NOAA
4. 1969 Pasadena data
5. 1970 San Nicolas Island data
6. Emission surveys
7. Miscellaneous

Aircraft Flights (MRI-Smith)

1. 3 basin coverage
2. Aitken nuclei
   nephelometer
   meteorological
   grab samples
   visual

Field Surveys (Husar)

1. San Joaquin Valley
2. Bay area
3. Desert, Big Sur, Big Basin, Pt. Reyes

Meteorological Report (MRI-Smith)

1. Expected weather patterns
2. Classification of days
3. Site selection
4. Sampling periods

*The San Joaquin Valley is a serious problem here.

Figure 1 Elements Comprising the Aerometric Evaluation chemical properties, its interaction in the atmosphere and its natural and anthropogenic origins.

(2) To evaluate the amount of the atmospheric aerosol in the cited three major air basins which can be related to (a) primary emissions such as from auto exhausts or smokestacks and (b) secondary production due to physical and chemical processes taking place in the atmosphere.

(3) To identify those major sources of particles and chemically reactive gases which can be related to aerosol pollution and visibility reduction.

(4) To estimate from aerosol source characterization in the three major regions the extent to which the ambient air quality standards can be achieved by existing technology.

(5) To evaluate the applicability of the aerosol analysis instrumentation employed in this study for use in present monitoring networks. Special emphasis is to be placed on an improved practical indicator (index) for relating ambient aerosol properties to potential health hazards and to visibility reduction according to established California standards.

The first objective is one requiring the performance of a variety of measurements, while the remaining four objectives are ones requiring mainly the interpretation of the experimental data. The achievement of all the objectives will depend crucially on our ability to make elaborate measurements of meteorological parameters, trace gases and aerosol properties simultaneously at different locations and "characteristic" times in each major basin. A characteristic time is defined here as a period or season when there is a high probability of observing a significant production of aerosol either from direct emissions or from physical and chemical processes in the atmosphere. It is impractical to conduct such a program with a large number of fixed stations. Thus, the use of a few fixed stations supplemented by a well instrumented mobile laboratory has been chosen, with the expectation that our resources can be applied best with intermittent, intensive measurements in locations chosen on the basis of past aerometric history.

The first objective can be attained by taking core measurements of several physical and chemical properties of the ambient atmosphere, as listed in Table 1. If all of these core observations can be made in a given run, the first objective will be met with subsequent data analysis and interpretation.

Table 1

MEASUREMENTS OF PHYSICAL AND CHEMICAL PROPERTIES OF AIR TO CHARACTERIZE THE AEROSOL IN THREE MAJOR BASINS

Observable	Instrument
A. Aerosol	
1. Distribution of number concentration, apparent surface area and volume as a function of particle size from 0.005μm to $\gtrsim$ 50μm diameter	Minnesota Aerosol Analysis System (best) with rotary impactor. Combination of Aitken nuclei concentration and optical counter (limited but useful).
2. Mass as distributed as a function of particle size	Rotating drum impactor with backup filter
3. Total Aerosol Mass	Hi-Volume Filter and a sum of stages in Lundgren impactor; Vibrating Quartz crystal analyzer and β-gauge - useful but not fully tested in field.
4. Total light scattering in the visible range	Integrating nephelometer
5. Particle Removal Rate at Surface	Dustfall collector; surface flux collector
6. Chemical properties as a function of particle size	Analysis of rotating drum impactor deposits and filter samples
7. Influence of liquid water content on light scattering and on chemical constitution	Nephelometer observation as a function of relative humidity; measure of liquid water content by filter or microwave cavity observation
B. Trace Gases	
1. Photochemically Active Gases (O_3, NO, NO_2, non-methane hydrocarbons), PAN	Continuous monitoring instruments, except for PAN
2. Aerosol producing Gases (SO_2, NH_3)	Continuous or sequential samplers
3. Weakly Reactive Gases (CO, methane)	Continuous or sequential samplers

Table 1: Measurements of Physical and Chemical Properties of Air to Characterize the Aerosol in Three Major Basins

(continued)

Observable	Instrument
C. Meteorological	
1. Temperature	-
2. Humidity	-
3. Wind Direction and Speed	-
4. Total Incoming Solar Radiation	Pyrheliometer
5. Visibility[+]	Human observation of selected targets
6. Precipitation (total amount and chemistry*)	-

[+]Only at fixed stations and selected mobile sites where feasible

*Chemistry will not be attempted in this study

More detailed analysis of their chemical properties must be focused on the specific program objectives. Thus certain chemical constituents have to be selected as critical to the achievement of one or more of the program objectives. These are listed in Table 2 and are identified with important sources or with other justification for their choice.

The achievement of the second goal depends strongly on our experience in identifying certain tracers that are unique to important sources of aerosols. Two main thrusts in this direction have been developing. The first makes use of certain features of the aerosol size distribution that appear to be linked with combustion sources. (See, for example, Whitby, 1). The second involves the geochemical tracer method, where a chemical element or constituent of the aerosol is identified with a major source or sources (e.g., Miller _et al_., 2; Friedlander, 3). The latter approach has been investigated further and shows great promise for deducing information about sources from data obtained in the list of Tables 1 and 2. These data will be considerably enhanced by use of other available monitoring data and meteorological trajectory analysis to deduce the most likely sources of certain kinds of material.

Perhaps the most important but difficult to achieve objective is the third one. From the standpoint of pollution control strategy, this information is now crucial to improvement of "visible" air quality in California. There are essentially two approaches leading to a better understanding of visibility reduction and sources of aerosols. The first is to utilize available monitoring data for emissions of particulates and for reactive gases and to examine the history of change of these emissions with patterns of change in visibility. The second is an intensive geochemical-meteorological study of a limited number of cases of detailed, validated data taken in a study projected here. Examination of visibility and monitoring data accessible to us in the three major basins indicates that this material is either insufficiently accurate or is incomplete with respect to the gas species monitored. Therefore, we believe that it will be necessary to rely heavily on the second method, which will require effective use of the data taken during the intensive experiment in 1972.

Table 2

PROJECTED KEY CHEMICAL CONSTITUENTS OF COLLECTED PARTICULATE MATTER

Element or Molecular Constituent	Remarks and Possible Origins
C (total & organics)	Primary-natural and anthropogenic sources secondary- photochem (?)
N(NO_3^-, NH_4^+, amino & pyridino	Sources - oxidation of NO_x, NH_3, fuel additives
Na	Mainly sea salt
Aℓ	Mainly soil - some possible anthropogenic
Si	Mainly soil
S($SO_4^=$, $SO_3^=$, S···)	Mainly secondary production from SO_2 oxidation
Cℓ	Mainly sea salt, but some man made
K	Mainly natural (?)
Ca	Cement production
Ti	Anthropogenic and natural
V	Power plant - fuel oil
Cr	Anthropogenic
Mn	Anthropogenic
Fe	Anthropogenic and natural
Ni	Anthropogenic
Cu	Anthropogenic
Zn	Tire dust, smelting, fuel additives
As	Combustion, metal prod. & proc.
Se	Combustion
Br	Auto exhaust
Cd	Metal prod. & proc.
I	Sea Salt & (?)
Ba	Diesel exhaust & Lub oil atomization
Pb	Auto exhaust, Industrial Proc.
H_2O	Liquid water content is a potentially important inert ingredient in visibility question

In focusing on this objective, the need for linking practical visibility observations with the physical and chemical properties of the visibility reducing particle size range is critical. The data taken by Charlson et al. (4) clearly showed in Pasadena that light was scattered (and visibility was most strongly effected) by particles in the 0.1-5μm diameter range. To identify the material from primary and secondary sources contributing to visibility reduction, efforts must be concentrated on detailed chemical analysis of material in this size range. Furthermore, because it has been found that the nephelometer response depends strongly on relative humidity, every effort must be made to account for this in terms of the hygroscopicity and liquid water content of aerosols in this size range. At the very least, it would be desirable to show a strong correlation between total liquid water content and changes in light scattering of the atmospheric aerosol.

An example of an important minor gaseous constituent contributing to aerosol formation is SO_2. None of the basins currently have a serious air quality problem with respect to existing standards. However, it is known that SO_2 is a major factor in aerosol production in the atmosphere. Thus small amounts in an urban basin could substantially degrade visibility (See Stephens & Price, 5). Because of the potential importance of SO_2 to visibility, it is crucial in this study to identify the major sources of this gas in each basin and estimate by a model such as that of Lamb and Neiburger (8) its ambient concentration distribution in the absence of atmospheric reactions. Comparison of such results with our observations should give a better picture of the relationship of SO_2 to visibility reducing aerosols, at least in the Los Angeles basin.

Once the chemical nature of aerosols in the light scattering size range is well documented in terms of "tracer" constituents, it should be possible to estimate better the requirements for improved visibility in the three major basins. This information combined with a continuing up-grading of our experience in control technology should enable us to provide information on the fourth objective.

With respect to the fifth objective, we feel that the type of instrumentation listed in Table 1 will provide us with ample testing for deduction of a suitable improved practical monitoring system at fixed stations. Such a system undoubtedly will require continuous monitoring of certain "key" physical and chemical properties of aerosols.

The main inadequacy in available instrumentation at this time is a device (or devices) for continuously monitoring the chemical properties of the aerosol. The planned experimental procedure will require reliance on existing methods of intermittent sampling with filters and impactors. However, it is possible that a continuously monitoring x-ray fluorescence instrument for elements heavier than atomic numbers of approximately 20 will be available to us during the experiment. We have discussed this with EPA, the sponsor for construction of the instrument, and we may be able to use this instrument for approximately one month, either in the Bay Area or at the Pasadena station. Evaluation of this device during the experiment could improve our assessment of possibilities for new monitoring approaches, as required in the fifth program objective.

The fixed station concept may not be adequate to monitor visibility changes. By closely coordinating our sampling with the ARB 3-dimensional aerosol mapping study, it should be possible to evaluate the use of intermittent aircraft surveys to supplement fixed station data. This coordination link is considered highly important because of the findings of the preliminary aircraft surveys conducted in the three major basins under this study. The flights over the San Joaquin Valley and the LA Basin confirmed earlier work of MRI and studies by Professor Edinger (UCLA) that there exist significant vertical heterogeneities of aerosol and ozone concentrations within a few thousand feet of the ground.

A third possibility for monitoring of visibility using an "integrated path" sensor such as a radiometer or an active device like LIDAR offers some promise. The possibility exists for coordinating with Dr. McCormick of the NASA Langley Research Center on exploratory LIDAR soundings conducted during the intensive experiment. The NASA LIDAR unit is expected to be operational by next summer (See McCormick(6) for a description of preliminary work). Dr. McCormick hopes to be in California in 1972 during part of our experiment.

With these remarks in mind concerning the achievement of the objectives of this study, the plan for the ARB core experiment is described in the next sections.

3. Design of the Stations

3.1 Fixed Laboratories

In accordance with the original plan, fixed stations in the Los Angeles area and in the Bay Area will be established to provide data throughout the twenty week intensive experiment and will provide data for an exploratory survey during the spring of 1972. It is felt that they should give a reasonably representative picture of aerosol behavior in receptor sites in the two major urban basins.

3.1.1 Locations. The locations of the fixed stations in the Los Angeles area are in Pasadena at the Keck Laboratories of Cal Tech and in Riverside at the air monitoring station of the Statewide Air Pollution Research Center (SAPRC). The Keck Laboratory site has been described in detail in the report by Whitby, *et al*. (7). The SAPRC station is approximately one mile south of the University of California Riverside campus. It is a one story air conditioned building situated at least 100 yards from any public roads. The building is equipped with adequate power and contains several windows and openings for sampling tubes.

Based on conversations with Dr. Feldstein and his staff at the Bay Area Air Pollution Control District (BAAPCD), it has been decided that the best location for the Bay Area fixed station is the BAAPCD monitoring station at San Jose. This station should provide a sample of aerosol representing a mixture of material from local sources, as well as aged particles from other parts of the Bay Area. In a sense it is geographically analogous to the Riverside site. This station is operated quite efficiently by Mr. Max Ahlstrom and is located at 104 W. Alma Street near the San Jose State College campus. This station is extremely well maintained and provides a strong base of operations in the South Bay area. It is situated in an urban light industrial area which is expected to be a receptor for aged aerosol mixed with local emissions in the urban complex of the Bay Area.

3.1.2 Instrumentation. The basic instrumentation for each fixed station is listed in Table 3. The tabulation includes a check list indicating responsibility for the instruments and whether they will be leased or purchased. When the ARB is listed, the equipment will be charged to the ARB contract.

All three fixed stations are somewhat limited in available space. Any special experiments to be conducted, therefore, will be considered carefully; the instrumentation listed in Table 3 will take operational priority over all alternate, special projects.

Table 3

A. BASIC INSTRUMENTATION FOR THE PASADENA STATION

Instrument	Supplier	Remarks
A. Aerosols		
1. GE Continuous Aitken Nucleus Counter	CIT	
2. B&L Optical Counter 0.3-5μm diameter particles	CIT	
3. Royco Model 245 Optical Counter 5-30μm diameter particles	CIT	
4. Thermo-Systems Continuous Mass Analyzer	CIT	Intermittent use
5. MRI Model 1550 Integrating Nephelometer	ARB-NRSC	Lease
6. ERC rotating drum impactor	ARB-CIT	Purchase
7. High-Volume Sampler (NASN type)	CIT	
8. Liquid Water Content (continuous-microwave cavity)	NRSC	Intermittent - space permitting - will be transported to other fixed sites
9. Liquid Water Content (Filter method)	ARB-NRSC	Intermittent - requires 24 hour sample; filter holders built by NRSC
10. Rotary Impactor	ARB-AIHL	Built by Noll; intermittent - alternate between fixed stations
11. Surface Flux Collector	ARB-NRSC	Built by NRSC; intermittent - alternate between fixed stations
12. Weather-Measure Dustfall Collector	ARB-NRSC	Purchase
13. Infrared Impactor	SAPRC-UCR	Minimum intermittent batch sampling
14. 2 Stage Hi-Volume Sampler (organics)	ARB-AIHL	Built by Bryan; batch sampling - alternate between stations

Table 3
A. BASIN INSTRUMENTATION FOR THE PASADENA STATION
(continued)

Instrument	Supplier	Remarks
B. Trace Gases		
1. Beckmann 6800 (Total HC, Non-Me HC, CO)	ARB-CIT	Purchase
2. REM Chemiluminescent NO-NO_2	ARB-NRSC	Purchase (may substitute traditional colorimetric method as alternate)
3. Beckmann Coulometric SO_2	CIT	
4. Gelman Sequential NH_3	ARB-AIHL	Purchase; intermittent sampling
5. REM Chemiluminescent Ozone	CIT	May use Bendix instrument as alternate
6. Gas Chromatography (HC, PAN)	SAPRC-UCR	Intermittent sampling in gas bottles
C. Meteorology		
1. Temperature - shielded silicon diode or thermistor	ARB-CIT	
2. Relative humidity	ARB-CIT	
3. Winds (Speed & direction)	ARB-CIT	
4. Eppley pyrheliometer	CIT	
D. Data Acquisition System	ARB-NRSC	Purchase; see Section 6 for details

Table 3

B. BASIC INSTRUMENTATION FOR THE RIVERSIDE STATION

Instrument	Supplier	Remarks
A. Aerosols		
1. Environment/1 Continuous Aitken Nuclei Counter	ARB-UCR	Purchase
2. B&L Optical Counter	UCR	
3. MRI Model 1550 Integrating Nephelometer	ARB-UCR	Purchase
4. ERC Rotating Drum Impactor	UCR	
5. High Volume Sampler	UCR	
6. Liquid Water Content (continuous-microwave cavity)	NRSC	Intermittent - alternate between fixed sites
7. Liquid Water Content (Filter Method)	ARB-NRSC	Intermittent; filter holders by NRSC
8. Rotary Impactor	ARB-AIHL	Built by Noll; intermittent - alternate between fixed stations
9. Surface flux collector	ARB-NRSC	Built by NRSC; intermittent - alternate between fixed stations
10. Weather Measure Dustfall Collector	ARB-NRSC	Purchase
11. Infrared Impactor	UCR	Minimum intermittent batch sampling
12. 2 Stage High Volume Sampler	ARB-AIHL	Built by Bryan; batch sampling - alternate between stations
B. Trace Gases		
1. Total HC and Non-Me HC, PAN (gas chromatograph)	UCR	Intermittent - regular on 24 hour runs by gas bottle
2. Beckmann 315A-CO analyzer	UCR	Minimum resolution capability for concentrations at Riverside
3. Meloy SO_2 Analyzer (flame photometric)	ARB-UCR	Purchase (may substitute another similar instrument)
4. Gelman Sequential NH_3	ARB-AIHL	Purchase; intermittent sampling
5. Mast total oxidant	UCR	
6. Atlas colorimeter NO, NO_2 (Saltzmann Method)	UCR	

Table 3
B. Basic Instrumentation for the Riverside Station
(continued)

Instrument	Supplier	Remarks
C. Meteorology		
1. Temperature	UCR	
2. Humidity	UCR	
3. Winds (Speed & Direction)	UCR	
4. Eppley Pyrheliometer	UCR	
D. Data Acquisition System	ARB-NRSC	Purchase; see Section 6 for details

Table 3

C. BASIC INSTRUMENTATION FOR THE SAN JOSE STATION

Instrument		Supplier	Remarks
A. Aerosols			
1	GE Portable Aitken Nuclei Counter (PCUC-1)	NRSC	
2	Royco PC210 Optical Counter	AIHL	
3	Continuous Analyzer (COH)	AIHL (BAAPCD)	
4	MRI Model 1550 Integrating Nephelometer	AIHL	
5	ERC Rotating Drum Impactor	ARB-AIHL	Purchase
6	High Volume Sampler	AIHL (BAAPCD)	
7	Liquid Water Content (continuous-microwave cavity)	NRSC	Intermittent - space permitting - alternate between fixed stations
8	Liquid water content (filter method)	ARB-NRSC	Intermittent, filter holders built by NRSC
9	Rotary Impactor	ARB-AIHL	Built by Noll; intermittent - alternate between fixed stations
10	Surface Flux Collector	ARB-NRSC	Built by NRSC; intermittent - alternate between fixed stations
11	Weather-measure dustfall collector	ARB-NRSC	Purchase
12	2 Stage High Volume Sampler	ARB-AIHL	Built by Bryan; batch sampling - alternate between stations
B. Trace Gases			
1	Total HC (Power Design)	AIHL(BAAPCD)	
2	Non-Me HC (Gas Chromatography)	AIHL	Intermittent, sequential by samples
3	Beckmann K75 NO, NO_2 (Saltzmann method)	AIHL(BAAPCD)	
4	SO_2 Analyzer (sequential)	ARB-AIHL	Purchase
5	Gelman (NEI) Sequential NH_3	ARB-AIHL	Purchase
6	Mast Total Oxidant	AIHL(BAAPCD)	
7	MSA CO	AIHL(BAAPCD)	

Table 3
C. Basic Instrumentation for the San Jose Station
(continued)

Instrument	Supplier	Remarks
C. Meteorology		
1. Temperature	AIHL (BAAPCD)	
2. Humidity	AIHL (BAAPCD)	
3. Winds (Speed & Direction)	AIHL (BAAPCD)	
4. Eppley Pyrheliometer	AIHL (BAAPCD)	
D. Data Acquisition System	ARB-NRSC	Purchase; see Section 6 for details

3.2 Mobile Laboratory Design

3.2.1 Design Philosophy. Several criteria have played a major role in shaping the design of the mobile laboratory. Some of these criteria are:

a. The mobile laboratory must meet the requirements of the intensive experiment of this program. The laboratory must accommodate the instruments, equipment, and personnel planned for the intensive experiment and must also be readily moveable without requiring excessive time and effort.

b. The mobile laboratory design must have sufficient flexibility to allow changes, both during the present program and during any subsequent programs. Future pollution measurement programs will undoubtedly use new equipment as it becomes available. The laboratory must be capable of accepting new or different equipment with as little effort and as little modification of the laboratory as possible.

c. Although we plan to build a neat, well-organized laboratory, functional utility must have priority over appearance. A beautiful laboratory which has been modified to make it more functional is no longer beautiful.

d. Within the limitations imposed by other requirements, the laboratory must be built of standard commercial hardware whenever possible. Not only is this less expensive now, but it also results in faster repairs or changes in the future.

3.2.2 Instrumentation. The basic instrumentation planned for the mobile laboratory is listed in Table 4. Essentially the equipment is the same as the fixed stations except the Thermo-Systems Inc. electrical mobility

Table 4

Basic Instrumentation for Mobile Laboratory

Instrument	Supplier	Remarks
A. Aerosols		
1. Environment/1 Aitken Nucleus Counter	ARB-Minn	Purchase
2. Royco Model 220 Optical Counter (0.3-5μm diameter particles)	ARB-Minn	Purchase
3. Royco Model 245 Optical Counter (5-30μm diameter particles)	ARB-Minn	Purchase
4. TSI Electrical Mobility Analyzer (0.0075-0.4μm diameter particles)	ARB-Minn	Purchase
5. TSI Continuous Mass Analyzer	NRSC	(May be deleted if performance tests inadequate)
6. ERC Rotating Drum Impactor	ARB-AIHL	Purchase
7. High Volume Sampler	ARB-Minn	Purchase
8. MRI Model 1550 Integrating Nephelometer	ARB-Minn	Purchase
9. Liquid Water Content (filter method)	ARB-NRSC	Intermittent; built by NRSC
10. Rotary Impactor	ARB-AIHL	Built by Noll; intermittent
11. Surface Flux Collector	ARB-NRSC	Built by NRSC; intermittent
12. Weather Measure Dustfall Collector	ARB-Minn	Purchase
13. 2 Stage Hi Volume Sampler (organics)	ARB-AIHL	Built by Bryan; batch sampling
14. Analytical Balance	AIHL or NRSC	
15. Optical Microscope	AIHL or NRSC	
B. Trace Gases		
1. Beckmann 6800 (Total HC, Non Me HC, CO)	ARB-AIHL	Purchase
2. REM chemiluminescent $NO-NO_2$	ARB-AIHL	Purchase (may substitute traditional instrument-Saltzmann method)

Table 4: Basic Instrumentation for Mobile Laboratory (continued)

Instrument	Supplier	Remarks
3. SO_2 Analyzer (Varian GC-flame photometric)	ARB-AIHL	Purchase (may substitute similar instrument)
4. Gelman sequential NH_3	ARB-AIHL	Purchase; intermittent sampling
5. REM Chemiluminescent ozone	ARB-AIHL	Purchase
C. Meteorology		
1. MRI - Automatic Weather Station a. Winds (Speed and Direction)	ARB-Minn	Purchase
2. Temperature - Rosemont Eng.	ARB-Minn	Purchase
3. Eppley Pyrheliometer (2) 1 ultra violet range, 1 total radiation	ARB-Minn	Purchase
4. Relative humidity (Cambridge 880 dewpoint)	ARB-Minn	Purchase
D. Data Acquisition System	ARB-NRSC	Purchase (See Sec. 6)
E. Miscellaneous and Special		
1. 50 ft. sampling tower	Minn	Intermittent testing

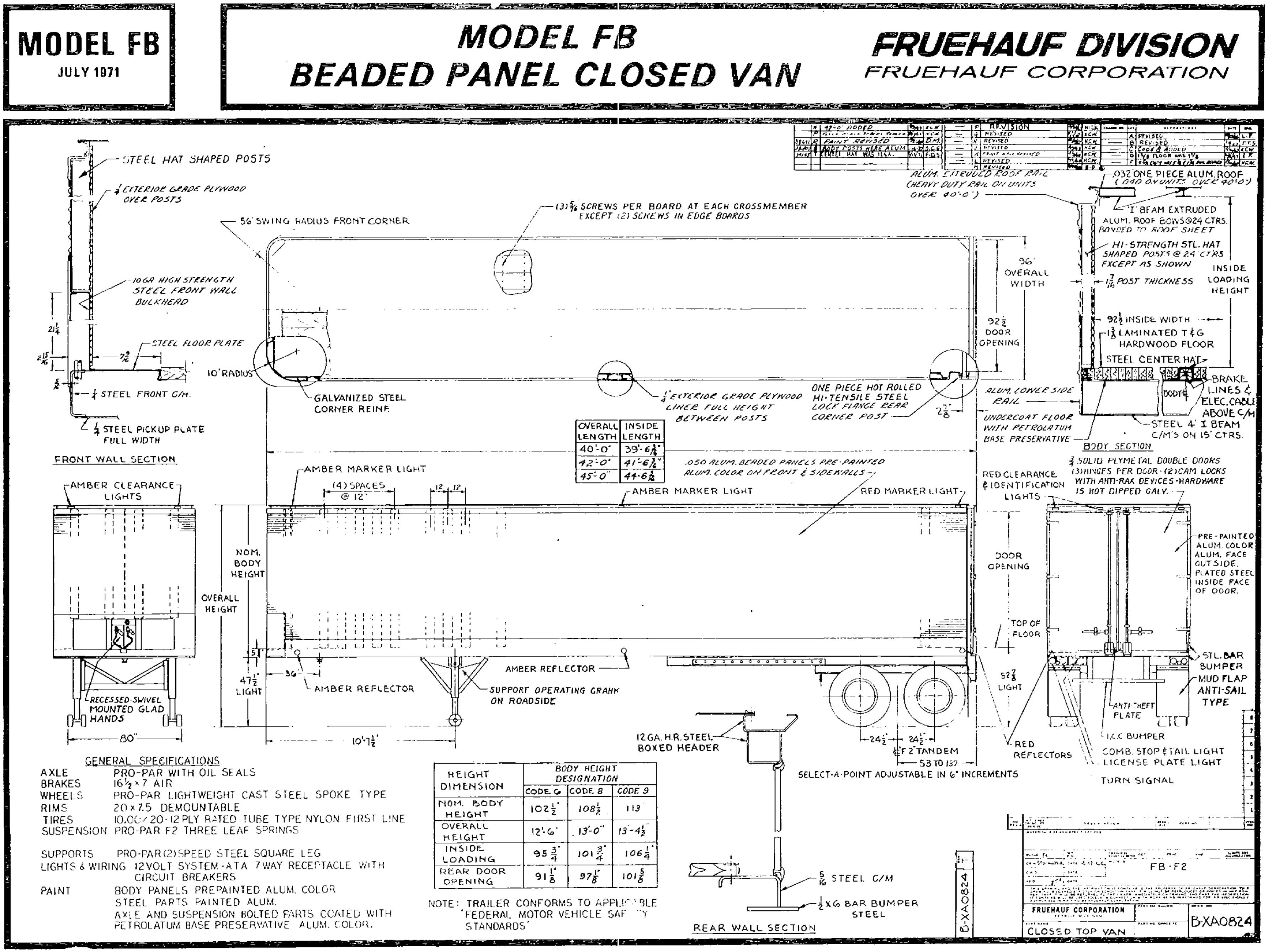
analyzers give a broader coverage of the aerosol size distribution. An extra optical counter is added to optimize the coverage in the large particle range. Also the Eppley pyrheliometer will be supplied with two different wavelength filters to measure solar radiation over narrow bands.

3.2.3 Description of the Laboratory. With the design requirements in mind, we have chosen a standard, commercial semi-trailer as the basic vehicle. A semi-trailer is the most maneuverable vehicle of its size, an important feature in a program which requires frequent relocation of the equipment. The space inside the trailer is more useable than any other commercial vehicle. Trailer manufacturers are experienced in making modifications to suit customers' needs. Such modifications are thus somewhat less expensive than similar modifications in a mobile home. Semi-trailers are rugged, made to withstand the difficulties of highway travel. In addition, a semi-trailer is no more expensive than a similarly-sized mobile home.

The semi-trailer model is the 40 foot Fleet Flyer Beaded Panel Van manufactured by Fruehauf Corporation. Figure 2 shows the overall dimensions and other specifications. The trailer meets all over-the-highway requirements for California. The length and width are the maximum allowable in most states. The height of the basic trailer is 13 feet, which is 6 inches below the California legal limit. The trailer readily connects to most standard semi-tractors.

We will make a number of major modifications to the exterior of the trailer. Figure 3 shows the modified exterior schematic. The modifications include:

- A catwalk will cover most of the roof, making the roof a working



OVERALL LENGTH	INSIDE LENGTH
40'-0"	39'-6 1/4"
42'-0"	41'-6 1/4"
45'-0"	44-6 1/4

HEIGHT DIMENSION	BODY HEIGHT DESIGNATION CODE 6	CODE 8	CODE 9
NOM. BODY HEIGHT	102 1/2"	108 1/2	113
OVERALL HEIGHT	12'-6"	13'-0"	13'-4 1/2
INSIDE LOADING	95 3/4"	101 3/4"	106 1/4"
REAR DOOR OPENING	91 1/8"	97 1/8"	101 5/8

Figure 2 Detailed Manufacturer's Specification of the Basic Trailer

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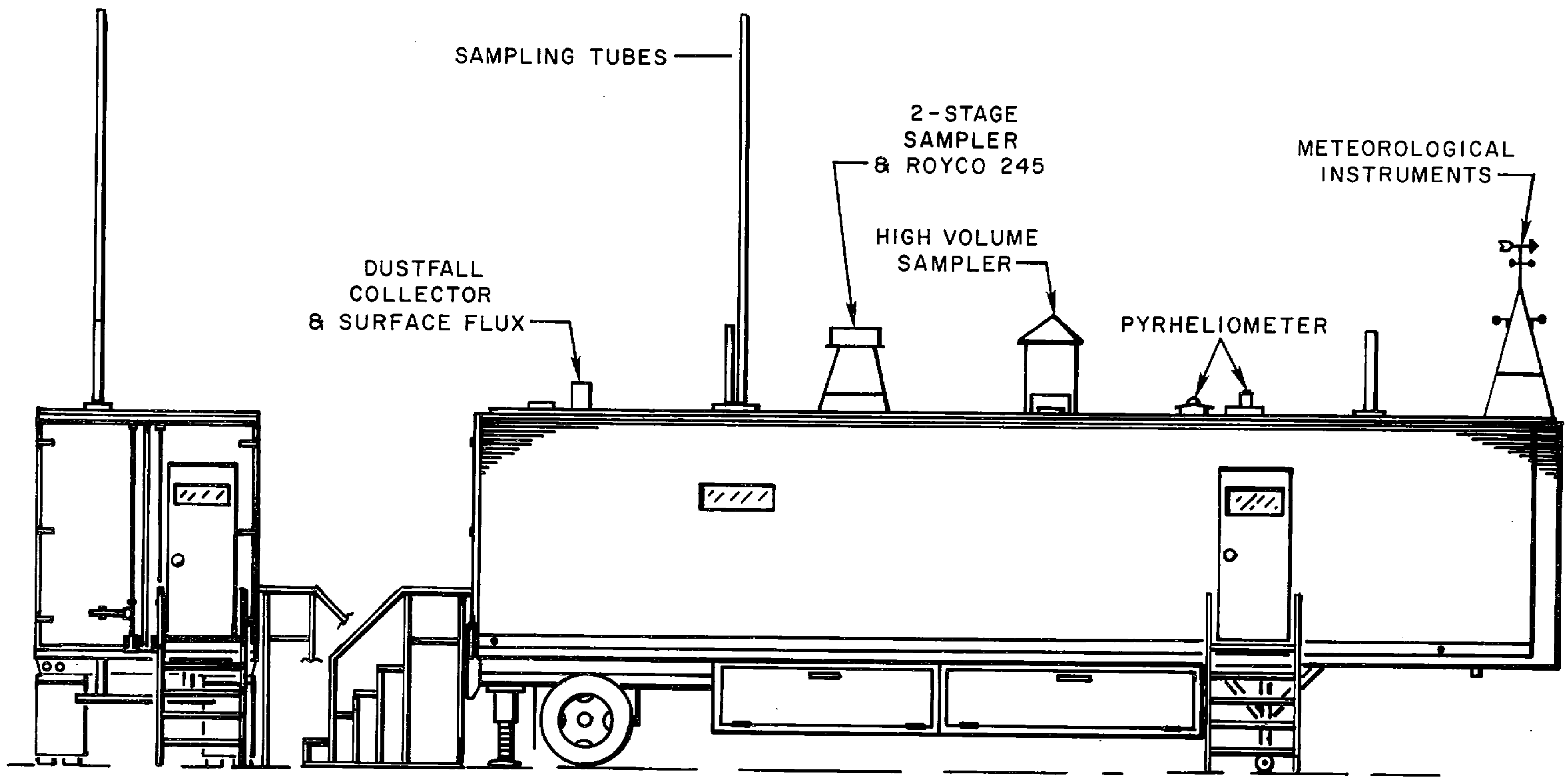


Figure 3 Curbside Exterior View of Mobile Laboratory

platform. The catwalk will extend 2 inches above the standard roof-line, still 4 inches below the legal limit. Much of the equipment which will be operated on the roof will attach directly to the catwalk. The entire trailer will be sufficiently reinforced to carry the additional load of the catwalk and equipment.

- Instead of the double rear axleshown in Figure 2, we will use a single, air-suspended rear axle with dual wheels on each end. A single axle is sufficient since the total load within the laboratory will be less than 5 tons. A single axle also allows about 3 feet of additional space in the under-compartment described below. Air-suspension on the rear axle will reduce the shock on equipment during transport. Previous experience has shown that air-suspension is sufficient to prevent nearly all equipment damage in a trailer such as this.

- A compartment will be installed below the floor of the trailer for transport and storage of miscellaneous equipment such as vacuum pumps, gas cylinders, and water. The under-compartment will be about 2 feet high by 3 feet wide by 20 feet long with doors on the curbe side. It will be installed between the front supports and the rear axle. Ground clearance of the under-compartment will be greater than the clearance of the rear axle.

- Two jacks will be installed, one on each rear corner, to stabilize the trailer when it is at a sampling site. These two jacks plus the front supports should be sufficient to stabilize the trailer under nearly all weather conditions.

- A door will be installed above the supports on the curb side. The door will be 32 inches wide and 6 ft. 8 inches high; large enough to allow equipment to pass through, but small enough to prevent excessive interior temperature fluctuations when operating in cold or hot locations. This door plus the rear door will provide emergency exits near each end of the trailer.

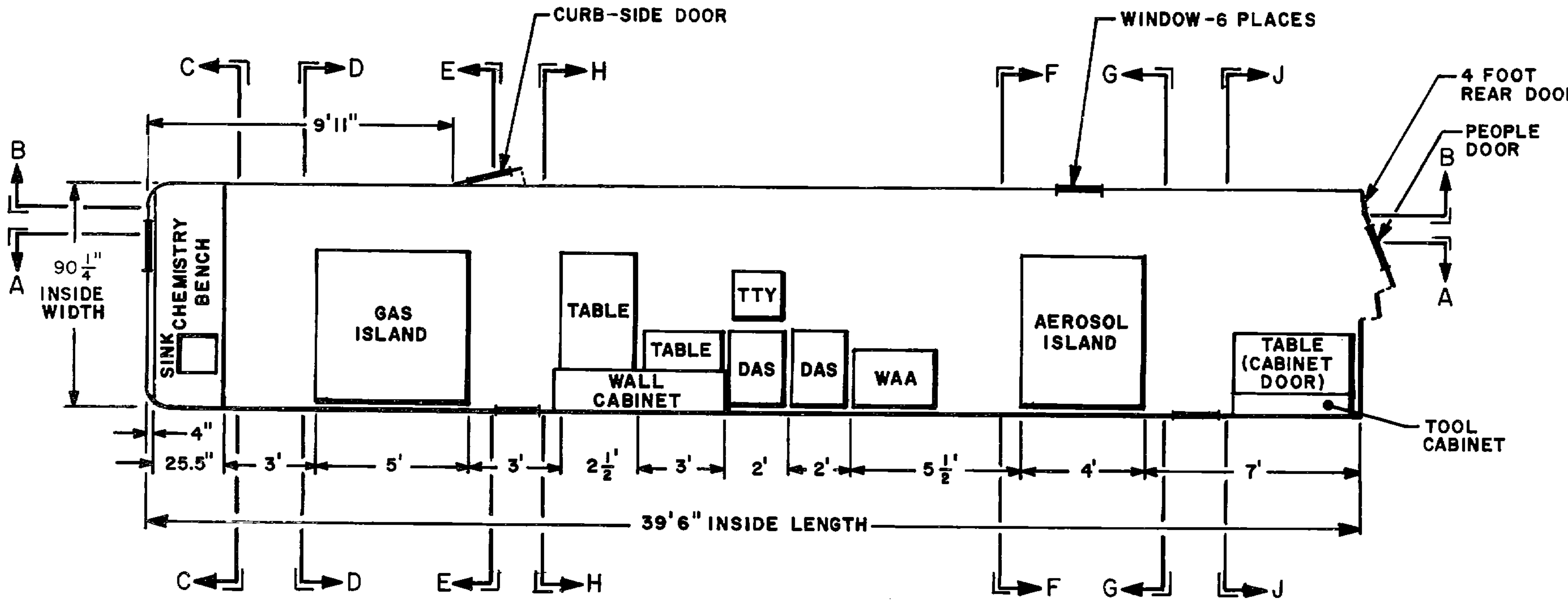
- A smaller door will be installed within the large right rear door. The smaller door will be used for routine entrance and exit by people. The large door will be used only for loading or unloading large equipment. The left rear door will be locked shut except when loading or unloading major equipment.
- Both doors will have suitable stairs, landings, and railings capable of folding flat for transport.
- At least two access ports will be provided through the roof. The ports will be large enough to handle sampling tubes, electrical extension cords, and electrical signal lines. These ports will be located to prevent the necessity of cutting additional holes in the roof at some future date.
- Six combination storm-screen windows will be installed in the walls. There will be 2 on each side and one in each end. The windows will be about 11 inches high by 18 inches long; large enough to allow the operators to see the surroundings, but small enough to prevent unauthorized personnel from entering.

The trailer will be insulated ($1\frac{1}{2}$-2 inches of foam) on all walls, floor, and ceiling. Twin air conditioner/heater units will be installed near the ceiling in the front of the trailer. The capacity of the units is large enough to keep the interior near 75°F with outdoor extremes of +120°F (desert) and +15° (mountains). The use of two identical units rather than a single larger unit has several advantages, including 1) increased reliability, 2) less wear and operating cost by operating only one unit when two are not needed, 3) the capability of operating one unit during transport. The conditioned air will be ducted down the center of the ceiling nearly the full length of the trailer. The two units will be vented through openings in the front wall of the trailer. For operation during transport, one unit will connect to a suitable generator on the tractor.

The interior walls will be finished with light-colored wood or masonite paneling. Logistic rails will be installed to allow equipment to be strapped down during transport. These are identical to the "tie-down strips" used in moving vans. The floor will be heavy-duty vinyl tile over the standard Fruehauf hardwood floor. The ceiling will be made of 3/4 inch veniered plywood paneling allowing some items to be easily hung from the ceiling. All electrical wiring, etc., will be on the outside of the interior paneling allowing modifications to be made quickly and neatly. Lighting will be by incandescent bulbs. Fluorescent lights would give better lighting, but they interfere with some electronic circuits.

Figure 4 shows the floor plan for the interior of the laboratory. Figures 5-13 show detailed cross-sections of the interior. The instrument arrangement may change slightly, but other aspects of the plan are firm.

This layout is different from most mobile laboratories, having an aisle down one side with work stations in the center and on the other side. The reason for this is to separate the traffic areas from the work places. The aerosol instruments will be located on one island arrangement with the gas instruments on another island. Instruments will be facing both forward and backward with some at desk-top height and others on a higher shelf. The rear of all instruments will be readily accessible and no instrument will rest on top of another. Repairs can thus be made without interfering with any other



SCALE: 1"=5'

Figure 4 Floor Plan

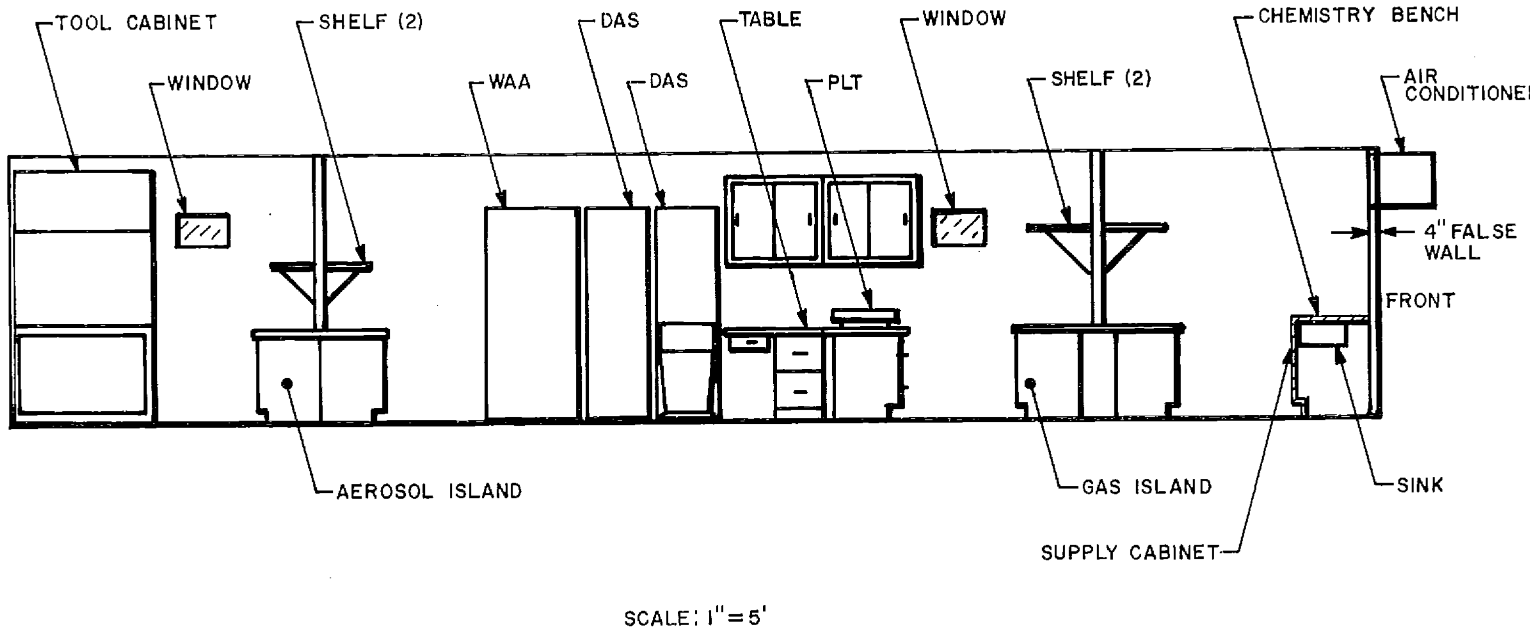


Figure 5 Roadside Wall (Section A-A of floor plan)

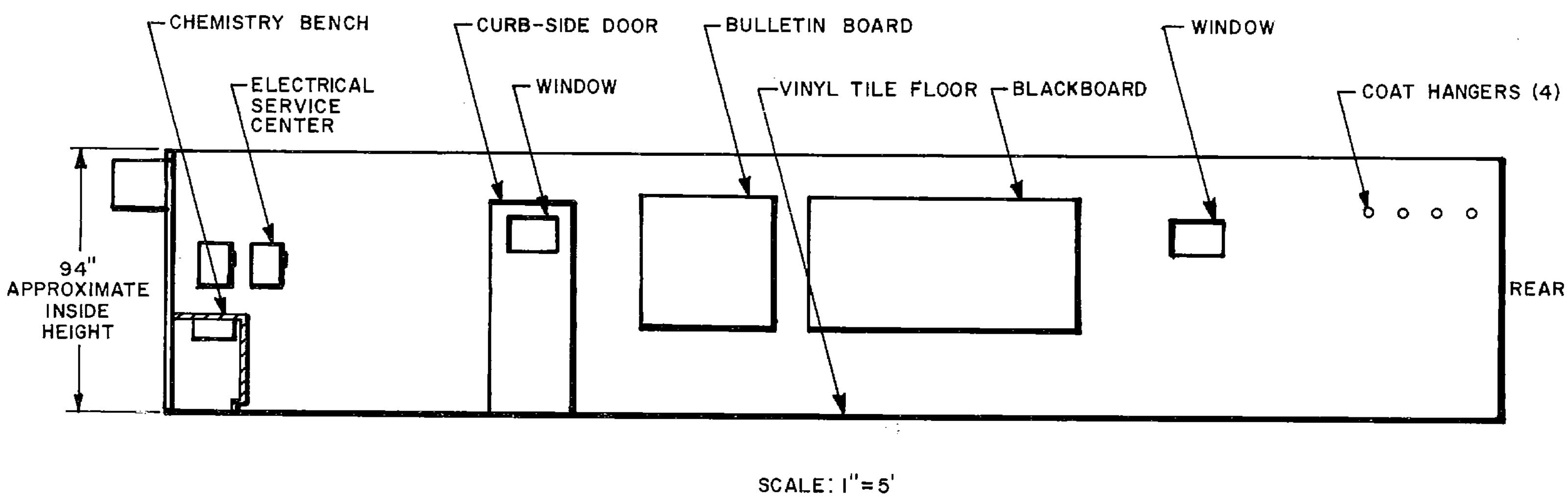


Figure 6 Curbside Wall (Section B-B of floor plan)

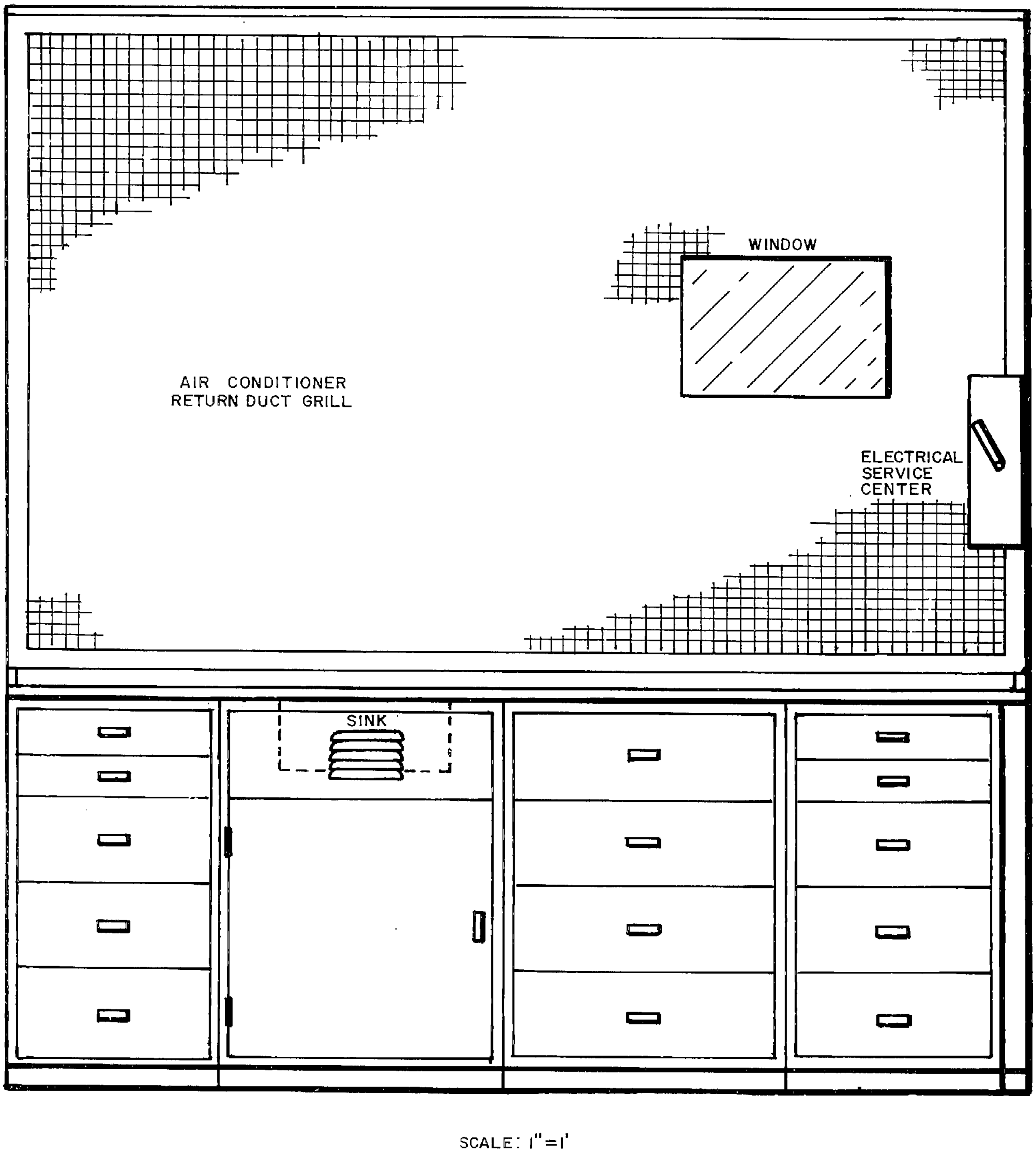


Figure 7 Chemistry Bench and Front Wall (Section C-C of floor plan)

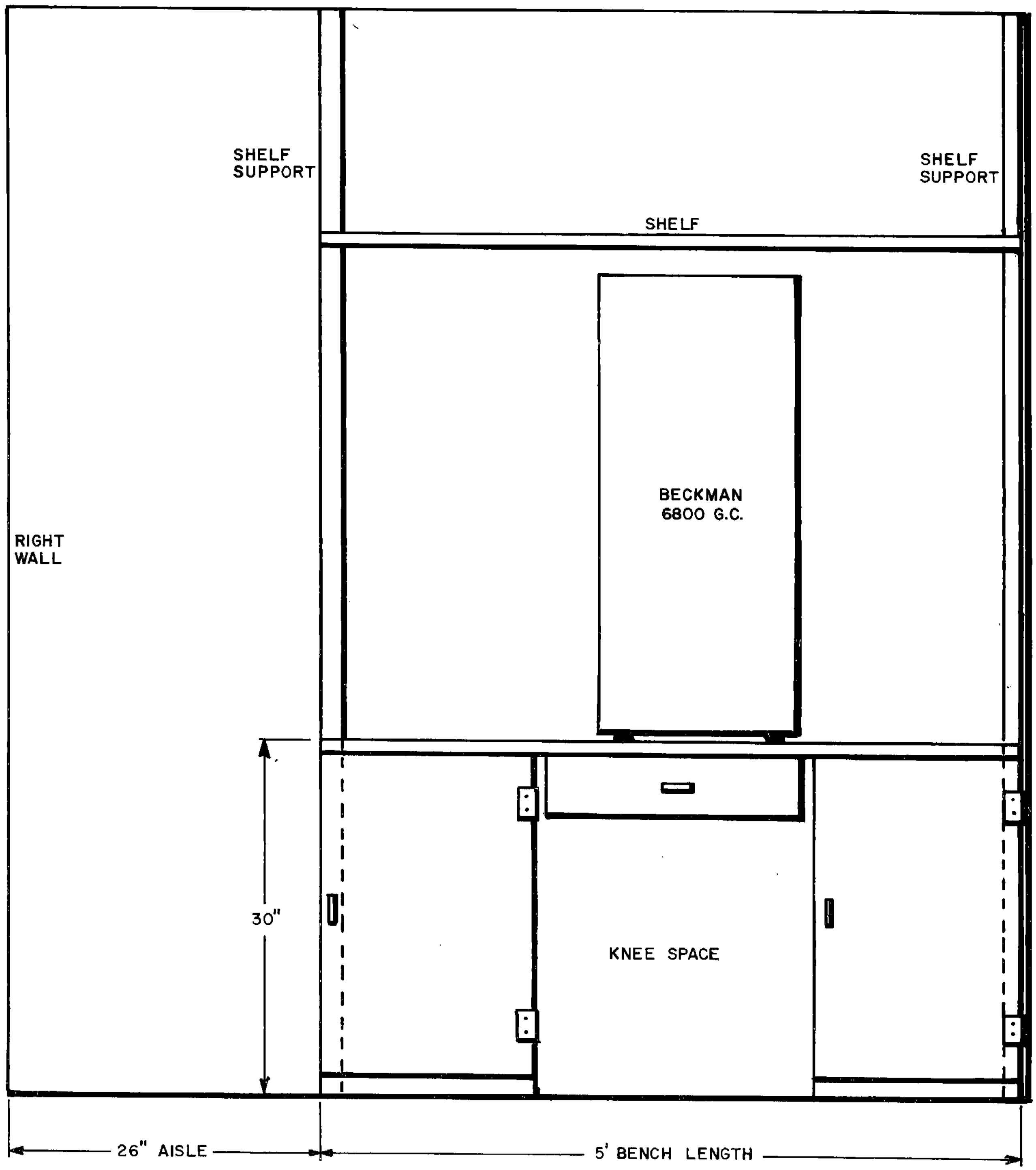
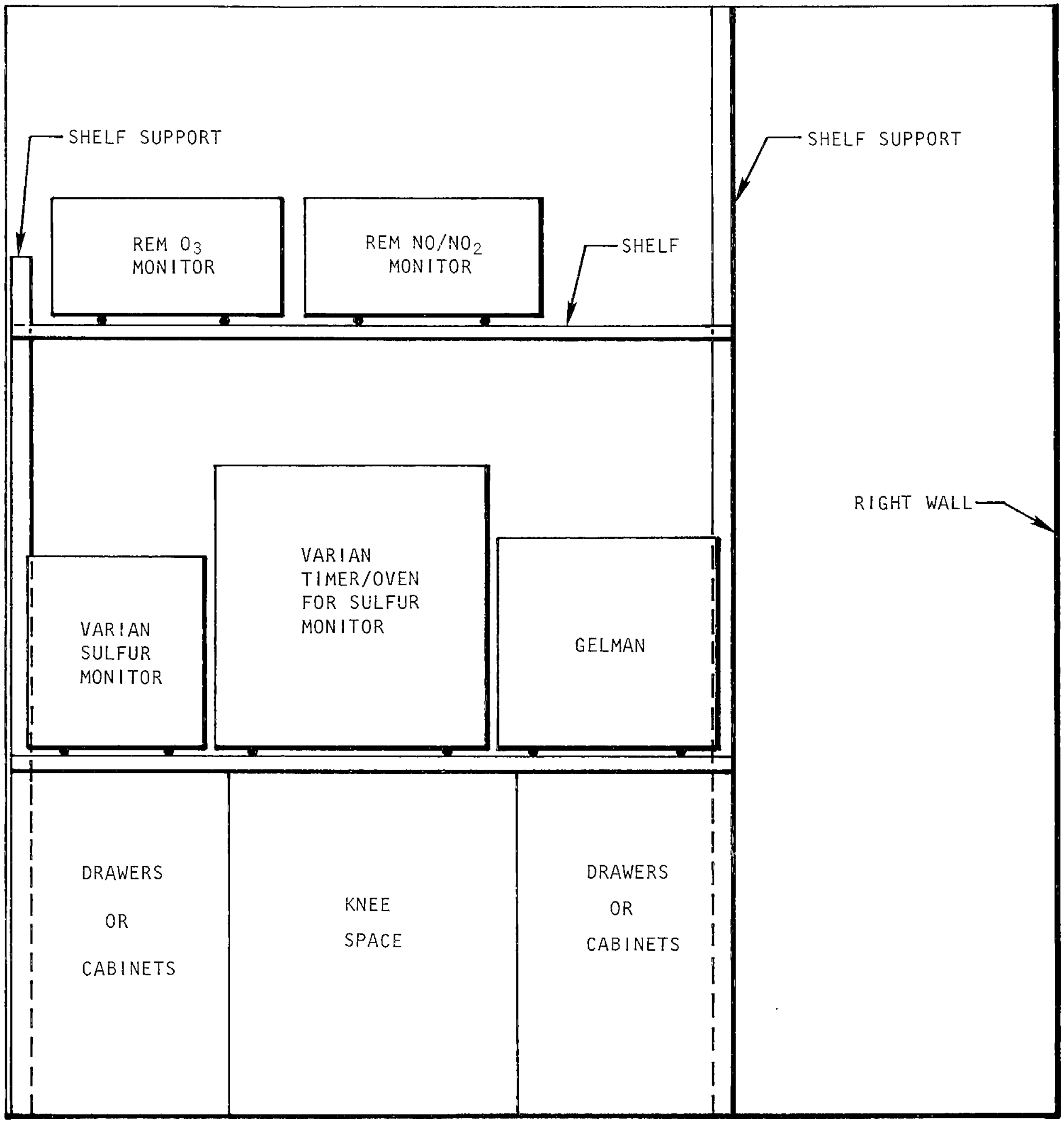


Figure 8 Front of Gas Island Bench (Section D-D of floor plan)



SCALE: 1'' = 1'

Figure 9 Rear of Gas Island Bench (Section E-E of floor plan)

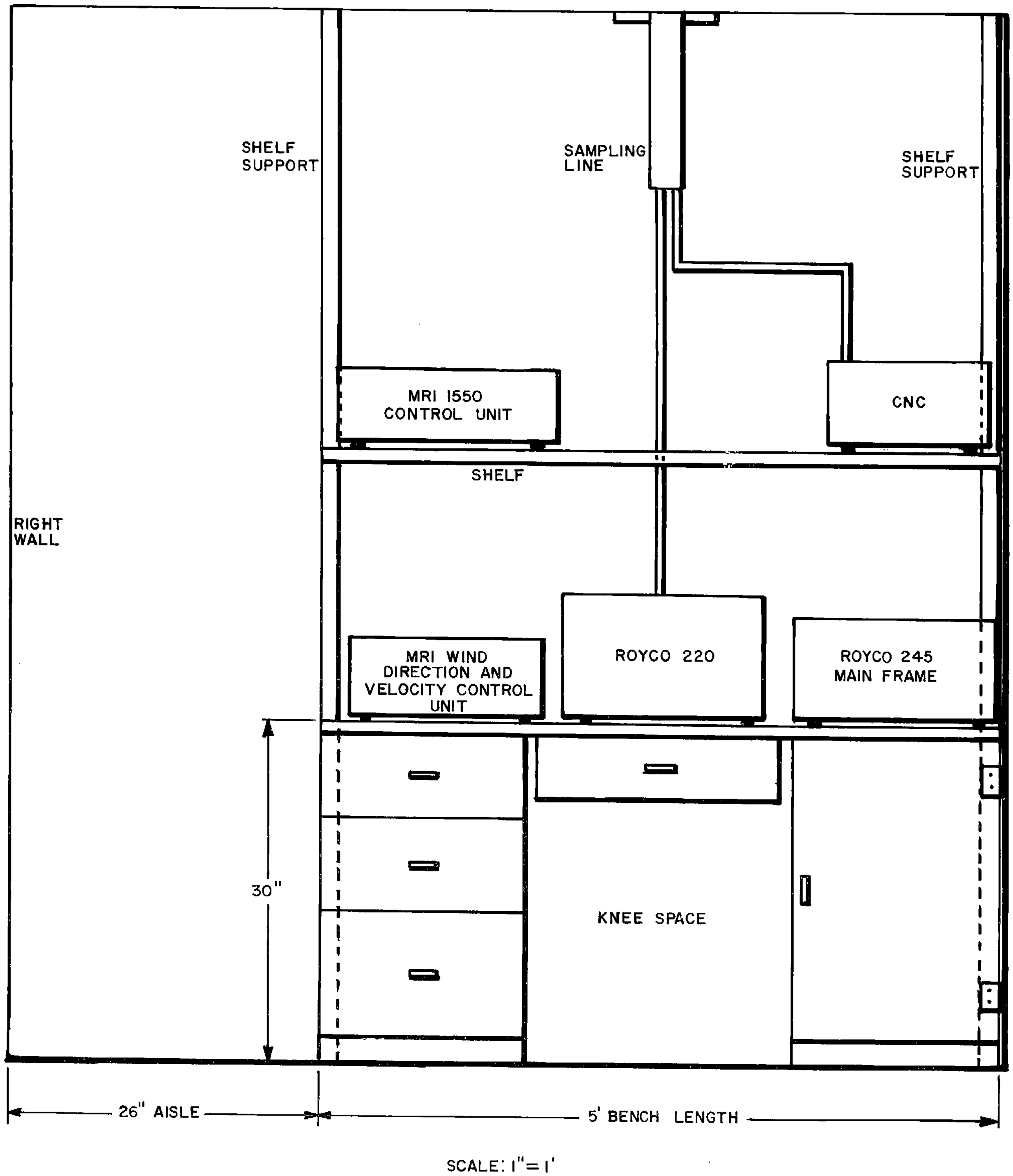
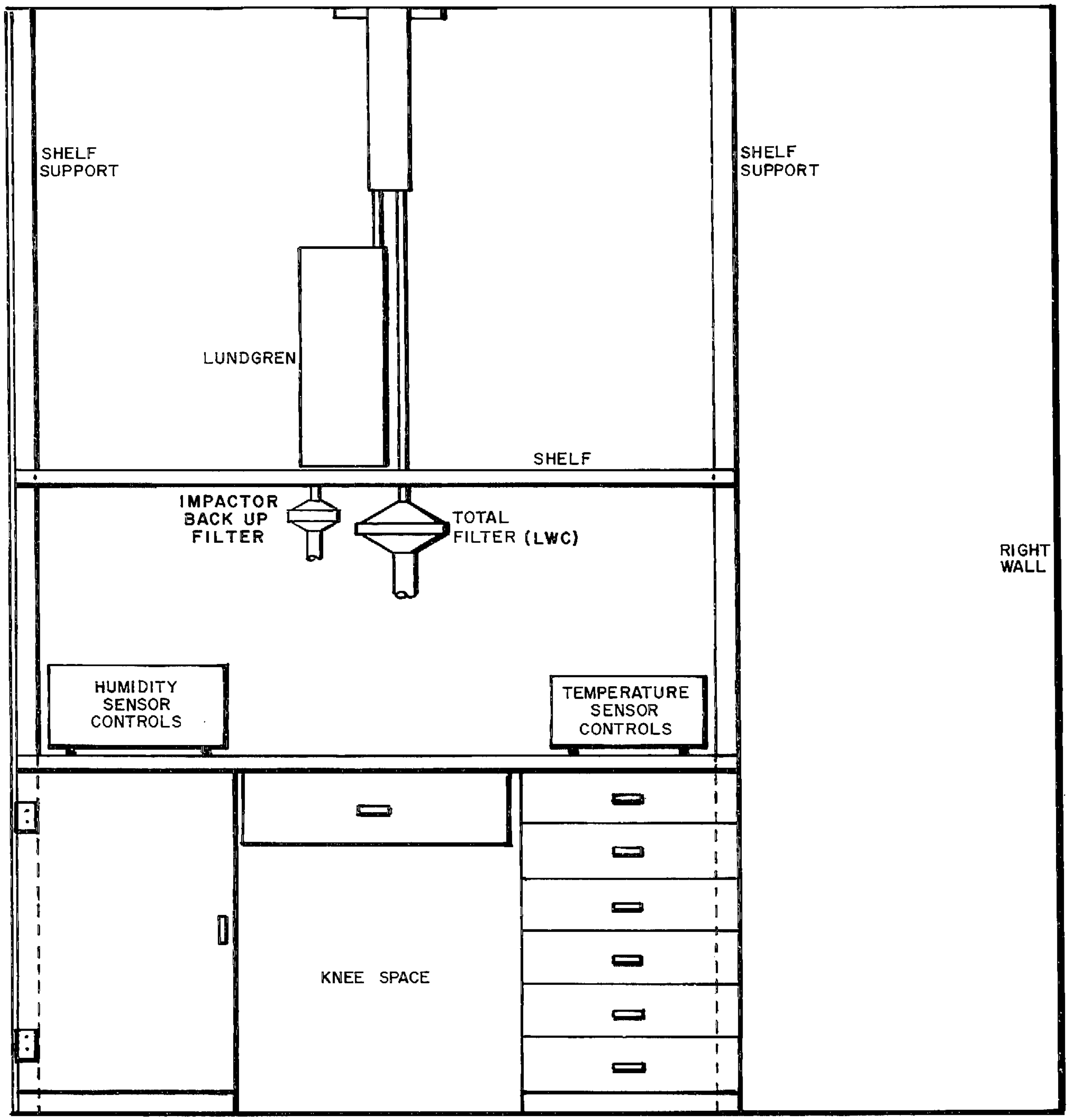


Figure 10 Front of Aerosol Island Bench (Section F-F of floor plan)



SCALE: 1"=1'

Figure 11 Rear of Aerosol Island Bench (Section G-G of floor plan)

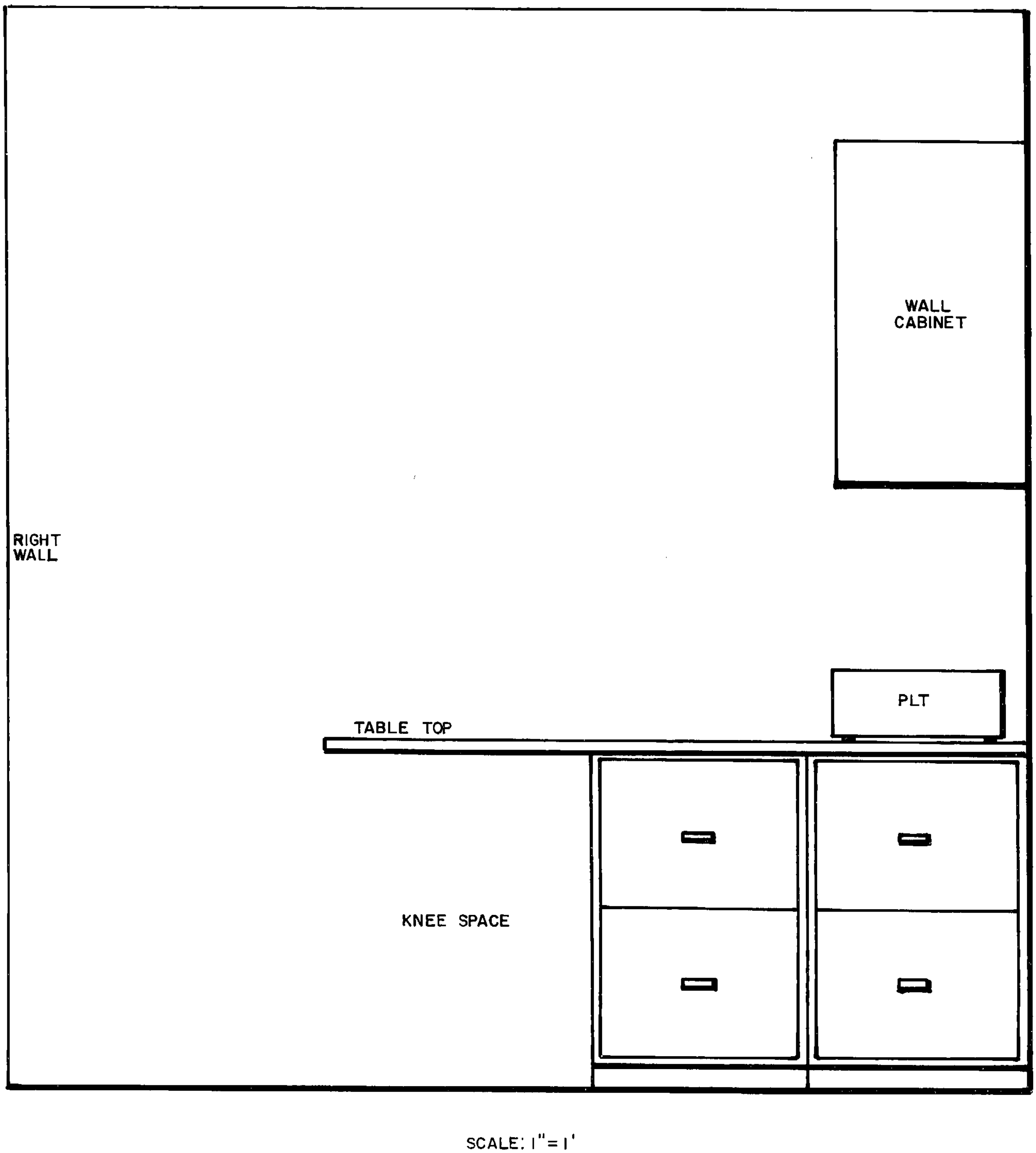


Figure 12 Front of Data Analysis Tables (Section H-H of floor plan)

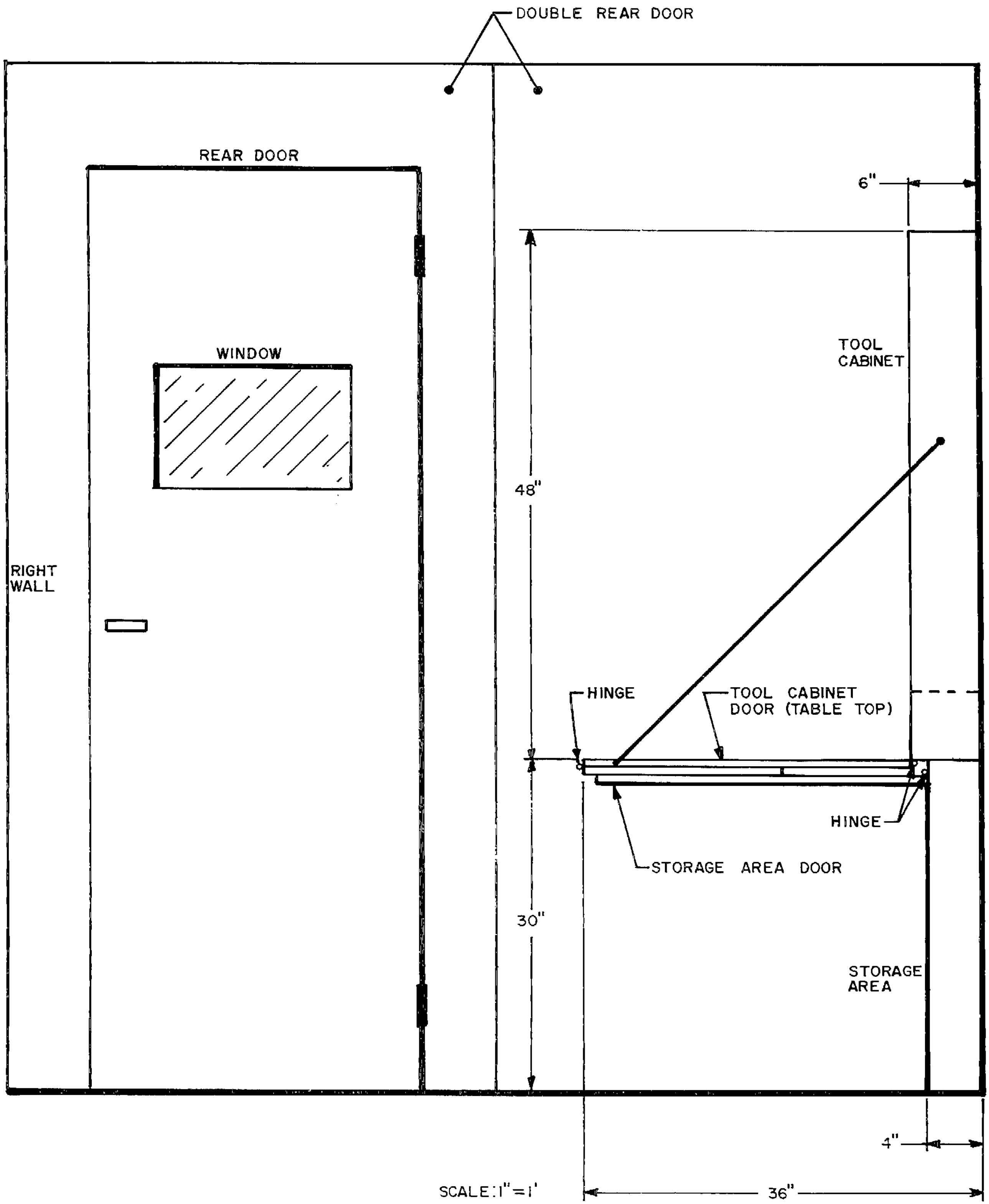


Figure 13 Tool Cabinet and Rear Door (Section J-J of floor plan)

equipment. The operators are out of the aisle making traffic flow much smoother. With some aerosol instruments located on a shelf above others, the loss of large particles can be minimized by making most sampling tubes vertical. The primary sampling tubes will be directly above the aerosol island with secondary sampling tubes above the gas island. Some equipment may be hung on the left wall and electrical signal lines will run along this wall.

The data analysis center with the data acquisition system, teletype, plotter, and tables is located in the center of the laboratory between the aerosol island and the gas island. Both groups of operators have ready access to the system.

The chemistry work bench with a sink is located in the front of the laboratory near the gas island. A work table is located in the rear of the laboratory near the aerosol island. A tool board will be attached to the wall above the rear work table. A blackboard and a bulletin board will be located opposite the data analysis center. The electrical service center will probably be near the front. A fire extinquisher will be hung on the wall near each door. We will place cabinets wherever possible for storage of equipment, instruction manuals, data, etc. The aerosol island, gas island, chemistry work-bench, and data analysis center will have storage drawers below the work level.

All equipment will be strapped (with seat-belt-like material) to the wall or to the island shelves during transport. Small loose items will be placed in the drawers.

Trailer balance is not a problem even with most of the equipment on the left side. The total weight of the trailer and contents is considerably below the allowable design weight of the trailer.

The layout of the equipment on the roof (Figure 14) is tentative and is shown here to convey the general scheme. We will install at least 2 access ports (see Figure 15) through the roof for sampling tubes, electrical power lines, electrical signal cables, etc. They will be located above the aerosol island and above the gas island. A small tower (6-12 feet) will hold equipment such as wind velocity and direction sensors, relative humidity or dew point sensor, ambient temperature sensor, and the large particle optical particle counter. Other equipment on the roof will be a solar radiation detector, a dust fall monitor, a rain gauge, and a high volume particle sampler. This equipment will be located to minimize the chance of contaminating the aerosol and gas samples. Most of the equipment will be carried in the under-compartment during transport.

There will be two sampling tubes above the aerosol island: one extending about 5-10 feet and the other about 30 feet above the roof. Both will be light metal tubes with flanges at the roofline for rapid setup. The 30-foot tube may require guy wires. The tubes will be vertical and have smooth walls to reduce particle losses. A separate blower will maintain a relatively high flow rate through the sampling tube to reduce particle losses, to reduce the response time of the system, and to allow any or nearly all instruments to be shut off without strongly affecting the total sampling rate through the tube.

Figure 16 shows a preliminary design for the lower end of the sampling tubes. The aerosol instruments, particularly the large particle monitors and samples, must sample as nearly vertically downward as possible. The inlet tubes of all the aerosol equipment will protrude upward about 10-

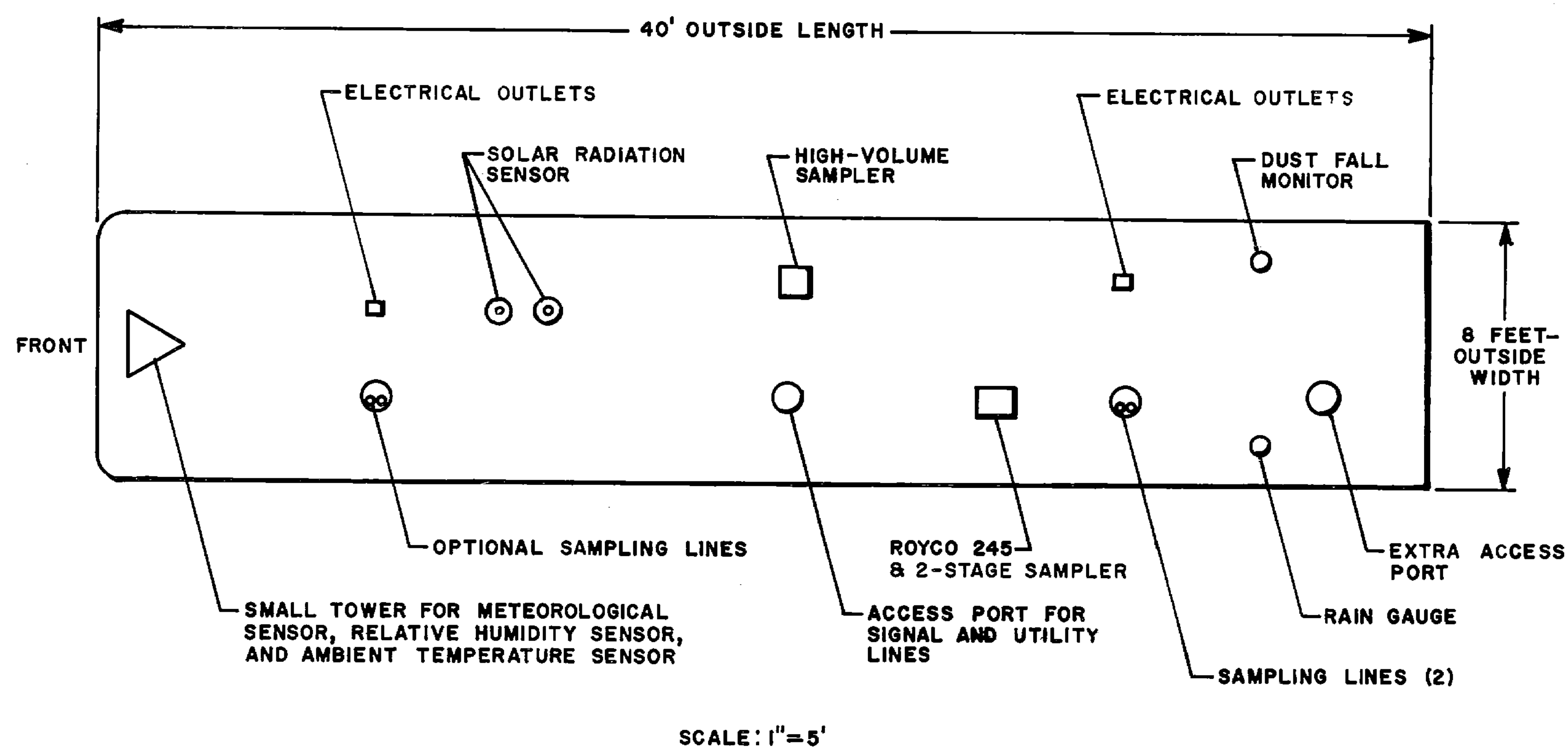
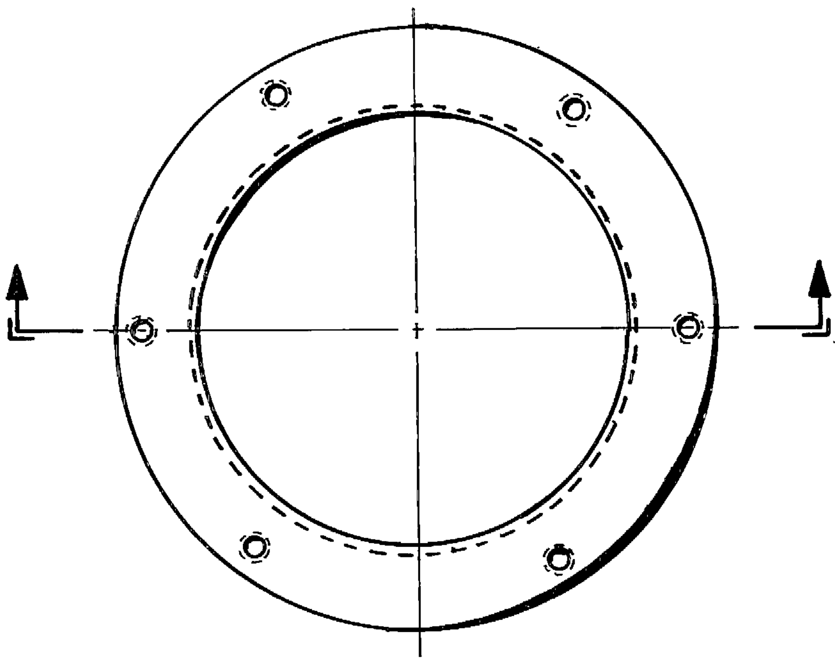


Figure 14 Roof Plan



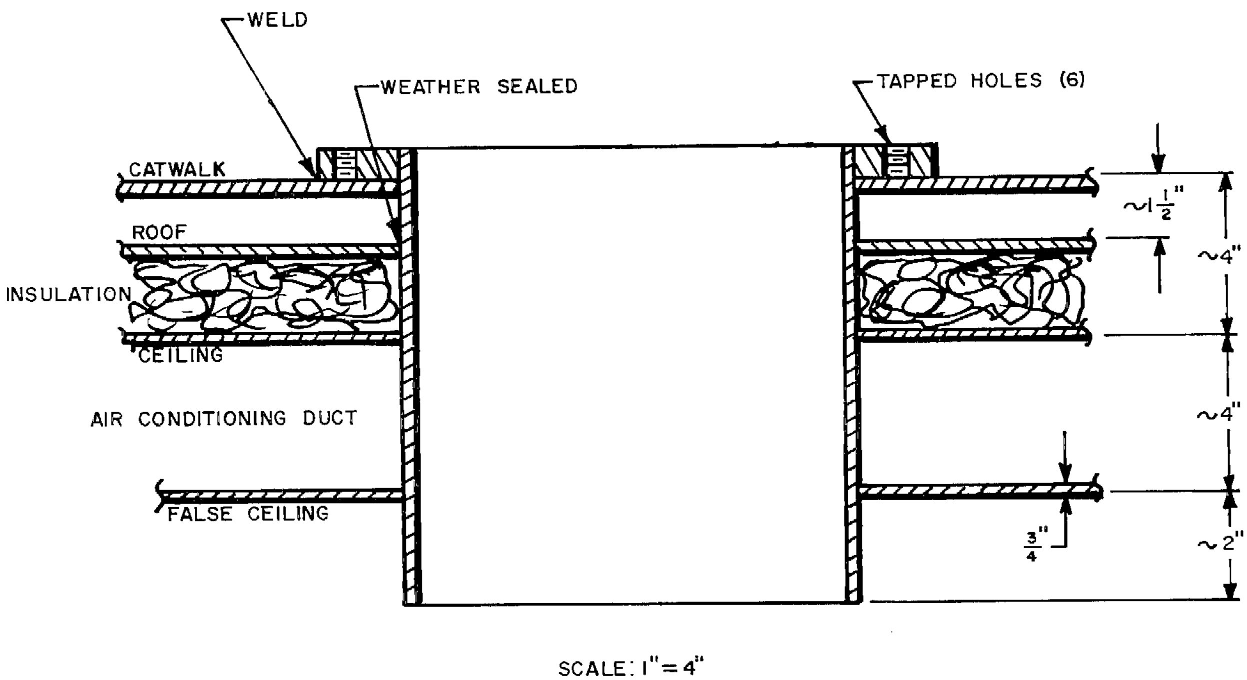


Figure 15 Roof Access Port

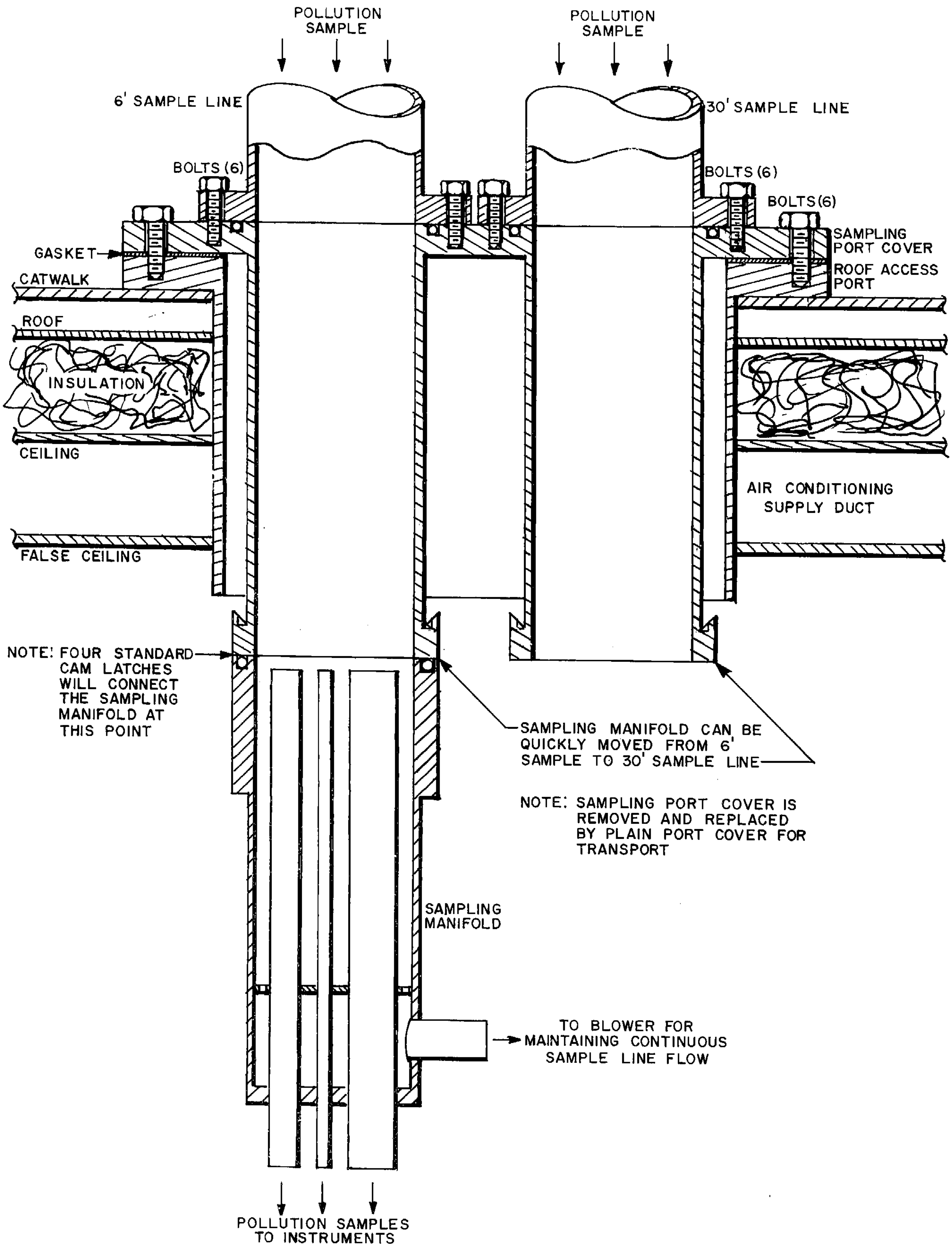


Figure 16   Tentative Design for the Sampling Manifold

12 inches into the vertical sampling tube and will sample approximately isokinetically at that point. The manifold section will be quickly removable so that the operator can switch from the 6-foot to the 30-foot sampling tube with no delay. This is a very important part of the mobile laboratory. Although the design shown in Figure 16 has not been finalized, it is probably a close approximation to the end model.

We plan to provide electrical circuitry for 200 amperes of 230-volt 2-phase power. We will probably provide a main connection-fuse box (weatherproof) on the exterior of the trailer so that the power company can connect directly. We will then provide a circuit breaker service center with separate circuit breakers as shown in Figure 17.

A bus-bar system will supply power to most of the instruments and auxiliary equipment. The bus-bar system offers maximum flexibility of circuit location and consists of a busway carrying 120 amperes at 115 volts running the full length of the trailer near the ceiling. Separate fused circuits (which will be supplied) may be plugged into the busway at any point on its length. If all the circuits are needed at one or two locations within the trailer, all the circuits can be plugged into those locations. If the location of major power usage changes at some later date, the same circuits can be plugged into the busway at the new location. The exterior of the busway is electrically grounded. The busway system has been widely used in laboratories and manufacturing buildings in the past and meets National Electrical Code and Underwriters Laboratory standards.

Communications to and from the mobile laboratory have not been settled at this time. Our first choice is a mobile telephone. However, there are complications with moving the laboratory into areas covered

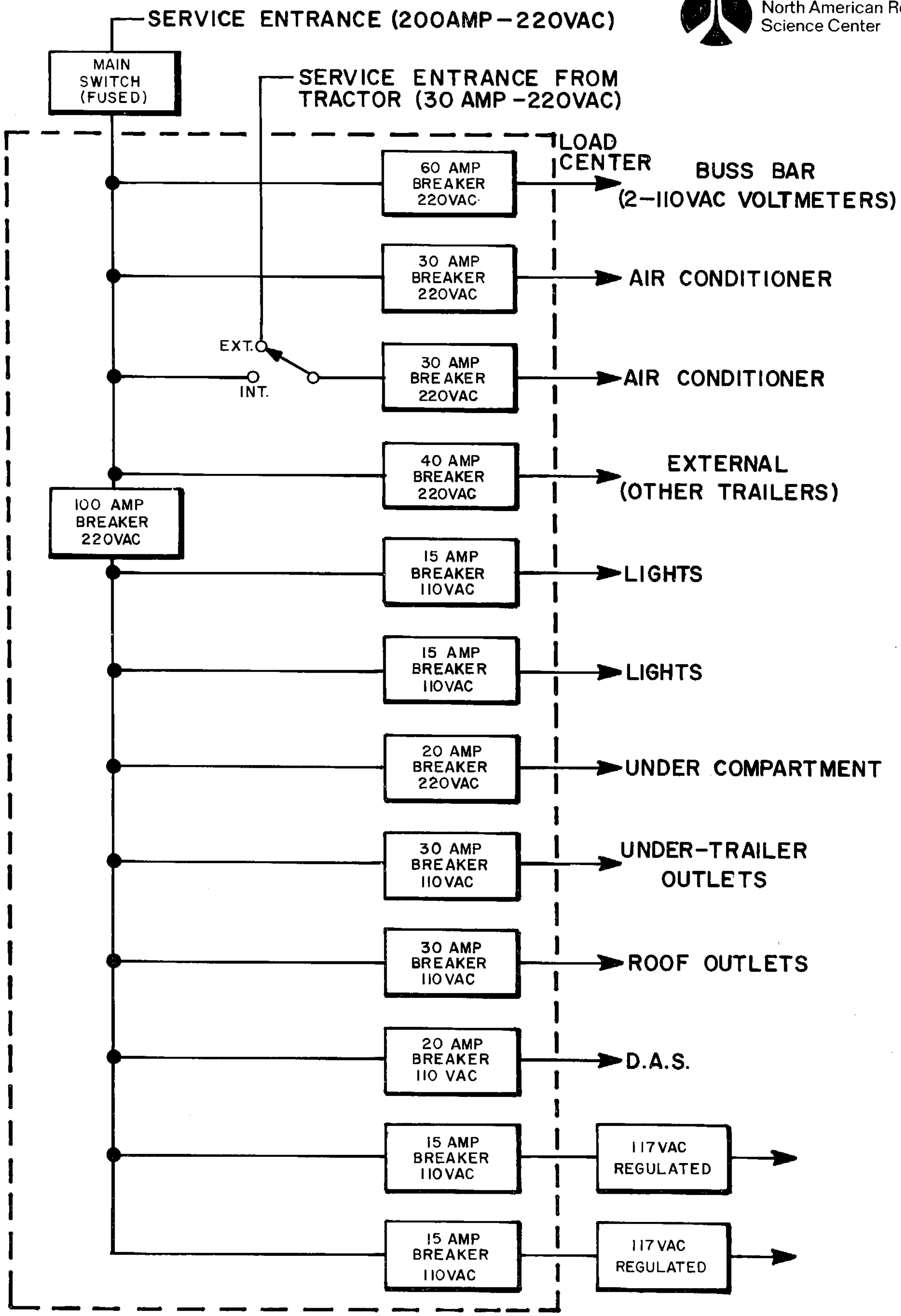


Figure 17 Tentative Electrical Block Diagram

by different telephone companies during the experiment. There also may be locations that are inaccessible to radio-telephone communication. The communications logistics must be reviewed with the telephone companies, and the alternative of a direct drop line hook-up at each site, with cost trade-offs, has to be evaluated before commiting to the system best suitable to our needs. This can be completed once the site route for the mobile laboratory is approved by the ARB.

3.3 Special Considerations

The University of Washington (UW) now plans to operate its nephelometer van during portions of the intensive experiment, tentatively set between August and November. Their program is sponsored partly under the ARB contract and partly from a grant from EPA to Dr. Charlson. ARB approval for coordination of this activity with EPA will be a point of discussion at the Experimental Design Review. Because of the increased mobility of the UW van, we now expect to have it located at the fixed sites and some of the mobile laboratory sites during the intensive experiment.

The instrumentation planned for the UW van is listed in Table 5. This unit is expected to supply us with limited four-wavelength nephelometer data, as well as intermittent data for the nephelometer response to relative humidity variations.

Because of the importance of the broad band nephelometer data to our objectives, each station must have an operating instrument. During period when the UW van is located at Cal Tech, the mobile laboratory and the fixed stations will be supplied with a MRI Model 1550 broad band integrating nephelometer.

It is desirable that direct visibility measurements be taken by observers, at least at the fixed stations, using the existing ARB method-

Table 5

INSTRUMENTATION FOR UNIVERSITY OF WASHINGTON TRAILER

	Instrument	Power Requirements	Outputs
1.	Multiwavelength Nephelometer	300 watts max.	4 channels log b_{scat} (-05 volts) vs. time 3 difference channels vs. time
2.	One or two regular nephelometers	200 watts max.	log b_{scat} (0-5 volts) vs. time
3.	CN Counter (old, big GE)		
4.	Humidity controlled nephelometer	1000 watts	two minute sweeps from 20-90% RH
5.	Data system		
6.	Other instruments, electric heat, pumps, etc.	2 KW max.	not known as yet
7.	Air conditioning	2 KW max.	

ology. Such observations should be invaluable in testing the instrumental measurements available at each site. Therefore, it is planned to set up a series of identified targets at each fixed site where observations by human eye can be made during the intensive experiment. Appropriate personnel will need training in these procedures. Such training will be conducted during the preparation phase.

4. Selection of Mobile Laboratory Sites

Considerable effort has been devoted to the review of choices for the sampling sites of the mobile laboratory. Three practical constraints are placed on this selection at the outset: first, one must have at least one week in a site to achieve measurement of any meaningful data; second, a shakedown period of two weeks will be required to accomplish the acceptance tests, and third, experience gained during the operation of a field laboratory in Denver indicates that as much as one week may be required for transporting and preparing the mobile laboratory for operations. Because of the additional constraints of budget and time, the intensive experiment cannot begin before mid-July 1972 and must end before January 1973 to meet the requirements of data processing and interpretation. Therefore, sampling can be conducted at only twelve sites in addition to the acceptance test site during the period from mid-July to the end of December.

To best achieve the objectives of the study, it is felt that the twelve sites should be divided equally between the three major basins and those areas representing marine, desert, and vegetation enriched backgrounds. Furthermore, it is recognized on the basis of our aerometric evaluation that there are certain crucial sampling periods that will give us the highest probability of measuring conditions of greatest pollution in the three basins.

4.1 Los Angeles Basin

The Los Angeles Basin is a very large geographical area with many different representative pollution locations. The prevailing winds much of the time are from the west or southwest. The historical data indicates that most of the year at least a moderate degree of photochemical smog formation can be expected, with the primary emissions of aerosols being linked, to an appreciable extent, with automobile emissions, SO_2 and NO_x from sources like the auto and power plants, SO_2 from chemical plants, carbon from aircraft, plus a variety of miscellaneous stationary sources. The major natural sources for particles is believed to be the marine (offshore) background as well as blowing soil dust.

Because of substantial amounts of materials like organics, sulfate, and nitrate observed in the Los Angeles aerosol, it is believed that secondary formation of particles and in situ visibility changes associated with air mass (and aerosol) aging are crucial, and perhaps unique to this basin. Thus, it is desirable to conduct sampling on a west-east (or downwind) orientation in order to follow transitions from source enriched sites on the west to receptor sites to the east. With these factors in mind, and with consideration of the fixed (receptor) sites at Pasadena and Riverside, three Los Angeles basin sites have been selected. These are:

1)	El Segundo (NR facility at Douglas Street south of Sepulveda)	Source enriched - marine, refinery-chemical, and power plant (Scattergood)
2)	Downey (NR Space Division)	Receptor - general industrial - residential area south of Pasadena
3)	Downtown - Department of Water & Power Building parking lot	Source enriched - automobile near interchange of Harbor, Pasadena, and Hollywood Freeways

An alternate site for Downey is Anaheim (either at the NR-Autonetics facility, or at the Department of Water and Power Processing Plant near La Brea Canyon). An alternate site for the Department of Water and Power Building is the AAA building near the Harbor Freeway.

The El Segundo site is directly downstream of a major refinery and the Scattergood power plant. It is desirable to sample at this location between November 12 and 25 to observe a possible change from natural gas burning to fuel usage at the power plant.

All three of the sites offer satisfactory security, are located with black top or concrete surroundings, and should be accessible to power.

4.2 The Bay Area

From the survey of the Bay Area aerosol conditions, this area has less of a particle pollution problem (mass concentration and visibility reduction) despite higher estimated emissions than the Los Angeles basin. There are two seasonal conditions that are prevalent in the Bay Area, which should be sampled. The first is photochemically enriched during the summer and early fall, and the second is mainly controlled by primary emissions in late fall and early winter. The latter appears to give more visibility problems because of more tendency for air stagnation and stronger inversion conditions late in the year. The zone of maximum oxidant concentration has been identified by the BAAPCD in the Livermore, Fremont, and San Jose areas. In general, the mass concentrations of particles and the visibility degradation is worse on the east to south sides of the Bay.

With these considerations in mind, and with a fixed station in San Jose (photochemical-urban), the following mobile laboratory sites have been chosen:

1)	Hunters Point (Naval Shipyard)	Receptor of downtown San Francisco primary emissions and industrial activity across the Bay
2)	SFO Airport (Foster City)	Receptor and aircraft source enriched
3)	Albany - Richmond (Golden Gate Fields Race Trace)	Receptor - industrial enriched

Alternate sites for (2) and (3) are the Oakland Airport (aircraft enriched) and Livermore (photochemical)

4.3 The San Joaquin Valley

The information available concerning the nature of aerosol pollution in the San Joaquin Valley is very limited. However, it appears that most of the visibility reduction and high mass concentrations have been recorded in the eastern and southern portions of the Valley. Like the Bay area, there are two different seasonal conditions that should be sampled in the Valley. The first involves a photochemical pollutant enrichment in summer and early fall, with highest oxidants observed east of Fresno, for example, in Visalia. The second is an agricultural burning period through mid-to-late fall. On this seasonal change a continuous dust and particle production from the petroleum industry, mineral production, and from automobiles is superimposed. An intense fogging condition also develops in early winter that is of interest in connection with its relationship to aerosols in the Valley.

The mobile sites that have been selected are as follows:

1)	Bakersfield (Kern County Fairgrounds)	Aged aerosol and local enrichment from agricultural and petroleum production. High recorded mass loadings.
2.	Fresno - Visalia (e.g., County Fairgrounds, Fresno State College, or ARB Visalia Station)	Photochemically enriched in late summer with agricultural and mineral industry.
3)	Fresno (e.g., County Fairgrounds, APCD station south and east of Fresno)	Late fall - winter agricultural burning receptor with possible dense fog conditions (non-urban)

An alternate to the Bakersfield urban site is a County APCD station near a bird sanctuary about five miles northwest of the city. An alternate to the late summer stop in Fresno may be a station at Stanislaus State College in Turlock, in consideration of the geographical heterogeneity of the Valley.

4.4 Background Sites

From independent work, there is increasing evidence that the offshore aerosol background will be quite different in Los Angeles as compared with the Bay Area. Experimental observations on San Nicolas Island indicate that the background offshore of Los Angeles is a highly complicated mixture of material of marine and continental origins. The aerosol entering the LA area is expected to be such a mixture, as a result of meso-scale stirring of air masses from over the Pacific Ocean, as well as eddying south of Pt. Arguello. On the other hand, the offshore component of the background entering the Bay area appears to be more marine dominated. However, high volume filter data taken by the BAAPCD shows a strong difference northwest to southeast across the Bay in contributions of soil dust vs. sea salt of the estimated background. The marine aerosol site for the mobile station has been chosen near the Bay area, tentatively at Pt. Reyes. Some additional information about the offshore background entering Los Angeles is expected from data taken at the El Segundo site.

In anticipation of potential heterogeneities in the offshore component of the natural background, we may require limited hi-volume filter or impactor samples at shore locations during the twenty week study. These will be arranged by the Principal Investigator in support of the intensive sampling operation of the mobile laboratory and the fixed stations in the Bay area and the Los Angeles area.

The desert background is not expected to vary appreciably in the absence of penetration of polluted air, except under changes of wind speed or gustiness. Therefore, we expect that only one week of sampling will be required on the desert. Based on our preliminary site survey, the CIT-Jet Propulsion Laboratory operated Goldstone Tracking Station near Barstow is ideally suited to our needs and has been selected as the desert aerosol site.

The last background contribution of concern is the aerosol generated from hydrocarbon emissions of vegetation. Such aerosols are believed to come from photochemical reactions involving terpene compounds, in a way that is similar to smog formation. Thus any attempt to characterize material coming from vegetation will require a remote site free of any influence except other natural background, and sampling at a time of year for more intense photochemical activity; i.e., late summer to early fall.

During the preliminary site survey, we examined the San Gorgonio wilderness area, Big Sur and Big Basin. The first was unsuitable because the campgrounds accessible to us had too much open burning to be reliable. Our first choice is now the Hunter-Liggett Military Reservarion just east of Big Sur. If this is unsuitable, we shall look at sites near Mineral King wilderness area or in Sequoia National Park. These latter choices are less ideal because of the eastward flow of polluted air into the Sierras from the San Joaquin Valley.

4.5 Summary of Site Selection and Scheduling

The aerometric evaluation of the three major basins has focused our attention on a list of first choices for the mobile laboratory. The twelve sites which have been selected are shown in Table 6 along with the sampling schedule. The time period is shown in the first column on the left. The site location is given in column two, and remarks are shown in

Table 6

SITE ROUTE FOR THE MOBILE LABORATORY

			Alternates	
	1	Remarks	2	3
July 15-30	Berkeley-AIHL	Acceptance tests	CIT-LA	CIT-LA
Aug. 1-7	SFOAP	Aircraft enriched	Fresno	Downey
8-13	SFOAP	Aircraft enriched	Fresno	Downey
15-21	Hunters Pt.	Urban-industrial	SFOAP	Fresno
22-27	Hunters Pt.	Urban-industrial	SFOAP	Fresno
28-Sept. 4	Fresno-Visalia	(Photochem. -	Hunters Pt	SFOAP
Sept. 5-11	Fresno-Visalia	(Agricultural	Hunters Pt	SFOAP
12-18	Hunter-Liggett	Vegetation	Hunter-Liggett	Hunters Pt
19-24	Freeway Loop	Auto enriched	Downey	Hunters Pt
25-Oct. 2	Freeway Loop	Auto enriched	Downey	Pt. Reyes
Oct. 3-9	Downey	LA Photochemical (Receptor)	Freeway Loop	Hunter-Liggett
10-16	Downey	"	Freeway Loop	Freeway Loop
17-23	Bakersfield	Agricult. burning petroleum	Bakersfield	Freeway Loop
24-30	Bakersfield	"	Bakersfield	Bakersfield
31-Nov. 6	Goldstone	Desert background	Goldstone	Bakersfield
Nov. 7-13	El Segundo	Marine, Power plant and chemical	El Segundo	El Segundo
14-20	El Segundo	enriched	El Segundo	El Segundo
21-27	Richmond	Urban-industrial	Richmond	Goldstone
28-Dec. 4	Richmond	Urban-industrial	Richmond	Richmond
Dec. 5-11	Pt. Reyes	Marine	Pt. Reyes	Richmond
12-18	Fresno	Urban and agri-cultural receptor; fog	Fresno	Fresno
19-20	Turn over mobile laboratory to Air Resources Board (Sacramento)			

column three. Columns 4 and 5 are alternate choices of site locations based on considerations of aerometric factors.

It is planned to visit each of the sites listed in Table 6 during the Preparation Phase prior to the intensive experiment and to make detailed logistical arrangements for the mobile laboratory.

5. Station Operations and Logistics

5.1 Personnel

During the intensive experiment, personnel from the various participating organizations will be working together both at the fixed stations and in the mobile laboratory. Although each co-investigator will be responsible for the technical management of his personnel, consistent with the contract between NR and the respective organization, there is a further requirement for delineating the responsibilities relative to decisions between organizations on matters related to the successful completion of the field experiment. Each co-investigator has identified a man who is directly responsible for the preparation and daily operation of the stations, or the key programs required during the experiment, such as the chemical analysis. The organizations involved in the program are shown in Fig. 18. Also listed are staff members assigned to the various activities.

5.1.1 Fixed Stations. The operation and preparation of the fixed stations will involve several people. During operation of each station during the intensive experiment, it is planned that two operators will be available so that instrumentation can be checked and maintained, and filters or impactors can be changed efficiently. At least one of the operators will be trained in making direct visibility observations. The station managers for each location are designated in Fig. 18. The coordination of measurements performed at a fixed station by personnel from other organizations will be the responsibility of the station manager.

5.1.2 Mobile Laboratory. Efficient operation of the mobile laboratory will require the delineation of responsibilities between the personnel from various organizations. Careful control and planning must take place

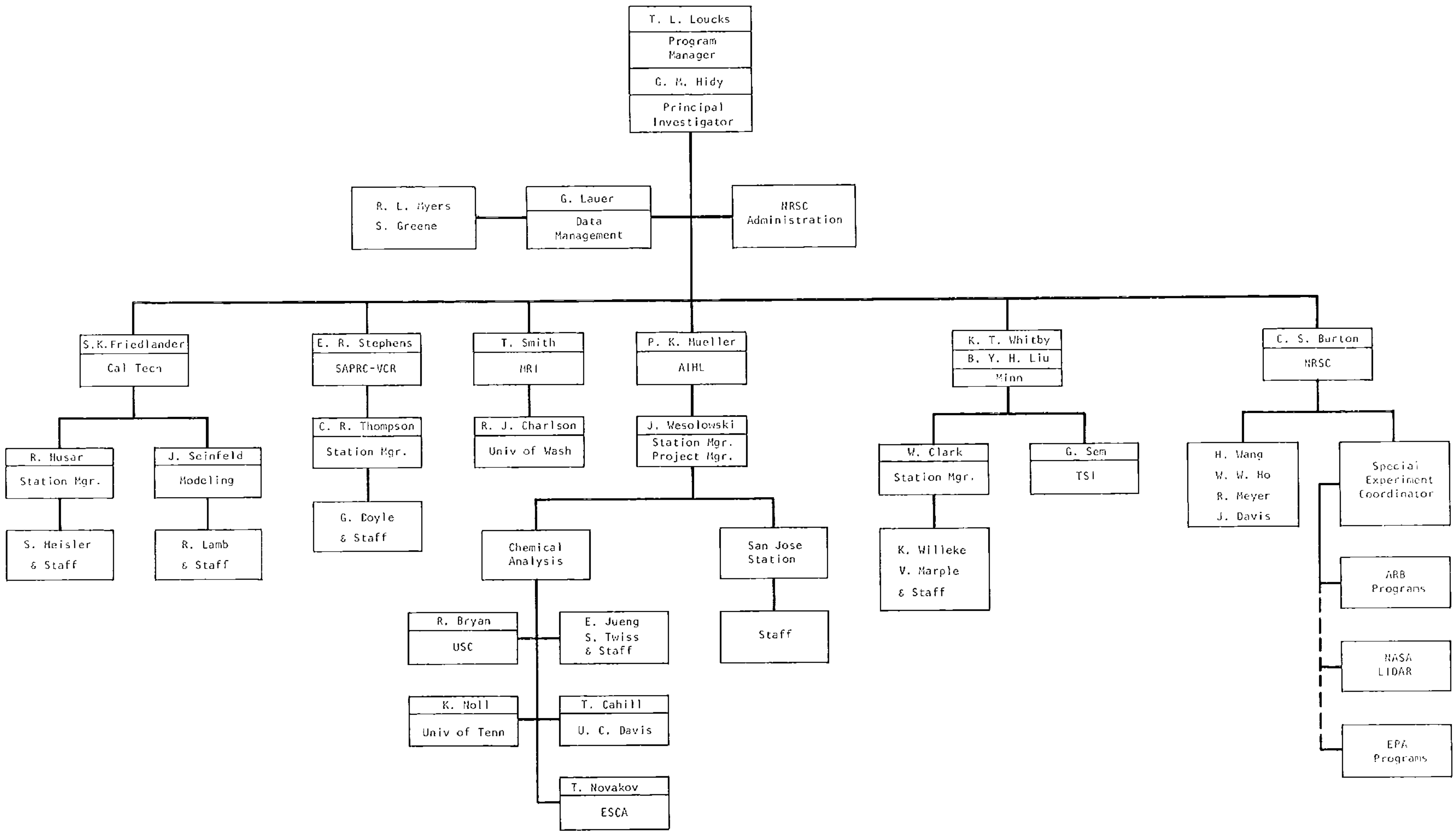


Figure 18 Elements of Organization for the Aerosol Characterization Study

so that the laboratory reaches each site as scheduled and the measurements are performed according to the Experimental Design. The organization of personnel in the mobile laboratory during the intensive experiment is shown schematically in Fig. 19. The station manager, who will be with the laboratory during the entire intensive experiment, is responsible directly to the principal investigator for the operation of the laboratory. The principal investigator will work very closely with the co-investigators shown as advisors in Fig. 19.

5.2 Mobile Laboratory Operations

Except for the crew working directly on the mobile laboratory, living quarters will be primarily at local motels. It is expected that the mobile laboratory will be accompanied by a leased mobile home or a trailer available from UCR which will serve for those on duty in the laboratory as a lavatory facility, office with working space, and a rest lounge. Power for the mobile home will be supplied from the drop line to the mobile laboratory. We anticipate that minimal cooking facilities will be required in the mobile home, except for one or two sites located in remote areas. Under these circumstances arrangements for meals will be made for the working crew.

Security has proven to be an important requirement to insure the safety of the mobile laboratory and its equipment during the experiment. At locations where the units are in an unfenced area, provisions will be made to supply at least one individual as a guard on the facilities during shutdown periods such as week ends and holidays.

To provide transportation to the crew of the mobile laboratory, at least one rented car will be assigned to the laboratory during the intensive experiment. The car will be used to transport a scouting group to inspect each mobile site just in advance of the mobile laboratory movement.

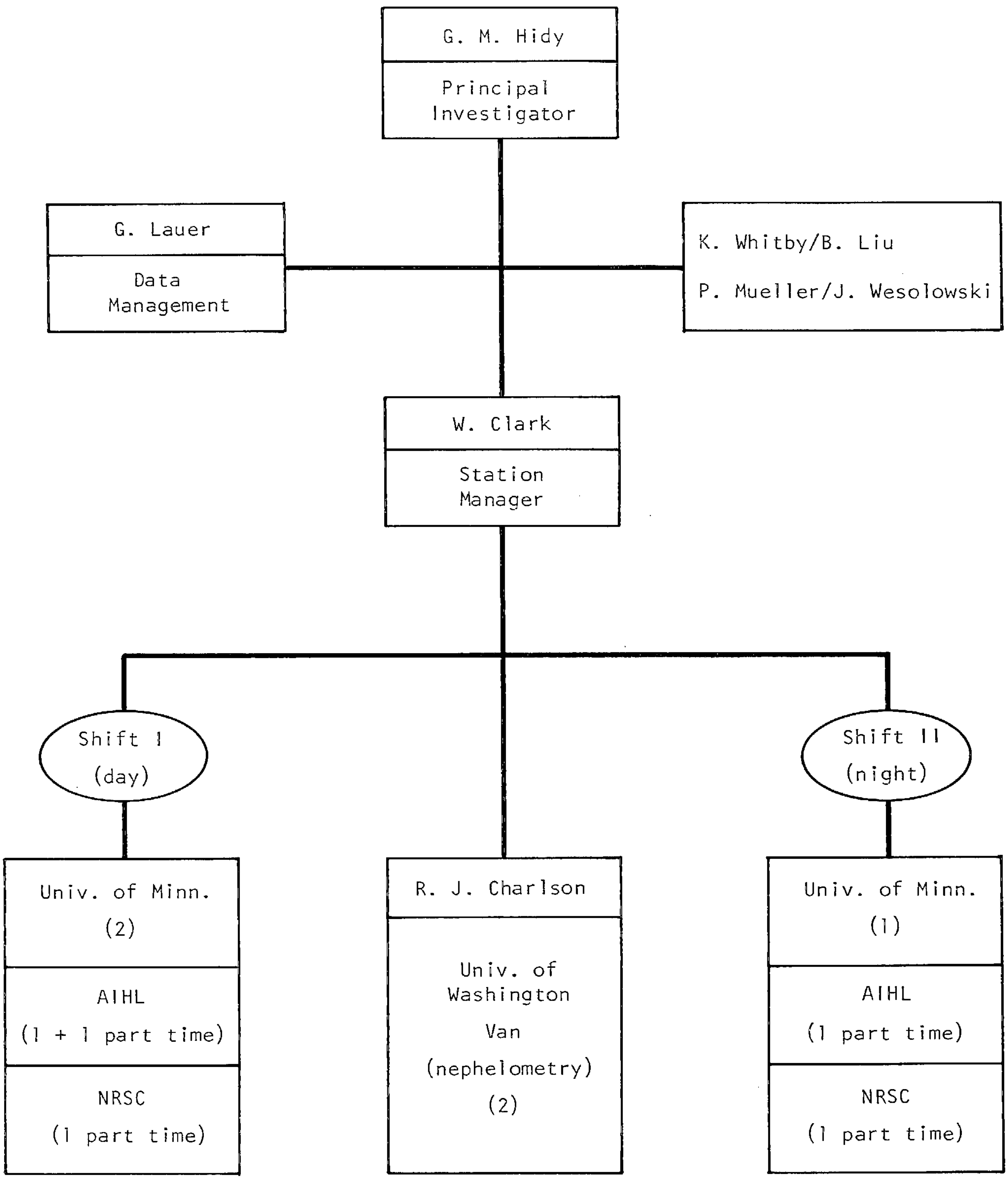


Figure 19 Operations Staff for Mobile Laboratory During the Intensive Experiment

The role of the scouting group is an important one to the efficient evolvement of the mobile laboratory program. This group will be under the jurisdiction of the mobile laboratory manager, and will be assigned to check that all facilities are ready for the laboratory before it moves to a new site. Any difficulties in preparation of a site will be reported to the Principal Investigator for immediate corrective measures to be implemented.

To avoid serious problems experienced in Denver with visitors and VIP's, the mobile laboratory will be closed to all unauthorized personnel, except for scheduled days. These visitor days will be set in advance by the Principal Investigator. Only visitors approved by the Principal Investigator will be allowed access to the mobile laboratory.

5.3 Sampling Strategy

We have chosen to stress a limited number of runs over 24 hour periods, where all equipment is working at each station, all stations in a particular basin are operating simultaneously, and chemical samples are taken with emphasis on these periods. The sampling schedule planned for the intensive experiment is shown in Table 7. The strategy is to achieve at least one successful 24 hour run per week at each station. The choice of day for the 24 hour runs will be determined by the Principal Investigator taking into account the aerometric forecast, weather, and operational capability of the stations.

The intermittent (daily-semicontinuous) sampling scheduled for the experiment is designed to supplement the intensive 24 hour sampling. The continuous aerosol analyzers will be operated "intermittently" during week days from approximately 9:00 a.m. to 6:00 p.m. (or continuously if maintenance requirements are minimal). The rotating drum (Lundgren) impactors will be operated during these 8 hour periods. The high-volume samplers will be operated on a 24 to 48 hour sampling basis. The dust collectors will operate during the entire periods. The analyzers to be operated on the daily schedule will include the Aitken nucleus counters, the optical counters, the nephelometers, the continuous gas analyzers, and the meteorological instruments. One day a week will be scheduled for

Table 7

SAMPLING SCHEDULE FOR OPERATIONS
(BASED ON 1ST CHOICE SCHEDULE FOR MOBILE LABORATORY)

Time	Area Emphasis	Fixed Station	Mobile Laboratory
July 15-30	Berkeley - AIHL	Pasadena 24(1), I Riverside 24(1), I San Jose, 24(1), I	Berkeley 24(1), I
Aug. 1-7	Airport Enriched & Photochemical	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol or Impactor at Ocean-SFO 24(1)	SFO-Airport 24(1), I
Aug. 8-13	Airport Enriched & Photochemical	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol or Impactor at Ocean-SFO 24(1)	SFO-Airport 24(1), I
Aug. 15-21	Urban-Industrial	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol on SFO-Ocean 24(1)	Hunters Pt. 24(1), I
Aug. 22-27	Urban-Industrial	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol on SFO-Ocean 24(1)	Hunters Pt. 24(1), I
Aug. 28 - Sept. 4	San Joaquin Valley	San Jose 24(1), I Pasadena 24(1) Riverside 24(1)	Fresno-Visalia 24(1), I
Sept. 5-11	San Joaquin Valley	San Jose 24(1), I Pasadena 24(1) Riverside 24(1)	Fresno-Visalia 24(1), I
Sept. 12-18	Vegetation Enriched	San Jose* 24(1), Pasadena* 24(1) Riverside* 24(1)	Hunter-Liggett 24(1), I 24(2)
Sept. 19-24	Auto Enriched-Freeway Loop	San Jose 24(1), I Pasadena 24(1), I Riverside 24(1), I Hi-Vol or Impactor at Ocean-LA area	Freeway Loop-LA 24(1), I
Sept. 25 - Oct. 2	Auto Enriched - Freeway Loop	San Jose 24(1), I Pasadena 24(1), I Riverside 24(1), I Hi-Vol or Impactor at Ocean-LA area	Freeway Loop-LA 24(1), I

Table 7: Sampling Schedule for Operations (Based on 1st Choice Schedule for Mobile Laboratory)

(continued)

Time	Area Emphasis	Fixed Station	Mobile Laboratory
Oct. 3-9	Mid LA Basin Receptor	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol or Impactor at Ocean - LA	Downey 24(1), I
Oct. 10-16	Mid LA Basin Receptor	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol or Impactor at Ocean - LA	Downey 24(1), I
Oct. 17-23	San Joaquin Valley	Pasadena 24(1) Riverside 24(1) San Jose 24(1)	Bakersfield 24(1), I
Oct. 24-30	San Joaquin Valley	Pasadena 24(1) Riverside 24(1) San Jose 24(1)	Bakersfield 24(1), I
Oct. 31 - Nov. 6	Desert Background	Pasadena* 24(1) Riverside* 24(1) San Jose* 24(1)	Goldstone Station 24(2), I
Nov. 7-13 Nov. 14-20	Source Enriched LA - marine, power plant, refinery.	Pasadena 24(1), I Riverside 24(1), I San Jose 24(1), I Hi-Vol or Impactor at Ocean - LA	El Segundo 24(1), I "
Nov. 21-27 Nov. 28-Dec. 4	Receptor SFO (Industrial & urban)	San Jose 24(1), I Pasadena 24(1), I Riverside 24(1), I Hi-Vol or Impactor at Ocean (SFO)	Richmond 24(1), I "
Dec. 5-11	Marine	San Jose* 24(1), I Pasadena* 24(1) Riverside* 24(1)	Pt. Reyes 24(2), I
Dec. 12-18	San Joaquin Valley	San Jose 24(1) Pasadena 24(1) Riverside 24(1)	Fresno 24(2), I

24(1) = twenty-four hour run - one
I = intermittent or daily, semicontinuous sampling
* = optional sampling at discretion of p.i. and co-investigators

preventive maintenance on all instruments. The week end days generally will be rest periods, or reserved for transporting the mobile laboratory. Other intermittent sampling will be conducted in the fixed stations or in the mobile laboratory on the basis of unusual aerometric conditions or at the Principal Investigator's request.

The daytime pattern for organics will be sampled with the 2-stage hi-volume filters. To obtain enough mass of organics essentially 48 hours of sampling is required. Thus, for each two hour period from approximately 8:00 a.m. to 6:00 p.m. a filter paper will be placed in the sampler and operated for the two hours. The filter paper will be removed and stored until the following day. At the same time of day, the following day, it will be placed back in the sampler for a second two hour sample, etc. After approximately two weeks the filters will represent a "composite" of daytime variation for each two hour interval during the day.

A typical sequence of events covering a two week period for the mobile laboratory is listed in Table 8. The schedule will be adjusted at times depending on conditions and aerometric factors.

Aircraft Program Coordination. Since MRI and the Navy (China Lake) are funded by the ARB for a three-dimensional aerosol gradient study, it was decided to use the aircraft flight time planned for our study in a preliminary survey of the ambient air over the three major basins. These flights were conducted for NR by MRI in late November 1971, and the results will be included in a monthly Progress Report.

Future phases of our study will rely heavily on coordination with the ARB gradient study using aircraft flights over the three major basins. These results will be used in our evaluations insofar as they are made available to us by the other ARB contractors. Coordination will include the providing of filters for airborne sampling by MRI and the

Table 8

TYPICAL OPERATING SCHEDULE IN MOBILE LABORATORY

Day		Activity
1		Set up and review plan site sampling program
2		Start continuous analyzers (optical counters, nephelometer, Aitken counter, gas analyzers) Start Lundgren impactor and filter sampling program - Daytime operations
3		Same
4		Intensive Experiment
5		Intensive Experiment
6	(Saturday)	Rest
7	(Sunday)	Rest
8		Preventive maintenance and calibrations (Continue Lundgren impactor and filter sampling)
9		Start selected continuous analyzers for daytime operations
10		Intensive Experiment
11		Intensive Experiment
12		Shut down and pack up equipment
13		Move - Rest
14		Rest

Navy. The filters will be returned to AIHL for chemical analysis under the present contract.

5.4 Chemical Analysis

The number of samples to be collected in the program, as projected for the intensive 24 hour sampling episodes, is shown in Table 9. The samples chosen to be most useful for chemical analysis will be processed with the various analyses listed in Table 10. The minimum number of samples to be selected for the various analyses also is shown in this table. The basic procedures described in the original proposal (SC2120T) remain the framework for the chemical analysis.

It is planned that the schedule for analysis will provide validated chemical data on all selected samples within 60 days after collection. The basic flow of the samples is illustrated for the case of the Rotating Drum Impactor (Lundgren) specimens in Fig. 20 . This approach is considered typical for all the samples to be analyzed. There is initial screening via AIHL for x-ray fluorescence analysis (XRF), followed by a series of decisions by the principal investigator in consultation with the co-investigators for more detailed analyses. According to the time schedule, early preliminary results from XRF will be available with approximately two weeks of sample delivery.

5.5 Meteorological Data Requirements

The sampling strategy of this program depends strongly on the availability of highly reliable meteorological data. The meteorological support requirements have been reviewed, and it has been determined that the meteorological data from the following sources will be sufficient.

Table 9

Projected Number of Specimens for Chemical Analysis Per Intensive Sampling Episode
Shown by Samples and Site

Site (from Table 7)	Hi-Vol	Hi-Vol. 2-Stage	Impactor 5-Stage	Impactor Rotary	Impactor 1-Stage (UCR)	Maximum No. of Episodes	Surface Collector	LWC Filter	Dustfall Collector
Pasadena	2		1200	20	12	20	20	20	20
Riverside	20	50	1200	20	24	20	20	20	20
San Jose	20		1200	20		20	20	20	20
Pasadena	2		120	2		2	1	2	1
Freeway Loop	2		120	2		2	1	2	1
Visalia	2		120	2		2	1	2	1
SFO Airport	2		120	2		2	1	2	1
Hunters Pt.	2	50	120	2	12 (San Jose through Fresno)	2	1	2	1
Hunter-Liggett	2		120	2		2	1	2	1
Downey	2		120	2		2	1	2	1
Bakersfield	2		120	2		2	1	2	1
Goldstone St.	2		120	2		2	1	2	1
El Segundo	2		120	2		2	1	2	1
Richmond	2		120	2		2	1	2	1
Pt. Reyes	2		120	2		2	1	2	1
Fresno	2		120	2		2	1	2	1
No of Specimens per Episode	86	100*	5160	86	48	86	43	86	43

Total Number of Samples . . . . 5738†

*composite by two hour period of several sampling episodes at each site
†this number does not include the 18 airborne filter samples also planned (see Table 10), hi vols at ocean sites, and samples taken on occasions other than intensive 24 hour runs

Table 10

Minimum Number of Samples for Chemical Analysis
(Samples will be selected from those in Table 9 or others)

Sampling Device	Analyses	Procedures	Minimum Specimen Analysis
Hi-Vol Filter	Mass Chemical Analysis - inorganics	1	86 48
Hi-Vol 2-Stage	Mass Organics by Solvent Extn. Groups Compounds Carbon Insolubles (Compounds by ESCA)	5	72
Impactors (All Except UCR)	Mass Elements Z ⩾ 20 by XRF Trace Elements V, Br, I, Cℓ Na, Aℓ, by NAA Chemical States of C, N, S, P, Si, & Pb by ESCA	4	862*
Impactor 1-Stage (UCR)	Dominant Compounds by IR of Deposit	1	48
Surface Flux Collector	Mass	1	16
Dustfall Collector	Mass	1	16
LWC (Filters)	Liquid Water Content	1	40
Airborne Grab Samples (Filter)	NAA, XRF		18
Minimum Total No. of Specimens to be analyzed			(2006)

*only a portion of these are to be analyzed by ESCA & NAA at the decision of AIHL & NRSC.

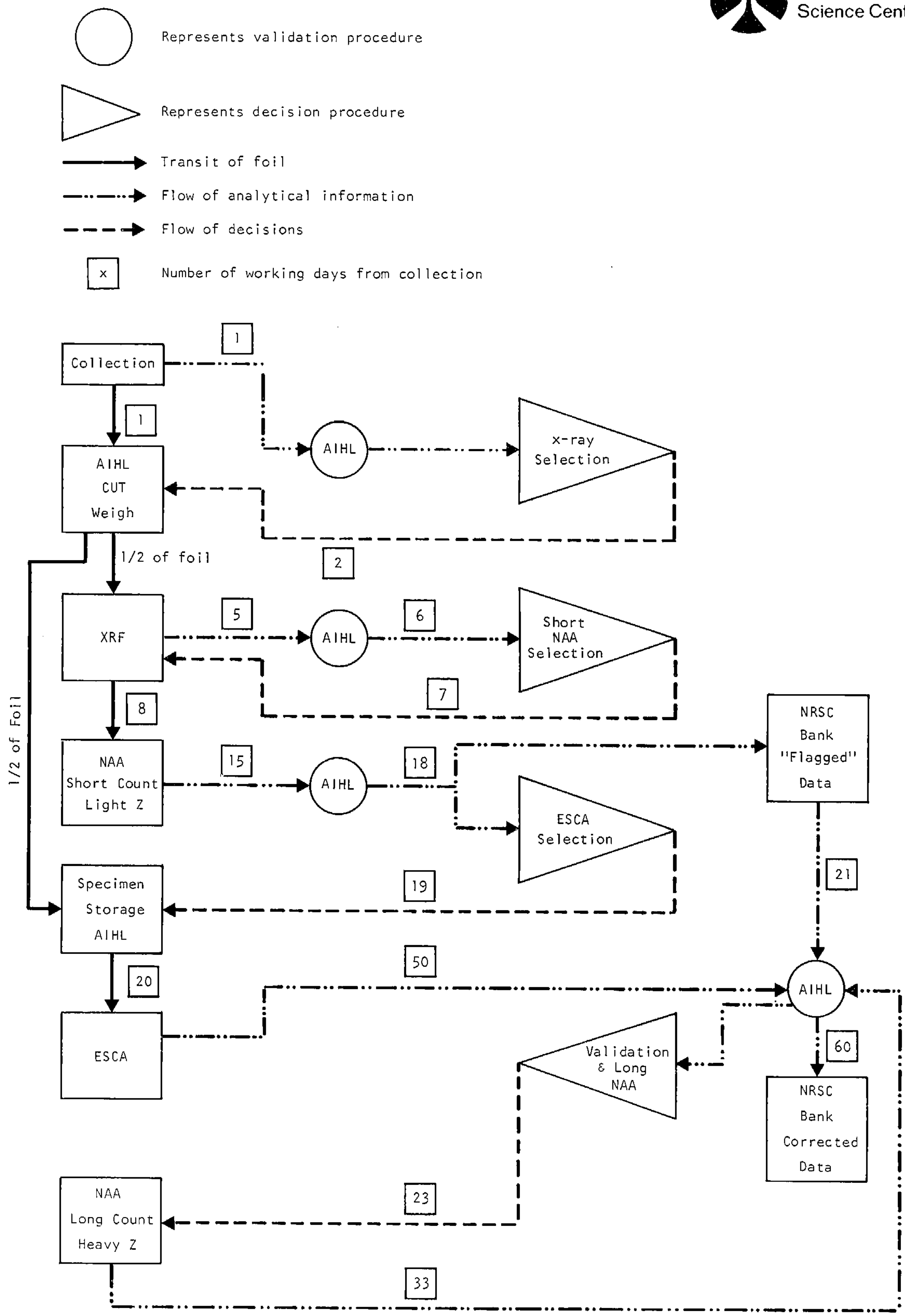


Figure 20 Basic Flow Diagram for Rotating Drum Impactor Samples

a) NOAA - National Weather Service

b) LAAPCD, BAAPCD, San Joaquin Valley agencies

c) Fixed stations and mobile laboratory

d) Aircraft observations (ARB Aerosol Gradient Program)

Data from the ground station of wind speed and direction, temperature and relative humidity averaged over fifteen minute (or one hour) periods will be adequate for trajectory-thermodynamic variable computations. Recorded rawinsonde soundings and other National Weather Service observations will be adequate for forecasting purposes.

The meteorological data in the San Joaquin Valley is rather sparse and is concentrated in a N-S direction along Highway 99. MRI is currently making exploratory observations in selected E-W cross sections to see if any stations will be required to supplement available observations during the intensive experiment.

6. Data Management

The design of the data management system for the Aerosol Characterization Study follows, for the most part, the concepts outlined in the original proposal to the Air Resources Board (SC 2120T). The following is a description of the system with a narrative of the considerations which went into the design.

6.1 Data Acquisition Systems

Each of the measurement stations will be equipped with an automated data acquisition system. These are shown schematically in Fig. 21. It was originally planned to purchase two systems and lease one (with the fourth site not requiring any new equipment). Investigation of the various possibilities indicated that it would be economically favorable to acquire all four systems. This provides a commonality of hardware which reduced costs of development. Furthermore, the costs of leasing data acquisition systems of the type required are such that purchase is considerably more attractive. The data acquisition systems employ a mini-computer as the principal control element. The advantage of using a mini-computer as opposed to the use of a hard-wired system are manifold, the primary advantage being flexibility. Since the program is experimental in nature, many of the measurement parameters will require modification as experience is gained.

It is considerably easier to make changes in the software (computer programs) than it is to make wiring changes. Changes can be made "on-line" during the acquisition by merely typing in the new variables. A second prime advantage to be gained is the capability of on-line data reduction and presentation. This capability permits the investigators to "validate"

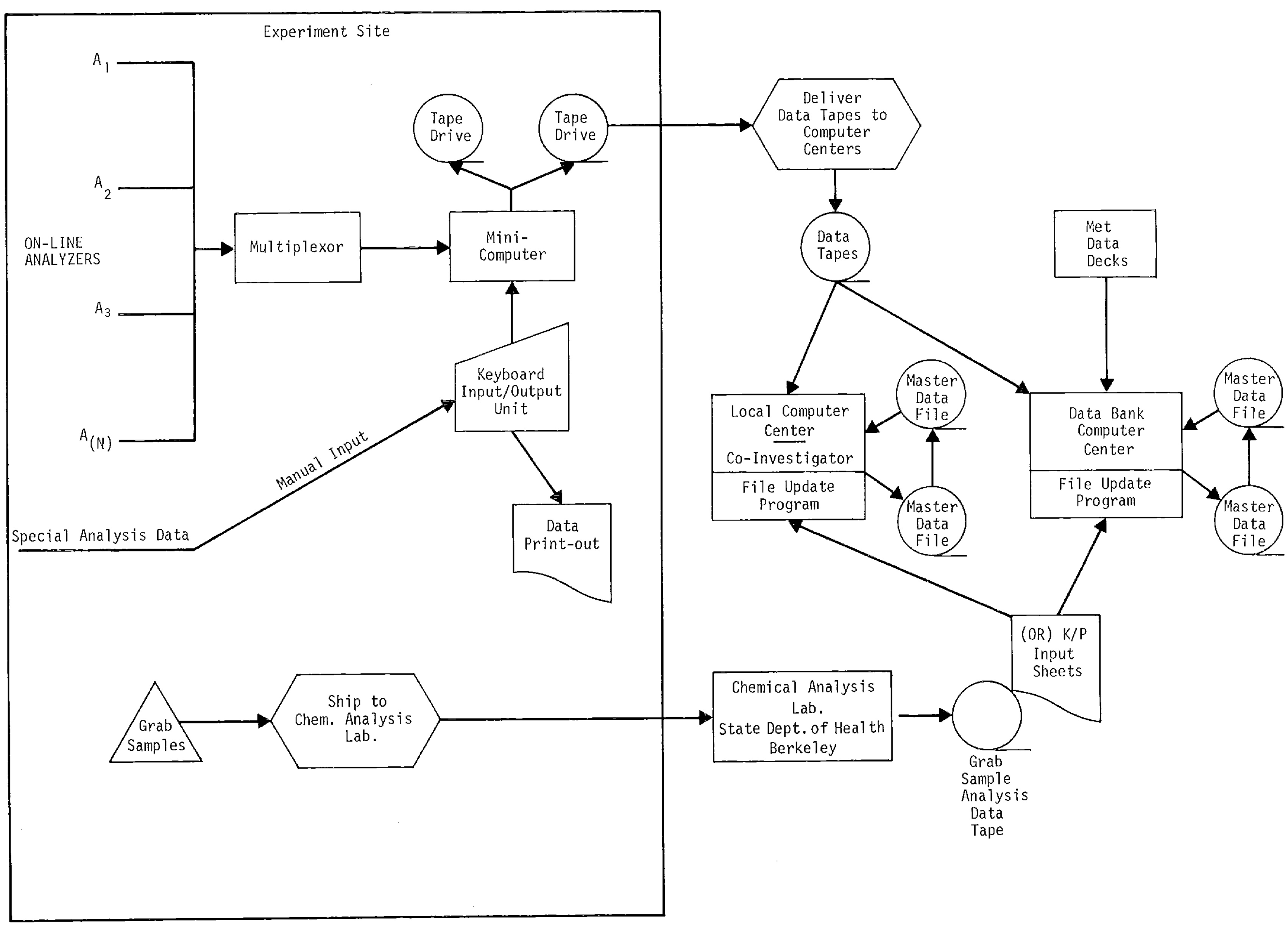


Figure 21   Typical Sampling Station Data Acquisition System

the data while it is being obtained and also permits changing of run-time parameters during the measurement cycle based on information being obtained.

A survey of the mini-computers available in the time frame required by the program schedule was made. There are presently over 200 models available. The principal features considered were price, performance, known history of reliability, and available software support. The operational requirements for the system are not very demanding in terms of speed, and therefore, this was not a primary consideration. The final choice is the Digital Equipment Corporation (DEC) Model PDP/8E. This computer provides minimum computing power of any of the machines available in a hardware sense; on the other hand, it is ideally suited for the tasks of data acquisition and experimental control. The hardware limitations in terms of computing power stem primarily from the word size which is only 12 bits long. This problem is overcome by using two or three words per "number" during calculations and by making use of the sophisticated systems monitors and programs developed by DEC for this machine. The type of computations which will be performed on these machines is discussed in some detail in Section 6.2.

Each machine is equipped with a real-time clock, 8 thousand words of high speed (1.2 microsecond memory; hardware multiply, divide, and normalize; a teletypewriter; and a dual drive magnetic tape unit. The latter is a special (non-industry compatible) type of magnetic tape. It makes use of 3/4" tape and employs dual redundant recording, using a separate timing track. The latter feature allows the tape to be used as a pseudo-random access device; that is, information may be written on any point of the tape without disturbing any other portion.

Each of the machines will be equipped with dual multichannel analyzer capability using the direct memory access ports provided by DEC. These are intended for use with the optical particle analyzers (Royco and B&L). In addition, each will be provided with a 4-1/2 digit autoranging voltmeter connected to a reed relay multiplexer (MUX). The MUX can be directed to connect one of 128 inputs (floating) to the DVM input, either on a manual basis or by the computer. This combination of MUX and voltmeter will allow data to be taken at rates of 400 samples per second. This rate can be as slow as 100 samples per second if the autoranging feature is required. However, it is anticipated that 100 samples per second will be more than adequate to meet the objectives of the program. The DVM chosen is the J. Fluke Co. Model 8002A; the multiplexer is being built by the NR Science Center.

Two digital-to-analog converters (DAC) will be attached to each machine. These converters may be connected to a suitable x-y recorder to graphic output of the data. There appears to be a requirement for range changing on some of the instruments; in addition, it is anticipated that some devices will have to be turned on or off under computer control. A set of 24 computer controlled relay closure points will be provided to accomplish these functions.

The computers will be programmed to acquire the data at intervals determined by the operator at the commencement of a particular run. In addition, the operator will specify how the data is to be averaged and may, at his option, specify a numerical limit at which an alarm is sounded. The data will then be gathered, formatted, and be recorded on magnetic tapes.

Simultaneously with the acquisition, the operator may request, via the teletype that specific parameter values be typed out so that he can insure proper operation of critical instrument. The numerical data from certain of the instruments such as the optical counters must be preprocessed in a standard manner before the data can be interpreted. Subroutines will be provided to allow such preprocessing and display of the reduced data during the acquisition.

The flow of data taken during the experiment is shown schematically in Fig. 22.

6.2 Data Reduction and Interpretation

One of the data acquisition computers will be provided with an additional eight thousand words of core, an additional dual magnetic tape drive, an industry compatible magnetic tape transport (7 channel - 556 bpi), punched card reader, and a line printer. This machine will be used during the intensive experimental phase for data acquisition and will then become the principal computing element for the data reduction and interpretation phase. In essence, this computer will be used as the "data bank."

The rationale for using a mini-computer as the prime computational element stems from the following considerations:

a) Economic. The costs inherent in the use of a large computing facility are very great. It is estimated that computer time for the data reduction and interpretation would come to a minimum of $30,000. In addition, a considerable amount of manpower would be required to perform the programming necessary.

b) Operational. The use of a large computing facility to reduce the data would require essentially batch type operation. This means that the investigator would have to wait for the data anywhere from 8 to 24 hours before the next iteration in processing. What is most desirable, on the other hand, is interactive operation where the investigator can follow the processing steps and take action immediately.

c) Technical. Establishment of scientific data banks has been fraught with various difficulties. Two principal problems have been encountered. The first stems from the desire on the part of the programmer to satisfy all desires in all respects from the initiation of the work. This has led to exorbitant computing and programming costs, with little actual improvement in data handling and retrieval capabilities as far as the user is concerned. In effect, the data bank becomes a toy of the computing center and is utilized only as a last resort by the user. The second problem stems from the fact that large computers have rather strict conventions and procedures insofar as the system supervisory software is concerned. This is due to the fact that the computer must be utilized by a large and varied group of users. Such conventions restrict the data format and method of accessing the data rather severely, and invariably lead to high computing costs to the user.

The use of the mini-computer overcomes most of the problems, although at the cost of losing some of the inherent "power." The principal trade-off is in operating time. Whereas the large computer can access a long file in a matter of seconds, the mini-computer may take minutes; however, the cost of running the mini is infinitesimal compared to the large computer. As far as the user is concerned, the operating using the mini-computer is actually faster. The only time used is actual hardware running time whereas there is additional delay at the computing center; and therefore, turn-around time for the mini-computer is on the order of minutes rather than hours. In essence, the user can "interact" with the computer.

6.3 Data Bank Operation

As described in the original proposal, each of the stations will transmit tapes to the central data bank (Fig. 22). The data bank will be centrally located at the Cal Tech PDP8/E computer during the intensive experiment. Afterwards it will be transferred to the NR Science Center for completion of all data processing. These tapes will be collated and will then become the prime repository for all of the data. Data obtained from laboratory analysis of impactor substrates will be merged with the continuous data, so that all of the data acquired on a given day at each station will be on one tape.

Complete software to service the requirements of the various co-investigators will be provided. This will include, but not be limited to, programs which will reduce and graphically present the data; statistical analysis programs analogous to the statistical packages available for large computers; etc. The principal difference in this operation and that normally associated with data banks will be the requirement that the investigator mount the tapes on the computer and operate it himself.

In addition to these facilities, each of the computers can be used to run standard programs written in FORTRAN II. We are providing the industry compatible tape transport on the one machine in order to provide compatibility of data storage medium between the mini-computers and large computers. If it does become necessary to use a large computer for a specialialized task (such as inverting a 40 x 40 matrix), the data can be transferred to the 7 channel tapes and the computation can be performed

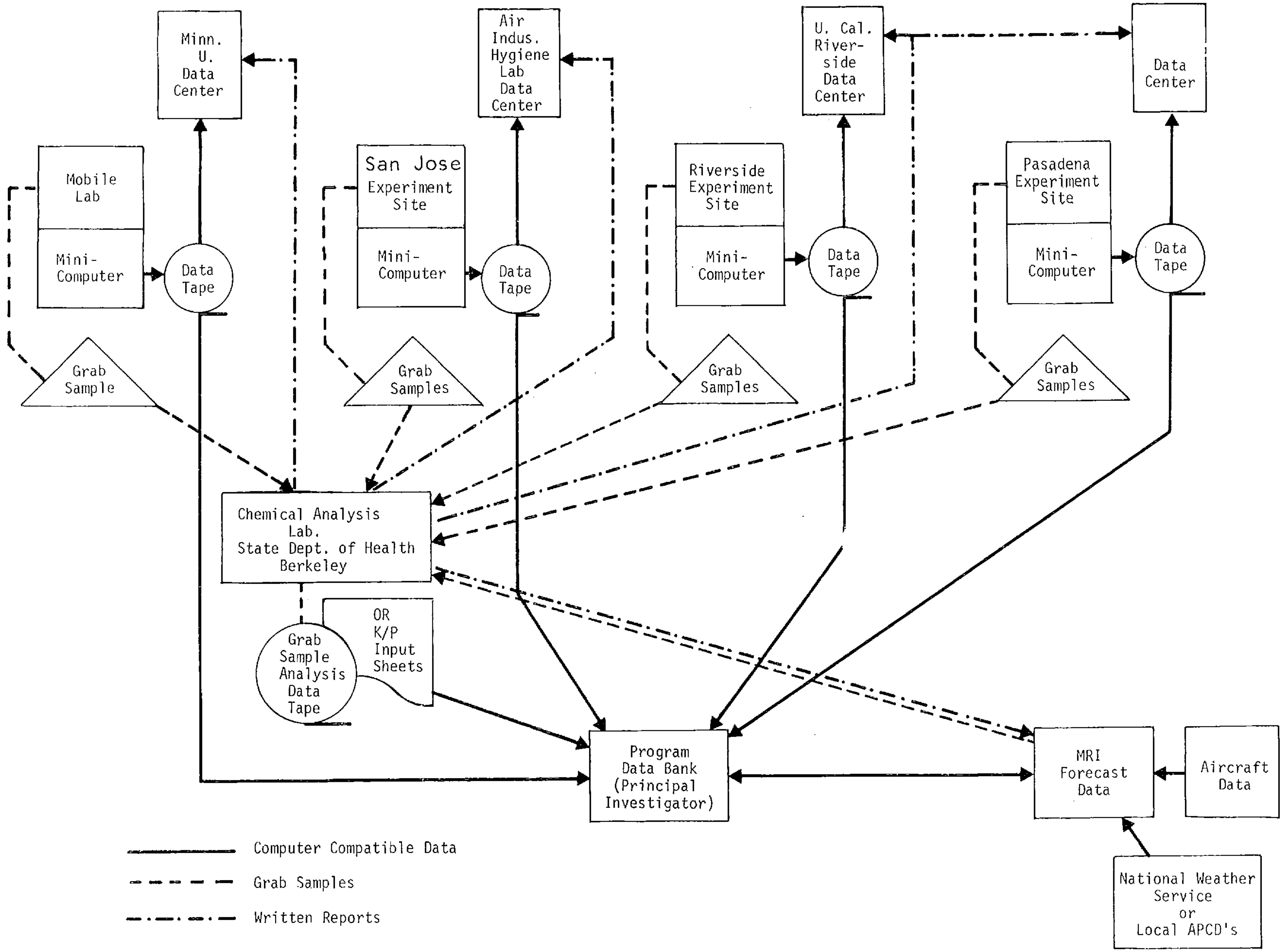


Figure 22 Generalized Data Flow

either on the Science Center CDC 6600 terminal or one of the computer centers associated with the co-investigators.

7. Implementation of Phase II - Preparations

The previous sections of this report have dealt with the essential elements required to make the observations and measurements during the intensive experiment. In addition, the experimental design must include a detailed plan for the Preparation phase.

The sequence of intermediate tasks leading to the beginning of the intensive experiment is illustrated and summarized in Fig. 23. Three major segments of effort are shown: the mobile laboratory, chemical analysis and support, and the fixed stations. The tips of arrows indicate goals for completion of certain phases of work that lead into subsequent activities. The diagonal lines show requirements for cross-referencing and communication links between the major segments. The flow of effort provides for the steps that must be taken beginning with purchase of instrumentation and services and ending with final operational checks just prior to initiation of the intensive experiment. As indicated, these several stages of preparation take into account many detailed aspects of the program.

The plan, which comprises the Preparation phase (Phase II), contains fifteen major steps. A brief description of each of these steps follows.

7.1 Purchase, Construction and Checkout of Equipment

The equipment responsibilities for each station have already been listed in Table 3. Each fixed-station manager is responsible for the procurement and delivery of mandatory items specified in the respective subcontracts. The optional items of equipment will be purchased or

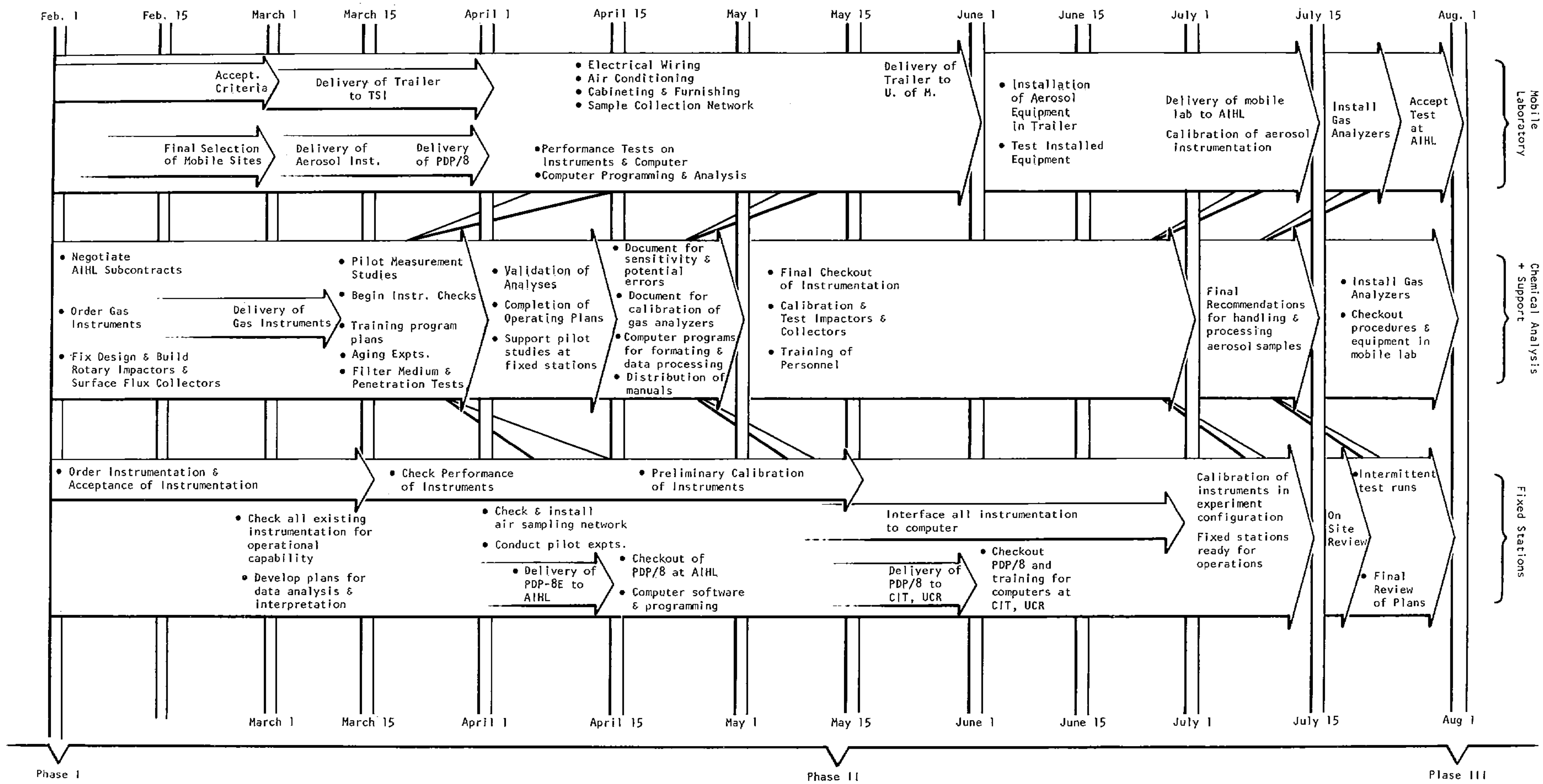


Figure 23 Projected Sequence of Events During Preparation Phase

leased with approval from NRSC. Major items for construction, other than the mobile laboratory, include the 2-stage hi-volume filters (USC), the rotary impactors (Dr. K. Noll - Univ of Tennessee), and the surface flux collectors (NRSC). All orders for this equipment will be placed after ARB approval of the Experiment Design.

Prior to calibration, all equipment required for the program (including purchased items), will be examined to determine operational status. Any equipment not meeting manufacturer's original specifications will be returned to the manufacturer or repaired by the responsible organization. All deliveries and checkout prior to calibration will be completed by May 1, 1972.

7.2 Data Acquisition Equipment

All four of the computer-data acquisition systems have been ordered; the first is expected to arrive at the Science Center by January 15, 1972. The others will arrive at monthly intervals thereafter. These systems will be checked out and tested by NRSC personnel. As a goal, the first will be delivered to University of Minnesota by April 1. The second will be shipped to AIHL by mid-April. The Cal Tech and UCR computers will be retained longer for finalizing computer programs and interfacing. They will be delivered by early June. NRSC will be responsible for installation and on-site testing of all systems except that for the mobile laboratory.

7.3 The Mobile Laboratory

The Fruehauf Trailer has been ordered. Final specifications for the mobile laboratory will be released after ARB approval of the

Experimental Design. The mobile laboratory will be furnished and equipped by Thermo-Systems, Inc., under the supervision of Professor Whitby and staff of the University of Minnesota.

Aerosol equipment and the data acquisition system will be tested and calibrated at the University of Minnesota by mid-May. They will be installed in the mobile laboratory by July 1. The mobile laboratory will be routed to AIHL in Berkeley by July 15 for installation of the gas analyzers and remaining equipment such as Lundgren impactors. It will remain in Berkeley for checkout and calibration of the gas analyzers by AIHL staff. It is planned that the mobile laboratory will then undergo acceptance tests under the direction of NRSC at AIHL.

7.4 Chemical Sampling and Analysis

All arrangements with sub-contractors of AIHL must be made soon after ARB approval of the Experiment Design. The arrangements will be made by Dr. Mueller at AIHL for the required support of UC Davis (x-ray fluorescence), Lawrence Livermore Laboratories (ESCA, Neutron Activation Analysis), and University of Southern California (Organic fractionation and analysis). A number of steps are required to complete preparations for chemical analysis of aerosol particles. These are summarized along with planned schedules in Fig. 24.

The expectations for all chemical analyses such as sensitivity and potential error will be specified in a preparatory document by May 1, in preparation for the training of personnel on operating and handling procedures for the samples.

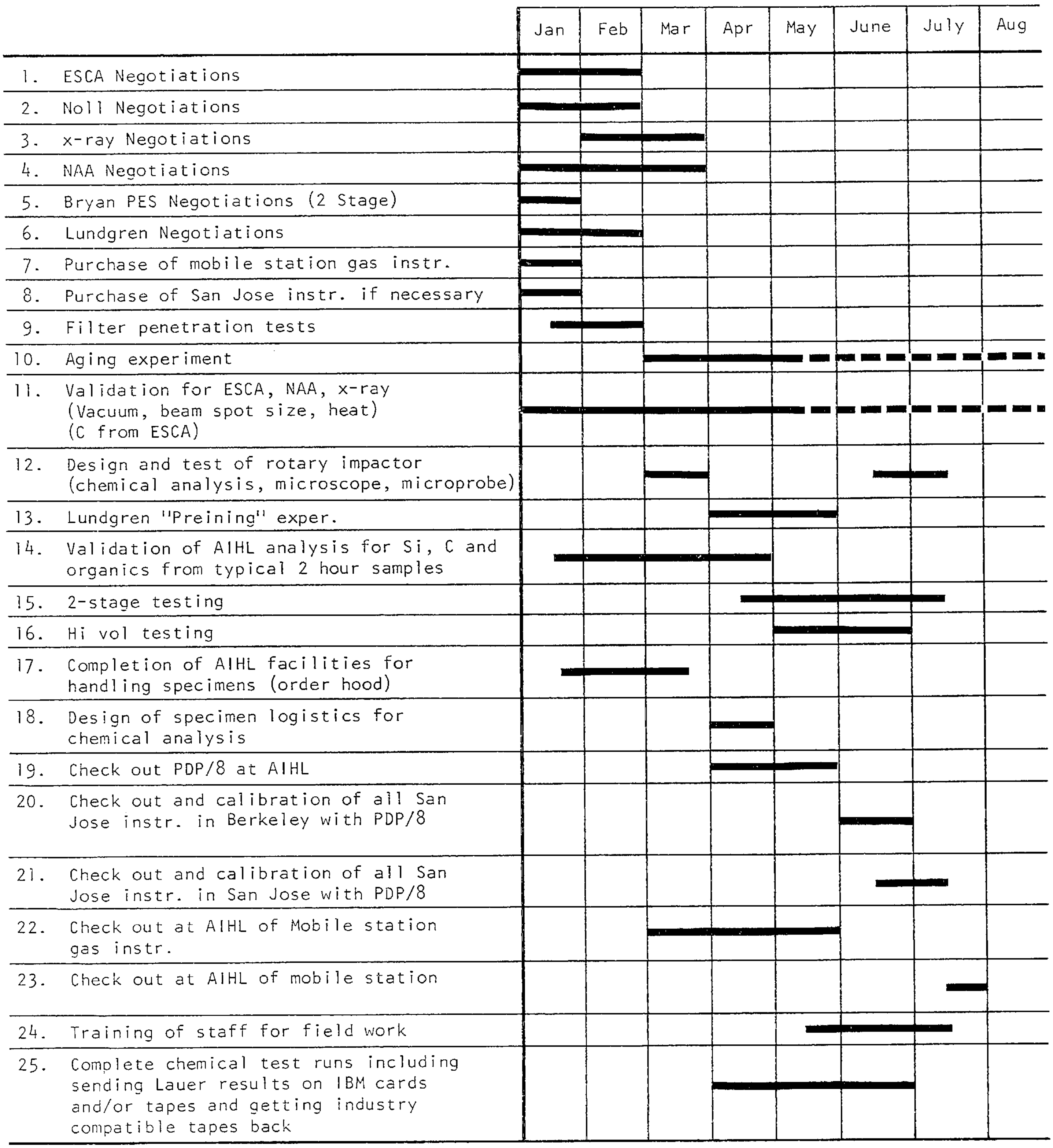


Figure 24 Steps in Preparation for Aerosol Chemical Analysis

7.5 Calibration of Equipment

All equipment to be used for quantitative analysis of aerosols, trace gases and meteorological variables will require calibration prior to the intensive experiment. Most of the equipment to be used will require intermittent calibration throughout the experiment.

AIHL is responsible for calibration of all the gas analyzers throughout the intensive experiment. AIHL will provide the station managers with procedures for the intermittent calibration of these instruments during the intensive experiment. The calibration procedure will be outlined along with other analytical procedures for the training of operators by May 1, 1972.

AIHL will be responsible for the calibration of all impactors and high volume filter units. This effort will be completed by July 1, 1972.

The University of Minnesota will have the responsibility of calibrating all the optical counters and Aitken nucleus counters for the program. These calibrations will be conducted by July 15, 1972 either in Minnesota or Cal Tech, depending on Professor Whitby's discretion (with approval from the Principal Investigator).

The equipment to be calibrated by AIHL and Minnesota must be delivered in working condition according to manufacturers' original specifications.

The calibration procedures will be documented for all instrumentation by July 15 with appropriate reports to the Principal Investigator.

7.6 Handling and Processing of Aerosol Samples

The logistics plan for handling of aerosol samples from filters and impactors, for transporting them to AIHL, and for distribution to analytical groups will be determined before the beginning of the intensive experiment. The major contingency in this operation will be the prevention of contamination, and minimizing possible substrate and aging effects.

The aging of samples will be checked using typical impactor and filter samples by AIHL staff. For this work some samples taken from the pilot/exploration experiments (Sec. 7.10) may be used. The results of these tests and other considerations will be completed by July 1, 1972 and will provide the basis for operational procedures for the intensive experiments.

7.7 Arrangements for the Mobile Laboratory Sites

The sites selected for the mobile laboratory must be examined in further detail. Exact locations at these sites have to be specified and arrangements for power and communications must be made.

The final selection of sites will be based upon a scouting expedition planned before April. It is anticipated that all sampling sites will be visited by a team consisting of the Principal Investigator and at least one representative from AIHL and the University of Minnesota. Before this scouting trip, permission from appropriate owners or control agencies must be obtained, and the feasibility of power and communications hookup have to be explored. This second screening will be complete by early April. The responsibility for final site selection activities is assigned to the Principal Investigator with close coordination between AIHL and University of Minnesota personnel.

7.8 Preparation of Fixed Stations

All fixed stations must be prepared for operation by July 15, 1972. To insure that all instrumentation and operational procedures are in order, each station will be reviewed and checked by the Principal Investigator in mid-July.

7.9 Operating Plans for Stations

The final operating plans for all stations must be completed by all station managers before May, 1972. These plans will include operating staff, logistics for 24-hour runs, plans for accommodations, data requirements for surveillance, and requirements for data review and communications between stations.

7.10 Plans for Data Processing

As part of the data management plans, the final computer programs for initial data formating and processing will be specified by May 1, 1972. It is important that all data from the stations and the mobile laboratory be processed uniformly in a compatible format. The formating and processing procedure will be developed by NR in collaboration with the co-investigators.

7.11 Pilot Measurement Studies

To test the available instrumentation at fixed stations, limited observations of physical and chemical properties of aerosols and trace gases will be made during April 1972. Intermittent measurements of Aitken nuclei and large particles will be made, with samples taken from the rotating drum impactors and filters, including liquid water content filters. Similar limited sampling will also be undertaken in Bakersfield or Fresno, with the assistance of the local APCD personnel. Sampling will be coordinated with the ARB Aerosol Gradient Program to attempt simultaneous aircraft flights over the basin. The samples will be submitted to AIHL for analysis.

7.12 Development of Methods for Data Interpretation

An important part of the research activity during the preparation phase is the continuance of work on data interpretation. The basic framework for the experiment and observational effort has now been set. It remains to explore the best plans for data utilization to achieve the objectives of this study.

Examples of work that is planned for this part of the preparations include determining the major stationary sources of SO_2 by location and emission level in the Los Angeles Basin. This information will be added to the numerical dispersion model for the LA basin (Lamb and Neiburger, 8). Sample calculations will be made using this model for dispersion of SO_2 in the absence of chemical reaction. Such SO_2 concentration contours will be compared later to data obtained for specific meteorological conditions in the intensive experiment. In this way, the extent of SO_2 reaction may be estimated and compared with the observed visibility degradation.

Efforts also will be devoted to investigate current knowledge of hydrocarbon vapor and particle emissions from motor vehicles to determine the utility of specific compounds or elemental ratios like C/O for separating direct emissions from organic production in the atmosphere.

7.13 Operations Manuals

To insure that common procedures and practices are adopted and followed in the experiment, operations manuals for the data acquisition system and for the chemical sample handling will be prepared and distributed to all operational personnel by May 1972. The operations manual for the data acquisition system will be prepared by Dr. Lauer (NRSC); the one for sample handling will be prepared by Dr. Wesolowski (AIHL).

7.14 Operator/Observer Training

Prior to the intensive experiment, all observers and operators will be thoroughly acquainted with the instrumentation and procedures of the experiment. A training program of approximately one week length will be conducted in June (or before). At this time, all personnel will be checked out on (a) the experimental plan, (b) visibility observations by the standard ARB methods, (c) chemical sampling handling, (d) the data acquisition, and (e) calibration and maintenance procedures for the instrumentation computers. This training program is considered to be crucial to the success of the program; thus, all individuals to be involved in the measurements will be required to attend such sessions. Final detailed planning for the training programs will be completed by the Principal Investigator by April 1972.

7.15 Acceptance Tests of Mobile Laboratory

The acceptance criteria for the mobile laboratory will be prepared prior to the intensive experiment. After consultations with the University of Minnesota staff and the AIHL staff, the Principal Investigator will formulate the acceptance criteria for the mobile laboratory. These criteria will be completed by March 1972 and will be made available to the Minnesota-TSI group and the AIHL group as standards for the tests.

The University of Minnesota will provide NRSC with acceptance tests for the data acquisition system. These will be used, in turn, to check the system at the final NRSC acceptance tests of the mobile laboratory.

The tests on the mobile laboratory are expected to be conducted at AIHL and are planned to be complete by July 1972. Part of the acceptance program will be at least one twenty-four run with all instruments operating.

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