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EXPERIMENTAL INVESTIGATION OF ATMOSPHERIC RESPONSE TO THE TOTAL--ETC(U)
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EXPERIMENTAL INVESTIGATION OF ATMOSPHERIC RESPONSE TO THE TOTAL SOLAR ECLIPSE OF 26 FEBRUARY 1979.

CONDUCT OF FIELD MEASUREMENTS.
PHASE III.

Contract No. DAAD07-78-C-0058

submitted to

U.S. Army Electronics Command
Atmospheric Sciences Laboratory
White Sands Missile Range, New Mexico

18 April 1979

NEW MEXICO STATE UNIVERSITY
Physical Science Laboratory
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FOREWARD

This report is intended to be a description of the field program carried out near Red Lake, Ontario, during a period of approximately ten days centered upon the solar eclipse of 26 February 1979. The report in no sense attempts to present quantitative data derived from the experimental program. Analysis of such data will be the subject of later reports.

Although this report concentrates on those portions of the eclipse field program supported by the Atmospheric Sciences Laboratory, some effort has been directed to brief descriptions of experiments supported by others. Further, the interrelationships among the several participating groups during the field program are outlined.

Finally, this report constitutes the Interim Technical Report called for under provisions of Contract DAAD07-78-C-0058, paragraph 3.3 of the Purchase Description. Data acquired by the various instruments is in the process of reduction and will be transferred to the participating experimental groups for subsequent analysis.

1. SUMMARY

During the solar eclipse of 26 February 1979, experiments sponsored by the U.S. Army Atmospheric Sciences Laboratory, U.S. Air Force Geophysics Laboratory, National Aeronautics and Space Administration and the National Research Council of Canada were carried out in the vicinity of Red Lake, Ontario. Measurements were carried out by:

- Fourteen large sounding rockets
- Nineteen small sounding rockets
- A ground-based partial reflection experiment
- A mobile optical observatory
- A ground-based polarimeter
- An Ionosonde located at Kenora, Ontario

Principal objectives of the experimental program centered upon measurements of background atmospheric parameters and their changes during the eclipse in the altitude range of 30-200 km. The experimental program was highly successful. Approximately 96 percent of the more than 80 measurements carried out by the sounding rockets were successful in terms of instrument operation. During the eclipse energetic particles were precipitating into the atmosphere, a factor of considerable importance in the analysis of data obtained from the experimental program.

The field program entailed coordinated operations at several sites with physical separations of up to 25 miles. Despite the generally cold weather (temperatures as low as -40°C), snowy conditions and nature of temporary installations, the operations were successful in meeting an inflexible schedule of activities while maintaining the critical ground support power, communications, telemetry and tracking.

2. INTRODUCTION

On 26 February 1979, a total eclipse of the sun took place over North America, the last such event this century. Location of the path of totality and times of maximum phase are shown in Figure 2.1.

Under sponsorship of the U.S. Army Atmospheric Sciences Laboratory (ASL), the Air Force Geophysics Laboratory (AFGL), National Aeronautics and Space Administration (NASA) and National Research Council of Canada (NRC), an extensive experimental program was carried out in conjunction with the eclipse. Sites for the field program were located in the vicinity of Red Lake, west central Ontario. Major activity in this program centered upon experiments carried out with sounding rockets launched within the time period 19-27 February. The large majority of the launchings took place on 26 February, the day of the eclipse. However, substantial supporting data were gathered by three ground-based experiments and appropriate scientific satellites of opportunity.

At the peak of activity, approximately 200 people, associated with the experiments, were present in the Red Lake area. In addition to personnel from the sponsoring agencies named above, scientists, engineers and technicians from the following institutions and organizations participated as well.

- Physical Science Laboratory, New Mexico State University
- Utah State University
- University of Texas at El Paso
- Pennsylvania State University
- Cornell University
- University of Pittsburgh
- University of Illinois
- University of Bern

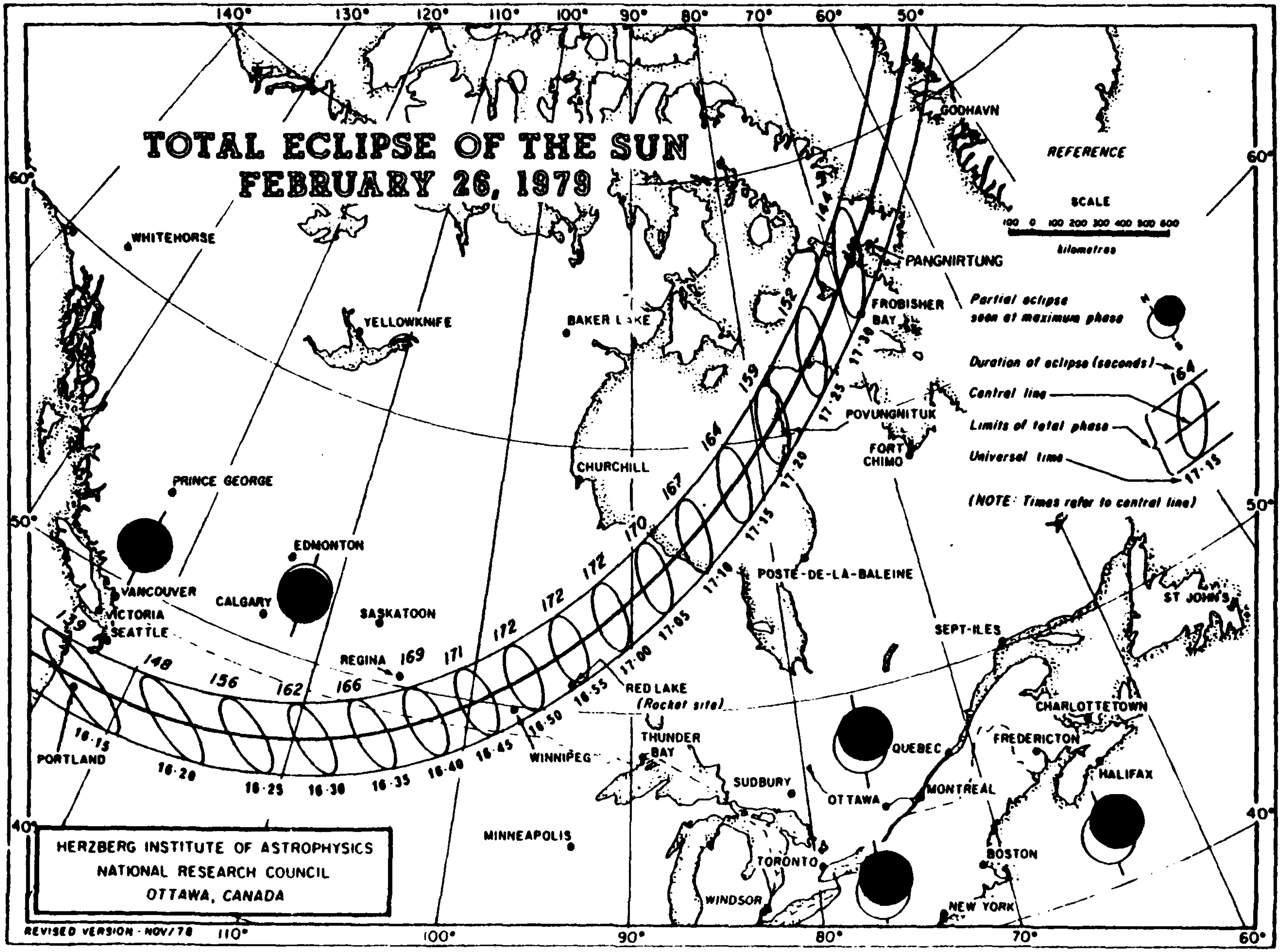
TOTAL ECLIPSE OF THE SUN
FEBRUARY 26, 1979
REFERENCE
SCALE
100 0 100 200 300 400 500 600
kilometres
Partial eclipse seen at maximum phase
Duration of eclipse (seconds)
Central line
Limits of total phase
Universal time
(NOTE: Times refer to central line)
WHITEHORSE
YELLOWKNIFE
BAKER LAKE
CHURCHILL
PRINCE GEORGE
EDMONTON
CALGARY
SASKATOON
REGINA
VANCOUVER
VICTORIA
SEATTLE
PORTLAND
WINNIPEG
RED LAKE
(Rocket site)
THUNDER BAY
SUDBURY
MINNEAPOLIS
TORONTO
WINDSOR
OTTAWA
MONTREAL
QUEBEC
SEPT-ILES
POSTE-DE-LA-BALEINE
POVUNGNITUK
FORT CHIMO
FROBISHER BAY
PANGNIRTUNG
GODHAVN
ST JOHN'S
CHARLOTTETOWN
FREDERICTON
HALIFAX
BOSTON
NEW YORK
HERZBERG INSTITUTE OF ASTROPHYSICS
NATIONAL RESEARCH COUNCIL
OTTAWA, CANADA
REVISED VERSION · NOV/78

Figure 2.1

- U.S. Naval Research Laboratory
- Oklahoma State University
- Northeastern University
- York University
- University of Saskatchewan
- Herzberg Institute of Astrophysics, National Research Council of Canada
- Accumetrics
- ADGA Systems International Ltd.
- Bristol Aerospace Ltd.
- SSAB-Scania Aerospace Division
- Ball Aerospace Service Division

In the field, NASA and NRC were represented by personnel from the Wallops Flight Center (WFC) and Space Research Facilities Branch, respectively. Sounding rocket launch operations on behalf of experiments sponsored by ASL and AFGL were carried out by operations personnel of ASL and PSL.

In planning for the experimental program supported by ASL, major consideration was given to the plans of other participants. This was done because many of the measurement objectives of others closely paralleled as complemented the ASL measurement objectives. Thus it was possible in the ASL-supported program to concentrate on measurements not carried out by other experimenters and count upon the results of others for a data set optimized in terms of cost and underlying scientific objectives. Because of this circumstance, the experiment details which follow in Section 3 of this report addresses the programs supported by all participants in the field efforts in the Red Lake area. The experiments supported by ASL are detailed in Appendix A to this report.

Background on the scientific objectives for the experimental program supported by ASL have been described in earlier reports prepared under the contract with the Physical Science Laboratory (PSL) and will not be repeated here. Two recent ASL reports [1, 2] (Section 5) have considered existing problems in the modeling of D-region ion chemistry and the potential contribution of experiments during the 1979 solar eclipse for addressing these problems.

Finally, a summary of the operations activities is presented in Section 4 of this report and details given in Appendices B and C.

3. EXPERIMENTAL RESULTS

Experiments carried out near Red Lake, Ontario during the several day period centering upon the eclipse of 26 February were characterized by an unusually high degree of success in the aggregate. Of the approximately 80 separate measurements made with sounding rockets only two appear to have failed or will yield substantially less data than planned. Several of these rocket measurements were of considerable complexity and required simultaneous functioning of several sensors. Ground-based measurements of electron densities in the D-region with the partial reflection technique and in the E- and F-regions by the ionosonde at Kenona appear equally successful. Good measurements of total electron content over a two week period were obtained by a polarimeter at the Chukuni launch site receiving the 136.47 MHz transmission from ATS-3. By virtue of location, the transmission path was in totality from 0-800 km at maximum phase.

During the period of the eclipse near Red Lake a particle precipitation event was in progress which can be expected to mask certain of the eclipse-induced effects in the high and middle atmosphere. In Figure 3.1 is shown, for TIROS N, the magnetic latitude/longitude orbital trace together with particle counts for a seven hour period including the time of the solar eclipse.* The particles counted were electrons with energies greater than 30 KeV. The circled points represent counts as the satellite crossed the geomagnetic latitude of Red Lake. In terms of x-ray flux, the sum was relatively quiet during the eclipse as shown in Figure 3.2. However, about two hours after totality at Red Lake, a solar flare did occur. Coincidentally a Super Arcas instrumented to measure solar Lyman alpha and electron density was launched at the onset of the flare. In Figure 3.3 is shown a record of the enhanced x-ray flux together with the flight period of the Super Arcas.

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*These data, together with x-ray flux measurements from the GOES-2 and GOES-3 satellites were supplied by the Environmental Research Laboratories of NOAA.

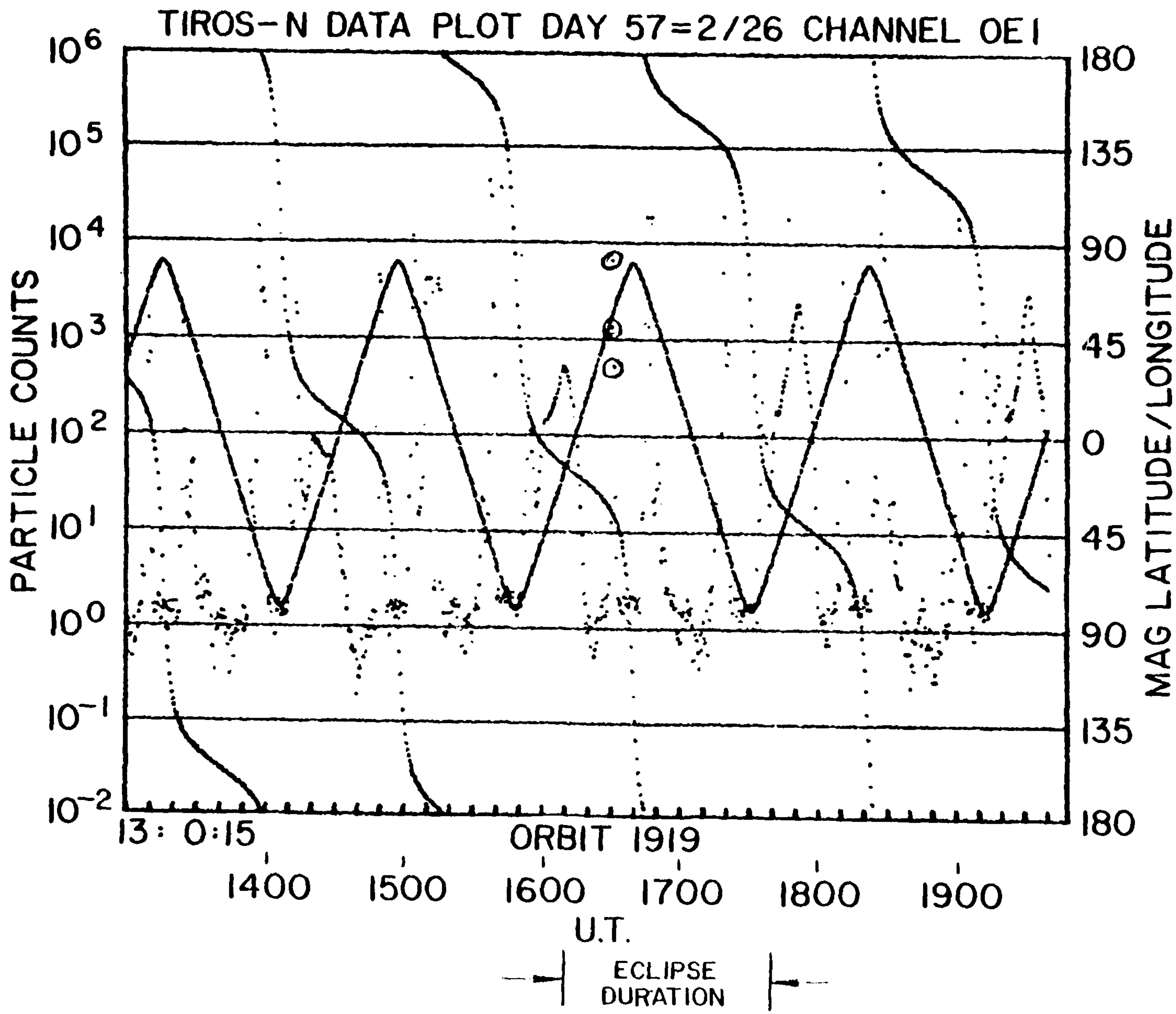

Figure 3.1 Counting Rate for Electrons: E>30 KeV

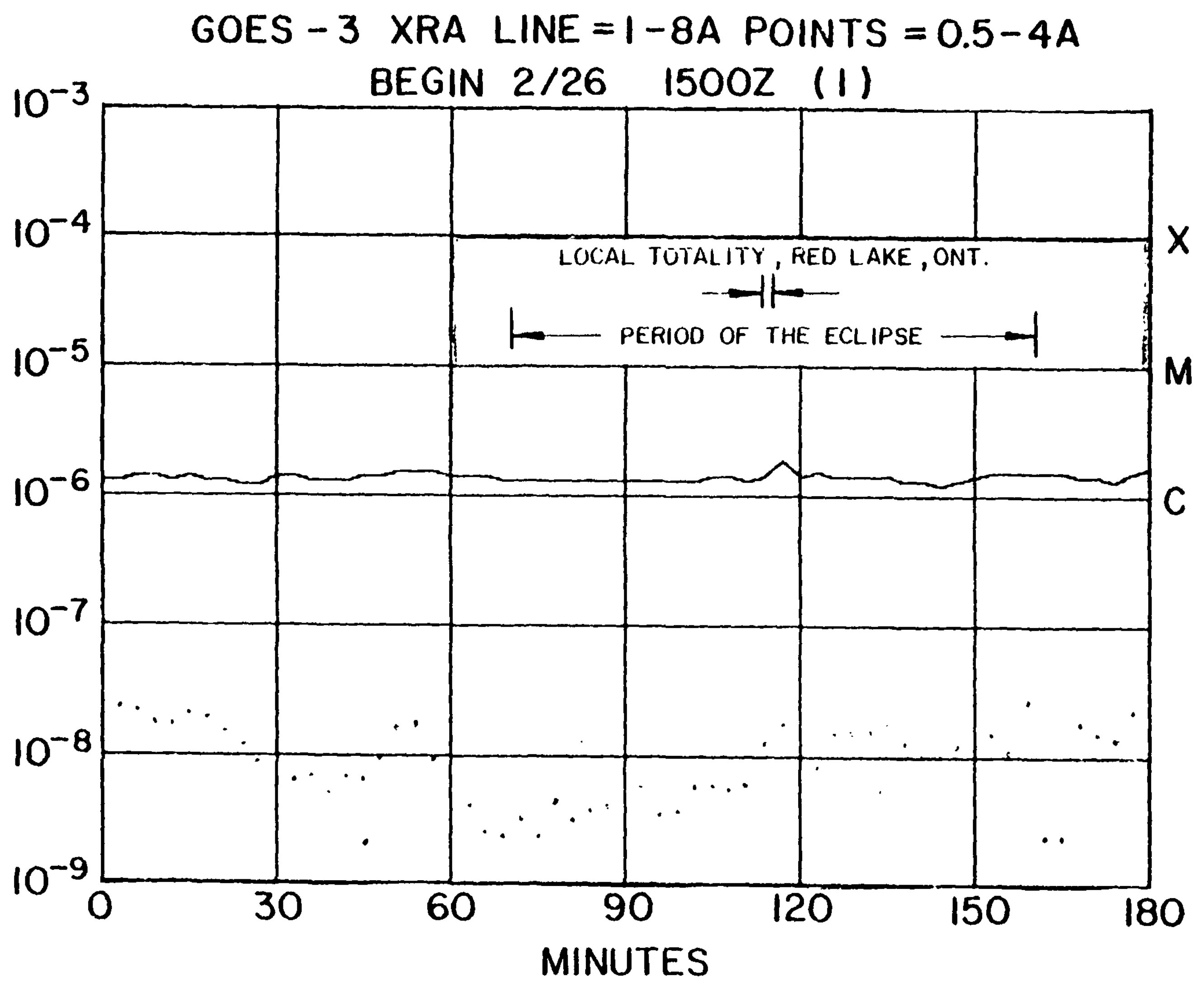

Figure 3.2 Solar X-Ray Flux Incident Upon the Atmopshere (watts/m^2)

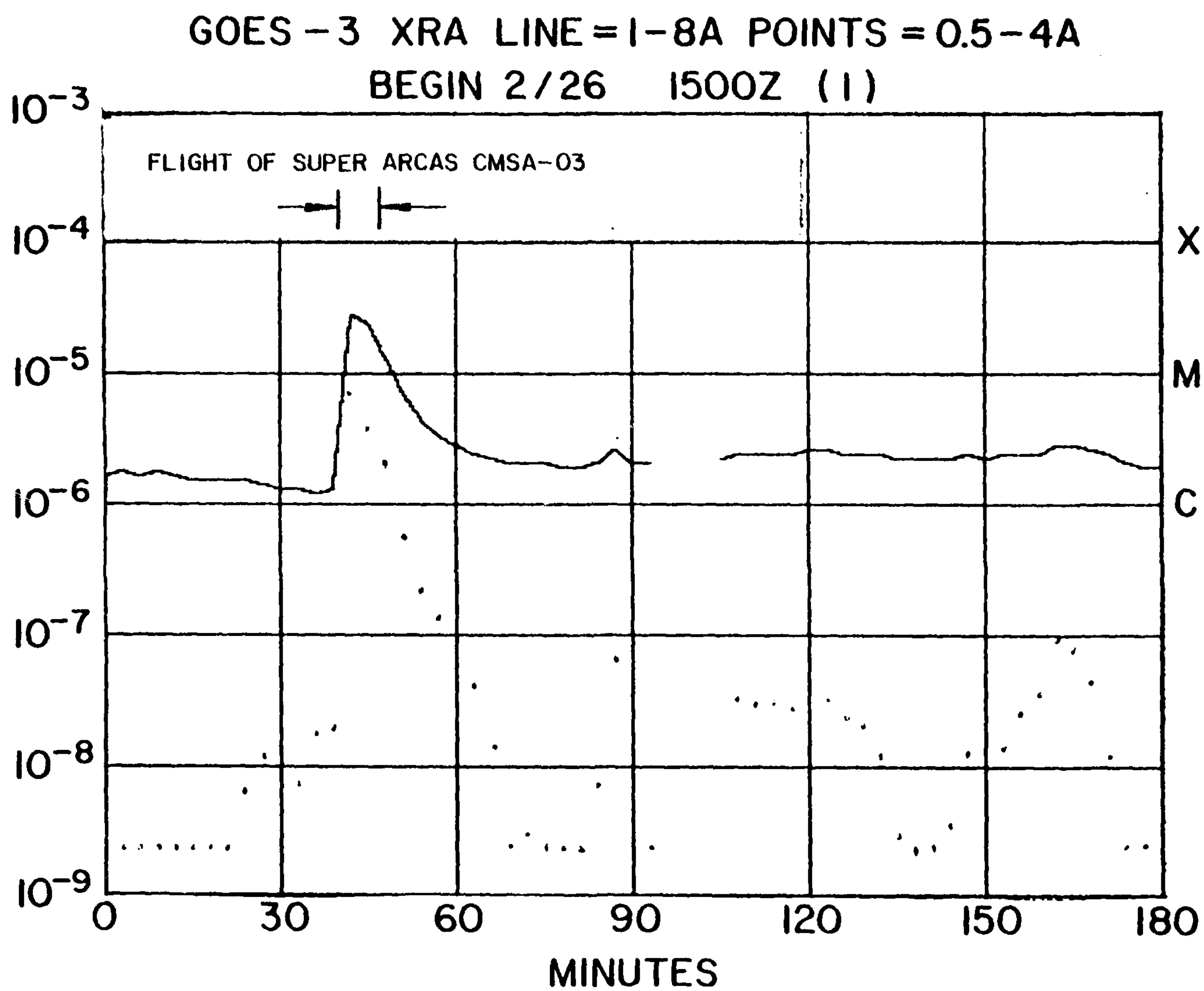

Figure 3.3 Solar X-Ray Flux Incident Upon the Atmosphere (watts/m^2)

The following has been assembled from materials prepared for the operations manuals and public release information from discussions held with experimenters and from the record of operations during the eclipse experimental program. The material may not be rigorously accurate in detail and should be treated accordingly. In particular, the post-operation comments by the experimenters are indicative rather than conclusive.

3.1 Summary Information

In Table I is summarized in generic terms the sources of data relevant to the measurements program carried out near Red Lake. In Table II is shown the schedule for the sounding rockets launched over a period of several days, together with the measurements attempted with each rocket. The information in Table II combined with material in the following section enables identification of experimenters and specific quantities measured in the sounding rocket experiments. Predicted and realized payload apogees were reasonably close. In Figure 3.4 is shown the time distribution of sounding rocket launchings. Not indicated are the meteorological rocket launches on 19 February and 23 February.

The partial reflection experiment, located in Balmertown, operated from 8 February to 28 February. The schedule of operations on the day of the eclipse is shown in Figure 3.5. Profiles of D-region electron density in the altitude interval of 60-100 km are anticipated.

The ionosonde located at Kenora, Ontario, began operations on 16 February and ceased operating on 27 February. On the day of the eclipse soundings were made every five minutes except for a three-hour period centered on local totality. For the latter period, soundings were made under continuous operation (approximately one sounding every 30 seconds). During the eclipse ionosondes were also operated at Saskatoon, Ft. Churchill and Ottawa.

TABLE I

Sources of Data Relevant to the 1979 Solar Eclipse Measurements near Red Lake

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Electron Density	Sounding Rocket	2/24	1652 U.T.	• Profile, 65-135 km
	Sounding Rocket	2/24	1654:50	• Profile, 60- 90 km
	Sounding Rocket	2/25	1700:03	• Profile, 60- 90 km
	Sounding Rocket	2/26	1628	• Profile, 65-135 km
	Sounding Rocket	2/26	1628:30	• Profile, 65-155 km
	Sounding Rocket	2/26	1650:45	• Profile, 65-130 km
	Sounding Rocket	2/26	1652	• Profile, 65-135 km
	Sounding Rocket	2/26	1653:30	• Profile, 80-195 km
	Sounding Rocket	2/26	1653:45	• Profile, 80-185 km
	Sounding Rocket	2/26	1654:10	• Profile, 65-135 km
	Sounding Rocket	2/26	1840	• Profile, 60- 90 km
	Sounding Rocket	2/27	1410	• Profile, 60- 90 km

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (Continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Electron Density	Polarimeter	2/15-2/27	Continuous except for infrequent power loss and maintenance	• Provides measure of total electron content between Chukuni launch site and satellite ATS-3
	Partial Reflection	2/8-2/27	Intermittent but one-minute intervals at time of eclipse	• Profile, 60-100 km
	Ionosonde	2/16-2/26	Intermittent but 30-second intervals (Kenora) at time of eclipse	• Profile of E- and F-regions • Ionsondes at Kenona (Ont.) Ottawa (Ont.), Churchill (Man.) and Saskatoon (Sask.)
Ion Composition and Relative Densities	Sounding Rocket	2/24	1652	• Positive Ions, 65-135 km
	Sounding Rocket	2/26	1652	• Positive Ions, 65-135 km
	Sounding Rocket	2/26	1652:30	• Positive and Negative Ions, 65-117 km
	Sounding Rocket	2/26	1653:30	• Positive Ions, 100-195 km
	Sounding Rocket	2/26	1653:45	• Positive Ions, 100-185 km • Neutral Ions, 100-185 km
	Sounding Rocket	2/26	1654:10	• Negative Ions, 65-135 km
	Sounding Rocket	2/26	1741	• Positive and Negative Ions, 65-117 km

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (Continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Atmospheric Emission	Sounding Rocket	2/26	1628	• Infrared at 1.27 μm, 1.595 μm, 1.944 μm
	Sounding Rocket	2/26	1650:45	• 2150 Å • Infrared at 1.27 μm
	Sounding Rocket	2/26	1651:55	• Infrared at 2.9 μm, 9.6 μm and 10.4 μm
	Sounding Rocket	2/26	1653:45	• UV at 1100-1600 Å • Visible at 3466 Å and 5199 Å
	Mobile Optical Observatory	2/24-2/26	Evening Twilight and Totality	• Infrared Spectrometer, 1-3 μm • Radiometers at 1.27 μm and 2.7 μm
Densities of Minor Neutral Species	Sounding Rocket	2/26	1628	• Profiles of O, NO, OH, O_3 and $O_2(^1\Delta g)$, 65-135 km
	Sounding Rocket	2/26	1650:45	• Profile of O_3, 65-130 km
	Satellite (NIMBUS G)	2/26	Sun Synchronous Polar Orbit	• Profiles, into lower mesosphere of NO_2, H_2O, O_3, HNO_3 and CO_2 • Profiles to altitude of 65 km (max), of H_2O, N_2O, CH_4, CO and NO • Total O_3 content
	Satellite (DMSP)	2/26	Early morning and local noon	• Profiles through stratosphere of H_2O and O_3
	Satellite (TIROS N)	2/26	Sun Synchronous	• Profile of H_2O to ~ 50 km

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (Continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Positive/Negative Ion Conductivity, Mobility and Density	Sounding Rocket	2/24	1722	• Conductivities, 30-85 km
	Sounding Rocket	2/25	1730	• Profile, 30-77 km
	Sounding Rocket	2/26	1650:50	• Profile, 45-85 km
	Sounding Rocket	2/26	1653	• Profile, 30-55 km
	Sounding Rocket	2/26	1738	• Profile, 30-77 km
	Sounding Rocket	2/27	0330	• Profile, 30-77 km
	Sounding Rocket	2/27	0440	• Conductivities, 30-65 km
	Sounding Rocket	2/27	1200	• Profile, 30-85 km
	Sounding Rocket	2/27	1306	• Profile, 30-77 km
	Sounding Rocket	2/27	1440	• Conductivities, 30-65 km
Direct and Scattered Solar Ultraviolet	Sounding Rocket	2/24	1652	• 1216 Å
	Sounding Rocket	2/24	1654:50	• 1216 Å
	Sounding Rocket	2/25	1700:03	• 1216 Å
	Sounding Rocket	2/26	1628	• 1216 Å
	Sounding Rocket	2/26	1628:30	• 1216 Å, 2050 Å
	Sounding Rocket	2/26	1652	• 1216 Å

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (Continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Direct and Scattered Solar Ultraviolet	Sounding Rocket	2/26	1654:10	• 1216 Å
	Sounding Rocket	2/26	1840	• 1216 Å
	Sounding Rocket	2/27	1410	• 1216 Å
	Satellite (AE-E)	2/24, 2/26	One Orbit	• 140 Å - 1190 Å, 1227 Å - 1850 Å
	Satellite (NIMBUS G)	2/26	Sun Synchronous	• 0.2 - 5 μm (9-channels)
Particle Precipitation	Rocket	2/24	1652	• Electrons/Protons >10 kev
	Rocket	2/26	1628:30	• Electrons/Protons >10 kev
	Rocket	2/26	1652	• Electrons/Protons >10 kev
	Rocket	2/26	1654:10	• Electrons/Protons >10 kev
	Satellite (TIROS N)	2/26	1315-2015	• Electrons >0.3 kev • Protons >30 kev
	Satellite (P-78-1)	2/26	Sun Synchronous	• Electrons $3<E<1000$ kev • Protons $100<E<10^5$ kev
Atmospheric Density and Temperature	Sounding Rocket	2/19	2023	• Temperatures, 30-65 km
	Sounding Rocket	2/23	1759:58	• Temperatures/winds, 30-65 km
	Sounding Rocket	2/24	1551	• Temperatures/winds, 30-65 km

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (Continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Atmospheric Density and Temperature	Sounding Rocket	2/25	1830	• Temperatures/winds, 30-65 km
	Sounding Rocket	2/26	1628:30	• Profile, 40-150 km
	Sounding Rocket	2/26	1748	• Profile, 30-105 km
	Sounding Rocket	2/26	1915	• Temperatures/winds, 30-65 km
	Sounding Rocket	2/27	0530	• Temperatures/winds, 30-65 km
	Sounding Rocket	2/27	1545	• Temperatures/winds, 30-65 km
	Satellite (TIROS-N)	2/26	Sun Synchronous	• Temperature to ~ 50 km
	Satellite (NIMBUS G)	2/26	Sun Synchronous	• Temperature to ~ 90 km
	Satellite (DMSP)	2/26	Early morning and local noon	• Temperature through stratosphere
Electric Fields	Sounding Rocket	2/26	1650:50	• Vertical, 45-85 km
	Sounding Rocket	2/26	1653:30	• AC/DC Vector, 100-195 km
	Sounding Rocket	2/27	1200	• Vertical, 30-85 km
Solar X-ray Flux	Sounding Rocket	2/24	1652	• 2-8 Å
	Sounding Rocket	2/26	1628:30	• 1-10 Å
	Sounding Rocket	2/26	1652	• 2-8 Å

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE I (*Continued*)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Solar X-ray Flux	Sounding Rocket	2/26	1654:10	● 2-8 Å
	Satellite (SOLRAD)	2/26	0000-1400	● 0.5-3 Å, 1-8 Å, 2-10 Å, 8-20 Å, 44-60 Å
	Satellite (GOES-3, -4)	2/26	0000-1400	● 0.5-4 Å, 1-8 Å
Cosmic Ray Flux	Sounding Rocket	2/26	1628:30	● E>2Mev

*All times are given in U.T.; Times for sounding rockets represent time of launch.

TABLE II

1979 SOLAR ECLIPSE SOUNDING ROCKET LAUNCH SUMMARY

Launch Date	Vehicle Identification	Launch Time (U.T.)	Predicted Apogee (km)	Predicted Flt. Time (sec)	Measured Parameters
19 February	CMSL-01	2023	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
23 February	CMSL-02	1759:58	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
24 February	CMSL-03	1551	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
24 February	18.1020 UE	1652	137	870	• Positive Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Solar Lyman Alpha (Lα)
24 February	CMSA-01	1654:50	92	360	• Electron Density; • Solar Lyman Alpha Radiation (Lα)
24 February	CMSA-10	1722	86	7200	• Positive and Negative Ion Conductivities
25 February	CMSA-02	1700:03	92	360	• Electron Density; • Solar Lα
25 February	CMSA-05	1730	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
25 February	CMSL-04	1830	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
26 February	ASL-SE-79A1 (A_1)	1628	133	354	• Density and Altitude Distribution of NO, O, O_3, OH and O_2 ($^1\Delta g$); • Solar Lα; • Electron Density and Temperature
26 February	ASL-SE-79B1 (B_1)	1628:30	150	374	• Solar Lα; • Electron/Proton Flux and Spectra; Solar X-Rays; • Cosmic Ray Flux (>2 Mev); • Solar UV (2050 Å); • Electon Density/Temperature; • Atmospheric Density/Temperature (40-150 km)
26 February	AMF-VA-51	1650:45	135	700	• Vacuum UV Spectra of Prominences and Corona/Chromosphere Interface; • Electron Density/Temperature; • Altitude Distribution of O_3
26 February	23.010 UE	1650:50	82	6300	• Positive and Negative Charge Conductivity (w/wo Flashing Lamps); • Vertical Electric Field
26 February	A12.9A2 (G_1)	1651:55	133	354	• Atmospheric Infrared Emission of OH (2.7μ), O_3 (9.6μ) and Excited O_3 or CO_2 (10.4μ)
26 February	18.1021 UE	1652	137	870	• Positive Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Direct/Scattered Solar Lα
26 February	A10.802-1 (C_1)	1652:30	120	700	• Positive and Negative Ion Composition and Relative Densities; • Total Positive and Negative Ion Densities
26 February	CMSA-06	1653	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
26 February	33.004 UE	1653:30	194	700	• AC/DC Vector Electric Fields; • Plasma Wave Amplitude/Spectra; • Electron Density/Temperature; • Positive Ion Composition
26 February	33.003 UE	1653:45	184	700	• Neutral and Positive Ion Composition; • Electron/Ion Density/Temperature; • Visible and VUV Airglow (Selected Wavelengths)
26 February	18.1022 UE	1654:10	137	870	• Negative Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Direct/Scattered Solar Lα
26 February	CMSA-07	1738	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
26 February	A10-802-2 (C_2)	1741	120	700	• Positive and Negative Ion Composition and Relative Densities; • Total Positive and Negative Ion Densities
26 February	A07.712-2 (B_2)	1743	200	560	• Atmospheric Density and Temperature (30-105 km)
26 February	CMSA-03	1840	92	360	• Electron Density; • Solar Lα
26 February	CMSL-05	1915	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
27 February	CMSA-08	0330	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
27 February	CMSL-09	0440	66	7200	• Positive and Negative Ion Conductivities
27 February	CMSL-06	0530	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
27 February	23.009 UE	1200	82	6300	• Positive and Negative Charge Conductivity (w/wo Flashing Lamps); • Vertical Electric Field
27 February	CMSA-09	1306	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
27 February	CMSA-04	1410	92	360	• Electron Density; • Solar Lα
27 February	CMSL-10	1440	66	7200	• Positive and Negative Ion Conductivities
27 February	CMSL-08	1545	66	7200	• Atmospheric Temperature; • Winds (10-60 km)

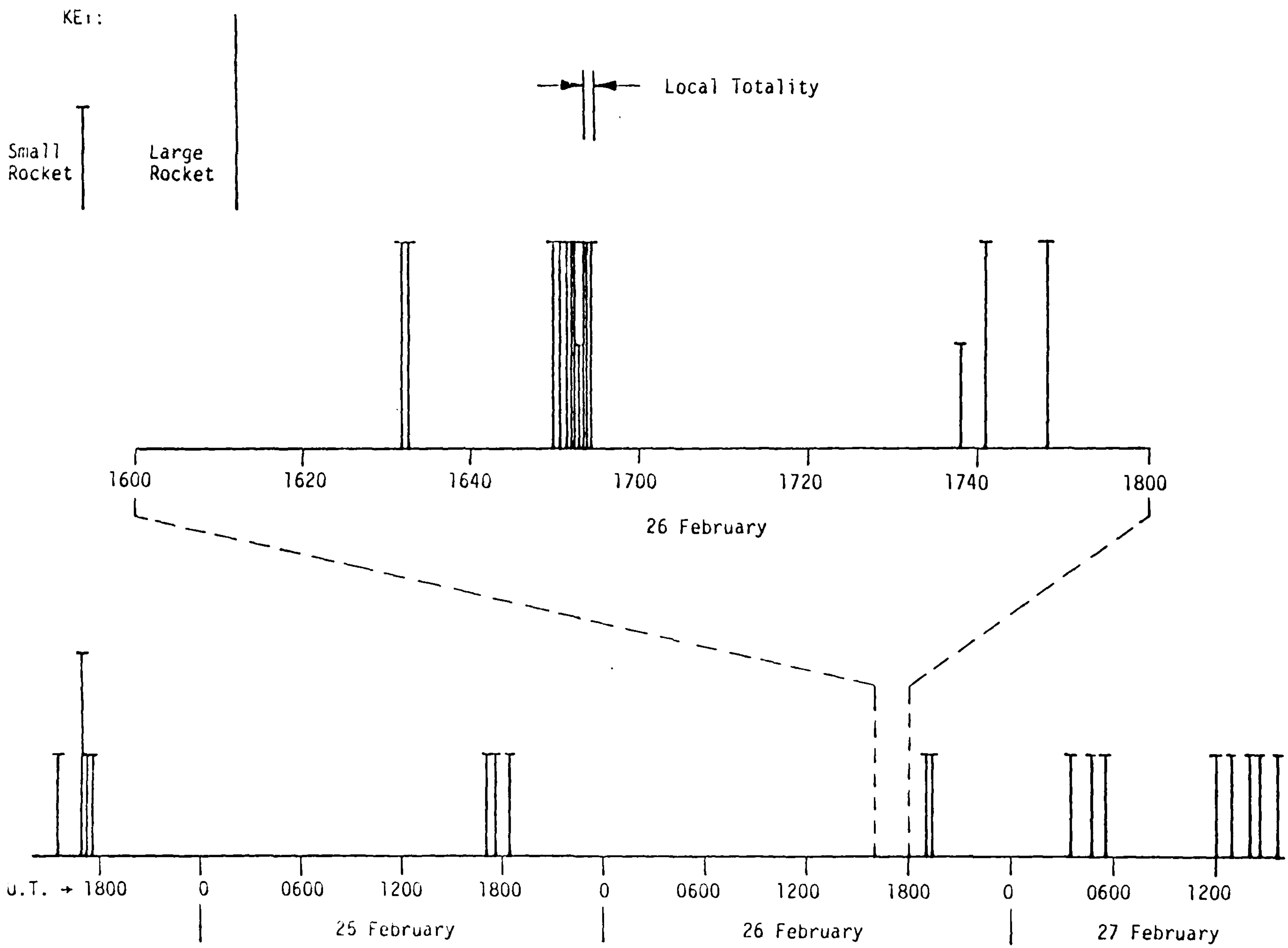

Figure 3.4 Time Distribution of Sounding Rocket Launches, Red Lake, Ontario
1979 Solar Eclipse

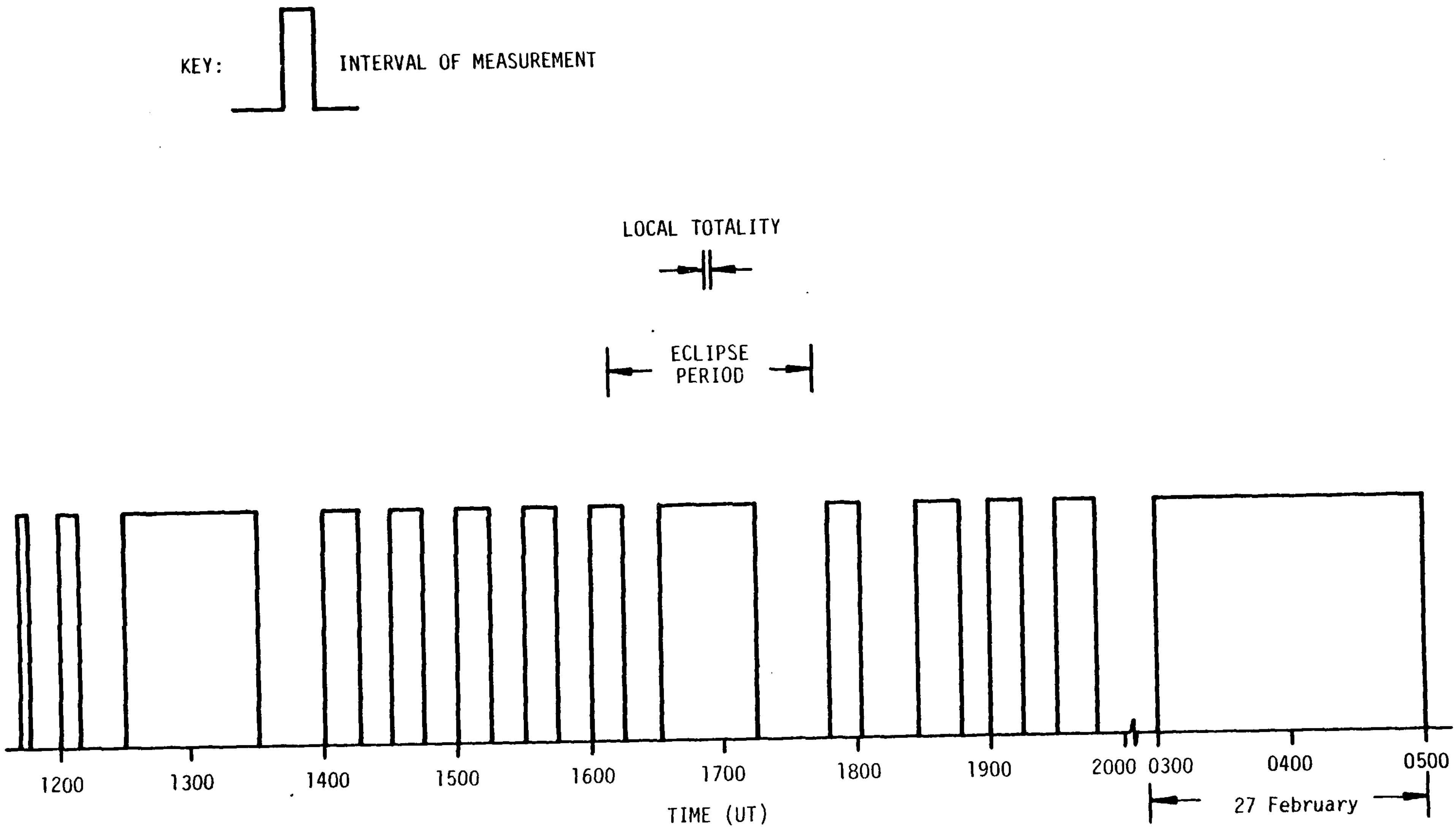

FIGURE 3.5 Data-Taking Intervals for Partial Reflection Experiment on Day of the Solar Eclipse

The Mobile Optical Observatory was located at Stoner Lake approximately 40 miles north of Cochenour. Twilight observations were carried out during the evenings of 24, 25 and 26 February as well as during the time of the eclipse.

3.2 Experiment Details

3.2.1 Sounding Rocket Program

3.2.1.1 Rocket No: ASL-SE79A1

Launch Vehicle: Nike-Orion

Principal Investigator: Professor Kay Baker
Space Science Laboratory
UMC 41
Utah State University
Logan, Utah 84322
(801) 752-4100 X7395

Sponsor: U.S. Army Atmospheric Sciences Laboratory

The principal objective was the measurement of density and altitude distribution of minor neutral species important to the neutral and ion chemistry of the middle atmosphere. Secondary objectives were the measurements of solar Lyman alpha flux and the density/distribution of free electrons.

Specific Instrumentation

1. UV lamp and photometer, ~1300 Å (oxygen number density by resonance excitation of triplet 1302, 1304, 1306 Å)
2. 5577 Å photometer (oxygen number density from emission of O['S])
3. 2150 Å photometer (resonance scattering of solar radiation by NO in the γ bands [~2050-2250 Å])
4. 1.27 μm radiometer (number density of $O_2[^1\Delta g]$)

5. 1.595 and 1.944 μm radimeters (number density of OH)
6. 2925, 2975, 3025 and 3075 Å photometers (number density of O_3)
7. 1216 Å ionization chamber (solar Lyman alpha flux)
8. Impedance probe (electron number density)

Comments

All instrumentation worked well and output signals behaved as expected and fell within the design range. Coning of the payload was not excessive, a factor which will ease data reduction for the attitude sensitive measurements. Peak altitude of the payload was 139.75 km, slightly higher than predicted. Early data from the atomic oxygen detector (resonance lamp experiment) indicates structure and a peak density of the order 10^{12} cm^{-3} at an altitude of 98 km. Very high background levels, particularly above 100 km, supports other measurements indicating significant particle precipitation at the time of the eclipse. The high background is consistent with high atomic oxygen densities.

3.2.1.2 Rocket No: ASL-SE79B_1*
Launch Vehicle: Nike-Orion
Principal Investigators:

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(505) 522-4400

Sponsor: U.S. Army Atmospheric Sciences Laboratory

Principal objectives were measurements of the photon and particle flux responsible for ionization and dissociation of the atmosphere, electron density and the density and temperature of the bulk neutral atmosphere.

*Instrumented jointly by Utah State University (USU) and Air Force Geophysics Laboratory (AFGL)

Specific Instrumentation

1. Electron spectrometer for particle flux in energy bins 10-30 kev, 30-100 kev, 100-300 kev, 300-1000 kev and >1000 kev.
2. Cosmic ray counter (energy >2 Mev)
3. Solar x-ray flux (1-10 Å)
4. 1216 Å photometer (solar Lyman alpha flux)
5. 2050 Å photometer (penetrating UV flux)
6. 10 inch falling sphere with triaxial piezoelectric accelerometer (atmospheric density and temperature)
7. Impedance probe (electron number density)

Comments

The 10 inch falling sphere (AFGL) was ejected at approximately 66 km on the upleg of the rocket flight. Sphere apogee appeared to be greater than 155 km. Data quality appeared to be excellent and atmospheric density in the altitude range of 40-150 km is anticipated. The sphere is sensitive to drag of 10^{-7}g and can provide resolution of 100-150 meters in density structure.

The energetic particle spectrometer observed exceptionally high fluxes for the latitude of Red Lake. At altitudes above 100 km the analogue output covering the power density range of 10^{-4} to 3×10^{-1} ergs/(cm^2 sec-ster) for electrons >7.5 kev was at times saturated. Pulse summation counters were frequently "rolled over" and should provide a very good measurement of energetic particle input.

The solar x-ray detector observed significant count rates to fairly low altitudes and the count rates were strongly spin modulated. The Lyman alpha detector provided very clear signals during the entire flight; the output increased to a maximum level at about 80 km and remained somewhat constant until payload descent to lower altitudes. The count rate from the cosmic ray detector increased from a background of approximately 1/second to about 100/second during flight.

All other instrumentation worked well.

3.2.1.3 Rocket Nos: CMSA 01, 02, 03, 04
Launch Vehicle: Super Arcas
Principal Investigator: Professor Kay Baker
Space Science Laboratory
Utah State University
UMC 41
Logan, Utah 84322
(801) 752-4100 X7395
Sponsor: U.S. Army Atmospheric Sciences Laboratory

Objectives were provision of electron density profiles and solar Lyman alpha flux under non-eclipse conditions for background data and for calibration of ground-based measurements of lower ionosphere electron densities.

Specific Instrumentation

1. RF impedance probe (electron density profiles)
2. DC probe (structure in electron density profiles)
3. 1216 Å ionization chamber (solar Lyman alpha flux)

Comments

Good data were obtained from all instruments on all flights. Lyman alpha flux was observed to change by approximately four orders of magnitude in a smooth fashion. Because of other commitments, radar did not track CMSA-03 (day of the eclipse). However, the Lyman alpha measurement combined with similar measurements from other rockets should provide good altitude information as a function of time.

3.2.1.4 Rocket Nos: CMSA 05, 06, 07, 08, 09
Launch Vehicle: Super Arcas
Principal Investigator: Professor Jack Mitchell
Electrical Engineering Dept.
University of Texas at El Paso
El Paso, Texas 79968
(915) 747-5470
Sponsor: U.S. Army Atmospheric Sciences Laboratory

Principal objective was to obtain altitude profiles of positive and negative ion conductivities, mobilities and total ion densities and to compare these measurements with those obtained by other measurement techniques.

Specific Instrumentation

1. Sub-sonic Gerdien condensor, parachute deployed (Starute decelerator) at rocket apogee.

Comments

Good conductivity data were obtained for all payloads flown. Due to payload ejection malfuction, CMSA-06, launched at 1653 U.T. on 26 February will not provide conductivity data above 55 km. Measurements indicate that negative particle conductivity was smaller than the positive particle conductivity.

3.2.1.5 Rocket No: CMSA-10
Launch Vehicle: Super Arcas
Principal Investigator: Professor Jack Mitchell
Electrical Engineering Dept.
University of Texas at El Paso
El Paso, Texas 79968
(915) 747-5470
Sponsor: U.S. Army Atmospheric Sciences Laboratory

Principal objective of this experiment was to obtain altitude profiles of positive and negative ion conductivities and to compare these with similar measurements made by Gerdien condensors.

Specific Instrumentation

1. Blunt probe, parachute deployed (Starute decelerator) at rocket apogee.

Comments

The instrumentation worked well and provided good charge conductivity data.

3.2.1.6 Rocket Nos: CMSL-01, 02, 03, 04, 05, 06, 08
Launch Vehicle: Super Loki
Principal Investigator: Mr. Frank Schmidlin
DAS
NASA/Wallops Flight Center
Wallops Island, Virginia 23337
(804) 824-3411
Sponsors: NASA/Wallops Flight Center; U.S. Air Force Air Weather Service; U.S. Army Atmospheric Sciences Laboratory

Objectives were the measurement of atmospheric densities, temperatures and winds in the altitude range of 30-65 km.

Specific Instrumentation

1. Bead thermistor, parachute deployed (Starute decelerator) at rocket apogee.
2. Tone ranging receiver (~400 MHz) to enable tracking and determination of winds.

Comments

Good data were obtained in the altitude range of 18-65 km (some apogees may be slightly lower). Good data were obtained for one flight and very good data for five flights. The seventh flight (CMSL-01) launched on 19 February was not tracked by radar so wind data is not anticipated. It may be possible to reconstruct the descent trajectory from GMD tracking if there is a strong desire for this. Tie-in with radiosonde data at the lower altitudes will be possible.

3.2.1.7 Rocket Nos: CMSL-09, 10
Launch Vehicle: Super Loki
Principal Investigator: Mr. Frank Schmidlin
DAS
NASA/Wallops Flight Center
Wallops Island, Virginia 23337
(804) 824-3411
Sponsors: NASA/Wallops Flight Center; U.S. Air Force Air Weather Service; U.S. Army Atmospheric Sciences Laboratory

Objectives were the measurement of positive and negative partical conductivities in the altitude interval 30-65 km and to compare these with measurements made by other experimenters.

Specific Instrumentation

1. Blunt probe, parachute deployed (Starute decelerator) at rocket apogee.

Comments

Instrumentation worked well and data on positive and negative particle conductivities were obtained. A third blunt probe in this configuration was scheduled for launch 1200 hrs U.T. on 27 February; however, instrumentation difficulties forced cancellation of flight and a meteorological payload, CMSL-08 was flown in its place (1545 U.T. on 27 February).

3.2.1.8 Rocket Nos: A10.802-1, -2
Launch Vehicle: Paiute-Tomahawk
Principal Investigator: Dr. Rocco Narcisi
Code LKD
Air Force Geophysics Lab.
Hanscom AFB, Maryland 01731
(617) 861-2109
Sponsor: U.S. Air Force Geophysics Laboratory

Principal objectives of the two flights were measurements of positive and negative ion composition and relative densities during totality and at a time when the atmosphere had recovered to nearly pre-eclipse conditions.

Specific Instrumentation

1. Cryopumped mass spectrometer measuring positive and negative ion mass spectra in alternating sequence. Positive ions measured in 14-100 AMU interval (sweep); negative ions measured in 14-200 AMU internal (sweep). Total number of ions with mass >160 AMU.
2. Boom-mounted Gerdien condensors to measure total positive and negative conductivity of the atmoshere.

Comments

Payload A10.802-1, launched at 1652:30 on 26 February was in totality 40 seconds of the up-leg and 120 seconds on the down-leg. Peak altitude for both payloads was approximately 117 km. Because of particle precipitation the O_2^+ density was enhanced and the NO^+/O_2^+ ratio depressed. Below approximately 90 km the positive ion data for both flights were very similar. For negative ions the data for eclipse and non-eclipse conditions were different. Good data were obtained on the distribution of clustered ions. Data were obtained to an altitude of

40 km on the down-leg. Data from the Gerdien condensors were obtained throughout flight (after their deployment). Neither payload was recovered because of inaccessibility of the impact site and penetration into the land surface.

3.2.1.9 Rocket No: A12.9A2
Launch Vehicle: Nike-Orion
Principal Investigators:

Professor Doren Baker
Dept. of Electrical Engineering
Utah State University
Logan, Utah 84322
(801) 752-4100

Mr. James Ulwick
Code OPR
Air Force Geophysics Lab.
Hanscom AFB, Maryland 01731
(617) 861-3188

Sponsor: Air Force Geophysics Laboratory

The objective was measurement of sunlit enhanced infrared emission from certain minor atmospheric species.

Specific Instrumentation

1. Three liquid helium-cooled radiometers sensitive to atmospheric emissions in the spectral regime about 2.9 μm, 9.6 μm and 10.4 μm. Radiating atmospheric species of principal interest were OH, O_3 and vibrationally excited O_3 and CO_2.

Comments

Good data were obtained from all three radiometers. Signals began at an altitude of approximately 74 km on the upleg and then decreased as apogee was approached. The reverse behavior was observed on descent. The observation of daytime aurora emissions under nighttime conditions (eclipse) should provide unusual information.

3.2.1.10 Rocket No: A07·712-2
Launch Vehicle: Nike-Iroquois
Principal Investigator: Mr. Andrew Faire
Code LKB
Air Force Geophysics Lab.
Hanscom AFB, Maryland 01731
(617) 861-3083
Sponsor: Air Force Geophysics Laboratory

Objectives of the experiment were the measurements of atmospheric density and temperature in the altitude regime, 30-105 km.

Specific Instrumentation

1. A seven inch falling sphere instrumented with a three-axis time-of-flight accelerometer.

Comments

The sphere was ejected at the programmed altitude on the up-leg and data from the descent portion of flight appears excellent.

3.2.1.11 Rocket Nos: 18.1020 UE, 18.1021 UE and 18.1022 UE
Launch Vehicle: Nike-Tomahawk
Principal Investigators:

Professor Leslie Smith	Dr. Ernest Kopp
Dept. of Electrical Engineering	Physikalisches Institute
University of Illinois	Sidlerstrasse 5, 3012 Bern
Urbana, Illinois 61801	Switzerland
(217) 333-4153	Tel.: 031/65 4415

Sponsor: National Aeronautics and Space Administration

The general objectives was the investigation of production and loss processes for ionization in the lower ionosphere during a total solar eclipse. The specific objectives of the flights were to obtain data on electron density, positive and negative ion composition, intensity of x-rays (1-8A), Lyman alpha (121.6 nm) and visible solar radiation, and flux of energetic protons.

Specific Instrumentation

1. Cryopumped ion mass spectrometer; 15-170 AMU (both positive and negative ions).
2. Boom-mounted probe for electron density structure and temperature.
3. Propagation experiments at 2225 kHz and 5050 kHz for electron density.
4. Geiger counter for x-rays (1 to 8 Angstroms).
5. Lyman alpha ion chamber (1216 Å)
6. Solar aspect sensor (eclipse modification)
7. Solid-state particle spectrometer: flux of particles with energies >40 kev, >70 kev and >125 kev.

Comments

Instrumentation performed well on all flights. Particle precipitation was high on both 24 and 26 February. The flux was greater and the spectrum harder on the 24th. Data were obtained in the altitude interval 65-135 km.

The positive ion mass spectrometer was flown on 24 February. Positive and negative ion spectrometers were flown on 26 February. On the 24th, a large number of intermediate clusters were observed and positive ion spectra to 170 AMU were obtained. On the 26th, the positive ion data looked much like the data on the 24th. The positive ion density was high. Good negative ion spectra to 170 AMU were obtained. The upper altitude for negative ions appeared to be approximately 85 km.

3.2.1.12 Rocket Nos: 23.009 UE and 23.010 UE

Launch Vehicle: Astrobee D

Principal Investigator: Professor Leslie Hale
Electrical Engineering, East
Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-6337

Sponsors: National Aeronautics and Space Administration;
U.S. Navy, Office of Naval Research;
U.S. Army Research Office

The object of this experiment was to determine the processes controlling charged particle densities in the ionospheric D-region, with particular emphasis on attachment and detachment processes. This was done under daytime (solar eclipse) and nighttime conditions. A blunt conductivity probe was used to sense positive ions and electrons. Multiple lamps at visible and ultraviolet wavelengths were cycled to determine their relative influence on the charged particle environment. An auxiliary experiment was an antenna to measure vertical electric (E) field, which may also affect charged particle densities. The probe is deployed with parachute at rocket apogee.

Specific Instrumentation

1. The outer electrode of a blunt conductivity probe contained six openings surrounding the central electrode in an annular configuration. Within these openings were flashing lamps, three operating in the visible spectrum, three in the ultraviolet. The ultraviolet lamps were filled with krypton with principal output at 1236 Å.
2. Antenna tied to riser on parachute for measurement of the vertical electric field.

Comments

Apogee for the 26 February flight was 86 km. The parachute did not deploy fully but the conductivity probe was working at second contact and on descent the mesosphere was in totality. Because of the parachute difficulty, the data are very ragged below 45 km. The flashing light experiment indicated that electron detachment was tied to the ultraviolet rather than the visible wavelengths.

The payload experienced a potential shift so that a compensation must be made to provide measurements of the vertical electric field.

3.2.1.13 Rocket No. 33.004 UE

Launch Vehicle: Taurus-Orion

Principal Investigators:

Professor Mike Kelley	Dr. Edward Szsuzczewicz
Phillips Hall	Code 7127
Cornell University	E.O. Hulburt Center for Space Research
Ithaca, New York 14853	Naval Research Laboratory
(607) 256-7425	Washington, D.C. 20375
	(202) 767-2513

Sponsors: National Aeronautics and Space Administration; U.S. Naval Research Laboratory

A principal objective was the measurement of electric fields within the eclipsed regions and the associated variations in E-region conductivity. Other objectives focused on electron densities and temperatures, and their fluctuations, and the measurements of positive ion composition in the E-region.

Specific Instrumentation

For the electric field experiment (Cornell), spherical sensors were extended from the payload. The upper sphere pair was extended to a separation of 3.0 meters while the lower pair was extended 5.5 meters in a direction perpendicular to the upper boom system. The differential signals between sphere pairs were amplified and filtered as a "DC" signal corresponding to ionospheric fluid motion and as an "AC" signal corresponding to plasma waves. A small section of the upper boom was exposed to the ambient plasma and biased at 5V in the electron saturation regime. This sensor was used to detect density perturbations in plasma waves.

The NRL ionospheric plasma experiment employed two types of diagnostic devices: the pulsed-plasma-probe for the determination of electron density, temperature and density fluctuation power spectra, and a quadrupole ion mass spectrometer for the determination of ion composition in the mass range of 10-60 AMU.

Comments

The pulsed plasma probe appeared to work perfectly and electron density and temperature measurements in the 80-195 km altitude interval are anticipated. The quadrupole ion mass spectrometer developed a leak in the vacuum system and no positive ion spectra were obtained. It is possible that late in the flight some spectra may be possible.

The experiment for measuring the DC and AC vector electric fields appeared to work well.

3.2.1.14 Rocket No: 33.003 UE

Launch Vehicle: Taurus-Orion

Principal Investigator: Professor Edward Zipf
Department of Physics
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-4361

Sponsor: National Aeronautics and Space Administration

Measurement objectives were (1) photoionization rate above 105 km, (2) EUV airglow, (3) densities of excited atomic nitrogen important to associative ionization in the production of NO^+, and, (4) electron and ion densities and temperatures.

Specific Instrumentation

1. Scanning monochrometer for airglow flux in 1100-1600 Å region.
2. Neutral and positive ion cryogenically pumped quadrupole mass spectrometer.
3. Boom-mounted probe for electron densities and temperatures.
4. Tilting filter photometer for airglow at 3466 Å (N^2P) and 5199 Å (N^2D).

Comments

The tilting filter photometer worked very well and the mass spectrometer clearly worked in the positive ion mode. The other instrumentation appeared to work well but the completed data tapes will be required for further assessment.

3.2.1.15 Rocket No: AMF-VA-51

Launch Vehicle: Black Brant VA

Principal Investigators:

Dr. R.W. Nicholls
Director, CRESS
York University
4700 Keele St.
Downsview, Ontario
M3J 1P3
(416) 667-3833

Dr. E.J. Llewellyn
ISAS
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 0W0
(306) 343-4271

Dr. A.G. McNamara
Herzberg Institute of Astrophysics
National Research Council of Canada
100 Sussex Drive
Ottawa, Ontario
K1A 0R6
(613) 992-6511

Sponsor: National Research Council of Canada

Objectives for experiments carried out were (1) spectrum, in the corona-chromospheric interface and prominences, in the vacuum ultraviolet, (2) vertical distribution of atmospheric ozone, and (3) electron and ion densities.

Specific Instrumentation

1. Slitless vacuum U.V. Wadsworth spectrometer in 1000-2000 Å region (attitude controlled). (York)
2. Infrared photometer measuring 1.27 μm emission from vertical column above the rocket (for O_3 profile). (Saskatchewan)
3. Three spherical Langmuir probes, exposed above 60 km, for the measurement of charge densities. (NRC)

Comments

The infrared photometer (1.27 μm) worked well and indicated some layering at 87 and 97 km. Data were obtained to approximately 42 km on descent.

Good electron density and temperature data were obtained from approximately 60 km to apogee. Data from the VUV spectrometer remains to be assessed.

3.2.2 Ground-Based Experiments

3.2.2.1 Partial Reflection Experiment

Principal Investigator: Mr. Robert Olsen
Atmospheric Sciences Laboratory
DRSEL-BL-SY
White Sands Missile Range, NM 88002
(505) 678-1939

Sponsor: U.S. Army Atmospheric Sciences Laboratory

The partial reflection experiment is ground-based and had as its experimental objective the provision of D-region electron density profiles throughout the eclipse and for background (non-eclipse) conditions. In operation, a low frequency (several megahertz) radar is used to transmit pulses of radiation vertically. Echoes backscattered from the D-region of the ionosphere are received and recorded as functions of pulse transit time. Circular polarization of the transmitted radiation is utilized, and pulses of both right and left hand polarization are employed. Because of the earth's magnetic field, the index of refraction of the ionosphere is different for the two polarization modes. The relative intensities of the waves partially reflected from a given altitude within the ionosphere contain information concerning the electron density at that altitude. This partial reflection technique can be used to measure the density of free electrons in the ionosphere as a function of altitude from 60 km to 100 km. A single frequency of 2.666666 MHz was employed. The partial reflection experiment was located in Balmertown, Ontario, and operated for a period of several days before, during and following the total solar eclipse.

<u>Comments</u>

The instrumentation worked well after some early equipment difficulties. For 30 minutes, centered approximately on totality at Balmertown, soundings were taken at one-minute intervals. Throughout this period, a broad layer of relatively high electron densities was found between 73 and 83 km. Peak densities were of the order 500-600 electrons

cm^{-3}. Such a layer is indicative of a particle precipitation event. Forty-eight hours earlier, coinciding with the launching of rocket 18.1020 UE, a similar layer, with peak densities of approximately 100 cm^{-3}, was found between 60 and 70 km. From these records it would appear that the energy spectrum for the precipitating particles was considerably harder on 24 February than on the day of the eclipse. On both days the total flux would appear to be high and the spectrum quite hard.

3.2.2.2 Mobile Optical Observatory

Principal Investigators:

Professor Doren Baker	Mr. James Ulwick
Dept. of Electrical Engineering	Code OPR
Utah State University	Air Force Geophysics Laboratory
Logan, Utah 84322	Hanscom AFB, Maryland 01731
(801) 752-4100	(617) 861-3188

Sponsor: Air Force Geophysics Laboratory

The objective was measurement of sunlit enhanced near infrared emission from certain minor atmospheric species in the high atmosphere. The measurements provided background information and eclipse comparison for experiments carried out in sounding rocket A12.9A2

Specific Instrumentation

1. Field-widened interferometer sweeping the infrared spectrum from 1-3 μm once each 15 seconds.
2. Infrared radiometers sensitive to radiation at 1.27 μm ($O_2(^1\Delta g)$) and 2.7 μm (OH).
3. Photometers sensitive to several visible airglow species.

Comments

The instrumentation worked well and good background data were obtained. In addition to radiation from the OH and $O_2(^1\Delta g)$ species, resonance radiation from Helium at 1.08 μm was measured. At the time of the eclipse, a thin cloud layer covered the site. As a result, measurements of the visible airglow was not possible. However, in the infrared relative emission from the radiating species could be measured. These combined with measurements from the sounding rockets ASL-SE79A_1 and A12.982 will provide the measurements desired. As noted by other experimenters, the period of observation was aurorally active.

4. OPERATIONS

The Red Lake sites were activated starting in late January 1979 and the experiments, both airborne and ground-based, were conducted during February 1979. The entire operation is considered to have been highly successful at this time with all major objectives obtained. The revised operational documents (Appendices B and C) gives details of operational parameters. The operational documents were written prior to the on-site operation. Some revisions have been made to reflect the operations as they actually occurred.

The Griffiths Mine rocket build-up areas, the Chukuni launch site, the Chukuni instrumentation site and the Partial Reflection Sounder sites were activated first. The Cochenour Mine and McMarmac Mine sites were activated about one week later. Reference map of sites is shown in Figure 4.1 and coordinates of principal sites in Figure 4.2.

The National Research Council of Canada (NRC) was responsible for overall site safety, interface with Canadian agencies in regards to impact areas, aircraft movements in the impact areas, recovery aircraft and public relations. The Physical Science Laboratory/New Mexico State University (PSL), Air Force Geophysics Laboratory (AFGL), NASA/Wallops Flight Center (NASA/WFC) coordinated their efforts directly between agencies including NRC.

PSL provided management of the launch support for the six large rockets of the Atmospheric Sciences Laboratory (ASL) enhanced program with assistance from the ASL launch team, AFGL and a coordinated effort with NASA/WFC during the rocket build-up and launch.

PSL provided management of the small rocket program with direct support from ASL small rocket personnel, ASL windweighters and NRC launch personnel and NRC windweighters. NASA/WFC provided wind data and radar support on a non-interference basis.

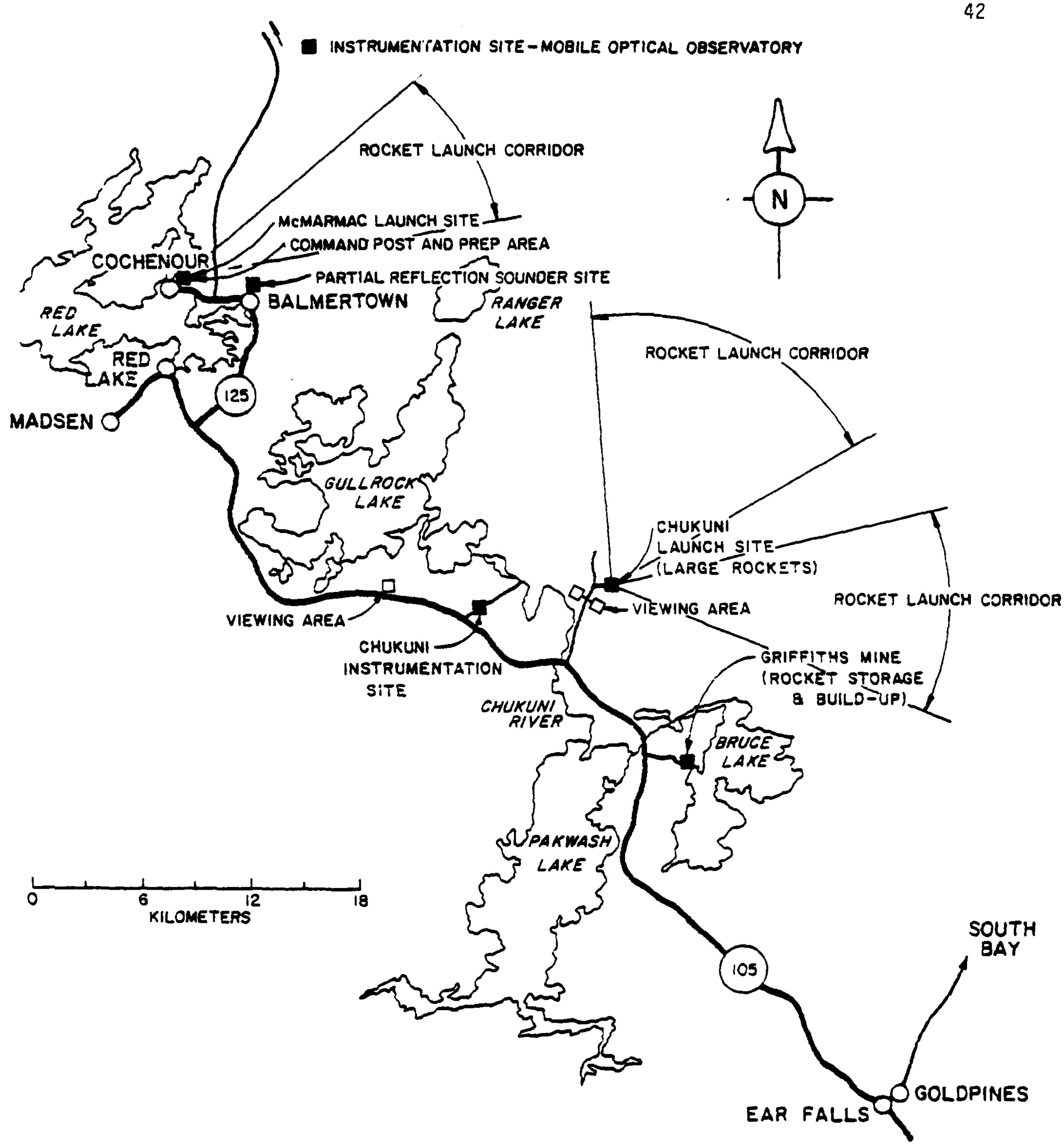


Figure 4.1 Locations of Eclipse Rocket Program Facilities and Ground Instrumentation Sites

1979 SOLAR ECLIPSE PROGRAM

	LATITUDE	LONGITUDE	ELEVATION (M)
Chukuni Launch Site			
1. Site Reference	50° 54' 10.9"	93° 27' 30.0"	379.33
2. Pad #5 Center	50° 54' 11.1"	93° 27' 30.4"	378.93
3. Pad #6 Center	50° 54' 11.3"	93° 27' 30.8"	378.49
4. Pad #7 Center	50° 54' 11.5"	93° 27' 31.2"	378.06
Chukuni Instrumentation Site			
1. Site Reference	50° 53' 08.0"	93° 32' 53.2"	394.03
Cochenour Instrumentation Site			
1. GMD/4 Tracker (North)	51° 04' 36.4"	93° 48' 21.7"	390.43
2. GMD/4 Tracker (South)	51° 04' 34.1"	93° 48' 19.7"	390.00
McMarmac Launch Site			
1. Launcher "A"	51° 05' 12.6"	93° 47' 26.2"	382.50
2. Launcher "B"	51° 05' 12.3"	93° 47' 25.8"	382.50
***Partial Reflection Sounder**			
1. Site Reference	51° 05' 00"	93° 45' 00"	380.00

*Calculated Information

Figure 4.2 Table of Surveyed Coordinates (Principal Sites)

Telemetry support of the small rocket program was provided by PSL with coordinated tracking and ranging support from Pan Am and PSL. Telemetry data were obtained by PSL on all six of the ASL/AFGL large rockets. Additional coverage of particular payloads was provided to the program from NASA/WFC and AFGL and the AFGL contractor, Oklahoma State University (OSU).

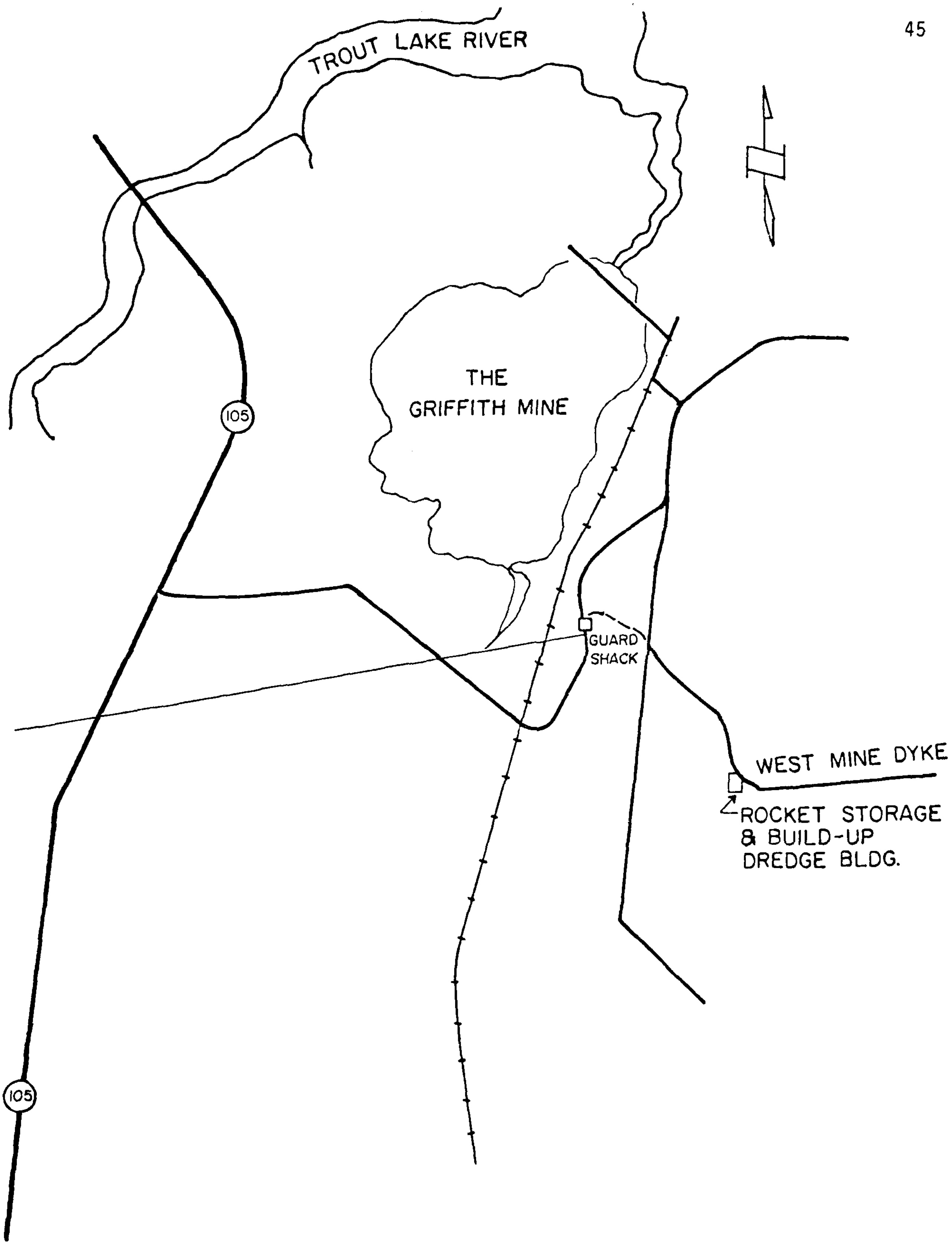
Electrical power was furnished by the NASA/WFC mobile generator at the Chukuni instrumentation and Chukuni launch sites. Power distribution systems were run on-site jointly by PSL and NASA/WFC. Cost of fuel and service to the generator and Herman Nelson heaters was also shared jointly by ASL and NASA/WFC.

Communications at and between the Chukuni sites were provided by NASA/WFC with the communications center located at the Chukuni instrumentation site. Part of the communications at the Cochenour and McMarmac sites were furnished by NRC and part by NASA/WFC. Telephone service was installed at the Cochenour Mine, McMarmac Mine, Partial Reflection Sounder and the Chukuni launch sites. Only intercom communications were available between the Chukuni instrumentation site and the Chukuni launch site.

4.1 Operating Sites

4.1.1 Griffiths Mine (Figure 4.3)

Activation at this site began on 23 January with snow removal and heating of the rocket preparations building. This building (approximately 40' x 70') was used to build up and prepare the large rockets for launch. The rockets were stored in this building after preparations until ready for moving to the Chukuni launch site. However, some rockets were stored after preparation in the "sponge building" on the mine property to gain additional floor space in the preparations building. Clean up and deactivation of this property was completed on 1 March 1979.



LARGE ROCKET BUILD-UP AREA

Figure 4.3

4.1.2 Chukuni Launch Site

The ASL machine van and the payload van to accomodate the AFGL payloads arrived on-site in the summer of 1978. The ASL launch control van and the PSL payload control van arrived the week of 5 February 1979. Concurrently snow removal and site activation was in progress. All cabling, power distribution lines, Herman Nelson heater fuel tanks and fuel lines were terminated and the entire launch complex completely checked out. This effort continued up until rocket loading and launch. Reference Figure 4.4 for site layout.

The three dual AML launchers for the ASL program were encased in styrofoam enclosures through which warm air was circulated after rocket and payload loading in order that the rockets and payloads could be held to an acceptable temperature. The covers were removed just prior to launch since the outside temperature was sufficiently high that cooling of motors and payloads presented no problem.

All six large ASL/AFGL rockets were launched as scheduled from this site. The site was deactivated on 2 March except for some site debris which was removed afterwards by the on-site contractor. All hardware, including the ASL machine van, ASL launch van and two each ASL payload vans have been shipped to White Sands Missile Range (WSMR). The three dual AML launchers were left on-site for removal during the summer of 1979.

4.1.3 Chukuni Instrumentation Site

The Chukuni instrumentation site was primarily divided into two areas. All NASA/WFC vans, telemetry, radar, windweighting, power etc. on one half of the site and the PSL telemetry vans, AFGL telemetry van and tracking dish, AFGL contractor (OSU) telemetry dishes, the two 22' x 56' payload buildings, a comfort trailer, an office trailer and the NASA/WFC communications center on the other half of the site.

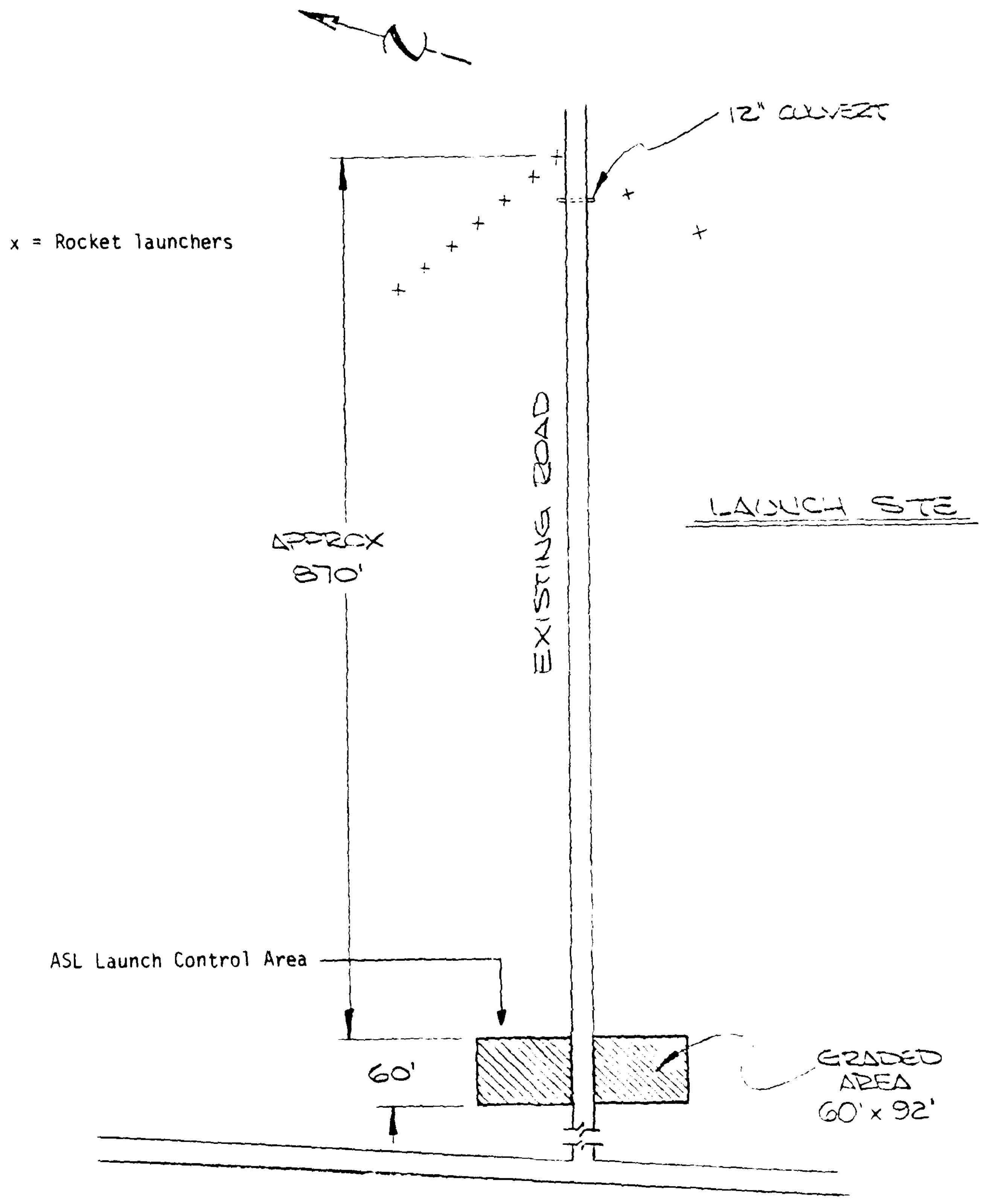


Figure 4.4 Launch Site Layout

The OSU telemetry station was located in the PSL/AFGL payload building. An antenna field for the NASA propagation experiment was located along the entire west side of the Chukuni instrumentation site. All PSL/ASL and AFGL payload preparations were carried out in the PSL/AFGL payload building.

Electrical power for the entire site was provided from a duel 350 kw NASA/WFC generator van. Service cables to the various power distribution systems had been laid during the summer of 1978. Hookup to the power generator was carried out the latter part of January.

Activation of the site began in late January with snow removal and hookup of Herman-Nelson heaters to the rocket preparation buildings and the power van. The PSL telemetry vans arrived on-site approximately 1 February. Most other equipment including the AFGL and OSU equipment arrived the first part of February. Some personnel and miscellaneous equipment arrived as late as the week before the eclipse.

The Chukuni instrumentation site was essentially deactivated by 2 March 1979 with some NASA/WFC hardware still on-site to be removed at a later date. Reference Figure 4.5 for site layout.

4.1.4 Cochenour Mine Site

The Cochenour Mine site, which was utilized for small rocket and payload preparation, GMD/4 tracking sets, PSL telemetry station and the Joint Operation's Command Center, was activated starting 31 January. Following snow removal, heat was turned on in all buildings to be used. Electrical power for the operation was furnished by the mine company and was in place upon activation of the site. The intercom units to be used for communication were furnished by NASA/WFC and the wiring and installation was completed by PSL personnel.

CHUKUNI INSTRUMENTATION SITE

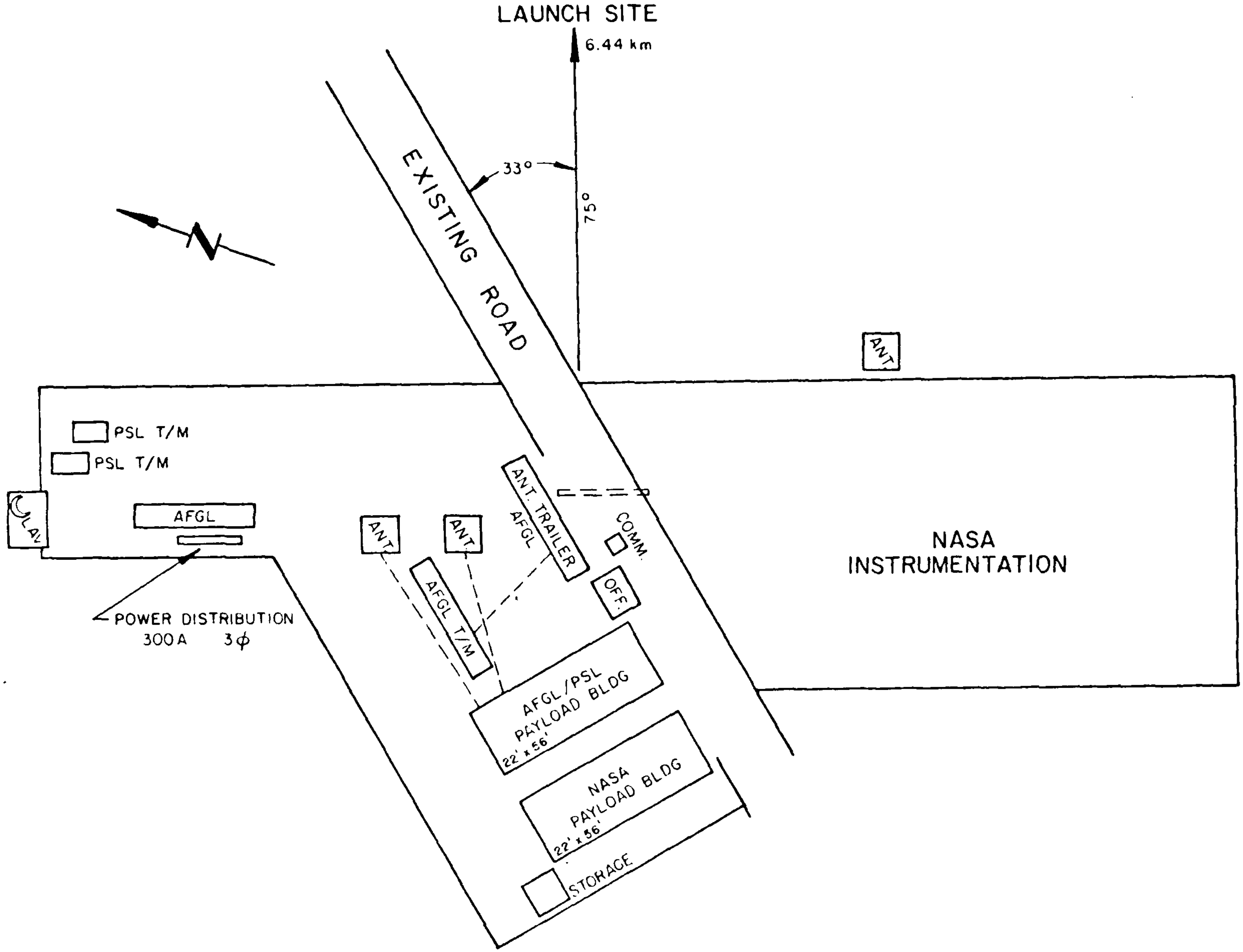


Figure 4.5

During the week of 5 February all small rockets, GMD/4 tracking sets and the PSL telemetry station were moved on-site. All operational personnel were on-site by 13 February. Set up and check out of all equipment was completed by 16 February.

The rocket and payload build up, data recovery and command operations, were accomplished during the eclipse program from this site. Deactivation and clean up of the site was completed by 5 March. All operational items were removed and clean up was approved by the mine custodian. Reference Figure 4.6 and 4.7.

4.1.5 McMarmac Launch Site

The Super Arcas launcher (A) and the Super Loki launcher (B) were installed in September 1978. The firing and communication lines were also placed and buried during this period.

Site activation commenced immediately following snow removal. During the week of 12 February, the small rocket firing console was installed and preliminary firing line checks were made. All power for the launch complex was furnished by Ontario Hydro Co. and a back-up generator was furnished by NRC. All command and range safety communications were installed by NRC and communications for the operational net was installed by PSL. Windweighting was done by ADGA (NRC Contractor) using weight factors and unit wind effects furnished by NASA/WFC, Ground and Flight Safety Section.

During the eclipse program, 19 February through 27 February, ten Super Arcas and nine Super Loki rockets were launched successfully.

Deactivation of the site was completed by 2 March. The launchers and all other equipment were removed and shipped. The buried firing cables and communication lines were not removed. Reference Figure 4.8.

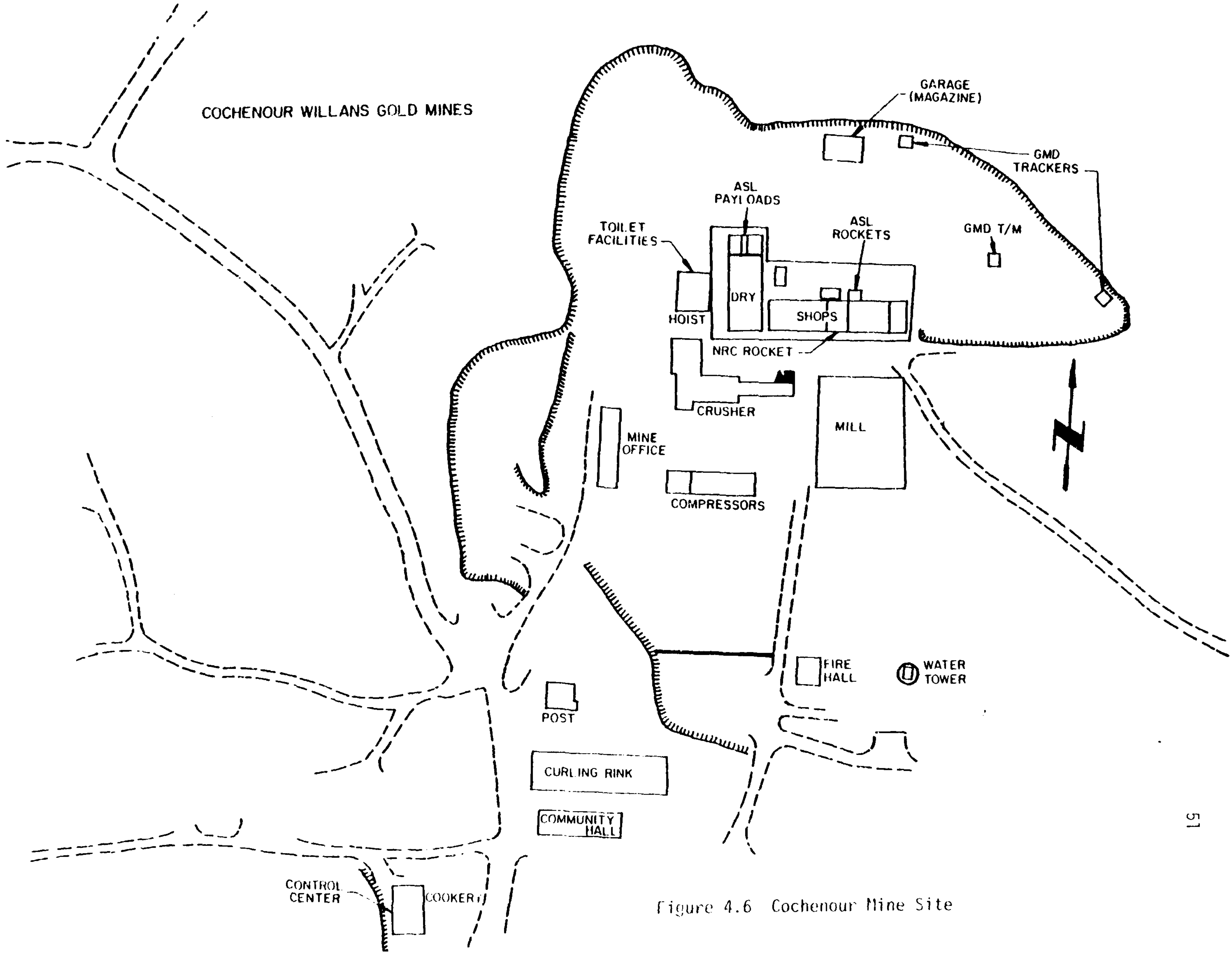


Figure 4.6 Cochenour Mine Site

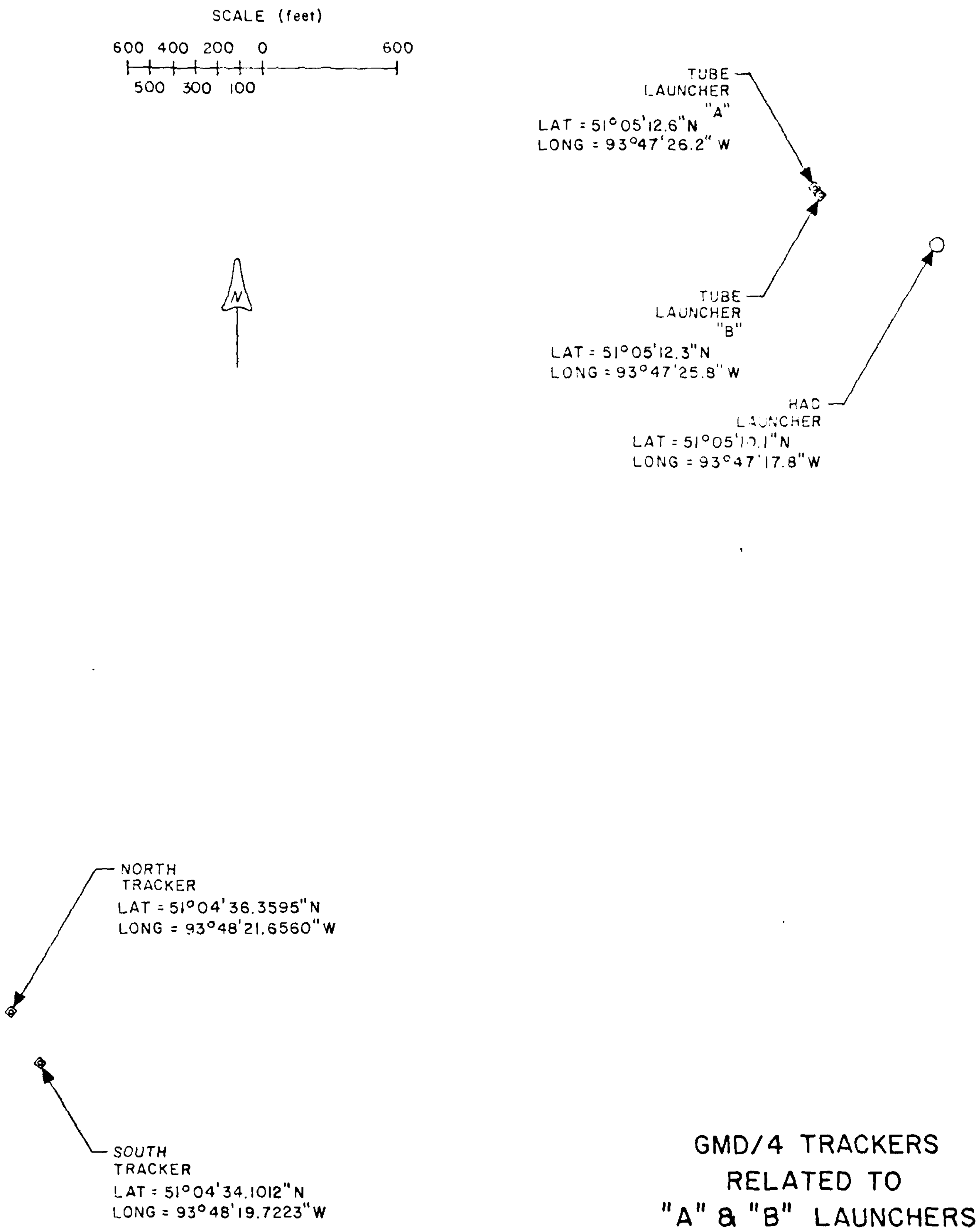

SCALE (feet)
600 400 200 0 600
500 300 100
N
TUBE LAUNCHER "A"
LAT = 51°05'12.6"N
LONG = 93°47'26.2" W
TUBE LAUNCHER "B"
LAT = 51°05'12.3"N
LONG = 93°47'25.8" W
HAD LAUNCHER
LAT = 51°05'10.1"N
LONG = 93°47'17.8"W
NORTH TRACKER
LAT = 51°04'36.3595"N
LONG = 93°48'21.6560"W
SOUTH TRACKER
LAT = 51°04'34.1012"N
LONG = 93°48'19.7223"W
GMD/4 TRACKERS
RELATED TO
"A" & "B" LAUNCHERS

Figure 4.7

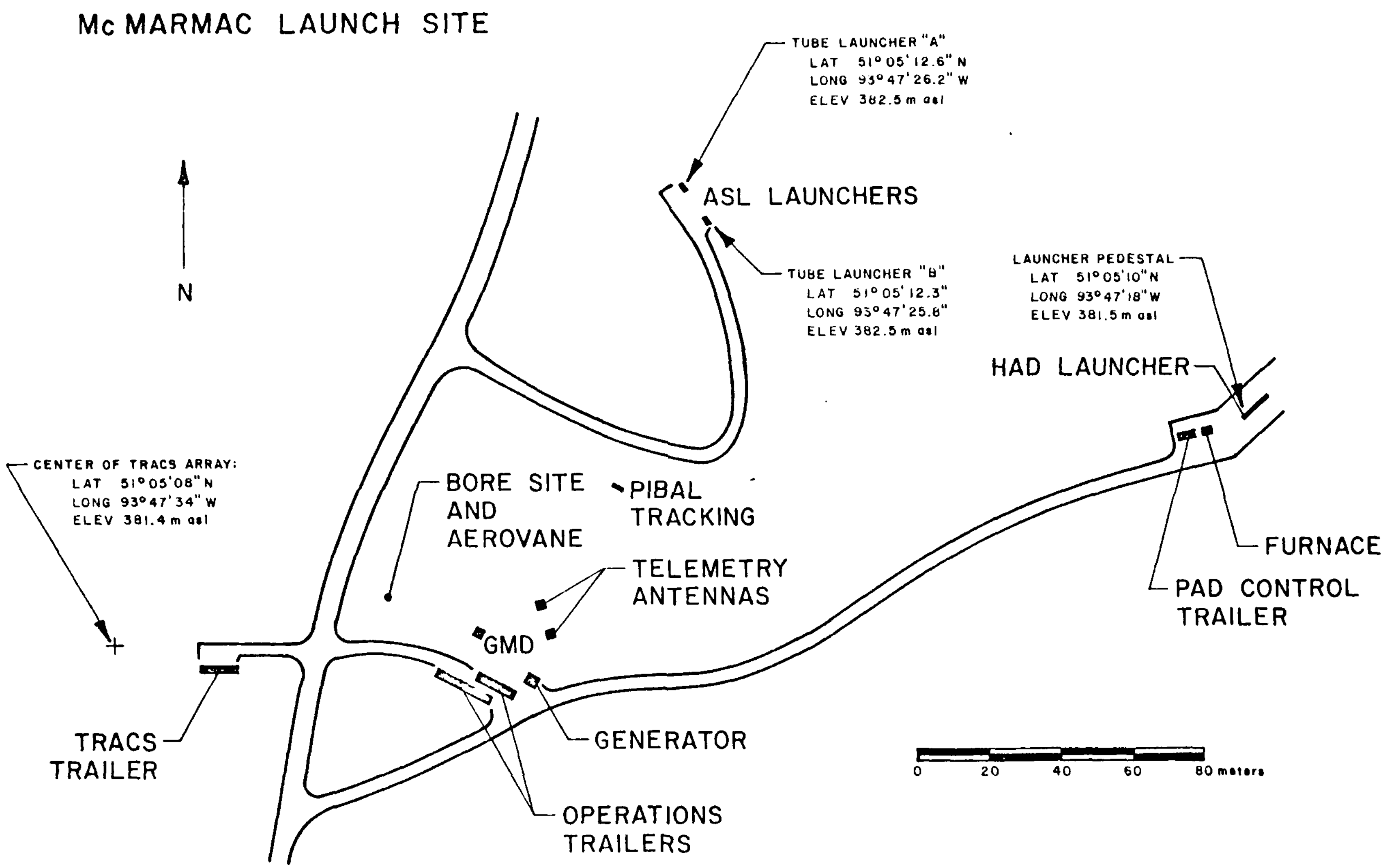

Mc MARMAC LAUNCH SITE
N
TUBE LAUNCHER "A"
LAT 51°05'12.6" N
LONG 93°47'26.2" W
ELEV 382.5 m asl
ASL LAUNCHERS
TUBE LAUNCHER "B"
LAT 51°05'12.3"
LONG 93°47'25.8"
ELEV 382.5 m asl
LAUNCHER PEDESTAL
LAT 51°05'10"N
LONG 93°47'18"W
ELEV 381.5 m asl
HAD LAUNCHER
CENTER OF TRACS ARRAY:
LAT 51°05'08"N
LONG 93°47'34"W
ELEV 381.4 m asl
BORE SITE AND AEROVANE
PIBAL TRACKING
TELEMETRY ANTENNAS
GMD
FURNACE
PAD CONTROL TRAILER
TRACS TRAILER
GENERATOR
OPERATIONS TRAILERS
0 20 40 60 80 meters

Figure 4.8

4.1.6 Partial Reflection Site

The Partial Reflection Sounder arrived at Balmertown and was spotted on-site during the first week in February 1979. The antenna poles and antennas had been installed during the summer of 1978. The antenna connections were made, commercial power connected and the check out and preoperational checks were completed by 7 February 1979.

The Sounder was prepared for shipment to PSL after termination of the soundings and all antenna cables above ground were removed and shipped in the sounder van on 2 March 1979. The site was cleaned of debris and the Campbell Mine management notified that the site had been deactivated and the electrical power was no longer required. Reference Figure 4.9.

4.2 Rocket Launch Operations

There were 19 small rockets and six large rockets fired during the on-site operations. The Loki motors and MET Darts were furnished by the Air Force Air Weather Service and the Super Arcas was furnished by ASL.

Of the six large rockets, NASA/WFC supplied the three Orions and three Nike boosters. The firing circuits, fins and Nike to Orion transitions were purchased by ASL from NASA/WFC. The Orion to payload transitions were designed and fabricated by PSL. The two Paiute Tomahawks and the NIRO rockets were furnished by AFGL. Reference Figure 4.10, Rocket Launch Sites and Impact Areas.

4.2.1 Chukuni Launch Site

Details of the operational sequence of events at this site are listed in Figure 4.11.

The launch operations progressed with some minor problems, but only two major problems. On one occasion the power generators went off line resulting in loss of power at the launch site. On 24 February the day scheduled for full dress rehearsal, the generator stopped running during the early morning. When the generator supply power to the

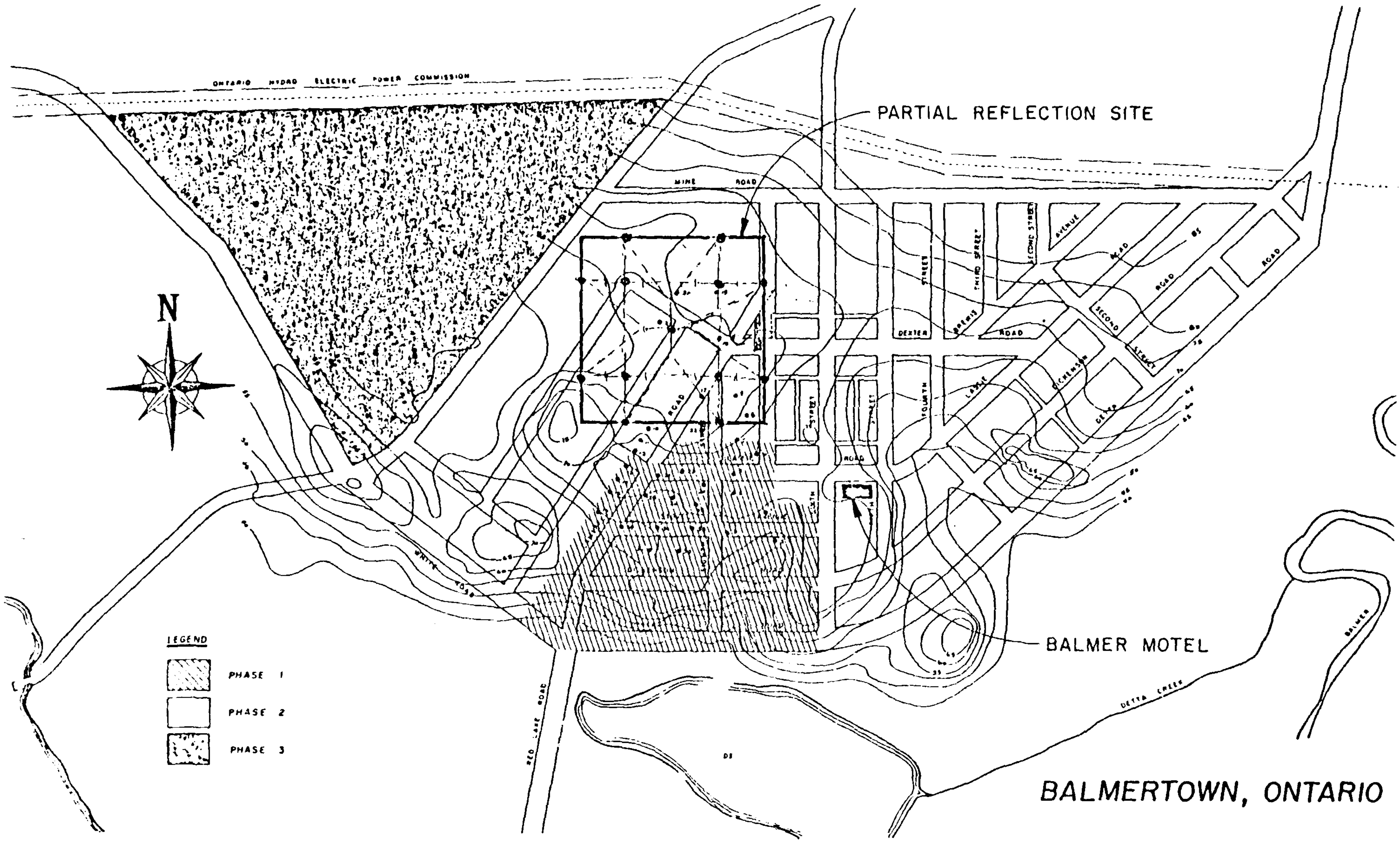
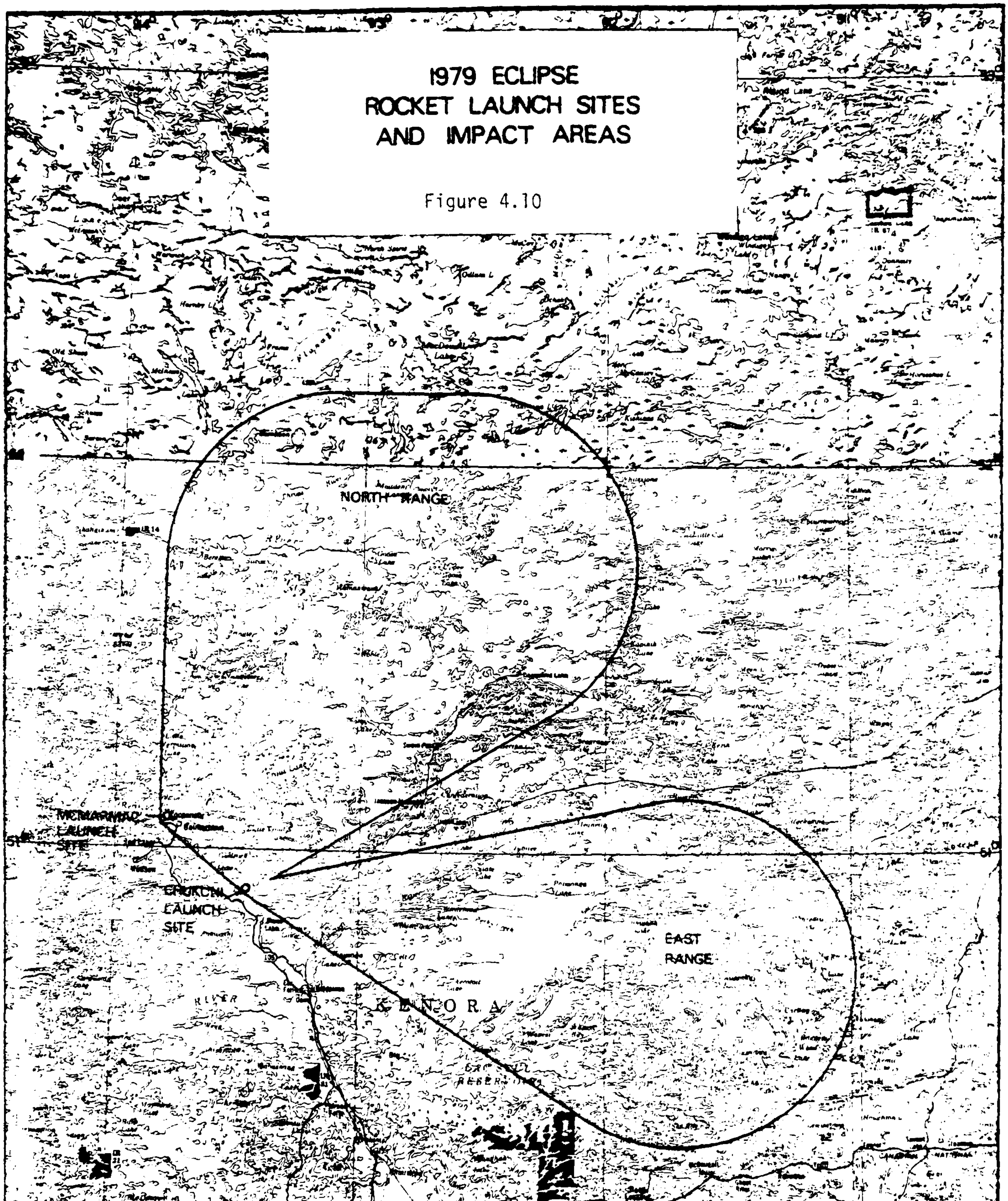


Figure 4.9 Partial Reflection Site



1979 ECLIPSE
ROCKET LAUNCH SITES
AND IMPACT AREAS

Figure 4.10

CHUKUNI SITES
(Large Rockets)

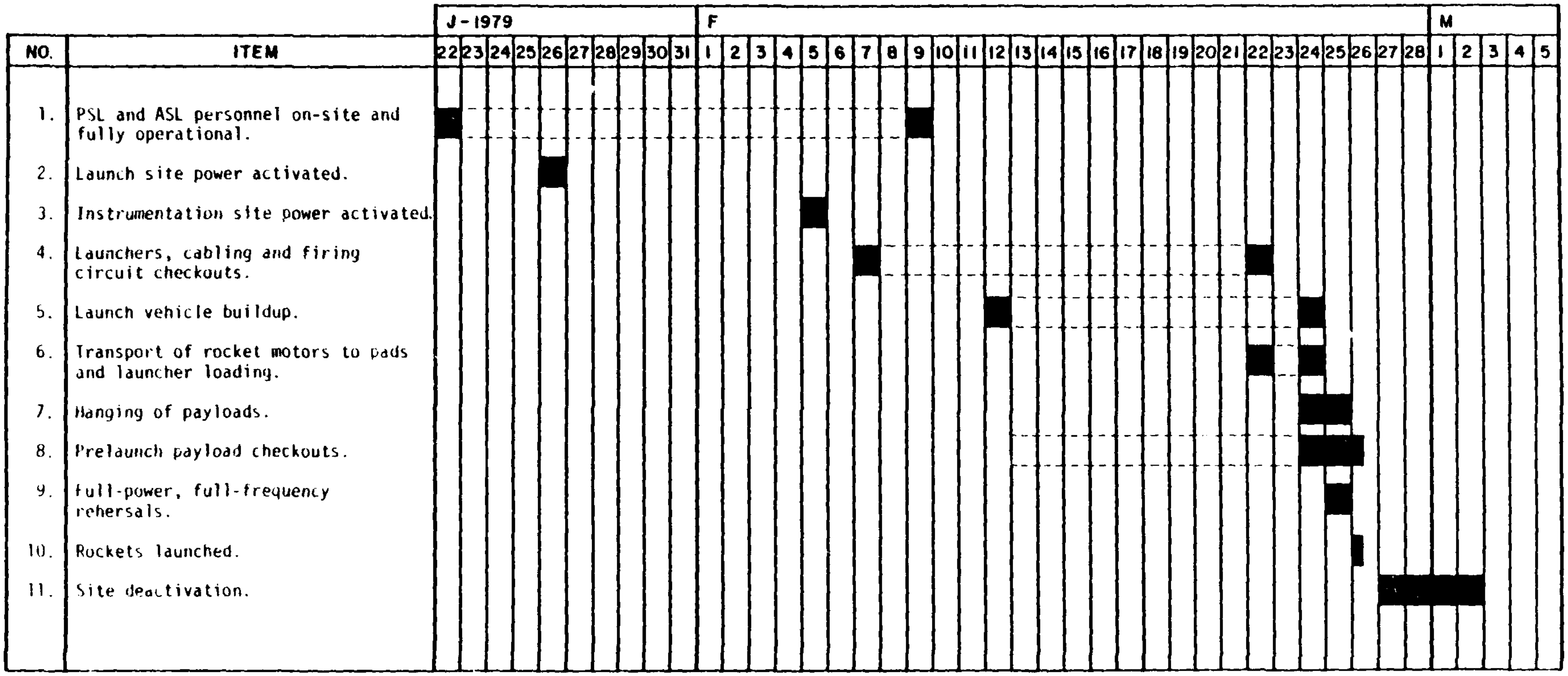


Figure 4.11

Herman Nelson heaters was put back on line, it was adjusted to 200 volts and blew out the starting capacitors in the Herman Nelsons. The problem was solved by lowering the output voltage of the generator and bringing the heaters from the rocket preparation area and the launch control area. A backup generator was put on line at the launch control area. The dress rehearsal was scrubbed until the following day, 25 February. A technician was flown in to service the Herman Nelsons and provisions were made to mann the generators around the clock. On 25 February the dress rehearsal was run. After the dress rehearsal the launch countdown was modified to insure sufficient time and proper sequence of the various operations to take place. The launch occured without any problems on 26 February and the firings and data retrieval were successful.

4.2.2 McMarmac Launch Site

Details of the operational sequence of events at this site are listed in Figure 4.12.

The small rocket launchings were accomplished with some changes from the original schedule, to allow more tracking time between rockets. The schedule was changed on days of multiple launchings but experiments that were critical to timed events were not changed.

Only one major problem occured during this program. On 19 February, CMSL-01-79 was scheduled to be launched at 1800 hours U.T. as part of the Super Loki pre-launch check, at minus one hour a firing line check was made on the dart expulsion system and the booster fire system. After this check was successfully completed, the AC cord furnishing power to the Loki fire line was accidently pulled from the AC distribution box. As a result of this loss of power, the expulsion system was ignited but the Loki failed to fire. The dart was expelled off the launcher at plus 120 seconds as programed. To assure that this problem would

McMARMAC SITE

(Small Rockets)

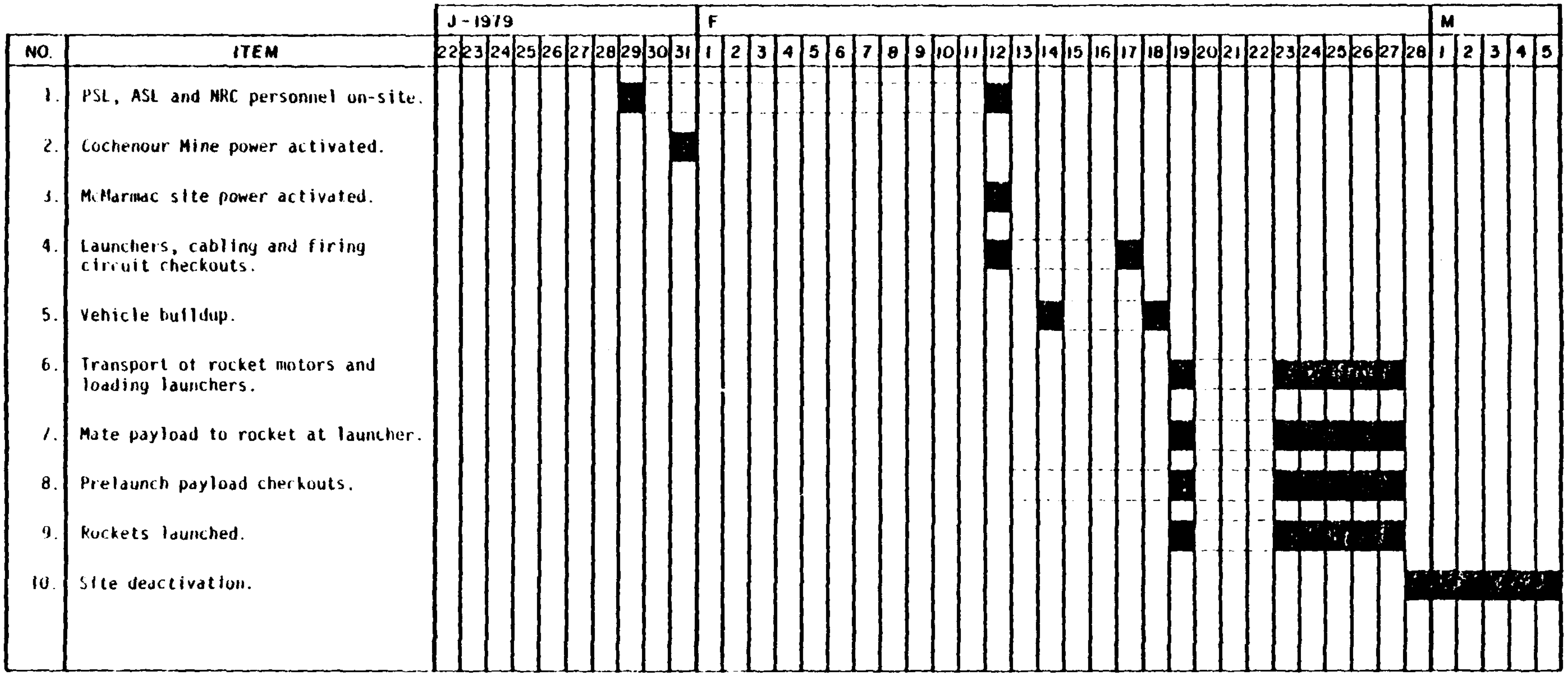


Figure 4.12

not occur in the future, the AC lines were hard fastened to the power distribution box. A second Loki/Dart system was installed into the launcher and launched successfully as CMSL-01-70 at 2023 hours the same day.

One other change was made in payloads, CMSL-08-79 scheduled to be launched as a Blunt Probe experiment at 1200 hours U.T. 27 February. During the countdown sequence, as a result of umbilical cable problems, the payload could not be turned on. The launch was cancelled and the payload changed to a meteorological probe and launched at 1545 hours the same day.

All other launchings of this program appeared successful and data is now being reduced.

4.3 Tracking and Telemetry

Telemetry support was provided by PSL on all ASL/AFGL large rockets. AFGL and OSU tracked and recorded telemetry data from the large rocket payloads and NASA/WFC tracked and recorded telemetry data on payloads A_1, B_1, C_2 and B_2. All telemetry data obtained were shared as desired between PSL, AFGL/OSU and NASA/WFC. Tone ranging was provided by PSL (from the NASA/GSFC Tone Ranging Van) on payloads A_1 and B_1. NASA/WFC provided radar coverage on A_1, B_1, C_2 and B_2 as well as several small payloads fired from the McMarmac Mine site.

Communications at and between the Chukuni sites were provided by NASA/WFC with the communications center located at the Chukuni instrumentation site. Telephone service was installed at the Chukuni launch site. Only intercom communications were available between the Chukuni instrumentation site and the Chukuni launch site. All communications were excellent throughout the operations and NASA/WFC provided maintenance and operational support on the system. A telephone line at the Chukuni instrumentation would have been desirable; however this did not impair the operation.

Only one major instrumentation problem occurred. During payload testing the radar uplink frequency to the payload transponders was beating with the 550 MHz tone ranging frequency resulting in an S-band frequency which interfered with several payload frequencies. The radar frequency was lowered and the associated transponders were retuned thereby shifting the interfering frequency. There remained some interference on one AFGL frequency which required frequency traps in the receiving systems to receive acceptable data. This solved the problem and there were no other major frequency problems.

Telemetry support of the small rocket program was provided by PSL with coordinated tracking and ranging support from Pan American and PSL. NASA/WFC provided upper wind data and radar tracking support, on a non-interference basis. ADGA, under contract to NRC, furnished the wind-weighting data.

4.4 Payload Recovery

No recovery was required for payloads flown under the ASL supported program. Recovery was required for the NRC Black Brant payload, five NASA supported payloads and two AFGL payloads. Recovery was effected through radar trajectory, recovery-beacon assisted fixed-wing aircraft for location and helicopter removal to sites where recovery could be effected by fixed-wing aircraft. The NRC and NASA payloads were quickly recovered. The AFGL payloads were located (not without difficulty) but could not be recovered. One AFGL payload was imbedded in the frozen ground and was broken in the attempt at removal. The second AFGL payload was located to within 100 yards but could not be seen or located by ground party because of exceedingly dense growth.

4.5 Partial Reflection Experiment

The site for the partial reflection experiment (Balmertown) was located on land owned by the Campbell Gold Mine and was selected in the summer of 1978. The poles required for the antenna supports were installed in the early fall and the lines required to erect the antennas were attached and reefed at that time. In late January, PSL personnel arrived at the site and the antenna installation was completed in early February. Operation of the experiment began on 8 February after instrumentation checkout. Mr. Glenn Falcon, consultant from the Institute for Telecommunication Science spent three days on-site (13-15 February) to assist in instrument check outs. The operation was deactivated on 28 February, the antenna cables removed by 1 March and the instrumentation van shipped to PSL on 2 March.

4.6 On-Site Contractor Support

On-site contractor support was provided through the NRC using local contractors. Materials required for site construction, site shelters, etc., was provided by the NRC. The command center at the Cochenour Mine was provided by the NRC as were the range safety and payload recovery functions. All of the above were furnished on a cost-reimbursible, prorate basis. Charges for services and materials supplied to the U.S. participants were forwarded to NASA (as the principal U.S. point of contact). The prorate allocation of costs to the U.S. participants have been and will be made by NASA (for obligations remaining to be met).

5. REFERENCES

1. The 1979 Solar Eclipse and Validation of D-Region Models. M.G. Heaps, U.S. Army Atmospheric Sciences Laboratory, ASL-TR-002, March 1978.

2. Modeling the Ion Chemistry in the D-Region: A Case Study based upon the 1966 Total Solar Eclipse. M.G. Heaps, F.E. Niles, U.S. Army Atmospheric Sciences Laboratory and R.D. Sears, Lockheed Palo Alto Research Laboratory, September 1978.

APPENDIX A

APPENDIX A

EXPERIMENTS SUPPORTED BY THE ATMOSPHERIC SCIENCES LABORATORY

In the body of this report measurement objectives and specific instrumentation for all the solar eclipse experiments in the Red Lake area have been summarizied. In this appendix more detail on those experiments supported by the Atmospheric Sciences Laboratory (ASL) is given. For convenience and to indicate simultaneity of measurements, the experiments are listed in combination (e.g. a rocket scientific payload) rather than categorized as to the physical quantities measured.

A.1 Large Rocket Payload ASL-SE79A$_1$ (Payload A)

Launch Vehicle: Nike Orion

Sampling Altitude: 60-135 km

Principal Investigator: Kay Baker, Utah State University

Number Launched: 1 (one)

Payload Description: The principal mission of this rocket payload was to provide altitude profiles of important minor neutral species. The parameters measured are indicated in the following tabulation:

Measurement	Instrument/Technique
O Density	UV Resonance Lamp (1300 Å)
O Density (Comparative)	5577 Å Photometer
O_3 Density	UV Absorption Photometer (2925 Å 2975 Å, 3025 Å, 3075 Å)
NO Density	UV Resonance Scattering Photometer (2150 Å)
OH Excitation	Cryogenic IR Radiometer (1.595 and 1.944 μm)
$O_2(^1\Delta g)$ Concentration	IR Radiometer (1.27 μm)
Lyman-alpha Flux (O_2 Density)	Ionization Chamber (1216 Å)
Solar Aspect	Sun Sensor
Magnetic Aspect	Magnetometer
Electron Density	RF Impedance Probe

Measurement of Atomic Oxygen -

Atomic oxygen may be accurately measured between altitudes of 60 and 135 km using an on-board resonance lamp/detector system. This technique, which has been established through previous flights, utilizes the large scattering cross sections associated with an O resonance triplet occurring near 1300 Å. The technique yields O number densities with good absolute accuracy and excellent relative accuracy between number densities of 10^7 to 10^{12} atoms/cm^3.

The O resonance radiation was generated in a square wave modulated lamp having a small quantity of oxygen in serveral torr of inert carrier gas. The lamp was excited by an RF discharge and produced in the order of 10^{13} protons/sec/sr with little self-absorption and moderate temperature (Doppler) broadening.

The effective cross section for the O resonance radiation by O atoms is approximately 3.4×10^{-14}cm^2. Obviously, with O number densities of 10^6-10^{12} atoms/cm^3 and a cross section of 3.4×10^{-14}cm^2 the interaction is very strong. For geometries and optical path lengths of one meter or less, non-linear effects due to multiple scattering and spectral hardening are not significant, except in the highest density cases, and then are quite manageable.

Cross sections for competing processes such as Rayleigh scattering and scattering from dust and aerosols are down considerably. The Rayleigh scattering cross section is down approximately 10 orders of magnitude, allowing small number densities of O to be measured in the presence of large concentrations of major species.

Calibration was accomplished from a knowledge of the optical characteristics of the lamp/detector combination and their geometrical relationships within the payload. This information, along with an accurate physical model of the resonance scattering interaction, provided the prime calibration. This was compared during the solar eclipse against measurement of 5577 Å O emissions from both the ground (column content) and a vertical viewing on-board photometer.

Ozone Number Density -

The altitude profile of the ozone concentration in the upper atmosphere was derived by measuring the absorption of solar ultraviolet emissions utilizing four photometers. The instrument consisted of photodiode detectors positioned behind filters whose windows were centered at 2925 Å, 2975 Å, 3025 Å, and 3075 Å. Multiple detectors were incorporated in order to insure the acquisition of attenuation data from ground level up to the region where no attenuation occurs ($\sim$80 km). Specialty amplifiers were incorporated to condition the detector outputs and to insure that they were compatible with the vehicle telemetry system.

The correction to be applied to the output data because of the non-uniform response of the detectors with changing angle of incident flux was determined using a solar aspect sensor. The unit was mounted next to the photometers and provided the attitude information coincidently with the photometer outputs.

Nitric Oxide Number Density -

The nitric oxide UV photometer measured nitric oxide by detecting the intensity of 2150 Å solar ultraviolet light resonantly scattered in the NO γ-band. The rocket experiment used an ultraviolet photometer coupled with a nitric oxide gas-filled optical absorption cell to remove correctly the Rayleigh - scattered background signal and to measure accurately the small γ (1, 0) band emission in the mesosphere.

An 18 cm solar baffle 6.4 cm in diameter and a honeycomb collimator with a circular field of view of 6° precede an interference filter. The center wavelength of this prefilter was 2150 Å with a half-power transmission width of 80 Å. Two optical cells were alternatively placed into the optical path between the prefilter and the photomultiplier tube. The optical cells were 3 cm in diameter, had a 2 cm path length, and were made of optical silica. The first cell was unfilled, while the second was filled with pure NO at a pressure of 200 torr. These cells were cycled back and forth at a frequency of 1 Hz. The NO cell acted as a rejection filter for NO gamma band emissions terminating at the ground vibrational level ($v'' = 0$).

This technique is useful during sunlit atmospheric conditions from about 60 to 140 km. During the solar eclipse the measurement was possible without serious degradation in the region below 100 km with 40 percent or more of the solar disk visible.

O_2 ($^1\Delta g$) and OH Number Density -

The infrared emissions from O_2 ($^1\Delta g$) at 1.27 μm and from OH at 1.595 and 1.944 μm were used to detect the presence of these species and to measure their concentration.

Infrared atmospheric emission in the wavelength region from 1.1 to 5.5 μm have been measured by rocketborne cyrogenically cooled radiometers.

These instruments use a bandpass interference filter in front of an indium antimonide solid state infrared detector. The incoming radiation is chopped and the detector output is synchronously rectified in a phase-sensitive amplifier. The optical system and detector are cooled to liquid nitrogen temperature in a closed dewar which is opened after the rocket has ascended to an altitude such that window frosting or heating is not a problem.

The radiometer consisted of an optical subsection containing indium antimonide (InSb) detectors, collecting optics, and interference filters in a cryogenic dewar cooled to near liquid nitrogen temperature (77°K). The components provided three independent optical channels, which utilized a common optical chopper to modulate the incident radiation. The system had an ejectable thermal shield to keep the optical system cold and yet protect it from frosting until a suitable altitude (approximately 50 km) was reached where the cover was ejected along with the payload nose tip, thereby exposing the radiometers.

Lyman Alpha Flux -

The measurement of very small incident photon fluxes in the vacuum ultraviolet wavelength region, and specifically at the Lyman-alpha wavelength of 1216 Å is theoretically possible using any one of several sets of hardware. The ionization chamber has been used for a number of years as a detector and was selected for use in this system because it possesses the sensitivity and spectral selectivity characteristics that were necessary for this effort. The conversion efficiency of the ionization chamber is dependent upon the solar radiation incidence angle (angle between the window normal and the incoming flux). The effect of angle of incidence on efficiency is twofold: first, as the incidence angles increases, the amount of solar flux impinging on the collector is reduced by a cosine factor; second, as the angle increases, the reflection of the window also increases. A correction factor, therefore, was applied to the system output to adjust for the non-uniform response.

The output of the ionization chamber was connected directly to an electrometer which was the primary element of a programmable (auto-ranging) amplifier. The electrometer output was inverted and fed to the multi-input commutator. The output was also sampled by a level detector which determines if the amplifier gain was correct for the level of input flux. If the sampled level was either above or below the limits established during the preset time intervals, the control logic switched the gain to the appropriate level. A digital-to-analog converter was used to sample the control pulse and provide a discrete voltage level for each gain setting. The gain level was then applied to the commutator input.

Because of the well known absorption coefficient of molecular oxygen at the wavelength of solar Lyman alpha, the vertical profile of Lyman alpha flux, property corrected for solar obscuration, provided a measure of O_2, and hence total, density as a function of altitude.

Rocket Attitude -

A small solar aspect sensor was included for determination of the correction factor to be applied when the sun was not normal to the vehicle. The unit was self-contained and was designed for minimum size and low construction cost. A flux-gate magnetometer was also flown in order to provide rocket attitude with respect to the earth's magnetic field. Proper interpretation of the measured parameters required knowledge of the vehicle attitude throughout flight.

Electron Density -

The electron density was measured above 60 km with an RF capacitance probe. The basic design of the RF capacitance probe utilized a remotely deployable, telescoping three foot whip antenna radially positioned and insulated from the payload. The antenna was excited with a low-level RF signal (approximately 0.5 volt rms) in the 0.5 to 15 MHz range; in addition, a slowly varying bias voltage from 0 to +5 volts was placed on the antenna with respect to the vehicle skin. The capacitance of the antenna was altered from its free space value by the plasma in which the antenna was immersed. Electrical signals related to this capacitance were detected and telemetered to the ground station. Local electron density can then be calculated from the variations in the antenna capacitance.

A.2 Large Rocket Payload $\left\{\begin{matrix}\text{ASL-SE79B}_1\\ \text{A12.9A1}\end{matrix}\right\}$ (Payload B_1)

Launch Vehicle: Nike-Orion

Sampling Altitude: 40-150 km

Principal Investigators: Kay Baker, Utah State University; James McCrary, Physical Science Laboratory; C. Russell Philbrick, Air Force Geophysics Laboratory.

Number Launched: 1 (one)

Payload Description: The principal mission objectives for this payload were an electron density profile, photoionization and photodissociation energy input and a profile of mesospheric density and temperature. The parameters measured are indicated in the following tabulation:

Measurement	Instrument/Technique
Electron Density	RF Impedance Probe
Solar X-Rays (1-10 Å)	Proportional Counter
Precipitated Electrons	Scintillation Counter
Cosmic Rays	Scintillation Counter
Solar UV Radiation	Photometers (2) (1216 Å Lyman alpha and 2050 Å)
Solar Aspect	Sun Sensor
Atmospheric Density, Temperature	Falling Sphere

Electron Density -

The electron density was measured above 60 km with an RF capacitance probe. The basic design of the RF capacitance probe utilizes a remotely deployable, telescoping three foot whip antenna radially positioned and insulated from the payload. The antenna was excited with a low-level RF signal (approximately 0.5 volt rms) in the 0.5 to 15 MHz range; in addition, a slowly varying bias voltage from 0 to +5 volts was placed on the antenna with respect to the vehicle skin. The capacitance of the antenna was altered from its free space value by the plasma in which the antenna was immersed. Electrical signals related to this capacitance were detected and telemetered to the ground station. Local electron density can then be calculated from the variations in the antenna capacitance.

Solar X-Rays (1-10 Å) and Bremsstahlung -

The basic detector was a proportional counter filled with one atmosphere of argon, covered with a 2 mil beryllium window 1/2 inch in diameter. The detector was mounted in the payload with its axis pointing about 25° above the payload radius vector. The diameter of the entrance aperture was 1/8 inch. The detector and its electronics could handle up to 10^4 photons/sec. Two channels of information were telemetered from the x-ray detector. Channel 1 sent back randomly selected pulses whose height was proportional to x-ray energy. If the count rate was not too high, all x-ray pulses were telemetered. Channel 2 telemetered the total count rate from the detector. The x-ray detector was also sensitive to bremsstrahlung. The variation in count rate with payload revolution provided a measure of bremsstrahlung intensity and spectrum. A permanent magnet was mounted in front of the detector to prevent the entrance of charged particles. It should be pointed out that neither of the particle detectors described below was sensitive to bremsstrahlung. This insensitivity made possible more accurate measurements of cosmic rays and charged particles.

From the electron energy and intensity measurements and from the atmospheric density and composition measurements the bremsstrahlung intensity and spectral distribution can be computed.

Precipitated Electrons -

The charged particle spectrometer consisted of a 1 mm thick by 5/8" diameter wafer of Pilot B plastic scintillator covered with 4500 Å of aluminum and viewed by a 3/4" diameter photomultiplier tube. The instrument was housed in the standard USU PM-2 package. The spectrometer acceptance solid geometry was conical in shape with a half angle of 45°. The detector was mounted at an angle of 45° with respect to the payload axis. It received radiation through a door in the payload skin which shadowed the detector's acceptance solid angle to some extent. However, due to the spin and precession of the payload, the charged particle spectrometer viewed most of the upper hemisphere. The value of $A\Omega$ for the detector was 1.97 x 1.84 = 3.63 cm^2sr. Six channels of information were telemetered from the charged particle spectrometer. Channels 1 through 5 transmitted the total number of pulses accumulated during the 10ms counting period within each of five incident particle energy ranges as follows:

Channel 1	10 - 30 keV
Channel 2	30 - 100 keV
Channel 3	100 - 300 keV
Channel 4	300 - 1000 keV
Channel 5	> 1000 keV

Channel 6 carried total PM tube current. At six revolution/second, the payload was rotating 21.6 degrees/10ms counting period. Since the detector window was totally opaque to visible solar radiation and since Channel 1 (above) began at 10 keV, there should have been no effect due to the detector's direct viewing of the partially occulted sun. The charged particle spectrometer was also sensitive to any precipitated protons which may have been present in the altitude regime under investigation. All such events would appear in telemetry Channel 5.

Cosmic Rays -

The cosmic ray counter was comprised of a cylinder of Pilot B plastic scintillator which was three inches in diameter and three inches long. A two inch thick lucite light pipe was used to optically connect the scintillator to a two inch diameter photomultiplier tube. The assembly was packaged in a 1/8 inch thick aluminum housing and mounted inside the payload with no preferred orientation due to the penetrating nature of the cosmic rays. Individual pulses from events occurring within the detector were telemetered to the ground station. No radiation energy information was contained within these signals. However, a lower level discriminator circuit blocked pulses corresponding to energy losses within the scintillator of less than about 2 MeV. The count rate from the cosmic ray counter was low, of the order of a few counts/sec to a few tens of counts/sec.

Solar Ultraviolet Radiation -

Two photometers were used for sampling the ultraviolet radiation in the mesosphere. The first photometer measured the solar flux at approximately 2050 Å. This penetrating spectral component is important because of the photodissociation produced at such wavelengths. The photometer was provided with an interference filter and photomultiplier tube of a type previously employed by USU. The second photometer, also operated with an interference filter and photomultiplier measured solar flux at 1216 Å (Lyman alpha radiation).

Solar Aspect -

Proper interpretation of the measurements carried out by this payload required that rocket attitude relative to the vector direction to the sun be known. Accordingly, the payload carried a solar aspect sensor together with a flux gate magnetometer to provide attitude information.

Atmospheric Density and Temperature -

An AFGL 10 inch rigid falling sphere, instrumented with a sensitive three axis strain gauge was used to determine atmospheric density in the altitude range 35-105 km. The sphere was deployed from the rocket vehicle at a programmed time during ascent that corresponded to an altitude of 50-60 km. In the course of free-flight the sphere accelerometer sensed atmospheric drag and provided two sets of related measurements below apogee. Except for the case of highly disturbed atmospheric conditions, structural details observed at a given altitude on the ascending portion of the sphere trajectory were also seen at the corresponding altitude during descent. This self-consistency raised the confidence level of the measurements. Drag data are combined with trajectory information to determine density, from which approximate temperatures can be calculated. Conversion to an accurate temperature requires temperature information in an altitude region which overlaps the falling-sphere-derived data. It is planned that this information will be furnished by a meteorological rocket combined with radiosonde data obtained from the existing meteorological network.

A.3 Small Rocket Payload ASL-SE79E (CMSA 01, 04)

Launch Vehicle: Super Arcas

Sampling Altitude: 60-92 km

Principal Investigator: Earl Pou

Number Launched: 4 (four)

Payload Description: Principal objectives for these rocket payloads were the measurement of electron density profiles and solar Lyman alpha radiation input to the mesosphere during the eclipse and under non-eclipse conditions. These measurements complimented the large rocket experiments and provided more frequent samples of electron density and solar Lyman alpha than would otherwise have been possible.

Electron Density -

In fashion similar to the technique employed on large rocket payloads A_1 and B_1 electron densities were obtained through use of RF (or Z-θ) probes.

The Z-θ probe does not measure electron density directly, but measures the change in impedance of an RF antenna due to changes in electron density when the antenna is immersed in the ionospheric plasma. The name of the probe is derived from the measurements taken -- impedance magnitude and phase angle. Actual electron density is then obtained by applying the antenna theory appropriate to the particular antenna configuration and altitude. The Arcas Z-θ probes use the rocket skin as the antenna in contrast to the whip antenna employed on payloads A_1 and B_1. In order to provide information on structure in the electron density profiles, the nose tip of the rocket payload was electrically isolated and operated as a DC Langmuir probe.

Lyman Alpha Flux -

The measurement of very small incident photon fluxes in the vacuum ultraviolet, and specifically at the Lyman alpha wavelength of 1216 Å were carried out through employment of an ionization chamber sensitive to Lyman alpha radiation because of its sensitivity and spectral selectivity. The technique is the same as that employed in rocket payload A_1.

Rocket Attitude -

A small solar aspect sensor was included in order to determine a correction factor for the measured Lyman alpha flux. Such correction is required whenever the solar direction vector is not normal to the aperture of the Lyman alpha detector.

A.4 Small Rocket Payload ASL-SE79F$_1$ (CMSA-05 to 09)

Launch Vehicle: Super Arcas

Sampling Altitude: 30-77 km

Principal Investigator: Jack Mitchell, University of Texas at El Paso

Number Launched: 5 (five)

Payload Description: The objective for these rocket payloads was the measurement of positive and negative charged particle conductivity, ion mobility and charge number density in the atmospheric interval sampled. The experimental device used was a Gerdien condensor lowered by parachute (at subsonic speeds) after ejection from the rocket carrier. The operating arrangement of the Gerdien condensor was such that the atmopsheric sample to be measured flowed at a determined velocity (given by the fall rate of the instrument) through a pair of concentric cylindrical electrodes. In the arrangement here used, the inner electrode served as the charge collector. A voltage applied between the inner and outer electrodes produced an electric field which accelerated the charged particles toward the collecting electrode. The resulting current of collected charged particles, in the presence of varying voltage, provided information about the electrical conductivity ion mobility and charge number density.

A.5 Small Rocket Payload ASL-SE79F$_2$ (CMSA-10)

Launch Vehicle: Super Arcas

Sampling Altitude: 30-85 km

Principal Investigator: Jack Mitchell, University of Texas at El Paso

Number Launched: 1 (one)

Payload Description: The objective for this rocket payload is the measurement of positive and negative charged particle conductivities in the atmospheric interval sampled. The instrument used is a blunt probe lowered by parachute (at subsonic speeds) after ejection from the rocket carrier near apogee. In configuration, the blunt probe consists of two concentric, electrically isolated, flat plate electrodes oriented normal to the airflow on descent of the package. The electric potential of the inner electrode (small) is varied with respect to the outer electrode (large); this potential assumes positive and negative values in a sweeping sequence. The potential of the large electrode with respect to the free atmosphere is assumed to be a known function. A combination of subsonic blunt probe theory together with the current-voltage measurements by the small electrode provides a measure of positive and negative charged particle conductivies during descent of the instrument package.

A.6 Small Rocket Payload ASL-SE79M1 (CMSL-01 to 06, -08)

Launch Vehicle: Super Loki

Sampling Altitude: 30-66 km

Principal Investigator: Frank Schmidlin, NASA/Wallops Flight Center

Number Launched: 7 (seven)

Payload Description: The objectives for these rocket payloads were the measurement of winds and of atmospheric temperature in the altitude interval sampled. The instrumentation was carried in a dart launched by the Super Loki rocket. At dart apogee the instrumentation sensors were ejected and measurements were taken on descent by parachute.

Wind Sensor -

The Datasonde Wind Sensor was a ram-air inflated decelerator called a "Starute." Portions of the "Starute" have been metalized to facilitate radar tracking. Atmospheric wind data were obtained from the positional data taken by the tracking radar.

Temperature Sensor -

The temperature sensor was a small, aluminized bead thermistor (about .25mm in diameter) whose electrical resistance varied inversely with its temperature. The thermistor was attached to a mylar loop mount by means of short lead wires. The mylar loop was coated on the side facing the transmitter to reflect long-wave radiation present. As the instrument descended, the thermistor resistance controlled the modulation rate of the data circuit. The temperature data received at the ground were interrupted periodically through electronic switching to permit the transmission of a reference resistance.

A.7 Small Rocket Payload ASL-SE79M_2 (CMSL-09, -10)

Launch Vehicle: Super Loki

Sampling Altitude: 30-66 km

Principal Investigator: Jack Mitchell, University of Texas at El Paso

Number Launched: 2 (two)

Payload Description: The objective and method of measurement were identical to those described under A.5 above.

A.8 Partial Reflection Experiment

Principal Investigator: Robert Olsen, Atmospheric Sciences Laboratory

Description of the Experiment: The partial reflection experiment was ground-based and has as its experimental objective the provision of D-region electron density profiles throughout the eclipse and for background (non-eclipse) conditions. In operation, a low frequency (several megahertz) radar was used to transmit pulses of radiation vertically. Echoes backscattered from the D-region of the ionosphere were received and recorded as functions of pulse transit time. Circular polarization of the transmitted radiation was utilized, and pulses of both right and left hand polarization were employed. Because of the earth's magnetic field, the index of refraction of the ionosphere is different for the two polarization modes. The relative intensities of the waves partially reflected from a given altitude within the ionosphere contain information concerning the electron density at the altitude. This partial reflection technique was used to measure the density of free electrons in the ionosphere as a function of altitude from 50 km to 100 km. A single frequency of 2.666666 MHz was employed. The partial reflection experiment was located in the vicinity of sounding rocket activities near Red Lake, Ontario, and operated continuously for a period of several days before, during, and following the total solar eclipse.

A complete schedule of operations is given in the following tabulation:

Partial Reflection Sounder
Data Log

Balmertown, Ontario
Time = CST

Tape	File	Time Start	Time Stop	Date
61	1	1100	1115	8 Feb. 1979
	2	1155	1210	8 Feb. 1979
	3	1320	1333	8 Feb. 1979
	4	1355	1405	8 Feb. 1979
	5	1455	1505	8 Feb. 1979
	13	1645	1655	8 Feb. 1979
62	1	0850	0900	9 Feb. 1979
	2	1130	1145	9 Feb. 1979
	6	1355	1408	10 Feb. 1979
63	1	0930	0940	11 Feb. 1979
	2	1000	1015	11 Feb. 1979
	3	1050	1105	11 Feb. 1979
	4	1200	1215	11 Feb. 1979
	5	1300	1313	11 Feb. 1979
	6	0800	0815	12 Feb. 1979
	7	0900	0915	12 Feb. 1979
	11	2215	2233	12 Feb. 1979
64	1	0820	0825	13 Feb. 1979
	2	0900	0915	13 Feb. 1979
	4	1000	1015	13 Feb. 1979
	7	1050	1105	13 Feb. 1979
	8	1150	1205	13 Feb. 1979
	11	1400	1415	13 Feb. 1979
	12	1500	1515	13 Feb. 1979
	13	1520	1530	13 Feb. 1979
68	1	1050	1105	16 Feb. 1979
	2	1150	1205	16 Feb. 1979
	6	1250	1305	16 Feb. 1979
	8	1350	1405	16 Feb. 1979
	9	1450	1505	16 Feb. 1979
	10	1600	1618	16 Feb. 1979
	11	1700	1715	16 Feb. 1979
69	1	1810	1822	16 Feb. 1979
	2	1945	2000	16 Feb. 1979
	3	0820	0830	17 Feb. 1979
	5	0850	0905	17 Feb. 1979
	8	0950	1005	17 Feb. 1979
	9	1050	1105	17 Feb. 1979
	10	1150	1205	17 Feb. 1979
	12	1350	1405	17 Feb. 1979
	16	1450	1500	17 Feb. 1979

Tape	File	Time Start	Time Stop	Date
70	1	1550	1605	17 Feb. 1979
	2	1650	1705	17 Feb. 1979
	3	1730	1740	17 Feb. 1979
	8	1815	1825	17 Feb. 1979
	9	0845	0900	18 Feb. 1979
	13	0950	1005	18 Feb. 1979
	14	1050	1105	18 Feb. 1979
	15	1150	1205	18 Feb. 1979
	16	1250	1305	18 Feb. 1979
	17	1350	1400	18 Feb. 1979
71	4	0830	0845	19 Feb. 1979
	8	0950	1005	19 Feb. 1979
	13	1050	1105	19 Feb. 1979
	14	1150	1210	19 Feb. 1979
	15	1250	1305	19 Feb. 1979
	16	1350	1410	19 Feb. 1979
72	1	1450	1505	19 Feb. 1979
	2	1550	1605	19 Feb. 1979
	3	1650	1705	19 Feb. 1979
	4	0630	0645	20 Feb. 1979
	5	0700	0715	20 Feb. 1979
	6	0730	0745	20 Feb. 1979
	7	0850	0905	20 Feb. 1979
	11	0950	1005	20 Feb. 1979
	12	1050	1105	20 Feb. 1979
	13	1150	1205	20 Feb. 1979
	14	1250	1258	20 Feb. 1979
73	1	1350	1405	20 Feb. 1979
	2	1450	1505	20 Feb. 1979
	3	1550	1605	20 Feb. 1979
	4	1645	1700	20 Feb. 1979
	5	0630	0640	21 Feb. 1979
	6	0700	0710	21 Feb. 1979
	7	0730	0740	21 Feb. 1979
	8	0850	0905	21 Feb. 1979
	9	0950	1005	21 Feb. 1979
	13	1050	1105	21 Feb. 1979
	14	1150	1205	21 Feb. 1979
	15	1250	1300	21 Feb. 1979
74	1	1350	1405	21 Feb. 1979
	2	1450	1505	21 Feb. 1979
	3	1550	1605	21 Feb. 1979
	4	0530	0540	22 Feb. 1979
	5	0600	0610	22 Feb. 1979
	6	0630	0640	22 Feb. 1979
	7	0700	0710	22 Feb. 1979
	8	0730	0740	22 Feb. 1979
	9	0850	0905	22 Feb. 1979
	10	0950	1005	22 Feb. 1979
	14	1050	1105	22 Feb. 1979
	15	1150	1207	22 Feb. 1979

Tape	File	Time Start	Time Stop	Date
75	1	1250	1305	22 Feb. 1979
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	3	0530	0540	23 Feb. 1979
	4	0600	0610	23 Feb. 1979
	5	0630	0640	23 Feb. 1979
	6	0700	0710	23 Feb. 1979
	7	0730	0740	23 Feb. 1979
	8	0850	0905	23 Feb. 1979
	9	0950	1005	23 Feb. 1979
	12	1050	1105	23 Feb. 1979
	14	1120	1125	23 Feb. 1979
	15	1150	1205	23 Feb. 1979
	16	1250	1305	23 Feb. 1979
76	1	1350	1405	23 Feb. 1979
	2	1450	1505	23 Feb. 1979
	3	1550	1600	23 Feb. 1979
	4	0805	0815	24 Feb. 1979
	5	0830	0845	24 Feb. 1979
	6	0900	0915	24 Feb. 1979
	7	0930	0945	24 Feb. 1979
77	1	1000	1015	24 Feb. 1979
	2	1015	1030	24 Feb. 1979
	3	1030	1045	24 Feb. 1979
	4	1045	1100	24 Feb. 1979
	5	1100	1115	24 Feb. 1979
	6	1115	1130	24 Feb. 1979
	7	1130	1145	24 Feb. 1979
	8	1145	1200	24 Feb. 1979
	10	1230	1240	24 Feb. 1979
	11	1250	1300	24 Feb. 1979
	12	1350	1405	24 Feb. 1979
	13	1450	1502	24 Feb. 1979
78	1	1550	1605	24 Feb. 1979
	2	0600	0615	25 Feb. 1979
	3	0620	0630	25 Feb. 1979
	4	0700	0730	25 Feb. 1979
	5	0800	0810	25 Feb. 1979
	6	0840	0850	25 Feb. 1979
	7	0900	0915	25 Feb. 1979
	8	0930	0945	25 Feb. 1979
	9	1000	1015	25 Feb. 1979
79	1	1030	1045	25 Feb. 1979
	2	1045	1100	25 Feb. 1979
	3	1100	1115	25 Feb. 1979
	4	1115	1130	25 Feb. 1979
	5	1130	1145	25 Feb. 1979
	6	1145	1200	25 Feb. 1979
	7	1200	1215	25 Feb. 1979
	8	1215	1230	25 Feb. 1979
	9	1300	1315	25 Feb. 1979
	10	0540	0550	26 Feb. 1979
	11	0600	0610	26 Feb. 1979

Tape	File	Time Start	Time Stop	Date
80	1	0630	0645	26 Feb. 1979
	2	0645	0700	26 Feb. 1979
	3	0700	0715	26 Feb. 1979
	4	0716	0730	26 Feb. 1979
	5	0800	0815	26 Feb. 1979
	6	0830	0845	26 Feb. 1979
	7	0900	0915	26 Feb. 1979
	8	0930	0945	26 Feb. 1979
	9	1000	1015	26 Feb. 1979
81	1	1035:00	1044:00	26 Feb. 1979
	2	1044:40	1115:00	26 Feb. 1979
	6	1150:00	1205:00	26 Feb. 1979
	7	1230:00	1232:10	26 Feb. 1979
	8	1233:00	1251:00	26 Feb. 1979
	9	1300:00	1315:00	26 Feb. 1979
	10	1330:00	1347:20	26 Feb. 1979
82	1	2100	2115	26 Feb. 1979
	2	2115	2130	26 Feb. 1979
	3	2130	2145	26 Feb. 1979
	4	2145	2200	26 Feb. 1979
	5	2200	2215	26 Feb. 1979
	6	2215	2230	26 Feb. 1979
	7	2230	2245	26 Feb. 1979
	8	2245	2300	26 Feb. 1979
	9	0530	0540	27 Feb. 1979
83	1	0545	0552	27 Feb. 1979
	2	0552	0615	27 Feb. 1979
	3	0615	0645	27 Feb. 1979
	4	0645	0720	27 Feb. 1979
	5	0745	0802	27 Feb. 1979
	6	0803	0825	27 Feb. 1979
	7	0825	0855	27 Feb. 1979
84	1	0930	0940	27 Feb. 1979
	2	1000	1010	27 Feb. 1979
	3	1030	1040	27 Feb. 1979

APPENDIX B

ASL SOUNDING ROCKET PROGRAM
SOLAR ECLIPSE
26 FEBRUARY 1979

Operational Document

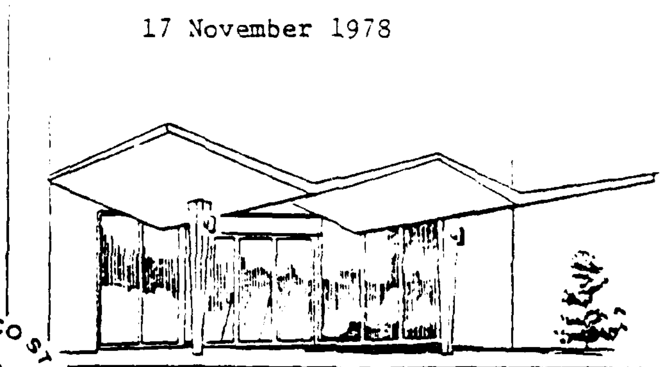
(Revised April 1979)

prepared for

U.S. Army Electronics Research and Development Command
Atmospheric Sciences Laboratory
White Sands Missile Range, New Mexico

Under Contract No. DAAD07-78-C-0058

17 November 1978



NEW MEXICO STATE UNIVERSITY
Physical Science Laboratory
Box 3-PSL, Las Cruces, New Mexico 88003
Area (505) 522-4400 TWX 910-983-0541

ATMOSPHERIC SCIENCES LABORATORY

LARGE SOUNDING ROCKET PROGRAM

OPERATIONAL DOCUMENT

SOLAR ECLIPSE

FEBRUARY 1979

(Revised)

Additional copies of document may be obtained. Address requests to:

John L. Cross
Physical Science Laboratory
New Mexico State University
Box 3-PSL
Las Cruces, New Mexico 88003

CONTENTS

ILLUSTRATIONS

TABLES

ACRONYMS

ASL - Atmospheric Sciences Laboratory

AFGL - Air Force Geophysics Laboratory

DNA - Defense Nuclear Agency

NASA/WFC - National Aeronautics and Space Administration/Wallops Flight Center

NRC - National Research Council of Canada

OSU - Oklahoma State University

PSL - Physical Science Laboratory/New Mexico State University

USU - Utah State University

WSMR - White Sands Missile Range

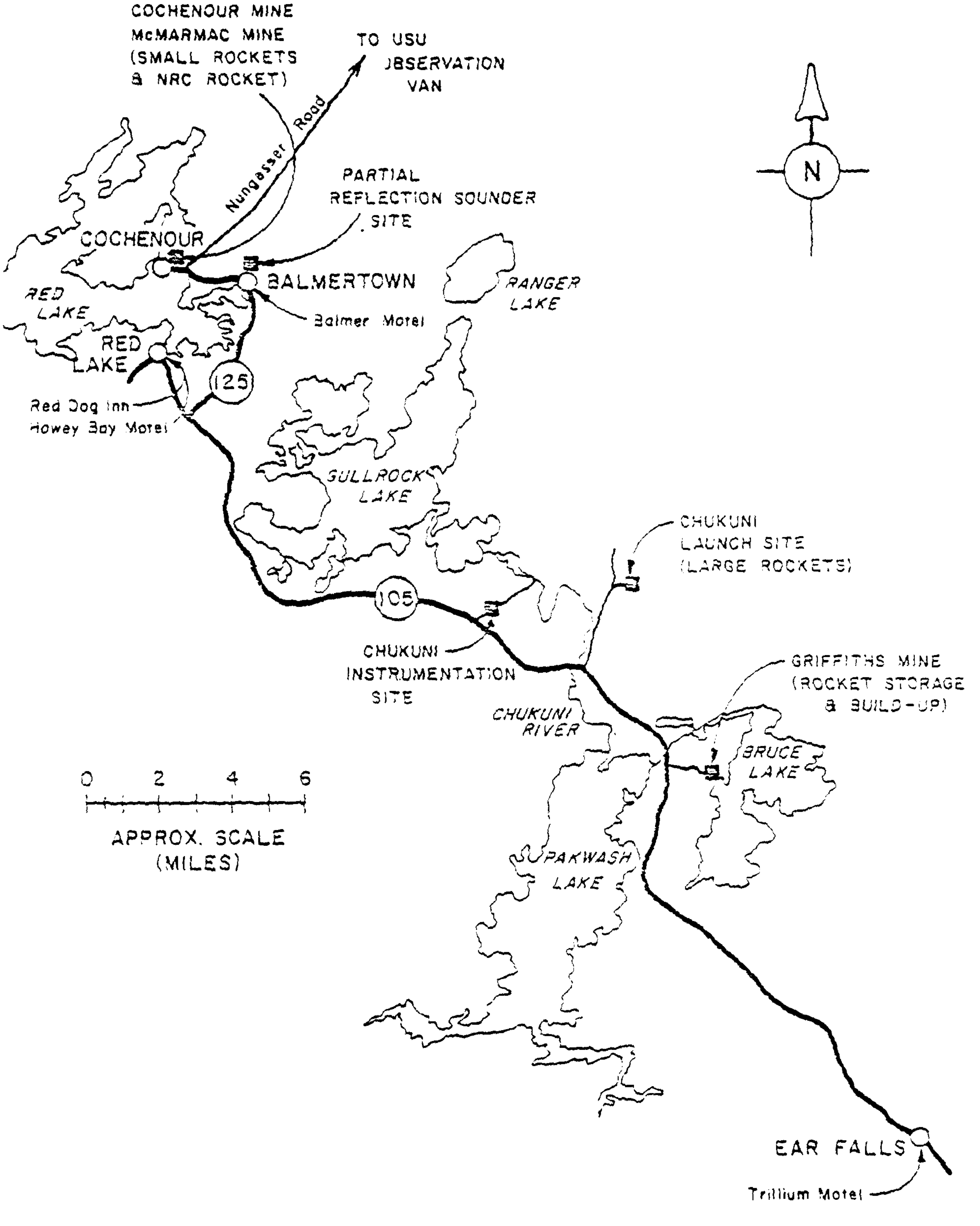
1. INTRODUCTION

On 26 February 1979, a total eclipse of the sun will occur with the path of totality passing over the Red Lake area of Western Ontario. A joint scientific Solar Eclipse Program will be conducted during this event. This will be the last total eclipse during this century that can be observed from the North American continent.

PSL, under contract DAAD07-78-C-0058 to the U.S. Army Atmospheric Sciences Laboratory, will participate in this Solar Eclipse '79 Program and launch a series of research sounding rockets near and during the period of totality. A number of other government agencies and universities will also participate in this program.

In developing a research program for the solar eclipse, principal interest centers upon the behavior of the ionized regions at altitudes below 100 km. Since the sun provides the major source of ionization at altitudes above 70 km, except under disturbed conditions characterized by significant precipitation of charged particles into the atmosphere, the varying ionizing source as the sun is eclipsed produces variations in the ionized regions. Measurements of the changing ionization source strengths coupled with measurements of the atmospheric response (both the ionized and neutral constituents) provide data necessary for the development of physical models of the ion and neutral processes in the atmospheric regions of interest. Ionization sources other than those related to direct solar radiation must also be measured for the complete development of the desired models and for extension to altitudes below 70 km.

The Red Lake area was selected for this program based on its location relative to the path of the eclipse and the availability of suitable operation areas and facilities. The PSL large rocket operations will be conducted from the Chukuni sites which are located about 20 miles south of the town of Red Lake. The Small Rocket and Partial Reflection Sounder operations which are part of this program, are covered in a separate Small Rocket Operations document (See Figure 1 for site locations).



SOLAR ECLIPSE '79 SUPPORT AREAS
RED LAKE, ONTARIO, CANADA

FIGURE 1

2. PERSONNEL

2.1 Program Personnel

Technical Director	M. Heaps (ASL)
Program Manager	W. Berning (PSL)
Assistant Program Manager	A. Gilcrease (PSL)
Program Coordinator	J. Cross (PSL)
Program Launch and Test Conductor	V. Parkerson (PSL)
Program Launch Engineer	E. Butterfield (ASL)
Program Safety Officer	R. Petracek (PSL)

2.2 (A_1) ASL-SE-79A1 Personnel

Project Manager	D. Burt (USU)
Project Engineer	L. Jensen (USU)
Project Scientist	K. Baker (USU)
Payload Experimenter	C. Howlett (USU)
Payload Experimenter	D. Morse (USU)
Payload Experimenter	E. Pound (USU)
Vehicle Engineer	R. Petracek (PSL)
Telemetry Engineer (Airborne)	R. Wagner (PSL)
Telemetry Engineer (Data Collection)	W. Harkey (PSL)
Tracking Systems Engineer	B. Gammill (PSL)

2.3 (B_1) ASL-SE-79B1 (Rocket Payload)

NOTE: See AFGL Operational Document for Sphere Payload (A12.9A1)

Project Manager	D. Burt (USU)
Project Engineer	L. Jensen (USU)
Project Scientist	K. Baker (USU)
Co-Investigator	J. McCrary (PSL)
Payload Experimenter	E. Pound (USU)
Payload Experimenter	C. Howlett (USU)
Vehicle Engineer	R. Petracek (PSL)
Telemetry Engineer (Airborne)	R. Wagner (PSL)
Telemetry Engineer (Data Collection)	W. Harkey (PSL)
Tracking Systems Engineer	B. Gammill (PSL)

2.4 AFGL Personnel

Personnel listings for Rocket Numbers (B_1) A12.9A1 (Sphere Payload only), (C_1) A10.802-1, (C_2) A10.802-2 and (G_1) A12.9A2 appear in the AFGL Operational Document.

2.5 Program Personnel (Total by Agency)

2.5.1 Atmospheric Sciences Laboratory

Technical Director	M. Heaps
Program Launch Engineer	E. Butterfield
Pad Chief	J. Carver
Pad Chief	J. Fields
Windweighting Personnel	L. Moore
	C. Price

2.5.2 Physical Science Laboratory/New Mexico State University

Program Manager	W. Berning
Assistant Program Manager	A. Gilcrease
Program Coordinator	J. Cross
Co-Investigator (B_1)	J. McCrary
Program Launch and Test Conductor	V. Parkerson
Vehicle Engineer and Safety Officer	R. Petracek
Telemetry Engineer (Airborne)	R. Wagner
Telemetry Engineer (Data Collection)	W. Harkey
Tracking Systems Engineer (Program)	B. Gammill
Tracking Systems Engineer (Project)	E. Lee
Tracking Systems Engineer (Project)	D. Nimrod
Telemetry Engineer	D. Schmidt
Telemetry Engineer	G. Freeman
Telemetry Technician	L. Jarry
Telemetry Technician	E. Rogers
Electronic Technician	G. Stanley
Electronic Technician	J. Davis

2.5.3 Space Science Laboratory - Utah State University

Project Manager	D. Burt
Project Scientist	K. Baker
Project Engineer	L. Jensen
Payload Experimenter (A_1 and B_1)	E. Pound
Payload Experimenter (A_1)	D. Morse
Payload Experimenter (A_1 and B_1)	C. Howlett
Payload Technician (A_1 and B_1)	D. Bunnell
Instrumentation Technician (A_1 and B_1)	D. Ballard
Instrumentation Technician (A_1)	K. Johnson

2.5.4 Defense Nuclear Agency

Program Liaison	A. Dykes

AD-A100 862 NEW MEXICO STATE UNIV LAS CRUCES PHYSICAL SCIENCE LAB F/G 4/1

EXPERIMENTAL INVESTIGATION OF ATMOSPHERIC RESPONSE TO THE TOTAL--ETC(U)

APR 79 DAAD07-78-C-0058

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3. ASL ROCKETS AND PAYLOADS

3.1 Solar Radiation, Minor Species (Dr. K. Baker, USU)

3.1.1 Project Designation: A_1

3.1.2 ASL Rocket Number: ASL-SE-79A1

3.1.3 Rocket Type: Nike-Orion (Figure 2)

3.1.4 Experimenter: C. Howlett, USU

3.1.5 Launcher Identification: AML 4K3 Dual Boom Pad 7A

3.1.6 Measurements

(a) Number density of atomic oxygen is determined by measuring the resonant scattering of 1302, 4, 6Å resonance triplet of O from an onboard modulated source.

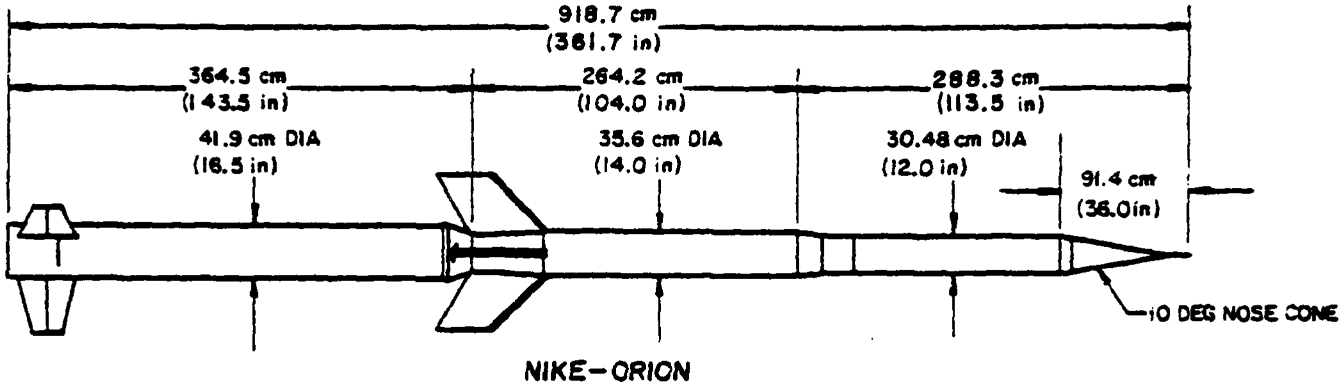
(b) 5577Å atomic oxygen emissions are determined by a selective photometer.

(c) Infrared atmospheric emissions at 1.27μ, 1.595μ and 1.944μ are measured using a cryogenically cooled radiometer.

(d) An altitude profile of the ozone concentration in the upper atmosphere is derived by measuring the absorption of solar ultraviolet emissions using four (4) photometers.

(e) Nitric oxide will be determined by measuring the intensity of solar ultraviolet light resonantly scattered in the NO γ-band.

(f) Solar Lyman-alpha radiation at 1216Å will be measured using an ionization chamber as a sensor.



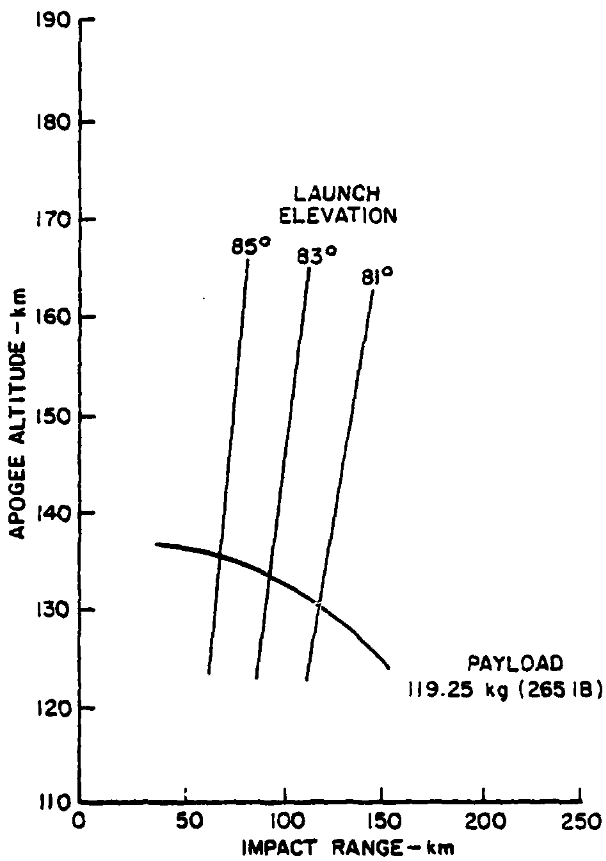


Figure 2 Configuration and Predicted Performance for Vehicle ASL-SE-79A1; Chukuni Launch (377.8 m elevation).

(g) Electron density will be determined using an impedance probe.

(h) A solar aspect sensor will be included to determine the altitude of the various instruments with respect to the sun.

(i) A magnetic aspect sensor is used to determine the magnetic pitch angle.

3.1.7 Scientific Objectives

The objectives of Payload A_1 are to measure:

(1) ozone concentration

(2) atomic oxygen concentration

(3) nitric oxide concentration

(4) molecular oxygen ($^1\Delta g$) concentration

(5) hydroxyl ion concentration

(6) Lyman-alpha radiation intensity

(7) electron density

as a function of altitude from 60 to 120 km at approximately 25 minutes before second contact.

3.1.8 Payload Flight Description

At an altitude of approximately 55 km the nose cone assembly and instrument cover doors will be ejected. As the nose cone departs, it will remove the cover from the radiometer and carry it away from the instrument. The impedance probe will deploy and along with the other instruments, commence data collection. No attempt will be made to despin or recover the payload.

3.1.9 Payload Configuration (Figure 3)

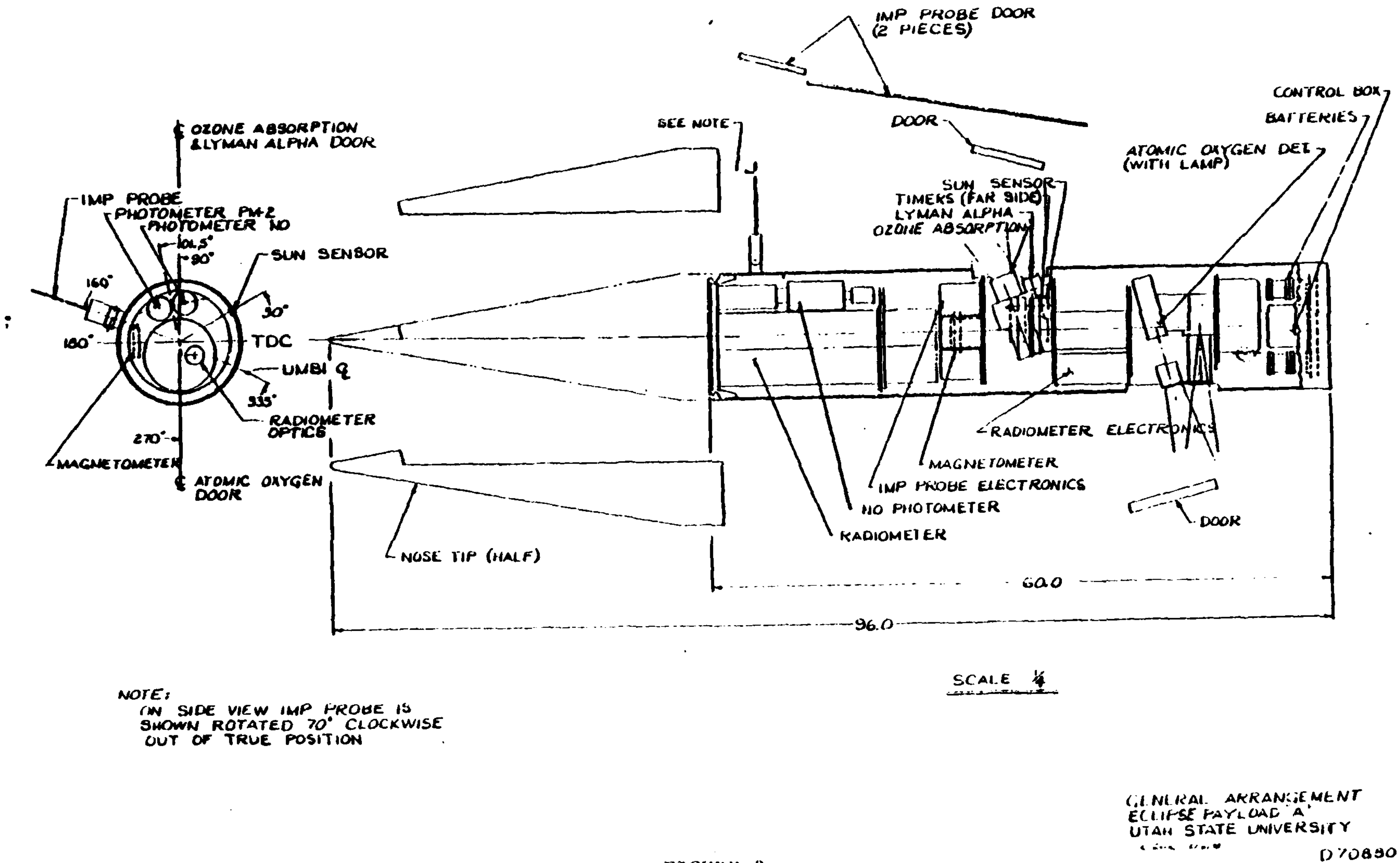

IMP PROBE DOOR
(2 PIECES)
CONTROL BOX
BATTERIES
SEE NOTE
DOOR
ATOMIC OXYGEN DET
(WITH LAMP)
℄ OZONE ABSORPTION
&LYMAN ALPHA DOOR
SUN SENSOR
TIMERS (FAR SIDE)
LYMAN ALPHA
OZONE ABSORPTION
IMP PROBE
PHOTOMETER PM-2
PHOTOMETER NO
101.5°
90°
SUN SENSOR
160°
30°
180°
TDC
UMBI ℄
335°
RADIOMETER
OPTICS
270°
MAGNETOMETER
℄ ATOMIC OXYGEN
DOOR
RADIOMETER ELECTRONICS
MAGNETOMETER
IMP PROBE ELECTRONICS
NO PHOTOMETER
RADIOMETER
DOOR
NOSE TIP (HALF)
60.0
96.0
SCALE ¼
NOTE:
IN SIDE VIEW IMP PROBE IS
SHOWN ROTATED 70° CLOCKWISE
OUT OF TRUE POSITION
GENERAL ARRANGEMENT
ECLIPSE PAYLOAD 'A'
UTAH STATE UNIVERSITY
D70890

FIGURE 3

3.1.10 Vehicle and Payload Characteristics:

	Total	Booster	Second Stage	Payload
Designation	—	M5E1	Orion	—
Number of Fins	—	3	4	—
Launch Weight (lb)	2517.7	1320.9	931.8	265.0
Max. Diameter (in)	—	17.0	14.0	12.0
Length (in)	361.7	143.5	104.7	113.5

3.1.11 Vehicle Performance (approximate)

Launch Elevation Angle (Estimated)	QE 84 Degrees
Apogee Time	186.45 sec.
Apogee Altitude	138 km
Apogee Range	41.0 km
Impact Time	360 sec.
Impact Range	82 km

3.1.12 Time Sequence for Vehicle and Payload

3.1.12.1 Launch Time

T_2 - 26 Min. 16:28 Note: T_2 = 16:54 UT (Second Contact)
Local Time 10:28:00
UT 16:28:00

3.1.12.2 Time After Launch (T + Seconds)

T0	Launch
T+3.35	Booster Burnout
T+9.0	Second State Ignition
T+41.55	Second Stage Burnout
T+58.0	Nose Cone Separation
T+360	Vehicle Impact

3.1.13 Trajectory System

3.1.13.1 Radar Transponder

Receiver Frequency	2763
Reply Frequency	2875
Code Space	6 μ sec.

3.1.13.2 Telemetry Ranging Systems

Receive (up link) Frequency	550.0 MHz
Reply (down link) Frequency	2259.5 MHz

3.1.14 Telemetry Systems

Rocket Vehicle Payload (Tech. Data 7.1)
(NMSU/PSL Telemetry System)
Frequency 2259.5 MHz
Modulation PCM/FM

3.2 Electron Density, Solar X-Ray, UV Flux and Radiation (Dr. K. Baker, USU, Dr. J. McCrary, PSL) NOTE: See AFGL Operational Document for Sphere Payload (A12.9A1)

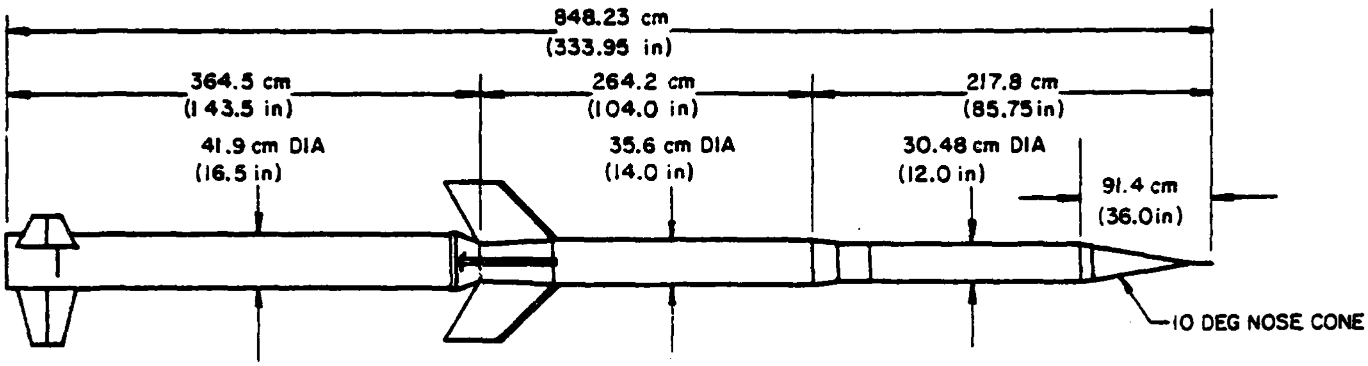
3.2.1 Project Designation: B_1

3.2.2 ASL Rocket Number: ASL-SE-79B1
AFGL Sphere Payload Number: A12.9A1

3.2.3 Rocket Type: Nike Orion (Figure 4)

3.2.4 Experimenters: G. Frodsham, USU, D. Morse, USU, C. Howlett, USU

3.2.5 Launcher Identification: AML 4K3 Dual Boom Pad 7B



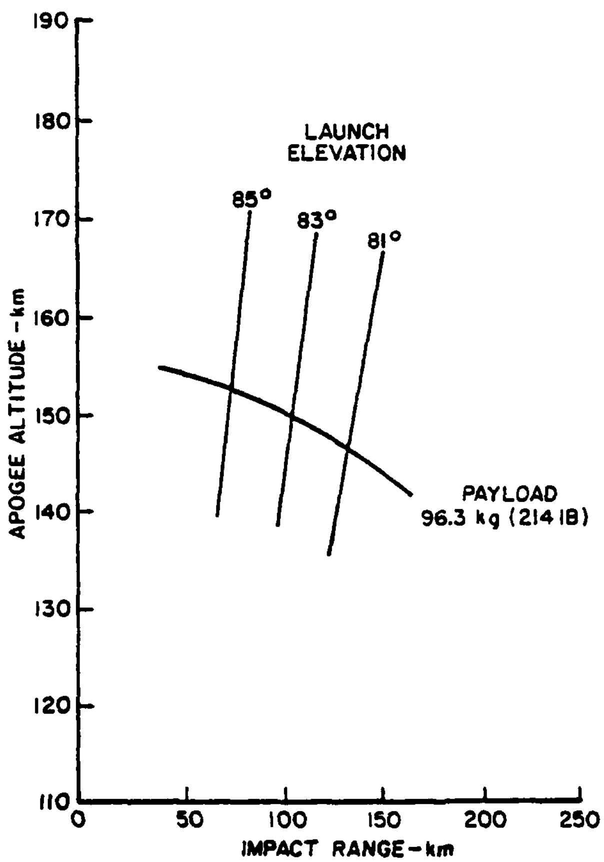


Figure 4 Configuration and Predicted performance for Vehicle ASL-SE-79B_1; Chukuni Launch (377.8 m elevation).

3.2.6 Measurements

(a) Flux and energy spectrum of particles (primarily electrons) between 30 KeV and 10 MeV will be determined with an energetic particle spectrometer.

(b) High energy particles of 1 MeV or more will be measured with a cosmic ray detector.

(c) Flux levels and the energy spectrum of x-rays between 1 and 10Å will be obtained using a solar x-ray counter.

(d) Solar Lyman-alpha radiation at 1216Å will be measured using an ionization chamber as a sensor.

(e) Electron density will be determined using an impedance probe.

(f) The level of solar UV flux at 2050Å will be measured using a special photometer.

(g) A solar aspect sensor will be included to determine the attitude of the various instruments with respect to the sun.

(h) A magnetic aspect sensor is used to determine the magnetic pitch angle.

3.2.7 Scientific Objectives

The objectives of Payload B_1 (lower) are to measure:

(1) solar x-ray flux (2-8 Å)

(2) changed particle intensity and energy distribution

(3) cosmic ray flux

(4) solar UV (2050 Å) intensity

(5) Lyman-alpha radiation intensity

(6) electron density

as a function of altitude from 50 to 160 km at approximately 25 minutes before second contact.

3.2.8 Payload Flight Description

At approximately 60 km the AFGL sphere nose cone will be ejected. The instrument covers will be removed and the impedance probe element deployed. All instruments will start data collection. The 10-inch sphere will be deployed about 10 seconds after the nose cone ejection.

3.2.9 Payload Configuration (Figure 5)

3.2.10 Vehicle and Payload Characteristics

	Total	Booster	Second Stage	Payload
Designation	—	M5E1	Orion	—
Number of Fins	—	3	4	—
Launch Weight (lb)	2468.7	1320.9	931.8	214.0
Max. Diameter (in)	—	17.0	14.0	12.0
Length (in)	333.7	143.5	104.7	85.5

3.2.11 Vehicle Performance (approximate)

Launch Elevation Angle (estimated)	QE 84 Degrees
Apogee Time	197 sec.
Apogee Altitude	155 km
Apogee Range	45 km
Impact Time	381 sec.
Impact Range	82 km

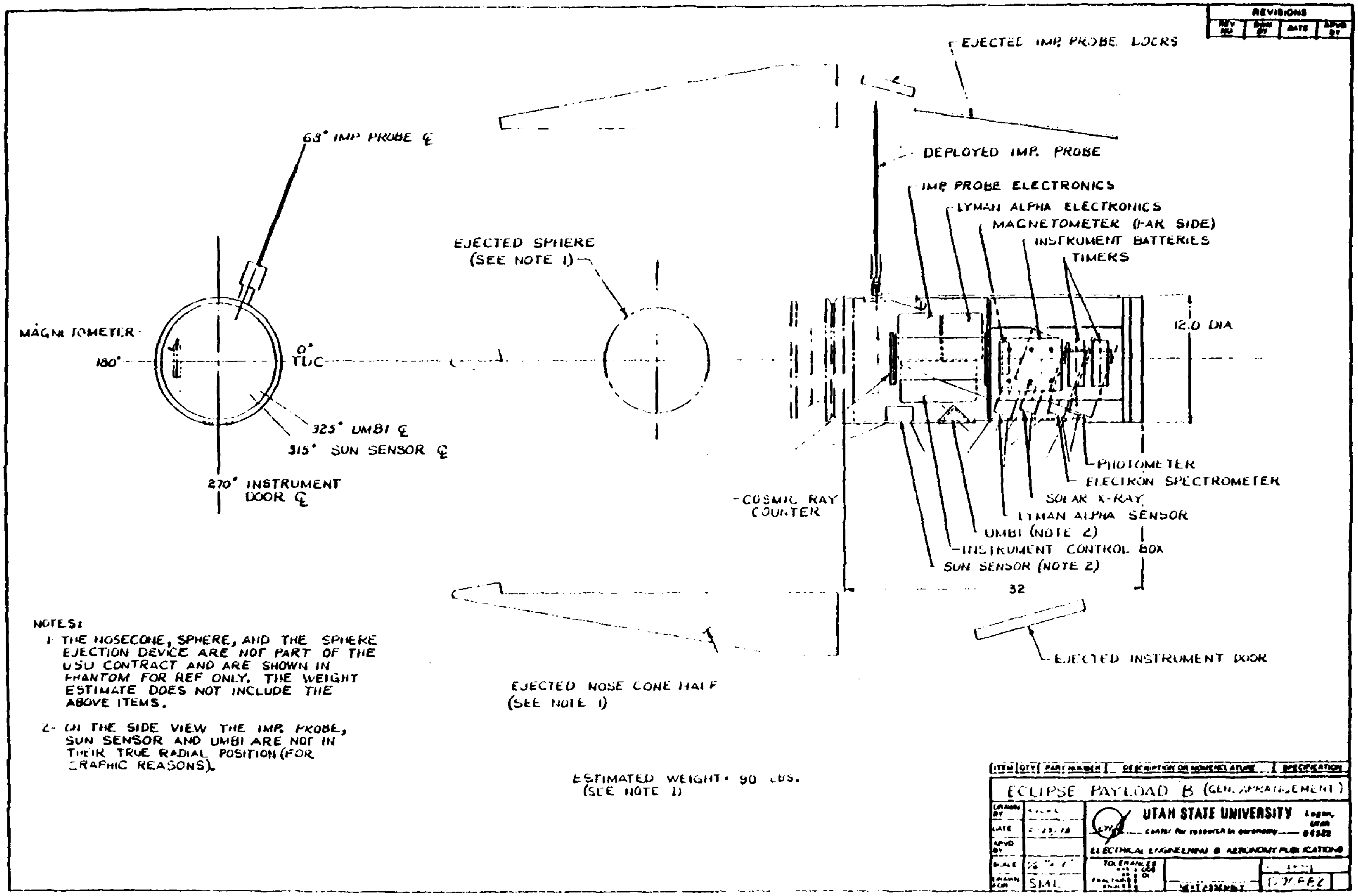

REVISIONS
EJECTED IMP. PROBE LOCKS
DEPLOYED IMP. PROBE
IMP. PROBE ELECTRONICS
LYMAN ALPHA ELECTRONICS
MAGNETOMETER (FAR SIDE)
INSTRUMENT BATTERIES
TIMERS
12.0 DIA
PHOTOMETER
ELECTRON SPECTROMETER
SOLAR X-RAY
LYMAN ALPHA SENSOR
UMBI (NOTE 2)
INSTRUMENT CONTROL BOX
SUN SENSOR (NOTE 2)
32
COSMIC RAY COUNTER
EJECTED INSTRUMENT DOOR
EJECTED SPHERE (SEE NOTE 1)
EJECTED NOSE CONE HALF (SEE NOTE 1)
68° IMP PROBE ℄
MAGNETOMETER
180°
0° TDC
325° UMBI ℄
315° SUN SENSOR ℄
270° INSTRUMENT DOOR ℄
NOTES:
1- THE NOSECONE, SPHERE, AND THE SPHERE EJECTION DEVICE ARE NOT PART OF THE USU CONTRACT AND ARE SHOWN IN PHANTOM FOR REF ONLY. THE WEIGHT ESTIMATE DOES NOT INCLUDE THE ABOVE ITEMS.
2- ON THE SIDE VIEW THE IMP. PROBE, SUN SENSOR AND UMBI ARE NOT IN THEIR TRUE RADIAL POSITION (FOR GRAPHIC REASONS).
ESTIMATED WEIGHT: 90 LBS. (SEE NOTE 1)
ECLIPSE PAYLOAD B (GEN. ARRANGEMENT)
UTAH STATE UNIVERSITY
ELECTRICAL ENGINEERING & AERONOMY PUBLICATIONS
SML

FIGURE 5

3.2.12 Time Sequence for Vehicle and Payload

3.2.12.1 Launch Time

T_2 - 25:30 min. Note: T_2 = 16:54 UT (second contact)

Local Time 10:28:30

UT 16:28:30

3.2.12.2 Time After Launch (T + Seconds)

T-0	Launch
T+3.35	Booster Burnout
T+9.0	Second Stage Ignition
T+41.55	Second Stage Burnout
T+58	Nose Cone Separation
T+60	Sphere Ejection
T+381	Payload/Vehicle Impact
T+451	Sphere Impact

3.2.13 Trajectory System

3.2.13.1 Radar Transponder

Receiver Frequency	2763 MHz
Reply Frequency	2890 MHz
Code Space	8 μ sec.

3.2.13.2 Telemetry Ranging System

Receive (up link) Frequency	550.0 MHz
Reply (down link) Frequency	2279.5 MHz

3.2.14 Telemetry Systems

Link 1 Rocket Vehicle Payload (Tech. Data 7.2)
Link 2 AFGL Sphere (Tech. Data 7.3)
(NMSU/PSL Telemetry System)
Frequency 2279.5 MHz
Modulation PCM/FM

4. OPERATIONAL REQUIREMENTS

4.1 A_1 and B_1 Payload Preparation Area

Space: Approximately 225 Sq. Ft.

Power: One 115VAC, 20 Amp. Circuit

Location: ASL/AFGL Payload Preparation Building - Chukuni Instrumentation Area.

4.2 ASL and AFGL Rocket Preparation Area

All solid propellant rockets and boosters will be stored and prepared in the Dredge Building located at Griffiths Mine.

4.3 A_1 and B_1 Payload Control (Van A)

Area: 15 Ft. X 40 Ft. Cleared and Level

Power: 208VAC, Three Phase, 100 Amp. Circuit

Location: Chukuni Launch Area

4.4 ASL Fire Control Van

Area: 15 Ft. X 40 Ft. Cleared and Level

Power: 208VAC, Three Phase, 100 Amp. Circuit

Location: Chukuni Launch Area

4.5 ASL Machine Shop Van

Area: 15 Ft. X 40 Ft. Cleared and Level

Power: 208VAC, Three Phase, 50 Amp. Circuit

Location: Chukuni Launch Area

4.6 PSL Telemetry Vans (2)

Each van requires the following:

Area: 20 Ft. X 40 Ft. Cleared and Level

Power: 208 VAC, Three Phase, 100 Amp. Circuit

Location: Chukuni Instrumentation Area

4.7 Launcher and Umbilical Line Requirements

4.7.1 First Motion

First motion indication to all telemetry stations is required from all launchers.

4.7.2 Umbilical Lines

(A_1)	Pad 7	Rail A	74 Lines
(B_1)	Pad 7	Rail B	74 Lines

Specific Line Information (Table 1)

4.8 Vehicle and Payload Handling Requirements

4.8.1 Rocket Vehicle Handling:

PSL/ASL launch crew will be responsible for rocket assembly, handling, transport and launcher installation. Vehicle environmental control will be accomplished by ASL launch crew.

4.8.2 Payload Handling:

Payload handling will be the responsibility of the experimenters. A pick up truck will be available to transport the payload to the launcher where chain hoister and launch crew will be available for launcher installation.

An "A" frame and one payload dolly will be available in the payload preparation building.

4.8.3 Temperature Control:

Temperature control and monitoring are required for all ASL/PSL rocket motors, igniters and payloads. Requirements during operations and during storage are as follows:

UMBILICAL LINES PAYLOAD CONTROL VAN "A"

LAUNCHER	ROCKET	CONNECTOR/ FUNCTION	PIN ASSIGN.	NO. OF WIRES	MAX. RESIST. OHMS	MIN. WIRE SIZE	P/L VAN TERM BOARD ASSIGN.
7A	A1	#1 (RED)	A-s	37	10.0	#19	1-37
		#2 (GRN)	A-s	37	10.0	#19	38-74
7B	B1	#1 (RED)	A-s	37	10.0	#19	75-111
		#2 (GRN)	A-s	37	10.0	#19	112-148
7A	A1	LIFTOFF		2	10.0	#19	149-150
7B	B1	LIFTOFF		2	10.0	#19	151-152
7	A1 & B1	P/L VAN COMMO		2	10.0	#19	153-154
T/B CONNECTIONS RESERVED FOR OTHER COMMO.					44 TERMINALS		155-208

TABLE 1

(ASL) Nike Orion Vehicles and Payload

Nike Rocket Motor	(Operating)	(-23 to 54°C)	(-10 to 130°F)
	(Storage)	(-28 to 54°C)	(-20 to 130°F)
Igniter	(Operating)	(-18 to 49°C)	(0 to 120°F)
	(Storage)	(-29 to 55°C)	(-20 to 130°F)
Orion Rocket Motor	(Operating)	(-23 to 54°C)	(-10 to 130°F)
	(Storage)	(-40 to 60°C)	(-40 to 140°F)
Igniter	(Operating)	(-23 to 54°C)	(-10 to 130°F)
	(Storage)	(-17 to 48°C)	(2 to 105°F)
Payload	(Operating)	(4 to 32°C)	(40 to 90°F)

4.9 Cryogen and Gas Requirements

4.9.1 Supply and Storage

NASA/WFC and NRC will coordinate the cryogen supply and a storage area will be selected at a later date. PSL will supply the nitrogen and helium gases. The required number of "K" bottles are now on-site and stored in the payload preparation area at the Chukuni Instrumentation Site.

4.9.2 Cryogen and Gas Handling

Each user agency must provide a vehicle for moving cryogens and/or gases to the launcher for payload servicing. The user must also provide necessary gas regulators and cryogen transfer equipment.

4.10 Snow Removal

The details of snow removal is covered under an NRC contract with a private company.

4.11 Security

Security is covered under an NRC contract with a private company. The remote sites will also be patrolled by the Ontario Provencial Police (O.P.P.).

4.12 Communications and Timing

4.12.1 Communications Requirements

4.12.1.1 Telephones

A commercial telephone will be installed in the NASA/WFC Fire Control Van with an extention installed in the ASL Fire Control Van.

ASL furnished field telephones will be used for communications between the payload control vans and the launch pads.

4.12.1.2 Interrange Communications

Fifteen channel intercoms will be provided by NASA/WFC throughout the Chukuni Instrumentation and Launch Sites. This communication complex will consist of a basic RF system and/or a hardwire net. Channel allocations will be assigned to various agencies at a later date.

4.12.1.3 PSL/ASL/AFGL Communications

Fifteen channel intercoms should be located in the following areas:

Payload Control Vans A and B
ASL Fire Control Van
ASL Machine Shop Van
Payload Preparation Building
PSL Telemetry Vans 1 and 2
AFGL/OSU TM/Tracking Station
AFGL Mobile Telemetry Van

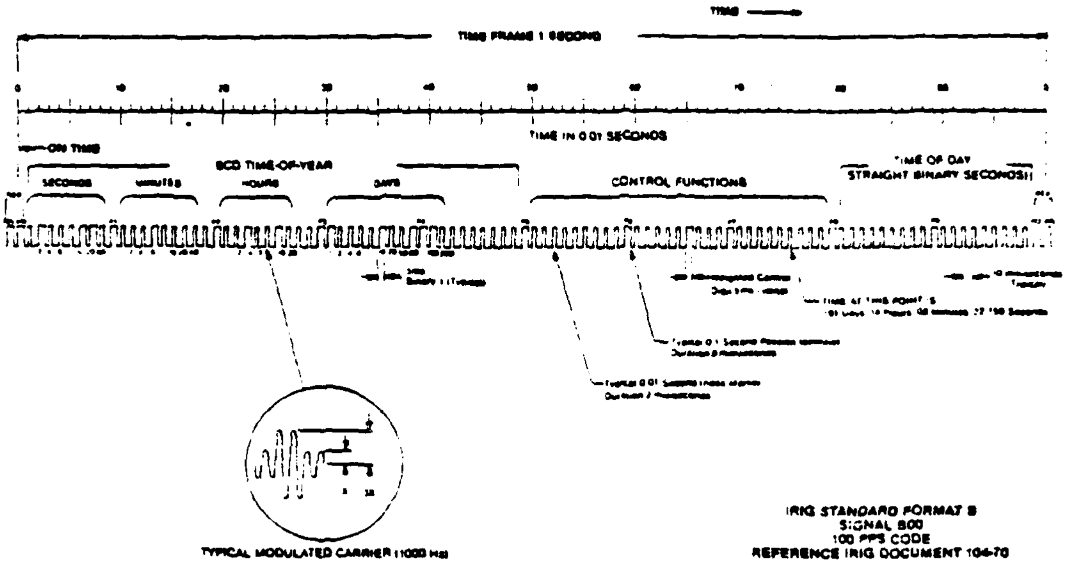
4.12.2 Timing Requirements

IRIG B and IRIG H (Figure 6) time code signals are to be provided to the following locations:

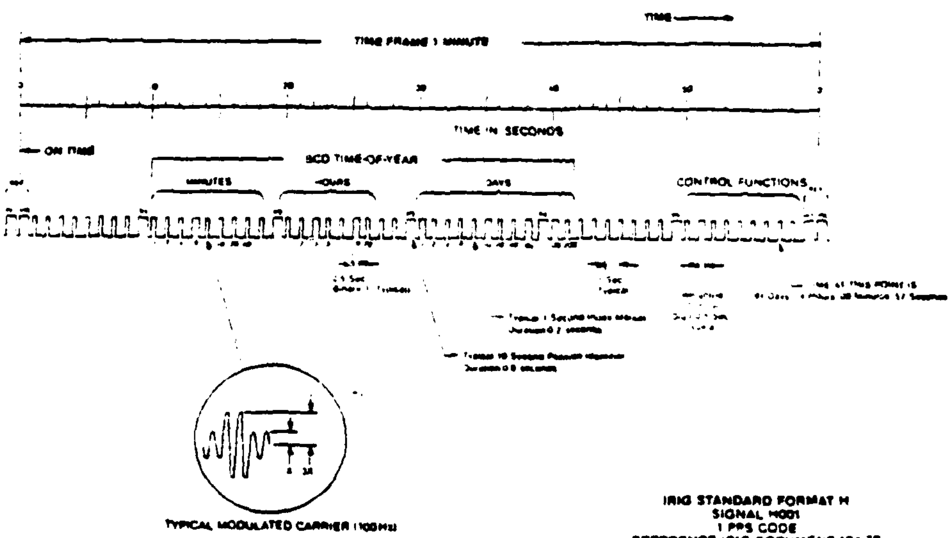
PSL Telemetry Vans 1 and 2

AFGL/OSU TM/Tracking Station

AFGL Mobile Telemetry Van



IRIG B Time Code Format



IRIG H Time Code Format

FIGURE 6

5. GROUND SUPPORT

5.1 Rocket Launchers

All ASL and AFGL rockets will be launched from the AML-4K3 launcher described as follows:

The AML-4K3 rocket launcher is a double-boom, electromechanically driven, launcher designed to rigidly support and precisely position for launch single and multiple stage rockets. The two rocket-support booms can be jointly positioned in azimuth for a full 360°; they can also be independently or simultaneously positioned in elevation from 0° to 90°. Each boom can support a rocket weighing up to 7000 pounds, and rocket launch may be accomplished either simultaneously or independently.

The launcher can be operated locally at the launch pad or at a remote control site several miles distant. Boom position information, both in azimuth and elevation, can be obtained from scale, and printer units mounted on the launchers, and from illuminated position-display units located at the remote control site.

5.2 PSL Telemetry Vans

Two PSL operated vans will be used for telemetry data recovery. Each van consists of dual "S" band manual tracking antennas, receiving and recording equipment. Both vans will be used as prime stations for the ASL flights and as back-up for AFGL.

5.3 NASA/WFC and AFGL Telemetry Stations

Back-up telemetry coverage for ASL rockets, will be requested on a non-interference basis from NASA/WFC and/or AFGL telemetry stations.

5.4 Radar Support

It is requested NASA/WFC furnish radar trajectory data from the MPS-19 radars. Transponder frequency data is listed for each ASL rocket in section 3 of this document.

5.5 "S" Band Interferometer (TRACS)

Both range and position data will be furnished for each ASL rocket from the PSL operated TRACS van. Tone range receiver frequency data is listed in section 3 of this document.

5.6 Rocket Fire Control Van

ASL/WSMR rocket launch group will furnish the fire control van. All ASL and AFGL rockets will be launched using a two stage alternating current firing panel with independent firing circuit to each boom of the AML-4K3 launchers.

5.7 Windweighting

5.7.1 Responsibility

Windweighting and impact predictions for all ASL and AFGL rockets will be handled jointly by NASA/WFC and ASL/WSMR Met support personnel. NASA/WFC will furnish the raw wind data and ASL/WSMR will do the final calculations.

5.7.2 Procedure

The object of this windweighting procedure is to define the profile of the winds that will alter the trajectory of the rocket vehicle from the nominal. This method is as follows:

This slant-range, azimuth and elevation angle readout from the radar is used to plot the ground track and rate of change of elevation of the balloon.

The change in ground track location per unit of time can be interpreted as the velocity of the winds at a given altitude.

The North-South and the East-West components of this total velocity at each altitude can then be used to plot wind profiles.

Knowing the altitude zones in which winds are desired, an average component wind for each zone is obtained.

Once the zone winds are known, it is necessary to determine the ballistic wind that would be acting on the rocket during its flight up to about 70,000 feet. This is accomplished by applying ballistic factors, which are a measure of the wind sensitivity of the vehicle during a particular part of the flight, to the zone wind components and thus arriving at an effective, or ballistic wind value.

The ballistic wind thus derived can be used with the unit wind effect of the vehicle to find the displacement in impact caused by the wind. By assuming the vector of the wind effect reversed aiming point can be derived. If this aiming point is considered to be the no wind impact point, the launcher settings can be determined to be the elevation and azimuth angles which would hit the aiming point in a no wind case, or will hit the desired impact point in the real wind case.

This method is a standard procedure at Wallops Island and White Sands Missile Range and will be accomplished utilizing raw wind data from NASA Wallops personnel and final processing done by White Sands Army Atmospheric Science personnel.

6. SAFETY

6.1 Ground Safety

6.1.1 Purpose

The purpose of this safety plan is to provide a systematic method of preforming hazardous operations in a safe manner.

6.1.2 Personnel

Mr. Raymond Petracek, PSL, will act as Project Safety Officer for the ASL launch operations. The designated ASL Pad Chief will be responsible for ground safety on and in the area of each launcher.

6.1.3 Safety Operating Procedures

All personnel performing any operation involving the payloads and rockets of the ASL Large Rocket Program will comply with the following procedures: SOP NR 224-5-78 (Rocket and Payload Assembly), SOP NR 224-6-78 (Pad Operations) and Safety Manual, AMCR 385-100.

Copies of the above will be held on-site by the designated Project Safety Officer.

6.1.4 Vehicle Description (Class "C" Explosives)

The Nike-Orion is a two-stage, solid propellant fin stabilized sounding rocket. The first stage motor is a Nike booster (M88) using three modified Nike-Ajax fins reduced in span to 25.31 inches.

Stage separation is accomplished using a slip-fit adapter and it depends on drag forces to separate the stages after first stage motor burnout at approximately 3.5 seconds. The second stage is a Orion rocket motor using a Wallops Flight Center developed fin assembly. The fin assembly is a four fin configuration with a tail can having a four degree boatail. Second stage motor ignition is initiated by an onboard ignition system.

The Orion is 14 inches in diameter and 105.5 inches long. Loaded weight of the Orion motor is 857 pounds which includes 612 pounds of propellant.

The Orion fins are each 475 square inches in area and are canted to provide a 4 to 6 revolutions per second spin rate at burnout. The fin and shroud assembly weighs 82 pounds.

The standard payload diameter for the Nike-Orion is 14 inches. Length can be varied to accommodate the mission with payload weights between 150 pounds and 300 pounds. Maximum acceleration experienced by the payload is approximately 25 g's.

The Nike-Orion will carry a 200-pound payload to 160 kilometers and a 300-pound payload 126 kilometers when launched from sea level at an 82-degree launch angle.

6.1.5 Firing Circuits

6.1.5.1 Orion Motor

The Orion motor is initiated utilizing an onboard, timed, redundant capacitor discharge circuit.

6.1.5.2 Other Rockets and Boosters

One and two stage alternating current firing panels will be utilized with the AML-4K3 launchers in Canada. Independent firing circuits are used for each boom. Isolation variacs are used to obtain proper voltage and current for firing the squibs. The variac settings are obtained by simulating the squibs with a load box connected to the first and second stage firing lines. This is done prior to loading the launcher. Firing voltage from the first stage variac is applied through the first motion switch to the first stage vehicle. Upon first stage ignition and forward motion, the first stage first motion switch opens removing voltage from the first stage firing lines. This prevents damage to the firing panel if a short circuit occurs when the first stage firing lines separate. Simultaneously firing voltage from the second stage variac is applied to the second stage first motion switch. As the first stage moves forward the first motion switch for the second stage closes applying voltage through the second stage firing lines to the second stage.

6.1.6 Firing Specifications

6.1.6.1 Nike Ignitor

Bridge Resistance:	9.3 ± 0.1 OHMS
Maximum No-Fire:	2 amps. for 5 min.
Recommended Fire:	10 amps.

6.1.6.2 Orion Ignitor

Bridge Resistance:	1.0 ± 0.1 OHMS
Maximum No-Fire:	1 amp. for 5 min.
Recommended Fire:	5 amps.

6.1.7 Personal Injury

All injuries will be reported to the Project Safety Officer.

During periods of severe cold weather, extreme cold weather (ECW) clothing should be worn by or carried with each individual. Freezing of the skin tissues (frostbite) can occur in minutes during low temperatures and high winds. Treat frostbite as an injury and receive proper treatment at once.

Extreme care must be exercised by personnel operating motor vehicles on the expected snow and ice covered roads.

The hospital for our working area is the Margaret Cochenour Memorial Hospital, located on the left side of Highway 105 as you enter Red Lake.

6.1.8 Safety Plan (NRC)

"The Safety Plan for Rocket Launching Operations" prepared by the National Research Council of Canada, dated September 1978, will be the overall safety plan for all operations during the 1979 eclipse program. A copy of this document will be held on-site by the designated ASL safety officer.

7. TECHNICAL DATA

7.1 Telemetry Description A_1 (ASL-SE-79A1)

7.1.1 A_1 TELEMETRY DESCRIPTION

A. Transmitter:

1. Frequency 2259.5 MHz
2. Deviation ± 220 KHz Nominal
3. Power 5 Watt Nominal

B. Antenna:

1. Type PSL Stripline
2. Polarization Linear

C. Data Characteristics:

1. TM Type PCM
2. Bit Rate 375 Kb
3. Code NRZS, MSB First
4. Bits/Word 10
5. Words/Frame 32
6. Frames/Subframe 32
7. Sync Description

$\overbrace{1110110010}^{\text{Word 0}}$ $\qquad$ $\overbrace{10000\underbrace{xxxxx}_{\text{incrementing SF count}}}^{\text{Word 1}}$

00000 = frame 0

D. Tone Range Characteristics:

1. Tone Range Frequencies 420 + 480 KHz
2. Mixing Ratio 10% of PCM

7.1.2 TELEMETRY CHANNEL ASSIGNMENT

A_1 PAYLOAD

SOURCE	FUNCTION	NO. SAMPLES/FRAME	PCM WORD NO.	SAMPLE RATE
USU	Atomic Oxygen	(4)	MF 2, 10, 18, 26	4687.5/SEC
USU	Sun Sensor	(4)	MF 3, 11, 19, 27	4687.5
USU	R. F. Probe #1	(2)	MF 4, 20	2343.75
USU	R. F. Probe #2	(2)	MF 5, 21	2343.75
USU	R. F. Probe #3	(1)	MF 6	1171.875
USU	R. F. Probe #4	(1)	MF 7	1171.875
USU	5577 Photometer	(1)	MF 8	1171.875
USU	Lyman Alpha	(1)	MF 9	1171.875
USU	I. R. Radiometer #1	(1)	MF 12	1171.875
USU	I. R. Radiometer #2	(1)	MF 13	1171.875
USU	I. R. Radiometer #3	(1)	MF 14	1171.875
USU	I. R. Radiometer #4	(1)	MF 15	1171.875
USU	N. O. Photometer	(1)*	MF 17	1171.875
USU	I. R. Radiometer #5	(1)	MF 22	1171.875
USU	I. R. Radiometer #6	(1)	MF 23	1171.875
USU	O_3 Photometer #1	(1)	MF 24	1171.875
USU	O_3 Photometer #2	(1)	MF 25	1171.875
USU	O_3 Photometer #3	(1)	MF 28	1171.875
USU	O_3 Photometer #4	(1)	MF 31	1171.875
USU	Magnetometer	(1)	MF 30	1171.875
PSL	Accelerometer	(1)	MF 29	1171.875

*Pulse signal counted by PCM unit. The counter is read and reset once per frame.

7.1.3 A_1 PAYLOAD TELEMETRY CHANNEL ASSIGNMENT SUBFRAME / ON MAINFRAME WORD MF16

SOURCE	FUNCTION	PCM WORD NO.	SAMPLE RATE/SEC.
USU	N. O. Temp	MF16-SF2	36.62
USU	N. O. H. V.	-SF3	36.62
USU	N.O. Cell Position	-SF4	36.62
USU	5577 Photometer Temp	-SF5	36.62
USU	5577 Photometer H.V.	-SF6	36.62
USU	Atomic Oxygen H.V.	-SF7	36.62
USU	Atomic Oxygen Lamp Intense X10	-SF8	36.62
USU	Atomic Oxygen Lamp Intense X1	-SF9	36.62
USU	Atomic Oxygen Pressure	-SF10	36.62
USU or PSL	Atomic Oxygen Spare*	-SF11	36.62
USU	Mag. Bias	-SF12	36.62
USU	Ozone Photometer Temp.	-SF13	36.62
USU	Radiometer CFT	-SF14	36.62
USU	Radiometer OT	-SF15	36.62
USU	Radiometer BT	-SF16	36.62
USU	Radiometer Chopper	-SF17	36.62
USU	+28V Battery	-SF18	36.62
USU	Nose Tip	-SF19	36.62
USU	Pop Cover	-SF20	36.62
USU	Atomic Oxygen Door	-SF21	36.62
USU	Ly-Alpha Door	-SF22	36.62
USU	Pyro Pri. Battery	-SF23	36.62
USU	Pyro Sec. Battery	-SF24	36.62
USU	Payload Temp	-SF25	36.62
USU	Atomic Oxygen Valve Release	-SF26	36.62
USU	+15VDC Battery	-SF27	36.62
USU	Impedance Probe Door	-SF28	36.62
PSL	Second Stage Ignition	-SF29	36.62
PSL	+28V Tel Bus	-SF30	36.62
PSL	TRR Signal Strength	-SF31	36.62

*SF11 - If not used by USU will monitor TM deck #1 temp.

7.2 Telemetry Description B_1 (ASL-SE-79B1)

7.2.1 B_1 TELEMETRY DESCRIPTION

A. Transmitter:

1. Frequency 2279.5 MHz
2. Deviation ± 220 KHz Nominal
3. Power 5 Watt Nominal

B. Antenna:

1. Type PSL Stripline
2. Polarization Linear

C. Data Characteristics:

1. TM Type PCM
2. Bit Rate 375 Kb
3. Code NRZS, MSB First
4. Bits/Word 10
5. Words/Frame 32
6. Frames/Subframe 32
7. Sync Description

$\overbrace{1110110010}^{\text{Word 0}}$ $\qquad$ $\overbrace{10000\underbrace{xxxxx}_{\text{incrementing SF count}}}^{\text{Word 1}}$

00000 = frame 0

D. Tone Range Characteristics:

1. Tone Range Frequencies 420 + 480 KHz
2. Mixing Ratio 10% of PCM

7.2.2 TELEMETRY CHANNEL ASSIGNMENT

B_1 PAYLOAD

SOURCE	FUNCTION	SAMP/FRAME	PCM WORD NO.	SAMPLES/SEC.
USU	Solar X-Ray #1	(4)	MF 2, 10, 18, 26	4687.5
USU	Sun Sensor	(8)	MF 3, 7, 11, 15 19, 23, 27, 31	9375
USU	R. F. Probe #1	(2)	MF 4, 20	2343.75
USU	R. F. Probe #2	(2)	MF 5, 21	2343.75
USU	R. F. Probe #3	(2)	MF 6, 22	2343.75
USU	R. F. Probe #4	(2)	MF 8, 24	2343.75
USU	Solar X-Ray #2	(1)	MF 9	1171.875
USU	Cosmic Ray	(1)	MF 12	1171.875
USU	2050 Photometer X1	(1)	MF 13	1171.875
USU	2050 Photometer X10	(1)	MF 14	1171.875
USU	Electron Spectrometer #1	(*)	MF17SF0	36.62
USU	Electron Spectrometer #2	(*)	MF17SF1	36.62
USU	Electron Spectrometer #3	(*)	MF17SF2	36.62
USU	Electron Spectrometer #4	(*)	MF17SF3	36.62
USU	Electron Spectrometer #5	(*)	MF17SF4	36.62
USU	Electron Spectrometer #6	(*)	MF17SF5	36.62
USU	Electron Spectrometer #7	(*)	MF17SF6	36.62
USU	Electron Spectrometer #8	(1)	MF 25	1171.875
USU	Lyman Alpha	(1)	MF 28	1171.875
PSL	Accelerometer	(1)	MF 29	1171.875
USU	Magnetometer	(1)	MF 30	1171.875

*Pulse signal counted by PCM unit.

7.2.3 B_1 PAYLOAD TELEMETRY CHANNEL ASSIGNMENT
SUBFRAME / ON MAINFRAME WORD MF16

SOURCE	FUNCTION	PCM WORD NO.	SAMPLE RATE/SEC
PSL	Second Stage Ignition	MF16-SF2, 10, 18, 26	146.48
USU	Sphere B+	-SF3	36.62
USU	Solar X-Ray H.V.	-SF4	36.62
USU	Cosmic Ray H.V.	-SF5	36.62
USU	Electron Spectrometer H.V.	-SF6	36.62
USU	Mag. Bias	-SF7	36.62
USU	2050 Photometer Temp.	-SF8	36.62
USU	2050 Photometer H.V.	-SF9	36.62
USU	Sphere Ejection	-SF11	36.62
USU	+28V Battery	-SF12	36.62
USU	Pyro Pri. Battery	-SF13	36.62
USU	Pyro Sec. Battery	-SF14	36.62
USU	X-Ray Door	-SF15	36.62
USU	Photometer Door	-SF16	36.62
USU	R. F. Probe Door	-SF17	36.62
USU	Payload Temp.	-SF19	36.62
USU	Nose Tip Ejection (Large)	-SF20	36.62
USU	Nose Tip Ejection (Small)	-SF21	36.62
PSL	+28V Bus	-SF22	36.62
PSL	+28V R. F. Bus	-SF23	36.62
PSL	+5V Ref.	-SF24	36.62
PSL	Temp. T1	-SF25	36.62
PSL	Temp. T2	-SF27	36.62
PSL	Temp. T3	-SF28	36.62
PSL	Temp. T4	-SF29	36.62
PSL	Spare	-SF30	36.62
PSL	TRR Signal Strength	-SF31	36.62

7.3 Telemetry Description B_1 (A12.9A1)

7.3.1

TECH DATA ICS-1 DATE: 5 Jul 78

PROJECT Solar Eclipse 79	ROCKET (B-1) A12.9A1	PG 1 OF 4 PGS
Scientist Philbrick (AFGL)	Rocket Type Nike Orion	Range Chukuni
T/M Engr R. Wilton (AFGL)	Veh Engr R. Patracek (PSL, J. Geary (AFGL)	Payload Engr [illegible] Stromberg [illegible], [illegible] Fryklund [illegible]

NOTE: Sphere Data Only

TELEMETRY SYSTEM TECHNICAL INFORMATION		REMARKS
RF Link Freq 2269.5 MHz	Link 1 of 2 Links	
Type Mod PCM/FM	Deviation ± 0.050 MHz	
Mod Direct on Transmitter (X) Yes ( ) No		(PCM Only)
In-flight VCO Calibration ( ) Yes ( ) No		(FM/FM Only)
TRANSMITTER INFORMATION		
Model CTS-402	Mfg CONIC	
RF Power 2.0 Watts	Coax type TNC	
Power Rqmts 28.0 ± 4 VDC @ 0.7 ADC Max		
Binary "1" causes (X) freq Incr ( ) freq decr		(PCM Only)
Mod Input (X) AC Coupled ( ) DC Coupled		
ANTENNA SYSTEM INFORMATION		
Type Stripline	Location Sphere Band	Slot in nose cone prior to ejection
Model 55.511-S	Mfg NMSU/PSL	
Freq. Range 2200 to 2300 MHz		
Polarization ( ) Cir ( ) Ellip (X) Linear		Sphere ejects from booster vehicle at
Pattern (X) Omni dir. ( ) Directional-see rmks		approx. T+ 72 sec
Power Gain -2 DBI Max -30 DBI Min		
-14 DBI @ 98 -8 DBI @ 50 % Coverage		
Multicoupler Model N/A	Mfg	
Ant Coax Type OSM/SMA	Multicoupler Coax Type	

Note: Use other sheets for added links

7.3.2

TECH DATA LCB-4 DATE: 5 July 78

PROJECT Solar Eclipse 79	ROCKET (B-1) A12.9A1	PG 2 OF 4 PGS

PCM MODULATION INFORMATION		REMARKS
Encoder Model EN-( )	MFG. AFGL	DATA LIST
Power Rqmnts 26.4 ±	VDC @ ADC MAX	WD1 X-4 Low Gain Amp
Serial Train (X) 2 Level ( ) Other-See Rmks	Data Polarity (X) Normal ( ) Inverted	WD2 X-3 Mid Low Gain Amp
Data Alignment (X) MSB First ( ) LSB First	Pre Mod Filter (X) Yes ( ) No	WD3 X-2 Mid High Gain Amp
Code Format BIØ-L	Bit Rate 12.8 KBPS	WD4 X-1 High Gain Amp
Bits/Wd 8 ( ) Incl Parity	Parity ( ) odd ( ) even (X) none	WD5 Y-4 Low Gain Amp
Wds/Minor Frame 16	Supercom ( ) yes-see rmks (X) no	WD6 Y-3 Mid Low Gain Amp
Wds/Major Frame 16	Sync Wd Location WD 16	WD7 Y-2 Mid High Gain Amp
Frame Sync Code 10111000		WD8 Y-1 High Gain Amp
		WD9 Z-4 Low Gain Amp
Input level + 5.0to -5.0 V	Input Z	WD10 Z-3 Mid Low Gain Amp
Binary Count 0% Data Level (+5V)00000000	Binary Count 100% Data Level (-5V)11111111	WD11 Z-2 Mid High Gain Amp
		WD12 Temperature

SUBCOMMUTATION INFORMATION			
			WD13 Nutation
SubFrame No.	S.F. No.	S.F. No.	WD14 Sphere Vol Monitor
S.F. Location	N/A	N/A	WD15 Sphere Ejection WD16 Sync 10111000
Wds/S.F.			
Sync Method			
Sync Location			
Sync Code			

SFID INFORMATION		
Starting ID N/A	Count Direction ( ) Up ( ) Down	
ID Bit Location ( ) First ( ) Last	No. Bits	

NOTE: 1st Word = 1st Data Word

Use other sheets for added subframes

7.3.3

TECH DATA LCS-1 DATE: 5 Jul 78

PROJECT Solar Eclipse 79	ROCKET (B-1) A12.9A1	PG 3 OF 4 PGS
Scientist McCrary/Baker	Rocket Type Nike Orion	Range Chukuni
T/M Engr R. Wagner (PSL	Veh Engr R. Patracek (PSL) J. Geary (AFGL)	Payload Engr L. Jensen (USU)

NOTE: Rocket Data Only

TELEMETRY SYSTEM TECHNICAL INFORMATION		REMARKS
RF Link Freq 2279.5 MHz	Link 1 of 2 Links	
Type Mod PCM/FM	Deviation ± MHz	
Mod Direct on Transmitter (X) Yes ( ) No		(PCM Only)
In-flight VCO Calibration ( ) Yes ( ) No		(FM/FM Only)
NOTE: PCM 375KBS NRZ-S		For PCM Data
		Info refer to PSL
TRANSMITTER INFORMATION		
Model CTS 705	Mfg CONIC	
RF Power 5 Watts	Coax type	
Power Rqmts ± VDC @ ADC Max		
Binary "1" causes ( ) freq Incr ( ) freq decr		(PCM Only)
Mod Input ( ) AC Coupled (X) DC Coupled		
ANTENNA SYSTEM INFORMATION		
Type Stripline	Location	
Model 55-805	Mfg NMSU/PSL	
Freq. Range 2200 to 2300 MHz		
Polarization ( ) Cir ( ) Ellip (X) Linear		
Pattern (X) Omni dir. ( ) Directional-see rmks		
Power Gain +4 DBI Max -30 DBI Min (0.5 degrees)		
-8 DBI @ 98 % Coverage		
Multicoupler Model N/A	Mfg	
Ant Coax Type OSM/SMA	Multicoupler Coax Type	

Note: Use other sheets for added links

7.3.4

TECH DATA LCS-2 DATE: 5 Jul 78

PROJECT Solar Eclipse 79 ROCKET (B.1) A12.9A1	PG 4 OF 4 PGS
TRANSPONDER TRACKING SYSTEMS	REMARKS
Model 312-S / Mfg Vega	S.N. 192
Power rqmnts 28.0 +4 -6 VDC @ 0.6 ADC Max	
Battery type / Coax type TNC	
Code ( ) SP (X) DP / Code Space 8 ± 0.15 µs	
TRANSMITTER INFORMATION	
Freq 2890 MHz / RF Power 300 Watts Peak	
PRF 2600 PPS max / Fixed Delay 2.5 µs	
Pulse Width 0.5 µs	
RECEIVER INFORMATION	
Freq. 2820 MHz / Sensitivity -70 DBM min	
ANTENNA SYSTEM INFORMATION	
Type Quadraloop / Location	
Model 6.060 / Mfg NMSU/PSL	
Freq. Range 2800 to 3000 MHz	
Polarization ( ) E Theta ( ) E Phi ( ) RHC ( ) LHC ( ) Linear (X) Circular	
Pattern (X) Omni Dir ( ) Directional -see rmks	
Power Gain 0 DBI max / Coax type TNC	
NOTE: -10 DBI @ 90% Coverage	
NOTE: Attach separate sheet for other tracking systems	

8. PREPARATION AND LAUNCH SCHEDULE

Date	Time Local	Time UT	*T-Time	Event
1-22	—	—	T-35 Days	Launch personnel arrive on-site.
1-26	—	—	T-31 Days	Rocket vehicles, launch support equipment, fire control van "A" arrives.
1-29	—	—	T-28 Days	Operational personnel arrives.
2-1	—	—	T-25 Days	PSL telemetry vans and operating personnel arrives.
2-5	—	—	T-21 Days	Range check-out begins.
2-7	—	—	T-19 Days	Rocket vehicle preparation begins.
2-12	—	—	T-14 Days	Payloads and payload personnel arrives.
2-13	—	—	T-13 Days	Payload preparation begins.
2-19	—	—	T-7 Days	Rocket vehicle preparation complete.
2-22	—	—	T-4 Days	Payload checks complete.
2-24	—	—	T-2 Days	Final rehearsal.
2-25	—	—	T-1 Day	Rocket motors installed on launchers.
2-26	0554:00	1154:00	T-5 hrs.	All personnel arrive on-site and begin countdown.
	1028:00	1628:00	T-26 min.	Launch ASL-SE-79A1 (A_1)
	1028:30	1628:30	T-25 min. 30 sec.	Launch ASL-SE-79B1 (B_1)
	1052:30	1652:30	T-40 sec.	Launch A10.802-1 (C_1)

*Scheduling references are made considering T-0 to be 1654 hrs. UT, 26 February 1979.

Date	Time Local	Time UT	*T-Time	Event
	1051:55	1651:55	T-0	Launch A12.9A2 (G_1)
	1141:00	1741:00	T+44 min.	Launch A10.802-2 (C_2)
	1148:00	1748:00	T+54 min.	Launch A07.712-2 (B_2)

*Scheduling references are made considering T-0 to be 1654 hrs. UT, 26 February 1979.

APPENDIX C

ASL SMALL ROCKET AND PARTIAL REFLECTION EXPERIMENT PROGRAM

SOLAR ECLIPSE

26 FEBRUARY 1979

Operational Document

(REVISED APRIL 1979)

prepared by

Physical Science Laboratory
New Mexico State University

Under Contract No. DAAD07-78-C-0058

17 November 1978

US ARMY ERADCOM

Atmospheric Sciences Laboratory

ATMOSPHERIC SCIENCES LABORATORY

Small Rocket and Partial Reflection Experiment Program

(REVISED)

Operational Document
Solar Eclipse
February 1979

Additional copies of this Document may be obtained. Address requests to:

John L. Cross
Physical Science Laboratory
New Mexico State University
Box 3 PSL
Las Cruces, New Mexico 88003

CONTENTS

ILLUSTRATIONS

TABLES

ACRONYMS

1. ASL - Atmospheric Sciences Laboratory
2. ITS - Institute of Telecommunication Sciences, Boulder, Colorado
3. NASA/WFC - National Aeronautics and Space Administration/Wallops Flight Center
4. NRC - National Research Council of Canada
5. Pan Am - Pan American World Airways
6. PSL - Physical Science Laboratory/New Mexico State University
7. USU - Utah State University
8. UTEP - University of Texas at El Paso
9. WSMR - White Sands Missile Range

1979 SOLAR ECLIPSE EXPEDITION

ACTUAL SMALL ROCKET LAUNCH SCHEDULE

FEBRUARY 1979

ROCKET NUMBER	TYPE	LAUNCH DATE	LAUNCH TIME (UT)	EXPERIMENT	LAUNCHER	ACTUAL FLIGHT AZIMUTH	EFFECTIVE FLIGHT AZIMUTH	ACTUAL FLIGHT ELEVATION	EFFECTIVE FLIGHT ELEVATION
CMSL-01-79	Super Loki	19 Feb.	20:23:00	Met. Probe	B	60.6°	60.0°	83.5°	84.0°
CMSL-02-79	Super Loki	23 Feb.	17:59:58	Met. Probe	B	92.4°	60.0°	85.2°	84.0°
CMSL-03-79	Super Loki	24 Feb.	15:51:00	Met. Probe	B	61.3°	60.0°	83.8°	84.0°
CMSA-01-79	Super Arcas	24 Feb.	16:54:50	Electron Density	A	70.6°	50.0°	82.7°	84.0°
CMSA-10-79	Super Arcas	24 Feb.	17:22:00	Blunt Probe	A	70.6°	50.0°	82.7°	84.0°
CMSA-02-79	Super Arcas	25 Feb.	17:00:03	Electron Density	A	35.0°	50.0°	80.3°	84.0°
CMSA-05-79	Super Arcas	25 Feb.	17:30:00	Gerdien Probe	A	34.9°	50.0°	80.1°	84.0°
CMSL-04-79	Super Loki	25 Feb.	18:30:00	Met. Probe	B	55.0°	70.0°	83.6°	84.0°
CMSA-06-79	Super Arcas	26 Feb.	16:53:00	Gerdien Probe	A	51.8°	50.0°	81.6°	84.0°
CMSA-07-79	Super Arcas	26 Feb.	17:38:00	Gerdien Probe	A	48.3°	50.0°	81.8°	84.0°
CMSA-03-79	Super Arcas	26 Feb.	18:40:00	Electron Density	A	45.3°	50.0°	81.3°	84.0°
CMSL-05-79	Super Loki	26 Feb.	19:15:00	Met. Probe	B	51.6°	60.0°	83.7°	84.0°
CMSA-08-79	Super Arcas	27 Feb.	03:30:00	Gerdien Probe	A	28.1°	50.0°	78.6°	84.0°
CMSL-09-79	Super Loki	27 Feb.	04:40:00	Blunt Probe	B	46.5°	60.0°	82.3°	84.0°
CMSL-06-79	Super Loki	27 Feb.	05:30:00	Met. Probe	B	46.5°	60.0°	82.3°	84.0°
CMSA-09-79	Super Arcas	27 Feb.	13:06:00	Gerdien Probe	A	52.5°	50.0°	79.9°	84.0°
CMSA-04-79	Super Arcas	27 Feb.	14:10:00	Electron Density	A	54.0°	50.0°	80.7°	84.0°
CMSL-10-79	Super Loki	27 Feb.	14:40:00	Blunt Probe	B	60.6°	60.0°	82.9°	84.0°
CMSL-08-79	Super Loki	27 Feb.	15:45:00	Met. Probe	B	60.6°	60.0°	82.9°	84.0°

TABLE 1

1. INTRODUCTION

The primary objective of the Solar Eclipse Program is to obtain measurements in the ionospheric D-region and compare these results to those obtained from models for the purpose of model validation. The solar eclipse provides a unique opportunity to examine the effect of solar energy upon the middle atmosphere and how it responds to near instantaneous change in conditions rather than the gradual change that occurs with varying zenith angle as the atmosphere goes from day to night.

The goal of the Small Rocket Program and Partial Reflection Experiment is to measure various atmospheric parameters during the week leading up to, through and after the eclipse, to provide a data background of the atmospheric variations during this period. The various payloads will be deployed utilizing meteorological rockets. The parameters to be measured or derived are ion conductivity, mobility, density, electron density, Lyman alpha radiation, temperature, neutral density and winds. In addition to the in-situ measurements, the Partial Reflection Sounder will be operated during the measurement period to provide near continuous profiles of electron densities.

Several of the payloads will be launched during totality and will complement similar data obtained from the larger sounding rocket payloads and provide backup measurements.

The Small Rocket Program has been scheduled in such a manner to provide comparisons between several different measurement techniques for obtaining electron and ion densities. Comparisons are planned between various in-situ and ground based measurements of electron densities and total ion densities derived from a subsonic Gerdien condenser and those obtained from Gerdien's and mass spectrometers measurements made on the larger rockets. All the results from this program should prove interesting in providing data for the Solar Eclipse Program and comparing various sensing techniques.

2. PERSONNEL

2.1 Program Personnel

Program Manager	John Cross (PSL)
Program Scientist	Melvin Heaps (ASL)
Program Engineer	Oscar Gottspooner (ASL)
Telemetry and Tracking Manager	Billy Gammill (PSL)
Windweighting	National Research Council Atmospheric Sciences Laboratory
Program Safety Officer	Oscar Gottspooner (ASL)

2.2 Meteorological Probes, Super Loki
CMSL-01-79 through CMSL-06-79 (7 each)
and CMSL-08-79

Project Scientist	Frank Schmidlin (NASA/WFC)
Vehicle Engineer	Oscar Gottspooner (ASL)
Telemetry and Tracking Systems	Bernie Alons (PSL) R. Bolton (Pan Am) H. Johnson (Pan Am)

2.3 Blunt Probes, Super Loki
CMSL-09-79 and CMSL-10-79 (2 each)

Project Scientist	Frank Schmidlin (NASA/WFC)
Payload Experimenter	Jack Mitchell (UTEP)
Vehicle Engineer	Oscar Gottspooner (ASL)
Telemetry and Tracking Systems	Bernie Alons (PSL) R. Bolton (Pan Am) H. Johnson (Pan Am)

2.4 Electron Density, Super Arcas
CMSA-01-79 through CMSA-04-79 (4 each)

Project Scientist	Robert Olsen (ASL)
Payload Experimenter (Electron Density)	Earl Pound (USU)
Payload Experimenter (Lyman-alpha)	Larry Jensen (USU)
Vehicle Engineer	Oscar Gottspooner (ASL)
Payload Technician	Mike Braegger (USU)
Telemetry and Tracking Systems	Bernie Alons (PSL) R. Bolton (Pan Am) H. Johnson (Pan Am)

2.5 Gerdien Probes, Super Arcas
CMSA-05-79 through CMSA-09-79 (5 each)

Project Scientist	Robert Olsen (ASL)
Payload Experimenter	Jack Mitchell (UTEP)
Project Engineer	Billy Gammill (PSL)
Vehicle Engineer	Oscar Gottspooner (ASL)
Telemetry and Tracking Systems	Bernie Alons (PSL) R. Bolton (Pan Am) H. Johnson (Pan Am)

2.6 Blunt Probe, Super Arcas
CMSA-10-79 (1 each)

Project Scientist	Robert Olsen (ASL)
Payload Experimenter	Jack Mitchell (UTEP)
Vehicle Engineer	Oscar Gottspooner (ASL)
Telemetry and Tracking Systems	Bernie Alons (PSL)
	R. Bolton (Pan Am)
	H. Johnson (Pan Am)

2.7 Partial Reflection Sounder

Principal Investigator	Robert Olsen (ASL)
Project Scientist	Dave Mott (PSL)
Technical Advisor	Glenn Falcon (ITS)
Project Engineer	Billy Gammill (PSL)
Sounder Operator	Robert Valdez (PSL)

3. ASL SMALL ROCKETS AND PAYLOADS

3.1 Meteorological Probes (ASL)

3.1.1 ASL Rocket Numbers: CMSL-01-79 through CMSL-06-79 and CMSL-08-79

3.1.2 Rocket Type: Super Loki/Dart

3.1.3 Project Scientist: Frank Schmidlin, NASA/WFC

3.1.4 Launcher Identification: (B) McMarmac

3.1.5 Measurements:

The meteorological probe is designed to measure vertical profiles of the atmospheric densities, temperature and winds between 30 km to 70 km with a datasonde instrument. Upon ejection, the starute is inflated and the sonde desends at a controlled fall rate. The sonde transmits atmospheric temperature data on a carrier frequency in the 1680 MHz range using a bead thermistor as the sensor. A ranging receiver tuned at 401 MHz is incorporated to provide position data.

3.1.6 Payload Configuration (Figure 1)

3.1.7 Characteristics

•	Loki	Dart	Total
Weight (lb) (2.25 lbs lead added)	52.45	20.13	72.58
Length (in)	78.8	51.9	130.70
Diameter (in)	4	2.125	---

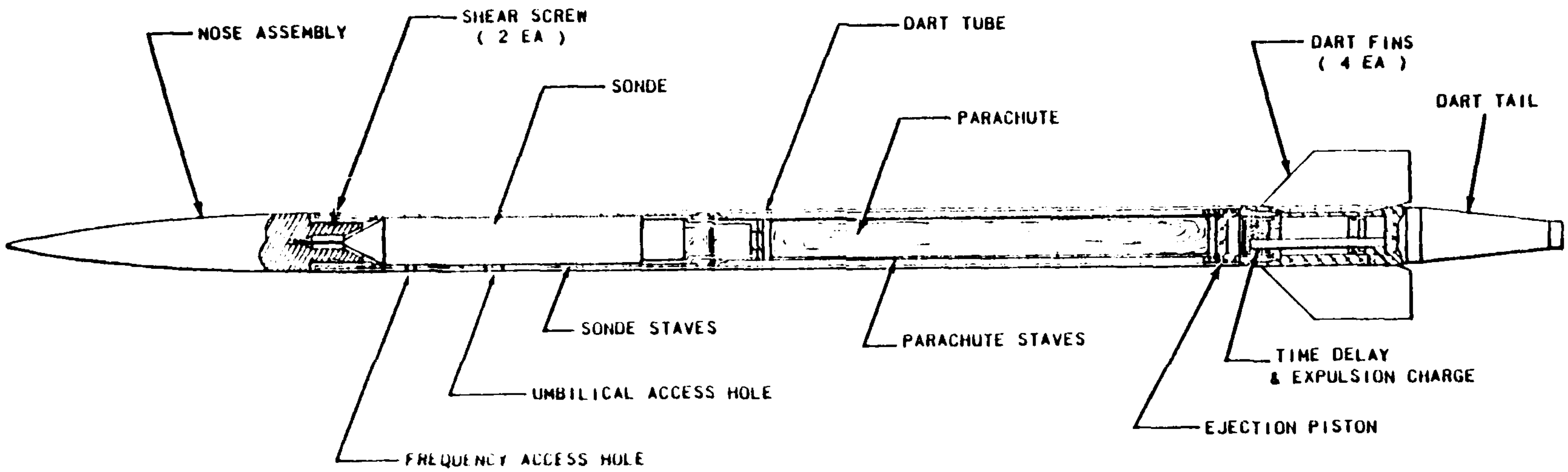


Figure 1 Cutaway View of Ogive, Telemetric Instrumentation Group

3.1.8 Performance QE 84° (2.25 lbs lead added)

3.1.8.1 Dart Performance

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Apogee	115.00	212235	43566	368
Impact	233.41	0	86038	2638

3.1.8.2 Loki Performance

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Burnout	2.02	4106	365	4758
Apogee	32.00	28987	4314	79.73
Impact	85.64	0	6927	656

3.1.8.3 Dispersion

Dart: 3 Sigma: See distributed NASA/WFC Trajectory Summary

Datasonde: The expelled datasonde is expected to drift on the parachute for 120 minutes. The impact point is dependent on wind drift. No personal or property damage should be anticipated upon impact.

3.1.9 Telemetry Ranging System

	Frequency	Modulation	Power
Transmit (up link)	401 MHz	AM	20W
Reply (down link)	1670 to 1690 MHz	FM	0.25W

3.2 Blunt Probes

3.2.1 ASL Rocket Numbers: CMSL-09-79 and CMSL-10-79

3.2.2 Rocket Type: Super Loki

3.2.3 Project Scientist: Francis J. Schmidlin, NASA/WFC

3.2.4 Launcher Identification: (B) McMarmac

3.2.5 Measurements

To measure positive and negative conductivities in the altitude interval from 30 km to 70 km utilizing a blunt probe sensor.

3.2.6 Scientific Objectives

(a) To determine the variation in conductivity under varying geophysical conditions.

(b) To compare measurements of conductivity with those obtained by other techniques.

3.2.7 Vehicle and Flight Description

The blunt probe will be deployed from a Super Loki Dart at apogee and desend subsonically on a starute decelerator. The GMD system will provide angular data on the up leg portion of the trajectory and the NASA radars will track the starute after explusion of position data from apogee to 30 km.

3.2.8 Payload Configuration (Figure 2)

3.2.9 Characteristics

	Booster	Payload	Total
Weight (lbs) (2.25 lbs lead added)	50.45	20.13	72.58
Length (in)	78.8	51.9	130.70
Diameter (in)	4	2.125	---

3.2.10 Performance QE 84° (2.25 lbs lead added) (Figure 3)

3.2.10.1 Dart Performance

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Apogee	115.00	212235	43566	368
Impact	233.41	0	86038	2638

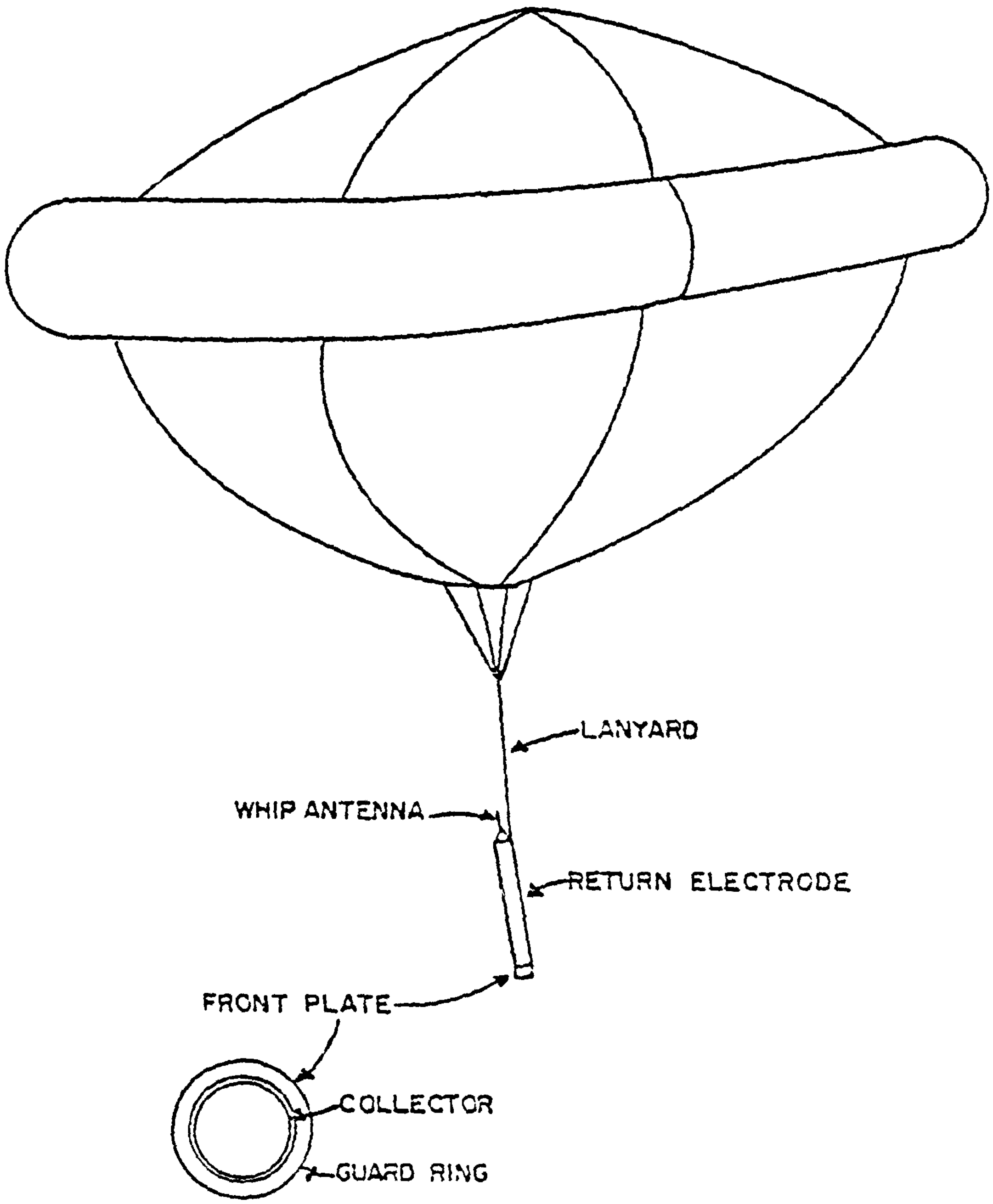
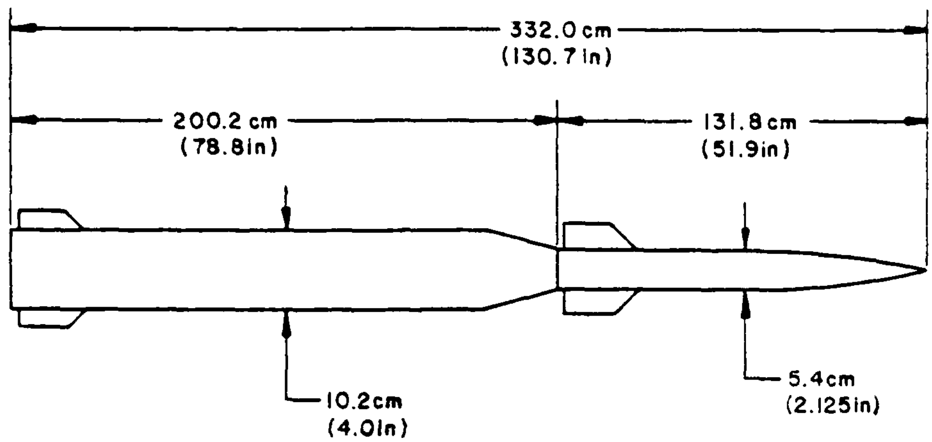


FIGURE 2 Deployed Super Loki Dart Blunt Probe



SUPER LOKI/DART (2.25 lbs. added weight, stable booster)

Dart Payload 9.13 Kg (20.125 lbs.)

QE	APOGEE ALTITUDE (KM)	IMPACT RANGE (KM)
85°	65.0 (115.5 sec)	21.9 (233.9 sec)
84°	64.7 (115.0 sec)	26.2 (233.4 sec)
83°	64.4 (115.0 sec)	30.5 (232.0 sec)
82°	64.0 (114.5 sec)	34.8 (232.1 sec)

McMarmac Launch Site

Launcher "B" (382.5M Elevation)

Figure 3. Configuration and predicted performance for ASL vehicles CMSL-01-79 through CMSL-10-79.

3.2.10.2 Loki Performance

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Burnout	2.02	4106	365	4758
Apogee	32.00	28987	4314	79.73
Impact	85.64	0	6927	656

3.2.10.3 Dispersion

Dart: 3 Sigma: See distributed NASA/WFC Trajectory Summary

3.2.11 Telemetry Ranging System

	Frequency	Modulation	Power
Transmitter	1670 MHz	FM	0.25W

3.3 Electron Density

3.3.1 ASL Rocket Numbers: CMSA-01-79 through CMSA-04-79

3.3.2 Rocket Type: Super Arcas

3.3.3 Project Scientist: Earl Pound, USU

3.3.4 Launcher Identification: (A) McMarmac

3.3.5 Measurements:

(a) Lyman-Alpha Flux (O_2 Density).

(b) A solar aspect sensor will be used to determine the attitude of the vehicle. A magnetic aspect sensor will determine the magnetic pitch angle.

(c) Electron Density will be measured using RF impedance probe and DC probe.

3.3.6 Scientific Objectives

The principal mission is provision of altitude profiles of Lyman-Alpha Flux and Electron Density, also to compare measurements with other techniques, with in-situ and ground based sensors.

3.3.7 Vehicle and Flight Description

At approximately 50 km on the up leg, a door will release exposing the Lyman-Alpha Detector. All other measurements are continuous.

3.3.8 Payload Configuration (Figure 4)

3.3.9 Characteristics

	Booster	Payload	Total
Weight(lbs)	82.7	---	93.7
Length(in)	58.7	28.8	87.5
Diameter(in)	4.5	4.5	---

3.3.10 Performance QE 84° (Figure 5)

3.3.10.1 Super Arcas

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Burnout	38.0	69945	17620	3971
Apogee	154.3	282852	144611	---
Impact	297.0	---	289222	---

3.3.10.2 Dispersion

Super Arcas: 3 Sigma: See distributed NASA/WFC Trajectory Summary.

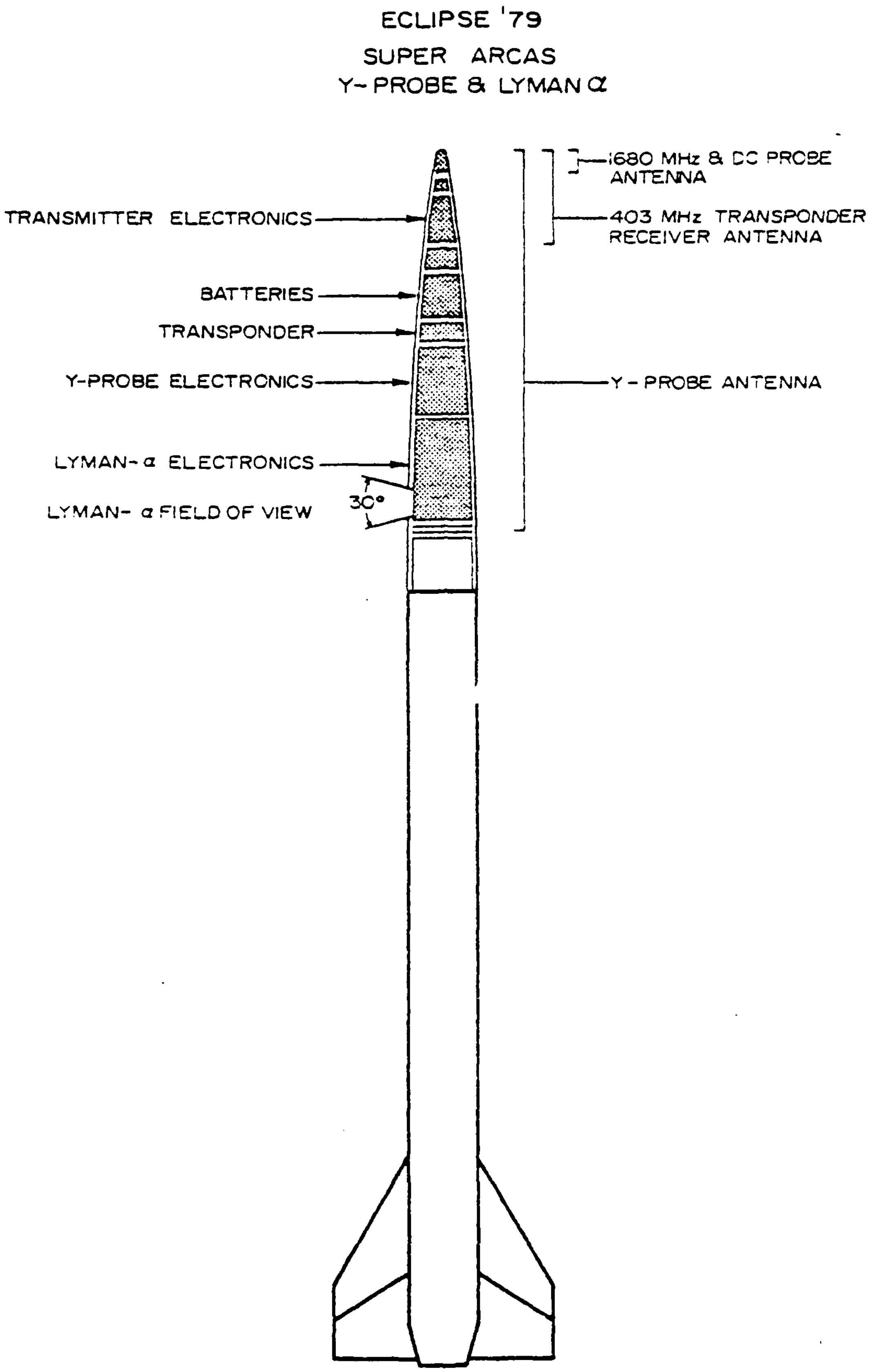
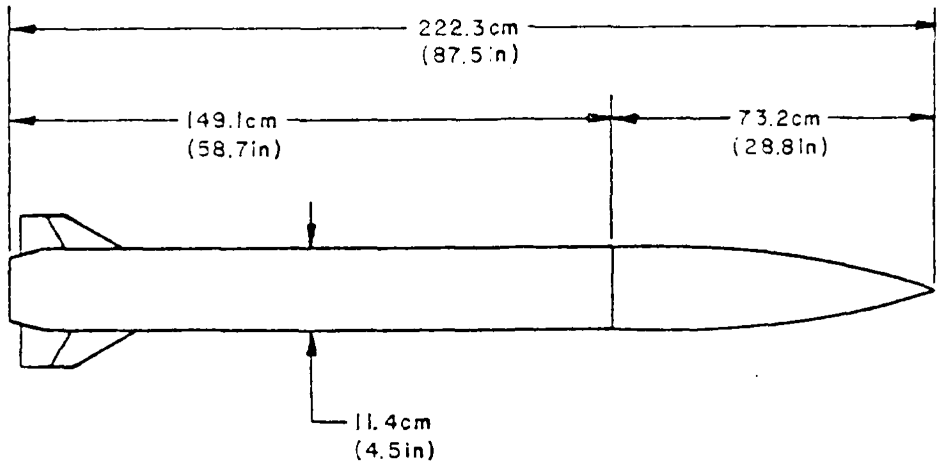


FIGURE 4 Electron Density



SUPER ARCAS

Payload 4.99 Kg (11 lbs.)

QE	APOGEE ALTITUDE (KM)	IMPACT RANGE (KM)
86°	90.6 (157.8 sec)	60.9 (303.3 sec)
84°	86.2 (154.3 sec)	88.1 (297.0 sec)
82°	80.4 (149.4 sec)	110.9 (288.4 sec)

McMarmac Launch Site

Launcher "A" (382.5M Elevation)

Figure 5. Configuration and predicted performance for ASL vehicles CMSA-01-79 through CMSA-04-79.

3.3.11 Telemetry Ranging Systems

	Frequency	Modulation	Power
Transmit (up link)	401 MHz	AM	20W
Reply (down link)	1670 to 1690 MHz	FM/FM	0.25W

3.4 Gerdien Probes

3.4.1 ASL Rocket Numbers: CMSA-05-79 through CMSA-09-79

3.4.2 Rocket Type: Super Arcas

3.4.3 Project Scientist: Robert Olsen, ASL

3.4.4 Launcher Identification: (A) McMarmac

3.4.5 Measurements

To measure positive and negative conductivities and mobilities from 30 km to 85 km.

3.4.6 Scientific Objectives

To obtain altitude profiles of positive and negative ion conductivities, mobilities and total ion densities and to compare these measurements with those obtained from other measurement techniques.

3.4.7 Vehicle and Flight Description

The Super Arcas will deploy the Gerdien condenser and starute decelerator at apogee (approximately 85 km). Measurements will be made during the descent of the payload system from 85 km to 30 km.

3.4.8 Payload Configuration (Figure 6)

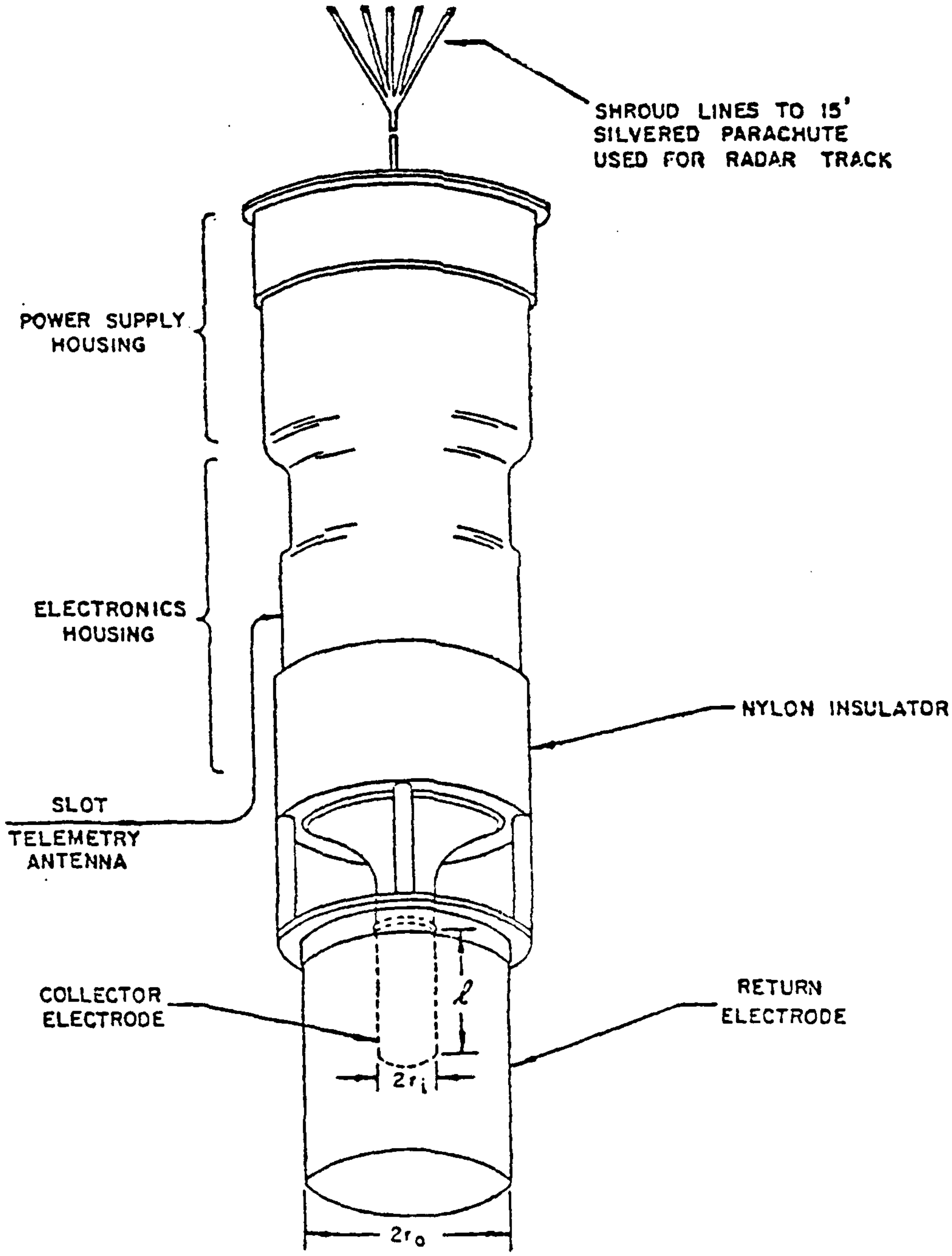


FIGURE 6 Gerdien Condenser

3.4.9 Characteristics

	Booster	Payload	Total
Weight(lbs)	82.7	13.5	96.2
Length(in)	58.7	35.4	94.1
Diameter(in)	4.5	4.5	---

3.4.10 Performance QE 84° (Figure 7)

3.4.10.1 Super Arcas

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Burnout	38.0	67482	17620	3779
Apogee	147.8	257778	133674	---
Impact	284.2	---	267956	---

3.4.10.2 Dispersion

Super Arcas: 3 Sigma: See distributed NASA/WFC Trajectory Summary.

3.4.11 Telemetry Ranging Systems

	Frequency	Modulation	Power
Transmit (up link)	401 MHz	AM	20W
Reply (down link)	1670 to 1690 MHz	FM/FM	0.25W

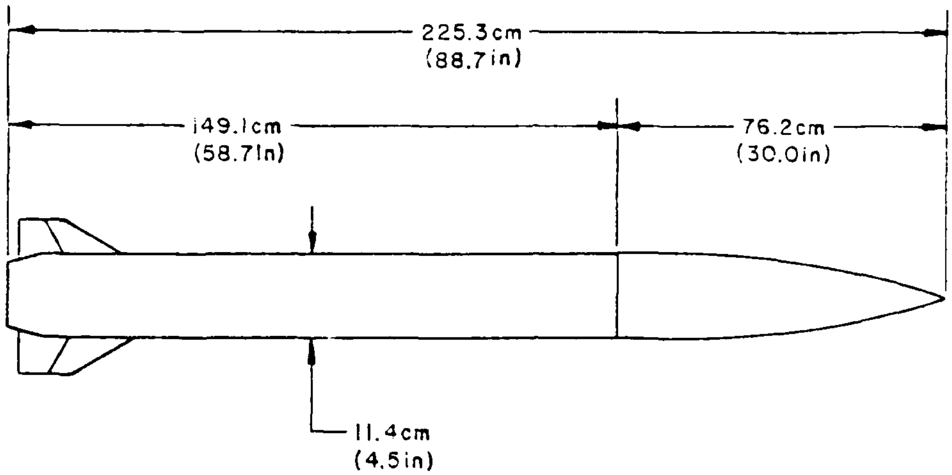
3.5 Blunt Probe (Super Arcas)

3.5.1 ASL Rocket Number: CMSA-10-79

3.5.2 Rocket Type: Super Arcas

3.5.3 Project Scientist: Robert Olsen, ASL

3.5.4 Launch Identification: (A) McMarmac



SUPER ARCAS

Payload 6.12 Kg (13.5 lbs.)

QE	APOGEE ALTITUDE (KM)	IMPACT RANGE (KM)
86°	82.7 (151.3 sec)	56.7 (290.4 sec)
84°	78.6 (147.8 sec)	81.7 (284.2 sec)
82°	73.1 (142.9 sec)	102.2 (275.7 sec)

McMarmac Launch Site
Launcher "A" (382.5M Elevation)

Figure 7. Configuration and predicted performance for ASL vehicles CMSA-05-79 through CMSA-10-79.

3.5.5 Measurements

Measure positive and negative ion conductivities.

3.5.6 Scientific Objectives

To obtain altitude profiles of positive and negative conductivities to compare ion conductivities derived from the Gerdien Condenser payload.

3.5.7 Vehicle and Flight Description

The payload will deploy on a stature decelerator at apogee and gather data during the descent portion of the trajectory.

3.5.8 Payload Configuration (Figure 8)

3.5.9 Characteristics

	Booster	Payload	Total
Weight(lbs)	82.7	13.5	96.2
Length(in)	58.7	30.0	88.7
Diameter(in)	4.5	4.5	---

3.5.10 Performance QE 84^{o}

3.5.10.1 Super Arcas

	Time(sec)	Altitude(ft)	Hor. Range(ft)	Velocity(fps)
Burnout	38.0	67482	17620	3779
Apogee	147.8	257778	133674	---
Impact	284.2	---	267956	---

3.5.10.2 Dispersion

Super Arcas: 3 Sigma: See distributed NASA/WFC Trajectory Summary.

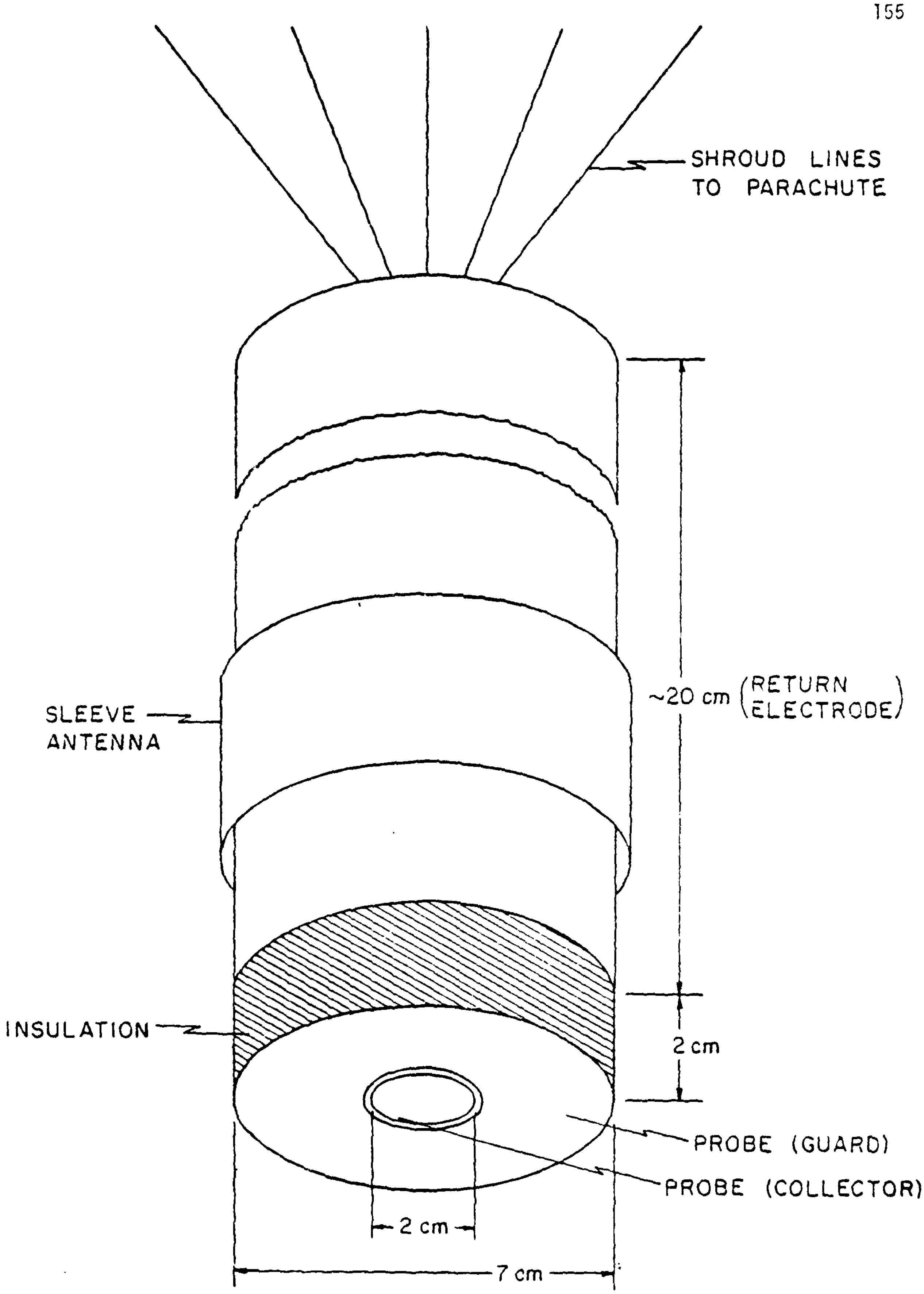


FIGURE 8 Blunt Probe Payload

3.5.11 Telemetry Ranging Systems

	Frequency	Modulation	Power
Transmit (up link)	401 MHz	AM	20W
Reply (down link)	1670 to 1690 MHz	FM/PCM	0.25W

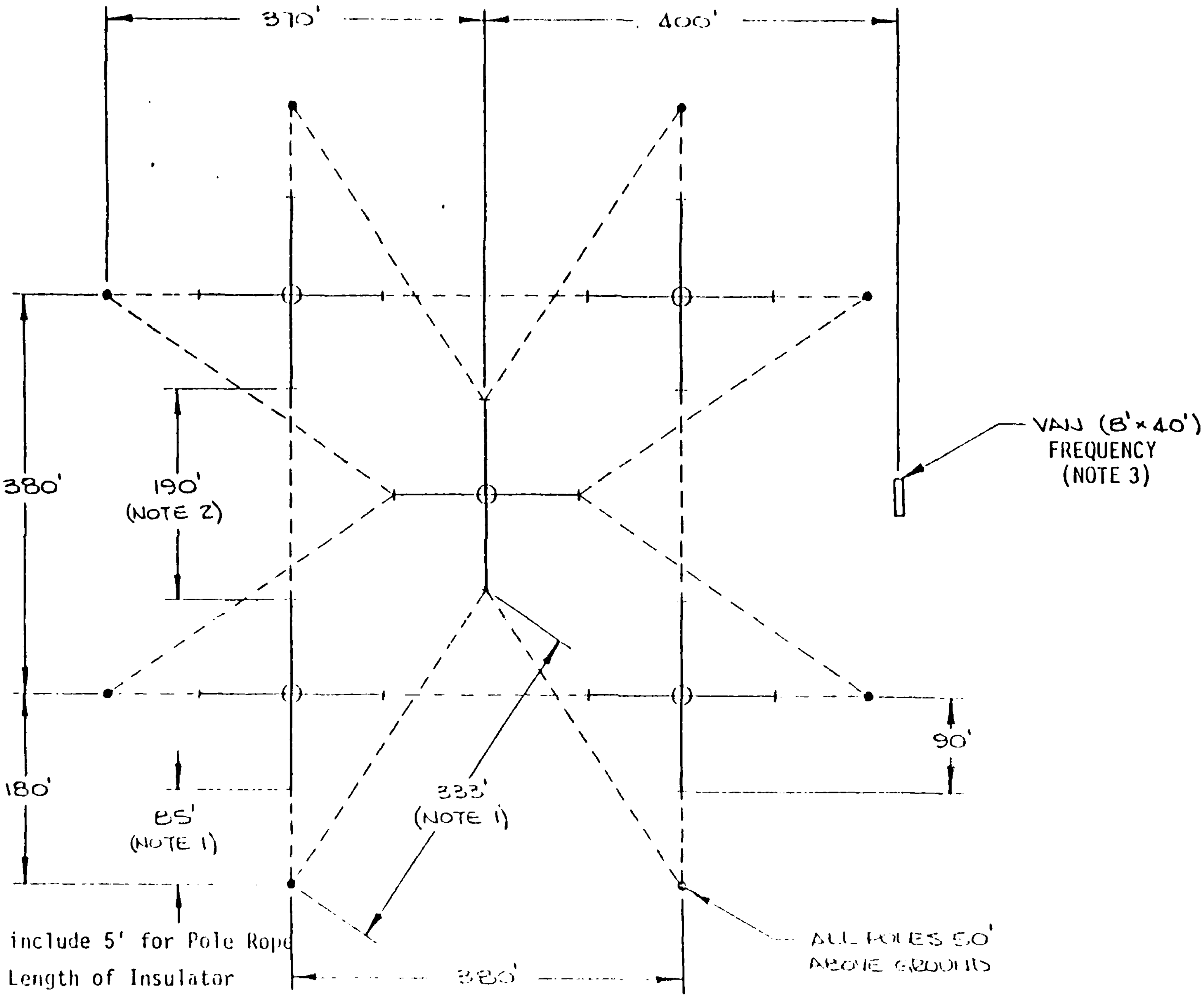
4. PARTIAL REFLECTION EXPERIMENT

Principal Investigator: Robert Olson, Atmospheric Sciences Laboratory

Sponsor: Atmospheric Sciences Laboratory

Description of the Experiment: The partial reflection experiment is ground-based and has as its experimental objective and provision of D region electron density profiles throughout the eclipse and for background (non-eclipse) conditions. In operation, a low frequency (several megahertz) radar is used to transmit pulses of radiation vertically. Echoes backscattered from the D region of the ionosphere are received and recorded as functions of pulse transit time. Circular polarization of the transmitted radiation is utilized, and pulses of both right and left hand polarization are employed. Because of the earth's magnetic field, the index of refraction of the ionosphere is different for the two polarization modes. The relative intensities of the waves partially reflected from a given altitude within the ionosphere contain information concerning the electron density at the altitude. This partial reflection technique can be used to measure the density of free electrons, in the ionosphere as a function of altitude from 50 km to 100 km. A single frequency of 2.666666 MHz is employed. The partial reflection experiment will be located in the vicinity of sounding rocket activities in Balmertown, Ontario, and operated continuously for a period of several days before, during and following the total solar eclipse of 1979.

A sketch of the instrumentation layout is shown in Figure 9.



Does not include 5' for Pole Rope

Includes Length of Insulator

Frequency 2.666666 MHz

Figure 9 Partial Reflection Sounder and Antenna Layout

5. OPERATIONAL REQUIREMENTS

5.1 Preparation Areas (Payloads)

5.1.1 Meteorological Probes CMSL-01-79 through CMSL-06-79 and CMSL-08-79

Blunt Probes CMSL-09-79 and CMSL-10-79

Electron Density CMSA-01-79 through CMSA-04-79

Gerdien Probes CMSA-05-79 through CMSA-09-79

Blunt Probe CMSA-10-79

Space: Two rooms approximately 400 sq. ft. shared by above payloads

Building: Cochenour Mine (Mine Dry) Building No. 12

5.2 Preparation Area (Rockets)

The Super Loki and Super Arcas Rockets (Boosters) will be prepared in the shop annex at Cochenour Mine.

5.3 Rocket Storage

The Super Loki and Super Arcas Rockets (Boosters) will be stored in the Cochenour Garage. Building No. 15.

5.4 Telemetry/Tracking Station

Space: 15' x 25' approximately 425 sq. ft.

Building: Cochenour Mine, Building No. 23

5.5 Fire Van

Bench space of 4' to 6' in the NRC Fire Van located at the McMarmac launch site will be required for the launching of the small rockets.

5.6 Snow Removal

Personnel and vehicle traffic must be able to move freely between all buildings used for this program. Access also must be provided to the Small Rocket Launchers, the NRC Fire Van and the AN/GMD-4 tracker pads located at Cochenour Mine. Snow should also be kept cleared from the west end of Dexter Road in Balmertown for the sitting of the Partial Reflection Sounder Van.

5.7 Communications

5.7.1 Common Communications and Countdown Network

A hardwire intercom net to all rocket and ground based projects is to be installed for the program. Early in the program this net will be used for intercommunications between projects. During operations it will be used as a common countdown net. ASL/PSL will require the following stations in this net:

(1) Small Rocket Telemetry/Tracking Building

(2) Small Rocket Fire Van.

(3) Small Rocket Launchers (McMarmac)

(4) Command Post

5.7.2 ASL/PSL Communications Net

The Small Rocket Program will require a hardwire intercom system between the following points:

(1) Payload Preparations (Building No. 12)

(2) Rocket Preparations (Shop Annex)

(3) Telemetry/Tracking (Building No. 23)

(4) Fire Van (NRC Fire Van)

(5) Small Rocket Launchers (McMarmac)

5.7.3 Partial Reflection Sounder (Balmertown)

A commercial telephone will be used for communications.

5.8 Timing

IRIG "H" Time Code Signals are to be provided by PSL to the ASL/PSL Telemetry/Tracking Station.

6. GROUND SUPPORT

6.1 Rocket Launchers

6.1.1 Super Loki Launcher (Launcher B)

The Super Loki will be launched from a four rail, spiral, open tube launcher inserted into a standard arcas launcher, with the breech plate, upper and middle launching tubes removed. The azimuth and elevation angles will be set manually using the azimuth table assembly and a gunners quadrant to set the elevation.

6.1.2 Super Arcas Launcher (Launcher A)

The Super Arcas will be launched from a standard arcas closed breech launcher. The azimuth and elevation angles will be set using the azimuth table assembly and a gunners quadrant to set the elevation.

6.2 Rocket and Payload Handling

The rocket vehicles will be placed in the original shipping crates and transported to the launch area in the bed of a pickup truck.

6.3 Telemetry and Tracking Instrumentation

6.3.1 Telemetry Station (Building No. 23, Cochenour Mine)

PSL will furnish and operate the following:

One (1) ACL Receiver (1650-1700 MHz)
One (1) PCM Decoder
One (1) 8 Track Analog recorder
One (1) Rack 210 Discriminators
One (1) Honeywell 5600 7 Channel Recorder

6.3.2 Telemetry/Tracking Instrumentation

Two Rawin sets AN/GMD-4 will be located at the Cochenour Mine. These units will record telemetry data and determine rocket position.

Two (2) Ampex 7 channel tape recorders and two (2) Bruch 4 channel analog strip recorders are used in conjunction with these units.

6.4 Firing Console

NASA/WFC will furnish a firing console capable of firing two (2) different vehicles. The console panel will have two (2) each of the following:

(1) Arming Switches

(2) Safe-Arm Switches

(3) Arming Light Indication

(4) Continuity Check Capability

6.5 Windweighting Procedure

The object of this windweighting procedure is to define the profile of the winds that will alter the trajectory of the rocket vehicle from the nominal. This method is as follows:

The slant-range, azimuth and elevation angle readout from the radar is used to plot the ground track and rate of change of elevation of the balloon.

The change in ground track location per unit of time can be interpreted as the velocity of the winds at a given altitude.

The North-South and the East-West components of this total velocity at each altitude can then be used to plot wind profiles.

Knowing the altitude zones in which winds are desired, an average component wind for each zone is obtained.

Once the zone winds are known it is necessary to determine the ballistic wind that would be acting on the rocket during its flight up to about 55,000 feet. This is accomplished by applying ballistic factors, which are a measure of the wind sensitivity of the vehicle during a particular part of the flight, to the zone wind components and thus arriving at an effective, or ballistic wind value.

The ballistic wind thus derived can be used with the unit wind effect of the vehicle to find the displacement in impact caused by the wind. By assuming the vector of the wind effect reversed aiming point can be derived. If this aiming point is considered to be the no wind impact point, the launcher settings can be determined to be the elevation and azimuth angles which would hit the aiming point in a no wind case, or will hit the desired impact point in the real wind case.

This method is a standard procedure at Wallops Island and White Sands Missile Range.

6.6 Radar Support

The NASA/WFC MPS-19 Radars will skin track the starute after expulsion (apogee) for position data down to 30 km altitude. This coverage will be for all Super Loki and Super Arcas flights on a non-interference basis.

7. SAFETY

7.1 Ground Safety

7.1.1 Purpose

The purpose of this safety plan is to provide a systematic method of performing hazardous operations in a safe manner.

7.1.2 Personnel

Mr. Oscar Gottspooner, ASL/WSMR, will act as Safety Officer for all ASL small rocket launch operations.

7.1.3 Operating Procedure (Safety)

All personnel performing any operation involving the payloads and rockets of the Small Rocket Program will comply with standing operating procedures: SOP NR 224-5-76 and Safety Manual, AMCR 385-100. Copies of the above will be held on-site by the designated Safety Officer. Any deviations from the operating procedure must be requested from and cleared by the designated Safety Officer.

7.1.4 Vehicles

7.1.4.1 Super Loki:

The Super Loki (Figure 10) is a two-stage rocket. consisting of a solid-propellant rocket motor and a non-propulsive dart with high ballistic coefficient. The ignitor is a metal-oxidant type which is initiated by an electrical squib.

7.1.4.2 Super Arcas:

The Super Arcas (Figure 11) is a single stage, end burning rocket. The igniter is a metal-oxidant type which is initiated by an electrical squib.

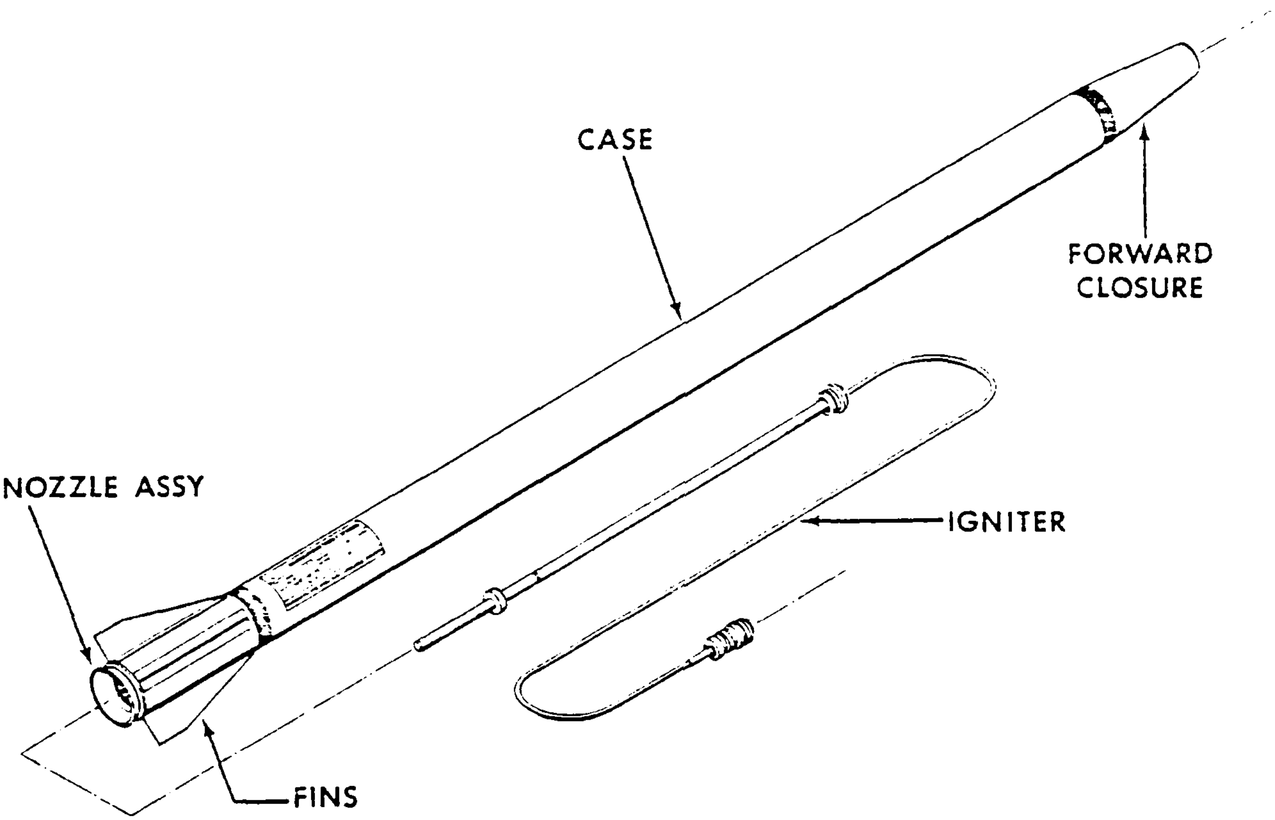


FIGURE 10 Super Loki Rocket

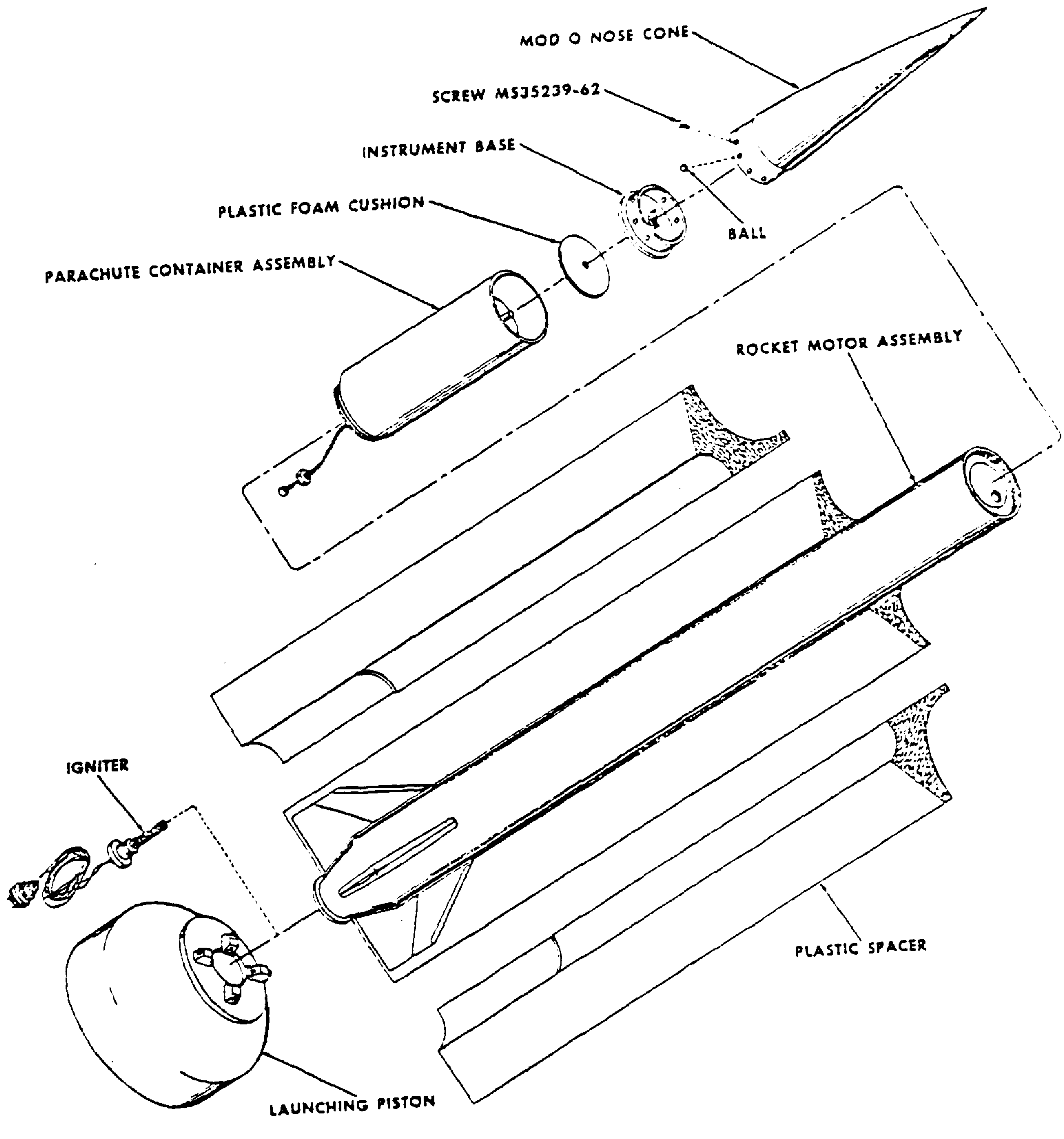


FIGURE 11 Super Arcas Rocket

7.1.5 Payloads

7.1.5.1 Super Loki:

The Dart payload is expelled utilizing a pyrodelay device which is electrically initiated at the same time the rocket ignitor is initiated.

7.1.5.2 Super Arcas:

The Super Arcas payload is expelled utilizing a pyrodelay device which is initiated by the burning propellant near vehicle burn-out time.

7.1.6 Personal Injury

All injuries will be reported to the Safety Officer.

During periods of severe cold weather, extreme cold weather (ECW) clothing should be worn by or carried with each individual. Freezing of the skin tissues (frostbite) can occur in minutes during low temperatures and high winds. Treat frostbite as an injury and receive proper treatment at once.

Extreme care must be exercised by personnel operating motor vehicles on the expected snow and ice covered roads.

The hospital for our working area is the Margaret Cochenour Memorial Hospital, located on the left side of Highway 105 as you enter Red Lake.

7.1.7 Safety Plan (NRC)

"The Safety Plan for Rocket Launching Operations" prepared by the National Research Council of Canada, dated September 1978, will be the overall safety plan for all operations during the 1979 eclipse program. A copy of this document will be held on-site by the designated ASL Safety Officer.

7.2 Instrumented Super Loki Check List - Launch Pad

T-60 MIN

1. LAUNCH CREW (2 MEN) ARRIVE ON STATION WITH SUPER LOKI INSTRUMENTED DART.
2. ESTABLISH COMMUNICATIONS TO ALL STATIONS AND CONFIRM THAT COMMUNICATIONS HAVE BEEN ESTABLISHED TO LAUNCH CONTROL OFFICER.

T-55 MIN

1. REQUEST FIRING LINE CHECK FROM LAUNCH CONTROL OFFICER.
2. PERFORM FIRING LINE VOLTAGE/NO VOLTAGE MEASUREMENTS AND REPORT READINGS TO LAUNCH CONTROL OFFICER (MAIN AND AUXILIARY LINES).
3. SHUNT FIRING LINES - REPORT CLEAR.

T-50 MIN

1. TRANSPORT BOOSTER MOTOR, IGNITER AND DART EXPULSION DEVICE TO LAUNCH PAD.
2. PLACE MOTOR OF ASSEMBLY CRADLE AND ATTACH GROUND CABLE TO MOTOR NOZZLE.
3. PLACE IGNITER IN IGNITER TEST CHAMBER, REMOVE SHUNT.
4. CONNECT ALINCO IGNITER TESTER TO IGNITER, READ IGNITER. RESISTANCE AND REPORT READING TO LAUNCH CONTROL OFFICER.
5. RE-SHUNT IGNITER LEADS AND REMOVE IGNITER FROM TEST CHAMBER.
6. PLACE EXPULSION DEVICE IN TEST CHAMBER, REMOVE SHUNT.
7. CONNECT ALINCO IGNITER TESTER TO EXPULSION DEVICE, READ EXPULSION DEVICE RESISTANCE AND REPORT TO LAUNCH CONTROL OFFICER, RE-SHUNT EXPULSION DEVICE.
8. REMOVE EXPULSION DEVICE FROM TEST CHAMBER.

T-45 MIN

1. RECORD BOOSTER MOTOR AND DART SPECIFICATION AND REPORT TO LAUNCH CONTROL OFFICER.
2. INSPECT LAUNCHER AND ASSURE THAT NO DEFECTS EXIST.
3. ATTACH DART EXPULSION DEVICE TO DART AND SECURE ALL ALIEN SCREWS IN FIN ASSEMBLY.

T-30 MIN

1. MATE DART TO BOOSTER MOTOR AND INSERT SHEAR PIN.
2. PLACE TOTAL ROCKET SYSTEM ON KNIFE EDGE AND ADJUST PLACEMENT UNTIL BALANCE IS REACHED.
3. MEASURE FROM NOZZLE END OF BOOSTER MOTOR WITH TAPE MEASURE TO POINT OF BALANCE ON KNIFE EDGE. REPORT THIS CG MEASUREMENT TO LAUNCH CONTROL OFFICER.
4. INSERT ELECTRICAL ACTUATION LINE INTO RECEPTACLE OF DART EXPULSION DEVICE.
5. TAPE ACTUATION LINE TO DART BODY.

T-25 MIN

1. TIE EXPULSION DEVICE ACTUATION LINE TO FEEDER CABLE.
2. LOAD ROCKET SYSTEM INTO LAUNCHER WHILE PULLING EXPULSION ACTUATION LINE THROUGH LAUNCHER.
3. ASSURE THAT LOCKING LATCH IS PROPERLY ENGAGED TO PREVENT ROCKET FROM MOVING WHEN LAUNCHER IS ELEVATED.
4. INSTALL IGNITER IN BOOSTER MOTOR.

T-10 MIN

1. OBTAIN CONFIRMATION FROM LAUNCH CONTROL OFFICER OF FIRING ANGLES. PROVIDE NRO REPRESENTATIVE WITH LAUNCHER ANGLES FOR CONFIRMATION PURPOSES.
2. ASSURE THAT TOP CLEVIS PIN IS INSERTED IN PROPER HOLE OF LAUNCHER FOR ELEVATION ANGLE DESIRED (80° NOMINAL).
3. TURN ON INSTRUMENT AND CONFIRM PROPER OPERATION FROM TRACK SHACK.
4. ELEVATE LAUNCHER AND INSERT CLEVIS PINS IN EXPANSION BAR FRAME.
5. CHECK WITH LAUNCH CONTROL OFFICER TO INSURE THAT FIRING LINES ARE CLEAR.
6. PERFORM FINAL NO VOLTAGE CHECK ON FIRING LINES.
7. HOOK UP EXPULSION DEVICE ACTUATION LINE TO AUXILIARY FIRING LINE.
8. HOOK UP BOOSTER MOTOR IGNITER LINE TO MAIN FIRING LINE.
9. INFORM LAUNCH CONTROL OFFICER THAT MAIN LINE FIRES BOOSTER MOTOR. AUXILIARY LINE IS EXPULSION.

10. INFORM LAUNCH CONTROL OFFICER THAT FIRING LINE HOOK UP IS COMPLETE, REQUEST PERMISSION TO ARM FIRING LINES AND EVACUATE PAD.

11. ARM FIRING LINES.

12. CHECK PAD WARNING LIGHT FOR ON CONDITION.

13. INFORM LAUNCH CONTROL OFFICER WHEN READY TO ACTUALLY EVACUATE PAD.

14. ALL PERSONNEL EVACUATE LAUNCH PAD.

T-5 MIN

1. INFORM LAUNCH CONTROL OFFICER, THAT LAUNCHING AREA IS CLEAR AND CONFIRM THAT ROCKET SYSTEM IS READY TO FIRE.

<u>*MISFIRE</u>

1. FOLLOW MISFIRE PROCEDURES SPECIFIED IN SOP NO. 224-5-76.

<u>**CANCELLATION OR ABORT</u>

1. FOLLOW CANCELLATION PROCEDURES SPECIFIED IN SOP NO. 224-5-76.

7.3 Super Arcas Check List - Launch Pad

T-60 MIN

1. LAUNCH CREW (2 MEN) ARRIVE ON STATION WITH ARCAS INSTRUMENTS.

2. ESTABLISH COMMUNICATIONS TO ALL STATIONS AND CONFIRM THAT COMMUNICATIONS HAVE BEEN ESTABLISHED TO LAUNCH CONTROL OFFICER.

T-55 MIN

1. REQUEST FIRING LINE CHECK FROM LAUNCH CONTROL OFFICER.

2. PERFORM FIRING LINE VOLTAGE/NO VOLTAGE MEASUREMENTS AND REPORT READINGS TO LAUNCH CONTROL OFFICER (MAIN LINE).

3. SHUNT FIRING LINE - REPORT CLEAR.

T-50 MIN

1. TRANSPORT ARCAS MOTOR, AND IGNITER TO LAUNCH PAD.

2. PLACE MOTOR ON ASSEMBLY CRADLE AND ATTACH GROUND CABLE TO MOTOR NOZZLE.

3. PLACE IGNITER IN IGNITER TEST CHAMBER, REMOVE SHUNT.

4. CONNECT ALINCO IGNITER TESTER TO IGNITER, READ IGNITER RESISTANCE AND REPORT READING TO LAUNCH CONTROL OFFICER.

5. RE-SHUNT IGNITER LEADS.

T-45 MIN

1. RECORD SUPER ARCAS MOTOR SPECIFICATIONS AND REPORT TO LAUNCH CONTROL OFFICER.

2. INSPECT LAUNCH AND ASSURE THAT NO DEFECTS EXIST.

3. CONFIRM PRELIMINARY LAUNCHER ANGLES.

T-30 MIN

1. TRIM AND GREASE STYRO FOAM SKIDS.

2. INSTALL HINGE STRAPS ON PISTON.

3. POSITION LAUNCHER TO PRELIMINARY AZIMUTH LAUNCH ANGLE.

4. LOAD AND ARM GAS GENERATOR (DELETE IF GAS GENERATOR NOT REQUIRED).

5. INSTALL PARACHUTE CONTAINER ON ARCAS MOTOR.

T-19 MIN

1. TURN ON INSTRUMENT AND NOTIFY TRACK SHACK THAT INSTRUMENT IS ON.

T-18 MIN

1. ASSEMBLE INSTRUMENT AND NOSE CONE.

2. INSTALL INSTRUMENT AND NOSE CONE ASSEMBLAGE TO SUPER ARCAS PARACHUTE CONTAINER.

3. PLACE TOTAL ROCKET SYSTEM ON KNIFE EDGE AND ADJUST PLACEMENT UNTIL BALANCE IS REACHED.

4. MEASURE FROM NOZZLE END OF BOOSTER MOTOR WITH TAPE MEASURE TO POINT OF BALANCE ON KNIFE EDGE. REPORT THIS CG MEASUREMENT TO LAUNCH CONTROL OFFICER.

T-15 MIN

1. LOAD ROCKET SYSTEM AND STYRO FOAM SKIDS INTO LAUNCHER.

2. ATTACH PISTON TO NOZZLE OR SUPPER ARCAS MOTOR WITH HINGE STRAPS POSITIONED PARALLEL TO ROCKET MOTOR.

3. INSERT TOTAL SYSTEM INTO LAUNCHER UNTIL STOP PINS CAN BE INSTALLED.

4. INSTALL STOP PINS.

5. REMOVE IGNITER FROM IGNITER TEST CHAMBER AND INSTALL IGNITER IN SUPER ARCAS MOTOR.

6. CONNECT IGNITER TO LAUNCHER DOOR.

7. CLOSE LAUNCHER DOOR AND SECURE ALL CLAMPS. RECEIVE AND CONFIRM FINAL LAUNCHER ANGLES FROM LAUNCH CONTROL OFFICER. PROVIDE NRO REPRESENTATIVE WITH FINAL ANGLES FOR CONFIRMATION PURPOSES.

T-10 MIN

1. CHECK WITH LAUNCH CONTROL OFFICER TO INSURE THAT FIRING LINES ARE CLEAR.

2. CONNECT MAIN FIRING LINE TO CONNECTOR ON OUTSIDE OF LAUNCHER DOOR.

3. POSITION LAUNCHER TO FINAL FIRING ANGLES (EL AND AZ)

4. INFORM LAUNCH CONTROL OFFICER THAT FIRING LINE HOOK UP IS COMPLETE. REQUEST PERMISSION TO ARM FIRING LINES AND EVACUATE PAD.

5. ARM FIRING LINES.

6. CHECK PAD WARNING LIGHT FOR ON CONDITION.

7. INFORM LAUNCH CONTROL OFFICER WHEN READY TO ACTUALLY EVACUATE PAD.

8. ALL PERSONNEL EVACUATE LAUNCH PAD.

T-5 MIN

1. INFORM LAUNCH CONTROL OFFICER, THAT LAUNCHING AREA IS CLEAR AND CONFIRM THAT ROCKET SYSTEM IS READY TO FIRE.

*MISFIRE

1. FOLLOW MISFIRE PROCEDURES SPECIFIED IN SOP NO. 224-5-76.

**CANCELLATION OR ABORT

1. FOLLOW CANCELLATION PROCEDURES SPECIFIED IN SOP NO. 224-5-76.

8. RECOVERY

No air search recovery is planned for the ASL Small Rocket Program.

It is desirable to have certain payloads returned for the salvage value of the instrumentation. These particular payloads will be tagged with the name and address of the local receiving agency, authorized by NRC. Upon receipt of these payloads, NRC will pay a finders fee (reward) of fifty dollars ($50.00) to the individual.

9. PREPARATION AND LAUNCH SCHEDULE (SMALL ROCKETS)

Date	Time Local	Time UT	*T-Time	Event
2-12	---	---	T-14 Days	Launch vehicle personnel arrive on-site
				Rocket motors and auxilary equipment shipment arrives.
				Telemetry station instrumentation and GMD-4 trackers with operating personnel arrive on-site.
2-14	---	---	T-12 Days	Payloads and payload personnel arrive on-site.
2-16	---	---	T-10 Days	Final launch checkouts complete.
2-17	---	---	T-9 Days	Final payload checkouts complete.
2-19	0900	1500		All personnel arrive on-site and begin countdown.
2-19	1423	2023		Launch CMSL-01-79.
2-23	0900	1500		All personnel arrive on-site and begin countdown.
2-23	11:59:48	1759:58		Launch CMSL-02-79
2-24	0800	1400		All personnel arrive on-site and begin countdown.
2-24	0951	1551		Launch CMSL-03-79
2-24	1054:50	1654:50		Launch CMSA-01-79
2-24	1122	1722		Launch CMSA-10-79
2-24	1300	1900		Dress rehearsal for 2-26-78 launchings.
2-25	0800	1400		All personnel arrive on-site and begin countdown.

*Scheduling references are made considering T-0 to be 1653 hrs. UT, 26 February 1979.

Date	Time Local	Time UT	T-Time	Event
2-25	1100:03	1700:03		Launch CMSA-02-79
	1130	1730		Launch CMSA-05-79
	1230	1830		Launch CMSL-04-79
2-26	0800	1400		All personnel arrive on-site and begin countdown.
2-26	1053	1653		Launch CMSA-06-79.
	1138	1738		Launch CMSA-07-79
	1240	1840		Launch CMSA-03-79
	1315	1915		Launch CMSL-05-79
	2130	0330 (27 Feb)		Launch CMSA-08-79.
	2240	0440 (27 Feb)		Launch CMSA-09-79.
	2330	0530 (27 Feb)		Launch CMSL-06-79.
2-27	0400	1000		All personnel arrive on-site and begin countdown.
2-27	**0706	1306		Launch CMSA-09-79.
	0840	1440		Launch CMSA-10-79.
	0810	1410		Launch CMSA-04-79.
	0945	1545		Launch CMSL-08-79.

** Sunrise

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