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# Technical Report

# SESAME/ENVIRONMENTAL RESEARCH LABORATORIES

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TECHNICAL REPORT
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# SESAME/ENVIRONMENTAL RESEARCH LABORATORIES

Prepared For

DATA SYSTEMS LABORATORY
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

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# INTRODUCTION

The Environmental Research Laboratories (ERL) have been designated as the basic research group of the National Oceanic and Atmospheric Administration (NOAA). ERL performs an integrated program of research and research services directed toward understanding the geophysical environment, protecting the environment, and improving the forecasting ability of NOAA. Twenty-four laboratories located throughout the United States comprise ERL.

Approximately 40% of the work of ERL involves the atmospheric sciences. The following six laboratories are either partially or fully dedicated to research in this area:

- National Hurricane Experimental Meteorology Laboratory (NHEML); Miami, Florida
- Atmospheric Physics and Chemistry Laboratory (APCL); Boulder, Colorado
- National Severe Storms Laboratory (NSSL); Norman, Oklahoma
- Air Resources Laboratories (ARL); Silver Springs, Maryland
- Geophysical Fluid Dynamics Laboratory (GFDL); Princeton, New Jersey
- Wave Propagation Lab (WPL); Boulder, Colorado.

The Project SESAME (Severe Environmental Storms and Mesoscale Experiment) Planning Office, under the direction of Dr. Stanley Barnes, is a Project Office within ERL as illustrated in Figure 1. SESAME is conceived as a joint effort involving NOAA, NASA, NSF, and the atmospheric science community to lay the foundation for improved prediction of severe convective storms. The scientific plan for SESAME includes a phased buildup of analysis, modeling, instrumentation development and procurement, and limited-scale observational activities to be conducted through the remainder of the 1970's, with two major multiscale field programs of three months each in the early 1980's. Each of these activities requires support from NOAA, NASA, and NSF, as well as participation from other agencies. Figure 2 depicts the interagency relationships. A schedule of planned SESAME experiments is shown in Figure 3.

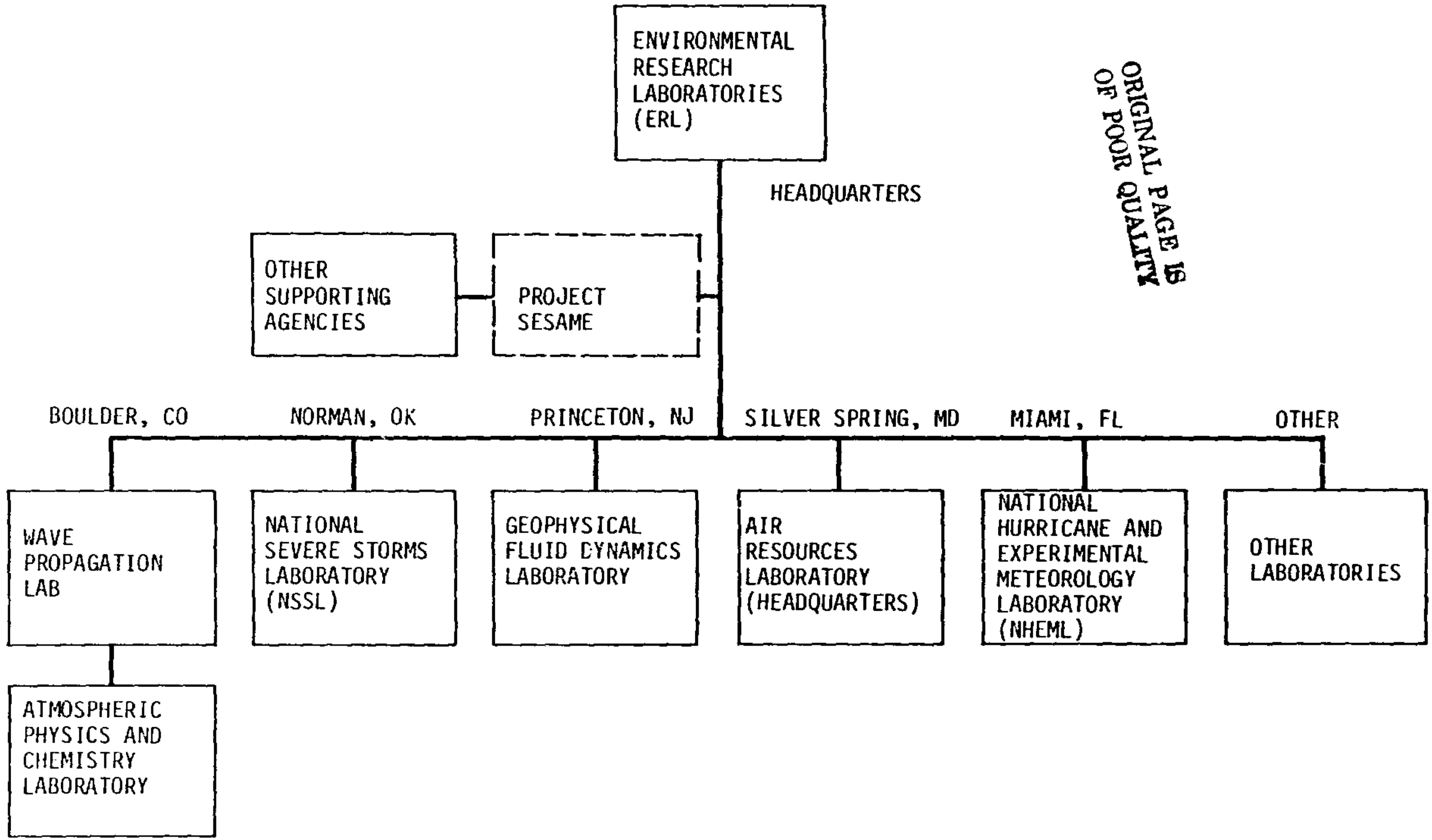


FIGURE 1. GENERAL DIAGRAM OF ENVIRONMENTAL RESEARCH LABORATORIES

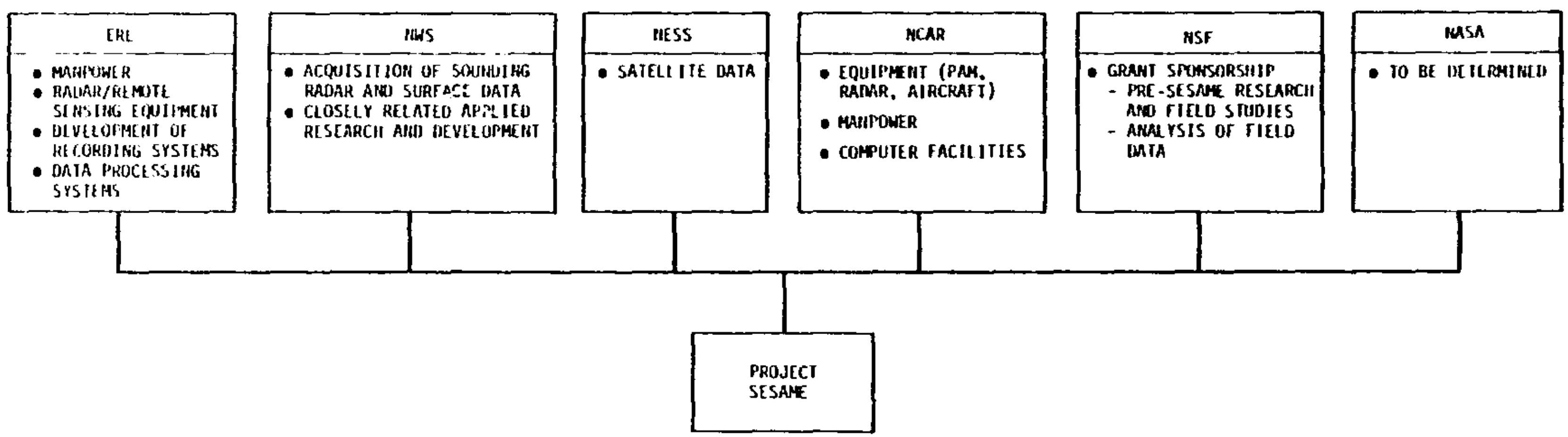


FIGURE 2. RESOURCE CONTRIBUTORS FOR PROJECT SESAME

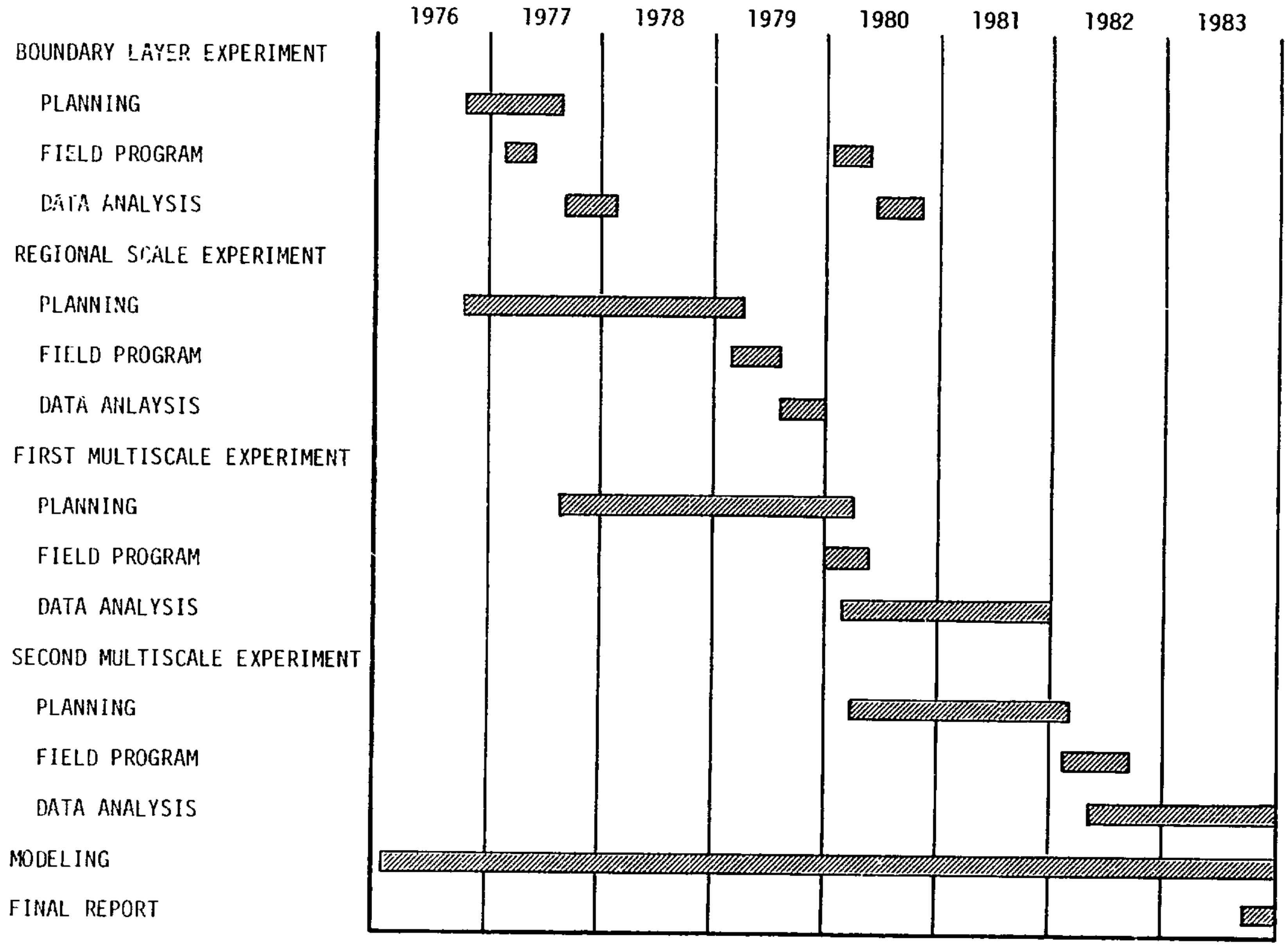


FIGURE 3. SESAME EXPERIMENT SCHEDULE

The first scheduled field activity is the Boundary Layer Systems Test. Measurements of mass and moisture convergence and boundary layer destabilization will be made over an area of approximately 40 km in diameter. The primary objective of the test is to determine the ability of various instrument systems, particularly a minimal surface and sounding measurements combination, to reliably observe the destabilization of the boundary layer. A secondary objective is to initially test the hypothesis that moisture convergence is the best short-range predictor for subsequent thunderstorm development. The successful accomplishment of the first objective is essential to the effective design of the SESAME Multiscale Experiment No. 1 (SME-1). Definitive results from the second objective are not expected until after the SME-1, but unexpectedly strong positive correlations could lead to early operational deployment of similar networks in heavily populated areas that are subject to severe storms.

The regional scale field experiment is scheduled to be carried out in 1979. As part of this experiment, approximately 20 new sounding stations will be distributed over a region of about $2 \times 10^6$ km$^2$. These stations coupled with about 21 currently operational National Weather Service stations in the same region will make frequent soundings during weather situations with high storm potential (see Figure 4). This data will be used in the initialization and verification of experimental regional-scale prediction models and to optimize the regional scale network design for SME-1. Results of this experiment are also likely to influence operational weather service decisions on enhancing the spatial and time resolution of their sounding networks over the continent.

The first and second multiscale experiments are planned for the spring of 1980 and 1982. These experiments will utilize an array of boundary layer sensors and additional high-resolution sounding systems nested within the regional scale net, and accompanied by an array of Doppler radars and other remote sensors capable of observing the significant details of severe storm development, inter-storm and storm-environment interactions over a region of order $5 \times 10^4$ km$^2$. Instrumented aircraft will contribute an important part of the measurements, and the maximum appropriate use will be made of satellite imagery and soundings.

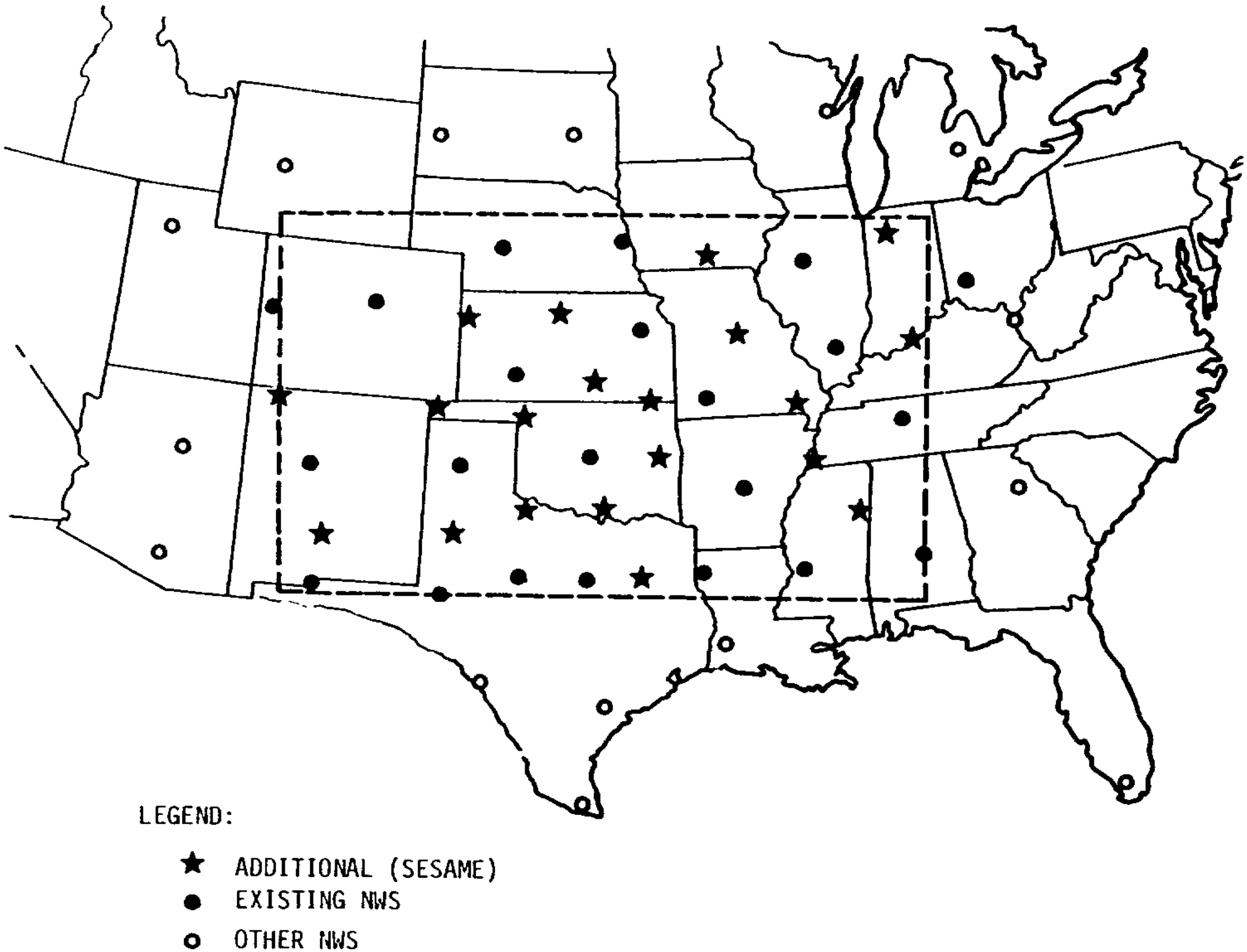


FIGURE 4. SESAME RAWINSONDE NETWORK FOR 1979 REGIONAL SCALE EXPERIMENT

Analysis and utilization of the data from SESAME experiments are expected to demonstrate the following:

- The capabilities of regional and mesoscale models to accurately predict conditions favorable for severe storm development many hours in advance of the storm.

- The ability of a limited array of ground-based direct and indirect sensors (including satellites) to provide more timely and accurate warning of the immediate formation of convective storms and of their evolution to dangerous systems containing tornadoes, severe winds, and/or hail.

# 1. DATA GENERATOR ELEMENTS

As in previous storm observation programs, rawinsonde networks are expected to be key elements in SESAME, with wind vector and humidity as the most important observational parameters. The following constraints are projected for the measurement capability of the rawinsondes used:

- Wind = rms vector error of 0.5 mps
- Temperature = rms error of 0.5°C
- Relative humidity = rms of 5%
- Ability to obtain data within first 100 m (or closest possible approximation to that distance).

Two candidate rawinsondes are the GMD -1 and METRAC.

Numerous aircraft have been used in meteorological research, ranging from small single-engine planes used as platforms for photography or dropping of chaff, to multiengined scientific laboratories carrying sophisticated instruments and recording systems along with a dozen or more scientists. Several aircraft will probably be available for use in SESAME from NASA (WP-57F or CONVAIR 990) and NCAR (PETRY-D), as well as several smaller research aircraft operated by universities with major cloud physics programs.

Sensors that will be available for use by 1978 on the WP-57F include the following:

- Cloud Top Scanning Radiometer - Measures cloud top temperatures, surface temperature, and water vapor distribution in the upper troposphere. Visible, 11- and 6.7-μm channels with 110-m spatial resolution on the ground with the aircraft at 18 km.
- Rain Mapping Radiometer - Measures rainfall coverage and rate at 19.5 GHz. Mostly used over water.
- Storm Structure Microwave Spectrometer - Measures temperature profiles at 60 GHz with short range plans for adding 118-GHz channels for the same purpose.

- 94-184-GHz Radiometer - the 183-GHz data will be used to measure water vapor profiles. A window channel at 94 GHz will be used to test theories concerning hail detection, rain-snow line detection, and rainfall coverage and rates.

The following sensors are expected to be ready for flight on the WP-57F by 1980, although some may be ready by 1979:

- Cloud Physics Radiometer - Determinations may be made of cloud top height using reflectance measurements in the oxygen A-band near 0.76 μm, and measurements of cloud phase may be made using two reflectance channels (one visible and one near IR).

- Infrared Detectors - Temperature and moisture profiles may be established from high spectral resolution measurements, plus the examination of other important quantities that can be measured in the 3- to 5-μm interval.

The instruments that follow are planned for flight on aircraft other than the WB-57F:

- Microwave Doppler (Vertically Pointing) - Measures vertical velocity within convective cells. Most useful when velocities exceed the fall velocities of raindrops.

- Infrared Doppler (Side Looking) - Measures horizontal winds in the clear air using backscattered radiation from aerosols. This device will be particularly useful for determining wind fields surrounding thunderstorms.

# 2. SPACE DATA PROCESSING ELEMENTS

Not applicable

# 3. SPACE DATA STORAGE ELEMENTS

Not applicable

# 4. SPACE DATA HANDLING ELEMENTS

Not applicable

# 5. SPACE-TO-GROUND COMMUNICATION ELEMENTS

Not applicable

# 6. PREPROCESSING ELEMENTS

Onboard data handling, data storage, and preprocessing elements are all considered under the heading of preprocessing, herein.

Data collected onboard the aircraft are preprocessed by means of three HP2100A computers. One of the computers is used by the radar; the remaining two operate as a dual system with one used for recording data and the other used for real-time parameter analysis and data display. In addition, the real time computer is designed to assume recording responsibilities should the recording computer malfunction. Data that are collected from each sensor are converted from analog to digital values. It is then made available for real-time display and written on digital magnetic tape in computer compatible format.

The preprocessing elements are depicted in Figure 6-1.

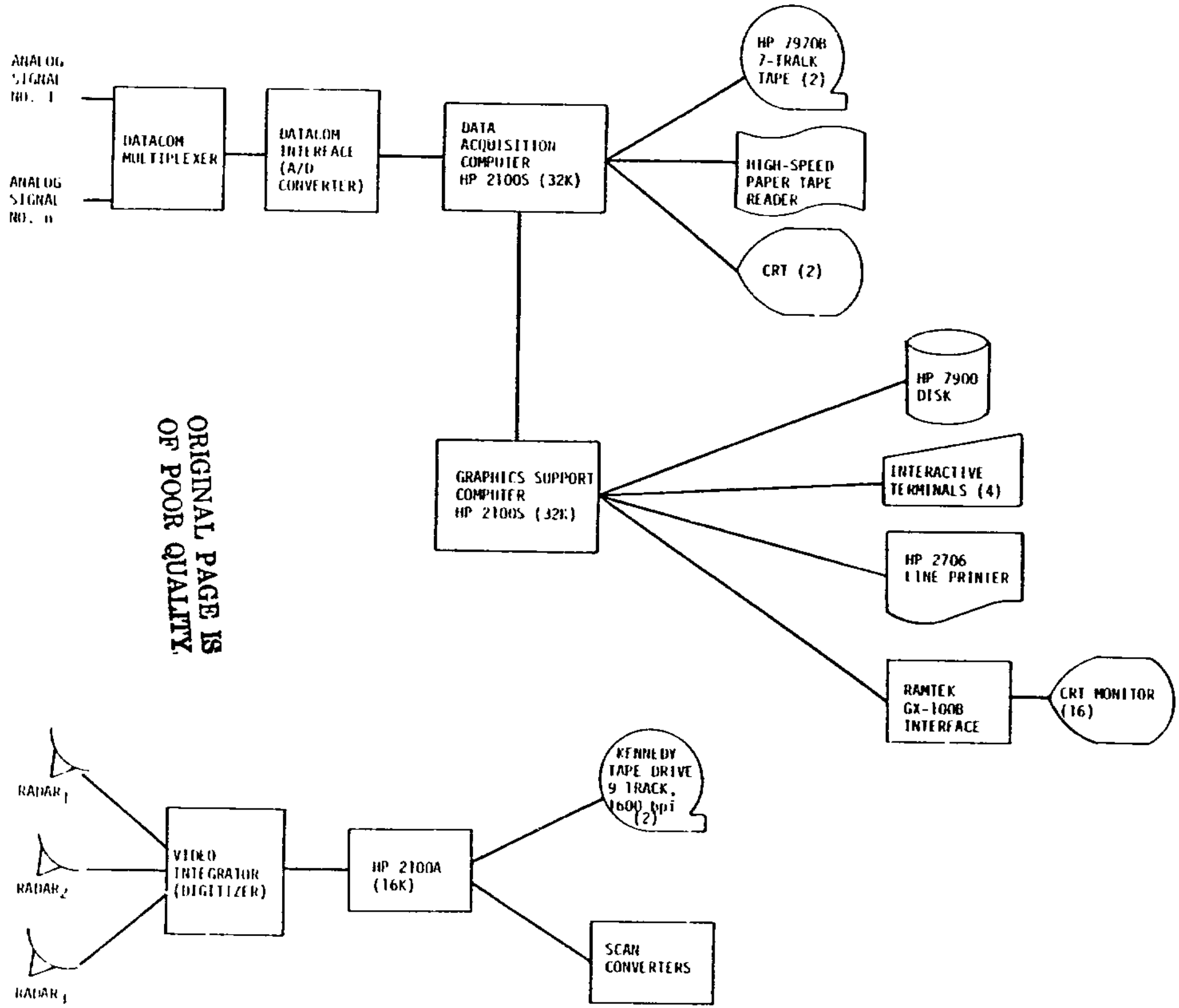


FIGURE 6-1. PREPROCESSING ELEMENTS

# 7. ERL PROCESSING ELEMENTS

The processing elements presented in this section are those elements that exist at the ERL Headquarters located at Boulder, Colorado.

## 7.1 CURRENT CAPABILITY

The data processing system configuration at ERL is shown in Figure 7-1. Specific hardware/software capabilities are listed in Paragraph 7.7.1.

### 7.1.1 Hardware Capability

- 1-CDC 6600 CPU Configured as follows:
  - ▲ 131 Kbyte main memory
  - ▲ 500 Kbyte extended core
  - ▲ Five 100 Mbyte disk drives (844-21)
  - ▲ Six 200 Mbyte disk drives (844-41)
  - ▲ Twelve 7-track tape drives
  - ▲ Six 9-track tape drives
  - ▲ One 35-mm computer microfilm output facility
  - ▲ Three Model 512 printers
  - ▲ One Model 405 card reader
  - ▲ One Model 415 card punch
- 1-XDS 940 CPU, Configured as follows:
  - ▲ 64 Kbyte main memory
  - ▲ One 1-Mbyte drum
  - ▲ 1 XDS printer
  - ▲ Two 7-track tape drives

### 7.1.2 Software Capability

Software and algorithms for the above systems are as follows:

- CDC 6600
  - ▲ KRONOS 4.19 Operating System
  - ▲ IMSL Libraries
  - ▲ PASCAL, COBOL, BASIC, SORT/MERGE, FORTRAN
- XDS 940
  - ▲ TBD
- Communications Interface
  - ▲ COED - (Communications - Editing, an in-house system)

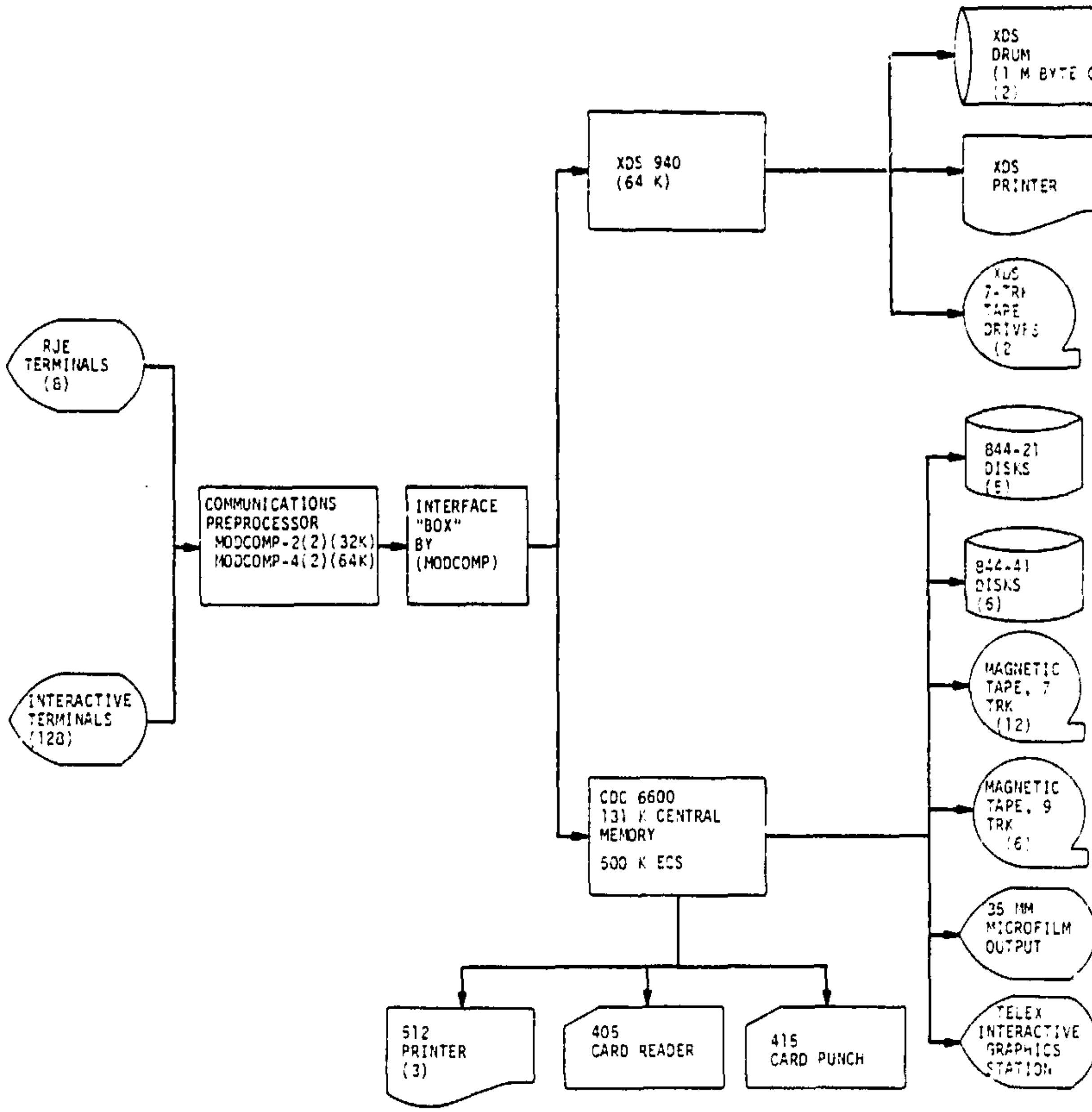


FIGURE 7-1. ERL COMPUTER FACILITY CONFIGURATION

## 7.2 CURRENT WORKLOAD

- Open three shifts, 24 hr/day, five days/week, plus Saturday
- Preventative maintenance - four hr/week
- Systems work - 9 to 10 hr/week, plus Sunday
- Normally 20 to 30 interactive jobs simultaneously
- Internal business processing comprises about 5% or less of total load.
- University/Federal grants personnel utilize about 7% of total load.

## 7.3 PROJECTED CAPABILITY TO 1980

### 7.3.1 Hardware



- 1977 - two 200 Mbyte disks
- 1979 - two to four 9-track tape drives
- 1979 - possibly another CDC 6600 joined as dual processor with current 6600
- May increase number of interactive terminals by increasing lines

### 7.3.2 Software

- Data Management System - TBD
- Graphics Package (e.g. DISSPLA) by 1978
- Modifications to communications preprocessor software to allow text editing and file management for interactive users

## 7.4 PROJECTED WORKLOAD TO 1980

- If second CDC obtained, it may be dedicated to modeling.
- Federal grantees/local universities will use about 7% of total time.

- Priority via time-of-day may be used to allow selected users [e.g., NHEML (MIAMI)] higher priority.

- Extent of Project SESAME data processing requirements is unknown.

## 7.5 PROJECTED CAPABILITY (1985)

### 7.5.1 Hardware

Not available

### 7.5.2 Software

Not available

## 7.6 PROJECTED WORKLOAD (1985)

### 7.6.1 Hardware

Not available

### 7.6.2 Software

Not available

# 8. DATABASE SYSTEM

None available at present.

# 9. INFORMATION DISTRIBUTION ELEMENTS

Distribution of information acquired from Project SESAME, that is provided to ERL, will be primarily in the form of magnetic tapes that are generated either on the airplanes or at the ground sites. The communication capabilities within the laboratories are used for remote job entry to the CDC 6600 and for interactive processing via either the CDC 6600 or the XDS 940, and consists of the following:

- 128 data lines ranging from TTY speeds to 9600 baud
- Two Modcomp 2 communication processors with 32-Kbyte main memory each
- Two Modcomp 4 communication processors with 64-Kbyte main memory each.

# 10. INFORMATION PRESENTATION ELEMENTS

Devices which provide the presentation of information at ERL are the following:

- Three CDC Model 512 printers (1100 lines/min)
- 118 interactive alphanumeric and/or graphics terminals connected to the communications interface
- XDS printer (for use only by privileged users).