X-552-65-269

NASA TM X-55242

MANNED SPACE FLIGHT NETWORK PERFORMANCE ANALYSIS FOR THE SA-8 MISSION

N65-29806

(ACCESSION NUMBER) (THRU)

30 (PAGES) 1 (CODE)

(NASA CR OR TMX OR AD NUMBER) 11 (CATEGORY)

FACILITY FORM 602

JULY 29, 1965

GPO PRICE $

CFSTI PRICE(S) $

Hard copy (HC) 2.00

Microfiche (MF) .50

ff 653 July 65

NASA

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

MANNED SPACE FLIGHT NETWORK

PERFORMANCE ANALYSIS

FOR THE

SA-8 MISSION

July 29, 1965

Approved by

O. Womick, Jr., Support Manager
Tracking and Data Acquisition

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

Liftoff of SA-8 Vehicle, May 25, 1965, Cape Kennedy

29806

SUMMARY

The Saturn-Pegasus spacecraft was successfully launched on May 25, 1965, from complex 37B at Cape Kennedy, Florida, on a launch azimuth of 90 degrees east of true north and maneuvered onto a flight azimuth of 105 degrees east of true north. The orbit was very near to the nominal, and the predicted lifetime of the satellite was computed to be two to three years.

The network provided radar data for the first three revolutions and full telemetry support until the last of the on-board batteries expired between TAN and CRO on the second revolution. Monitoring continued until the end of the revolution to confirm expiration of all links. Real-time computing support was provided by the GSFC computing center. The NASA Global Communications Network (NASCOM) provided voice and teletype communication between Goddard Space Flight Center (GSFC), Cape Kennedy, and all participating stations; and high-speed data circuits between GSFC and Cape Kennedy, and between GSFC and Bermuda. All network systems performed exceptionally well for the duration of the mission.

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

This report covers the orbital portion of the SA-8 mission through the first five revolutions. A separate report will be issued to cover the reentry phase.

A brief description of the performance of the MSFN for the SA-8 mission is presented in this report. It is prepared for those who have some familiarity with the network systems. The report concentrates on troubles experienced without emphasis on those systems which performed as expected.

The flight plan was to launch a Saturn S-1 stage, an S-IV stage, an R&D pressurized instrument unit, and an Apollo boilerplate spacecraft and Pegasus B payload combination. Following launch, separation, and insertion of the payload, the panels of the satellite were extended and the Pegasus B began its programmed 18-month experiment.

The general network requirements were (1) to provide real-time computation support during the first five revolutions, (2) to provide C-band radar tracking (beacon and skin) for the first five revolutions, and (3) to receive and record telemetry data until battery expiration. The Space Tracking and Data Acquisition Network (STADAN) assumed tracking responsibility for the satellite after the fifth revolution. All of the MSFN stations that participated in the mission are listed in table 1. The table reflects the support provided by each station.

This report reviews the network mission preparations, performances of the basic on-station systems, and the computing and ground communications systems. Finally, the mission data accumulation program is summarized.

Stations of other networks were called upon for this mission. This ancillary support is covered in Appendix A.

Table 1. SA-8 MSFN Station Participation

Station		REVOLUTION NUMBER		
		TLM	S-BAND	C-BAND
Merritt Island	(MLA)	-	-	1, 2
Patrick AFB	(PAT)	-	-	1, 2
Cape Kennedy (TEL-2)	(CNV)	1,2	-	-
Grand Turk Island	(GTK)	2	-	1,2,3
Bermuda	(BDA)	1,2	-	1
Antigua	(ANT)	1,2	-	1
Ascension	(ASC)	1,2	-	1,2,3
Pretoria	(PRE)	1,2	-	1
Tananarive	(TAN)	1,2	-	-
Carnarvon	(CRO)	1,2	-	1,2,11,12 13,14,15
Hawaii	(HAW)	1,2	-	-
California	(CAL)	1,2	-	-
Guaymas	(GYM)	1,2	-	-
White Sands	(WHS)	-	-	1,2
Texas	(TEX)	1,2	-	-
Eglin*	(EGL)	1	-	1
Wallops Station	(WLP)	-	2,11,12, 13,14,15	-

NOTE: CRO and WLP support was required on revolutions 11 through 15 for signature analysis studies.

* Supported for training purposes only.

2. NETWORK SUPPORT PREPARATIONS

2.1 DOCUMENTATION STATUS

2.1.1 Operational Documents

NOP - The Network Operation Plan (NOP) was published by GSFC on April 21, 1965, and revised on May 11, 1965. The NOP covered the orbital tracking support and data acquisition for the first five revolutions.

OR 2460 - Operations Requirement 2460 was revised for SA-8 on April 9, 1965 and contained the DOD requirements for orbital tracking and data acquisition for the first five revolutions.

OD 2460 - Operations Directive 2460 was revised for SA-8 on April 30, 1965 by the DOD.

2.1.2 Premission Dcoumentation

A Premission Documentation Change (PDC) was issued to all participating stations by teletype on May 10, 1965, to correct the NOP.

2.1.3 Support Instructions

A total of three Instrumentation Support Instructions (ISI's) were written affecting the following:

Radar

Corrections to the NOP

Commencement of mission status.

2.1.4 Queries

Seven queries were generated by the following supporting stations:

GYM--2 CAL---2 CRO----3

Six queries pertained to telemetry and one query concerned radar scheduling.

2.2 EQUIPMENT STATUS

All systems were GREEN on simulation day except WHS which reported radar RED due to a burned out transformer. The radar was repaired prior to launch day.

2.3 NETWORK STATUS AT LAUNCH

Stations shown in table 2 were RED during part of the countdown for the reasons shown. All stations scheduled for participation were either fully operational or able to support at launch.

2.4 ENGINEERING MODIFICATION STATUS

There were no RED engineering modifications when mission status was declared.

Table 2. Equipment Reported RED

Station	System	Time Reported RED	Remarks
CRO	Radar	25/0200Z	Defective water coolant temperature switch and an air leak in the azimuth rotary coupler. Parts on order.
BDA	Acq Aid	25/0249Z	Acq Aid number one amplidyne failed. GREEN at 25/0400Z.
TAN	SCAMA	25/0300Z	Propagation problems, GREEN at 25/0500.
TAN	TTY	25/0316Z	Propagation problems, circuit restored at 25/0344Z via Paris.

3. SYSTEM PERFORMANCE

3.1 ACQUISITION AID

The primary acquisition aid system at all stations used link P1 (253.8 mc) as the beacon source. Link F6 (240.2 mc) was used as the backup source. Stations with a second acquisition aid system used link D2 (251.5 mc) as the acq aid 2 beacon source with link P1 as the backup. At applicable stations, Teltrac systems were designated as the primary system.

The performance of acquisition aids at supporting stations was excellent. Autotrack was utilized for more than 50 percent of the pass time at all sites. Only one problem was encountered with the acquisition aid systems. Bermuda reported the amplidyne unit on acquisition No. 1 RED during the count down. The unit was replaced in sufficient time to support the mission.

3.2 TELEMETRY

3.2.1 General

The SA-8 Spacecraft carried four telemetry links in the instrument unit and three in the S-IV stage. The S-IV contained one SSB/FM, one PCM/FM link, and three PDM/FM links. The power output for all of these links was from 10 to 25 watts. Tables 3 and 4 contain the supporting stations, percent TLM coverage, and AOS and LOS times for revolutions 1 and 2.

Dropout of links S3 and F5 occurred after PRE LOS (08:26:14Z) on the first revolution. CRO reported loss of modulation on links D1 and D2 four minutes and forty-four seconds after AOS on the first revolution. HAW confirmed loss of modulation on D1 and D2. However, they reported modulation came back up on link D1 approximately 6 minutes after their AOS. HAW also verified that links S3 and F5 had expired.

3.2.3 Telemetry Performance Summary

Telemetry reception was very successful and resulted in ample data recorded at all participating stations.

GYM reported at 0609Z that one of their receivers would not meet the 20 db of quieting specification. The receiver was repaired at 0630Z. Since it had been reported by HAW that no modulation was present on link D2, GYM reconfigured their wide band receiver to receive link D3. A crystal was not available for link D3 which prevented accurate tuning of the receiver prior to spacecraft acquisition. This resulted in a 40 percent data loss on this link.

The next station (CAL) reported carrier and modulation on all links except S3 and F5 which had previously expired. GTK reported that link S3 was reacquired on revolution No. 2 and that the link was 12 percent usable.

Links P1, F6, D2, D1 and D3 were usable until ANT acquisition on the second revolution. ANT reported 10 percent coverage on these links. Links P1 and F6 were usable 70 and 98 percent respectively at TAN on the second revolution. The next station (CRO) reported telemetry decay on all links. HAW, CAL, GYM, and TEX confirmed complete telemetry decay on all links. Total battery life during the orbital flight for links S3 and F5 was approximately 40 minutes. Battery life for links P1, F6, D2, D1, and D3 during the orbital flight was approximately 149 minutes.

BDA exercised their PCM system for training purposes. Although not required, BDA included lock status of the PCM station in their summary messages for the first pass. They reported that PCM "lock up" was good.

3.3 TIMING

The timing system performed normally at all stations except as noted below.

3.3.1 Guaymas

During the first revolution, a faulty cable on the timing conditioner shorted out the serial decimal time (SDT) to the Sanborn recorders. However, the recorders were kept running until after the pass when the SDT was repaired. The "seconds" marks were scaled off and annotated back through the pass to the point where SDT was present.

3.3.2 Bermuda

At T-219 minutes during the network countdown BDA reported that the timing system jumped one second. The trouble was traced to the binary code translator, and the problem was corrected before liftoff.

3.4 RADAR

3.4.1 General

Continuous C-band beacon tracking was required from launch through insertion. Maximum C-band skin tracking was desired after beacon expiration through the fifth revolution, consistent with tracking capabilities of MSFN stations. F+1 day skin tracking coverage was desired from

Table 3. Revolution 1 Telemetry Coverage

STA	GMT (hrs:min:sec)		PERCENT OF COVERAGE						
	AOS	LOS	P1	F6	D2	D1	D3	S3	F5
CNV	07:35:01	Not Reported	100	100	100	100	100	100	100
BDA	07:38:00	07:50:01	100	100	100	100	100	100	100
GTK△									
ANT	07:39:34	07:53:33	100	100	100	100	100	100	100
ASC	07:54:30	08:08:33	100	100	100	100	100	100	100
PRE	08:06:36	08:21:35	100	100	100	100	100	100	100
TAN	08:12:10	08:25:29	75	98	95	95	-	-	-
CRO	08:26:14	08:43:40	100	90	100	100	90	X	X
HAW	08:56:36	09:10:20	100	100	60	60	80	X	X
CAL	09:06:40	09:20:28	100	100	100	100	100	X	X
GYM	09:10:13	09:22:45	100	100	0	100	60	X	X
TEX	09:13:13	09:26:15	100	100	100	100	-	-	-
EGL*	07:35:45	07:46:15	95	95	95	95	95	95	95

* - Supported for training purposes only

△ - Deleted from support on this pass

X - Link expired

Table 4. Revolution 2 Telemetry Coverage

STA	GMT (hrs:min:sec)		PERCENT OF COVERAGE						
	AOS	LOS	P1	F6	D2	D1	D3	S3	F5
CNV	09:17:28	09:29:48	100	100	100	100	100	X	X
BDA	09:22:16	09:30:05	90	90	90	90	90	X	X
GTK	09:20:48	09:32:40	100	100	100	100	100	12	X
ANT	09:22:52	09:34:54	10	10	10	10	10	X	X
ASC	09:39:50	09:51:10	95	59	X	X	X	X	X
PRE	09:49:52	10:05:08	75	100	X	X	X	X	X
TAN	09:56:00	10:05:14	70	98	X	X	X	X	X
CRO	-	-	X	X	X	X	X	X	X
HAW	-	-	X	X	X	X	X	X	X
CAL	-	-	X	X	X	X	X	X	X
GYM	-	-	X	X	X	X	X	X	X
TEX	-	-	X	X	X	X	X	X	X

X - Link expired

WLP Spandar and CRO FPQ-6 during revolutions 11 through 13 for signature analysis purposes. Figures 1, 2, and 3 illustrate the radar coverage by station for the first and second day of the mission. Figures 4 and 5 illustrate the S-band Pegasus radar reflectivity and figures 6 and 7 illustrate the C-band radar reflectivity obtained for this mission.

C-Band beacon characteristics were:

Interrogate frequency........5690 mc

Transpond frequency..........5765 mc

Code.........................Single pulse

Delay........................408 yds

Battery life.................Estimated 20 min

3.4.2 Prelaunch Activities and Status

During the prelaunch countdown, Carnarvon reported the radar RED due to a defective water coolant temperature swtich and an air leak in the azimuth rotary coupler. Carnarvon, however, was able to support all mission requirements.

3.4.3 Powered Flight

The radar beacon operated throughout the entire launch phase and excellent radar coverage was obtained.

MLA, GBI, GTK, BDA, and ANT provided continuous radar coverage. BDA noted interference by what appeared to be a search radar operating at a PRF of approximately 1000 cps during launch tracking. This interference, however, did not prevent BDA from acquiring 679 seconds of valid data.

Although not scheduled to support this mission, PAT was permitted to track at their request. A transmitter failure occurring at T + 150 seconds resulted in a premature termination of PAT launch tracking and ended their support for the remainder of the mission.

EGL, at their request, was also permitted to attempt passive beacon track on launch, but failed to establish contact.

WLP Spandar tracking for revolution 1 was deleted from launch support after the possiblity of interference with ETR C-band range safety radars was considered. WLP predicted coverage after launch phase during revolution 1 was negligible.

MLA revolution 3 coverage and ASC revolution 5 coverage was deleted as tracking was improbably, based on failure of CRO, GTK, and ASC to track at similar ranges.

3.4.4 Orbital Phase

PRE had a long track on revoultion 1, however, they acquired only 229 seconds of valid data due to dropouts caused by sporadic beacon replys just prior to beacon expiration. It is noteworthy that SA-8 beacon expiration occurred within approximately one minute of beacon expiration during SA-9.

CRO and WLP did not receive pointing data for revolution 11 and consequently were unable to acquire the spacecraft. This was due to a misunderstanding at the GSFC computing center.

CRO failed to achieve track during revolution 2. Since there is no evidence of equipment failure or any degradation in performance which could be attributed to equipment deficiences, it is assumed that the combination of range, which was in excess of 2400 K yards, and the nature of the target prevented skin tracking by the radar.

3.4.5 Conclusion

Radar coverage was generally in accordance with that which was predicted.

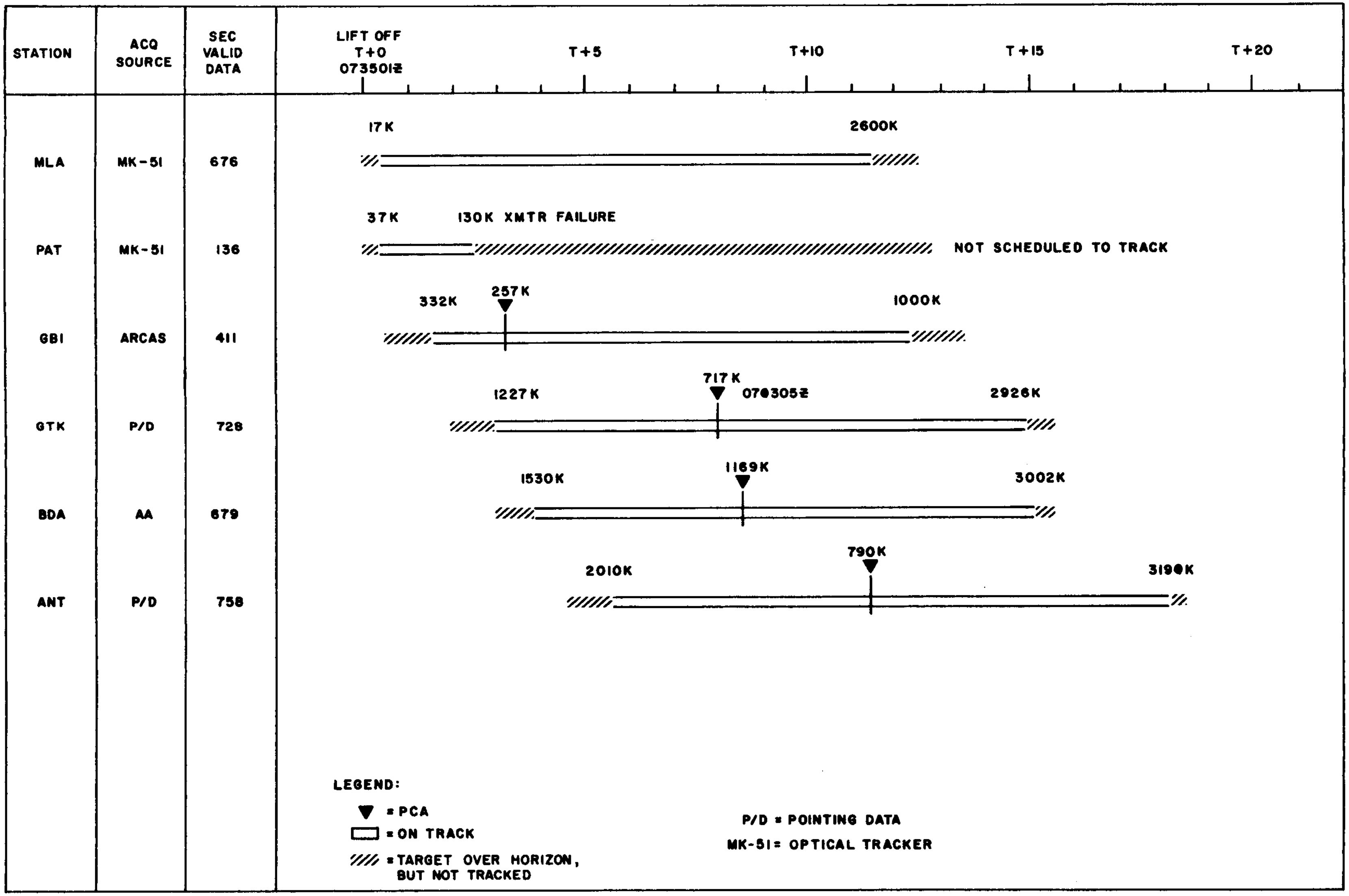


Figure 1. SA-8 Launch Phase Radar Coverage

STATION	REV	ACQ SOURCE	PCA TIME Z	SEC OF DATA	EL ANGLE
ASC	1	1206	08:01:55	240	73°
PRE	1	1206	08:13:48	229	13°
CRO	1	AA2	08:36:01	16	44°
WHS	1	P/D	09:17:18	162	49°
MLA	2	MK-51	09:23:31	180	24°
GTK	2	P/D	09:26:29	352	32°
ANT	2	P/D	09:29:10	293	28°
ASC	2	N/A	09:44:00	N/A	19°
CRO	2	N/A	10:18:01	N/A	10°
WLP	2	N/A		N/A	4°
GTK	3				
ASC	3				

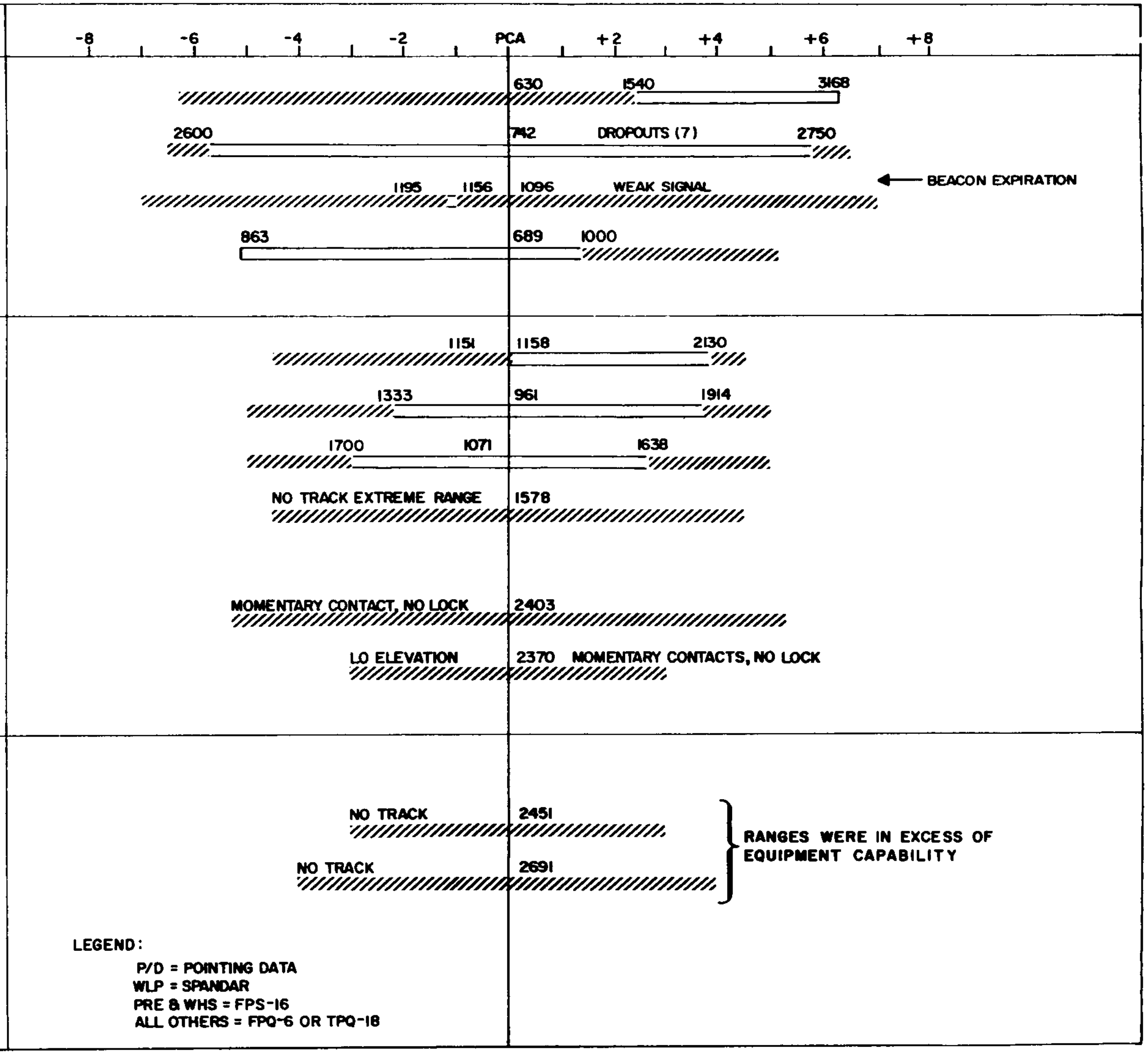


Figure 2. SA-8 Orbital Phase Radar Coverage, First Day

STATION	REV	ACQ SOURCE	PCA TIME	SEC OF DATA	EL ANGLE
WLP	11	N/A	1723	N/A	8°
CRO	11	N/A	1821	N/A	71°
WLP	12	P/D	02:51:31	525	23°
CRO	12	P/D	03:43:24	378	38°
WLP	13	P/D	04:33:57	543	10°
CRO	13	P/D	05:27:03	513	43°
WLP	14	P/D	06:16:23	567	28°
CRO	14	P/D	07:10:24	402	86°
WLP	15	P/D	07:58:33	383	12°
CRO	15	P/D	08:53:21	324	25°

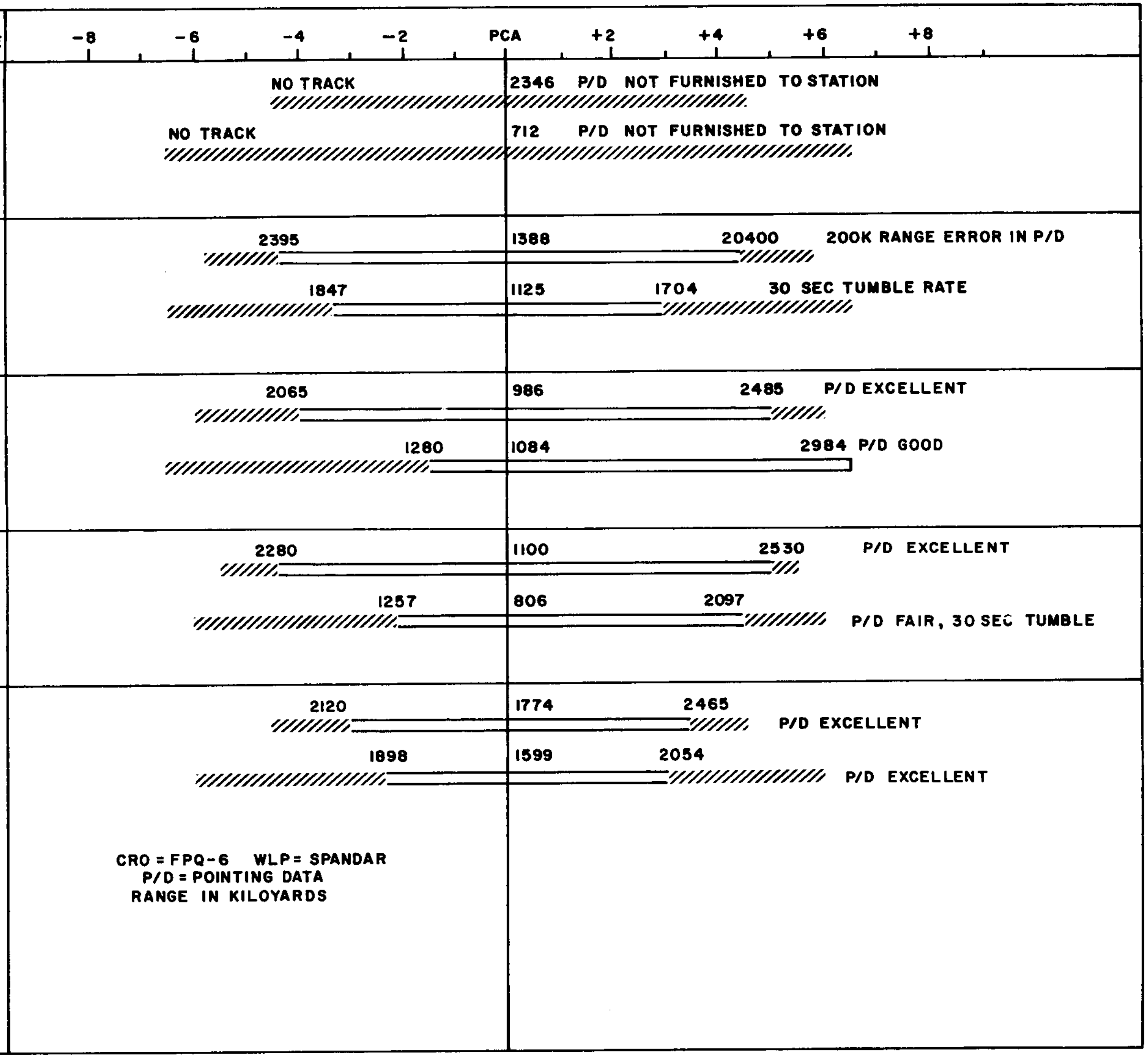


Figure 3. SA-8 Orbital Phase Radar Coverage, Second Day

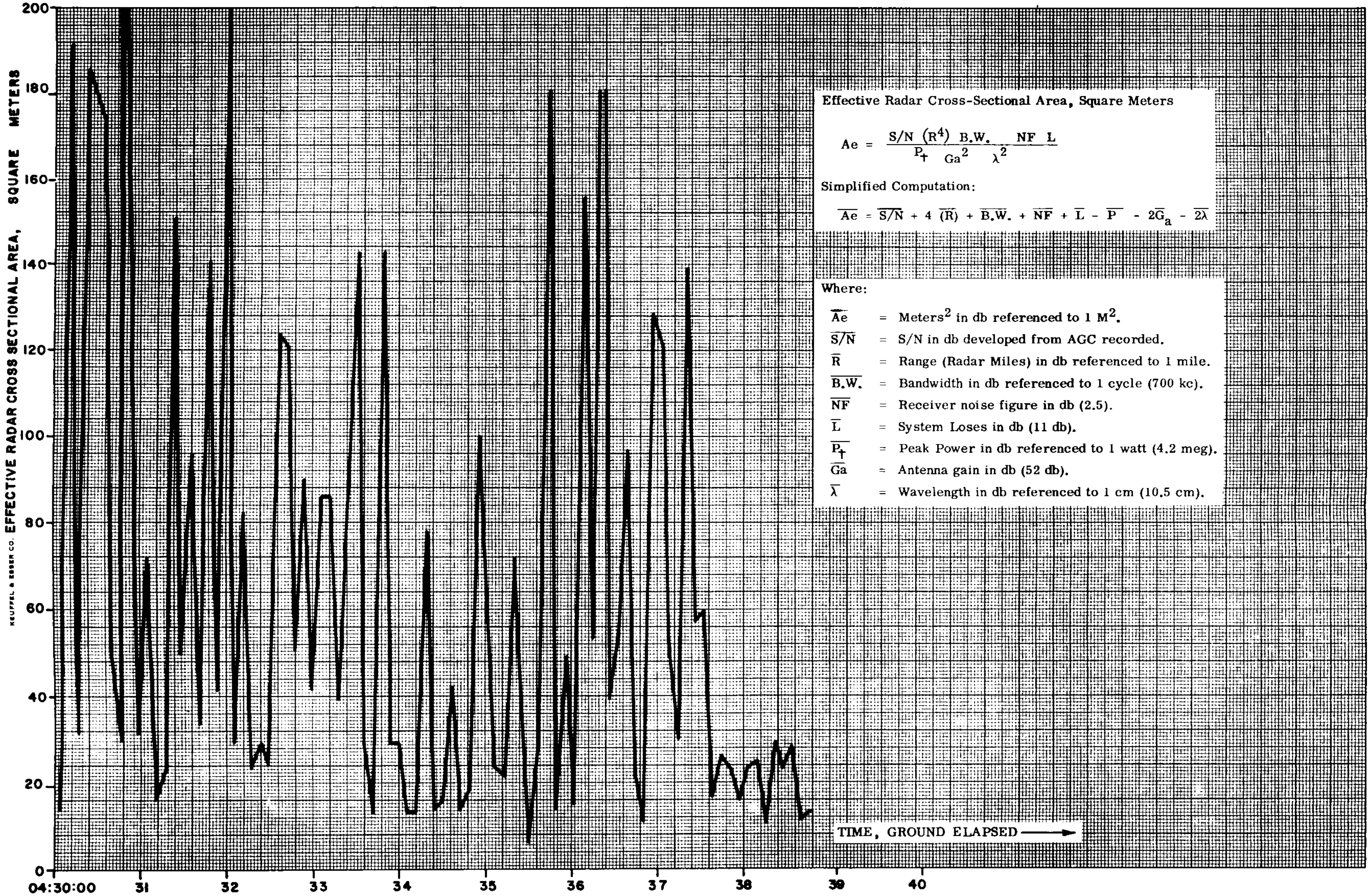


Figure 4. SA-8 Payload (Pegasus) Radar Reflectivity Based on Rev 13 WLP Spandar S-Band

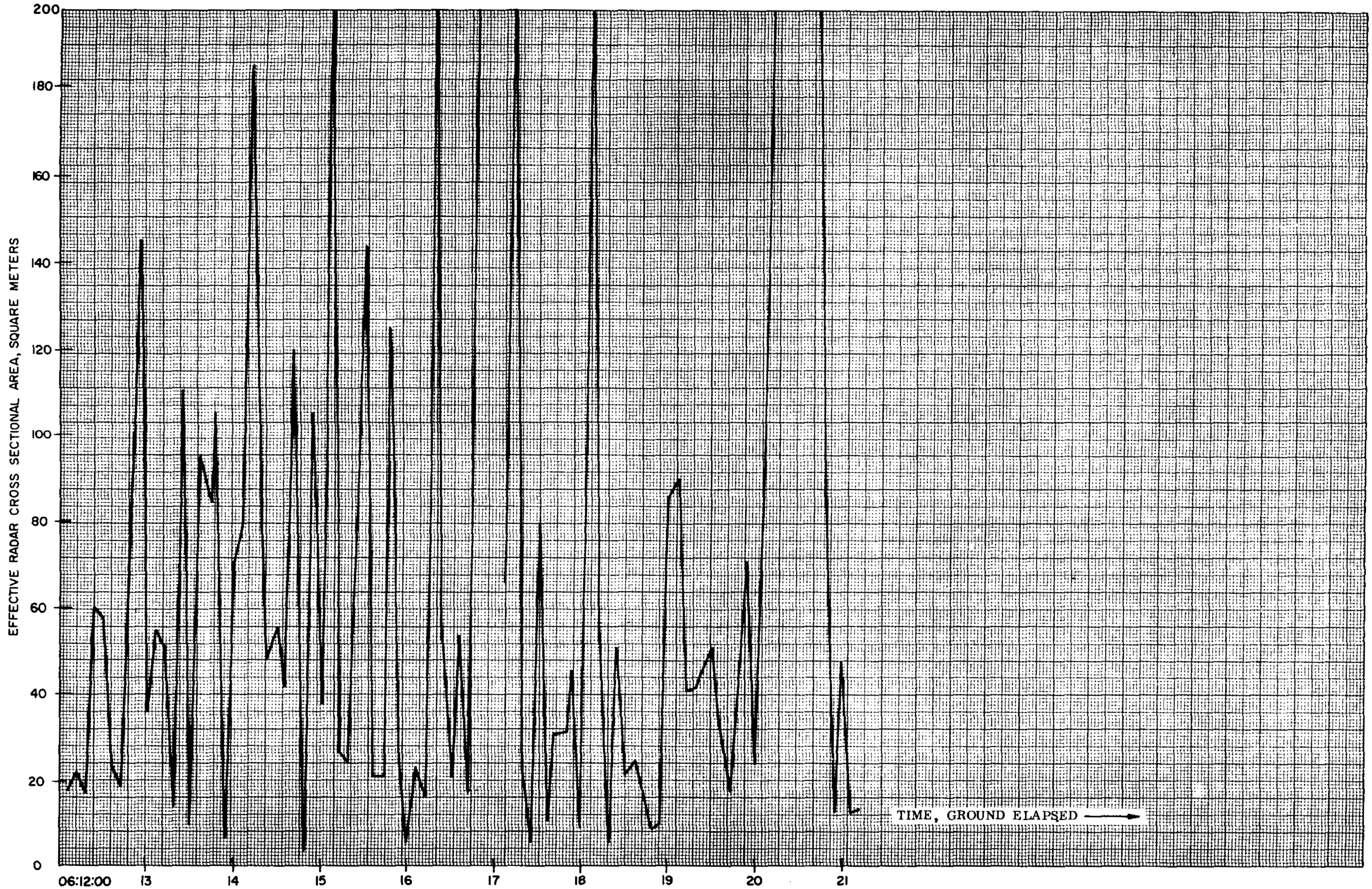


Figure 5. SA-8 Payload (Pegasus) Radar Reflectivity Based on Rev 14 WLP Spandar S-Band

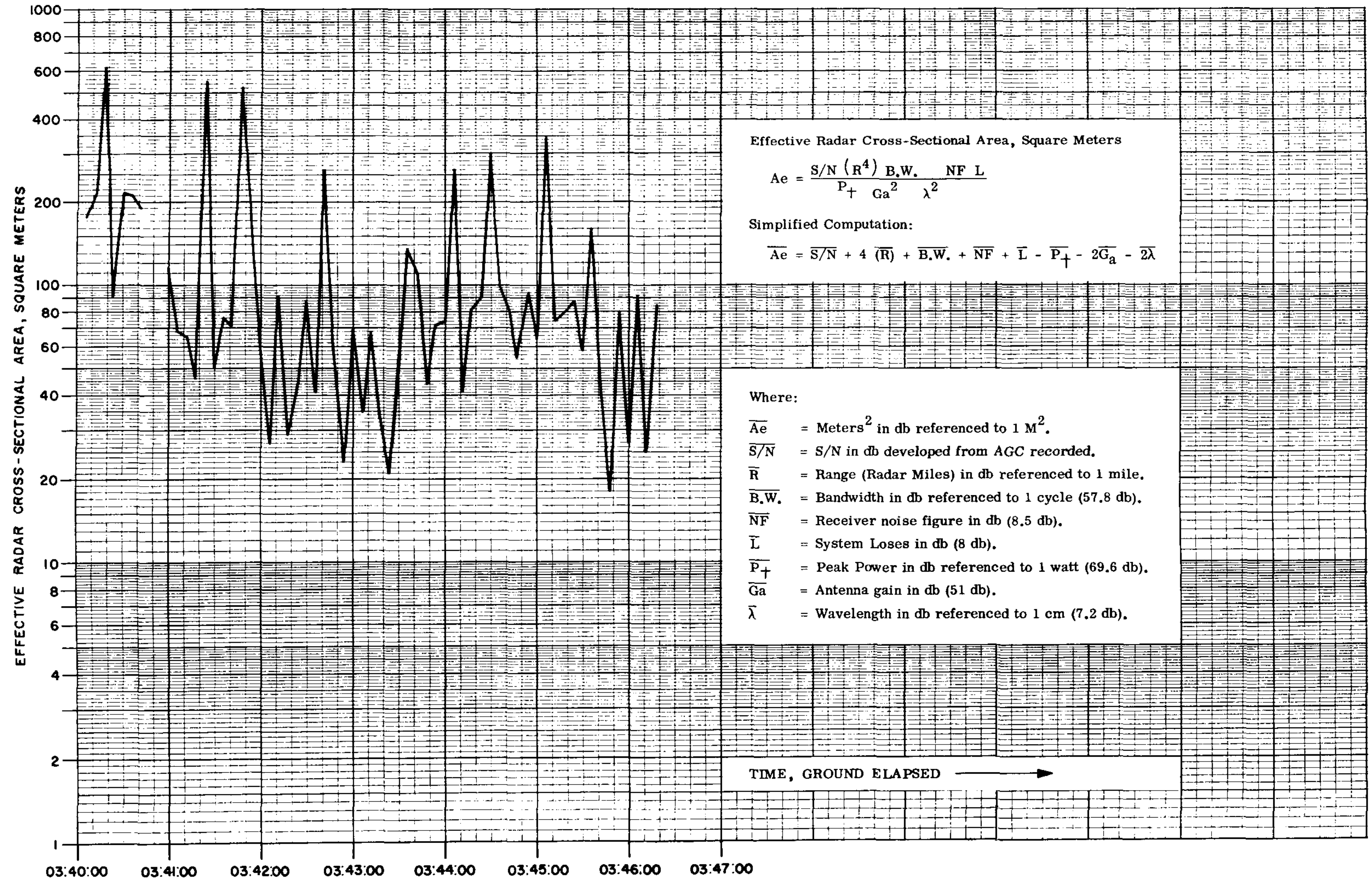


Figure 6. SA-8 Payload (Pegasus) Radar Reflectivity Based on Rev 12 CRO FPQ-6 C-Band

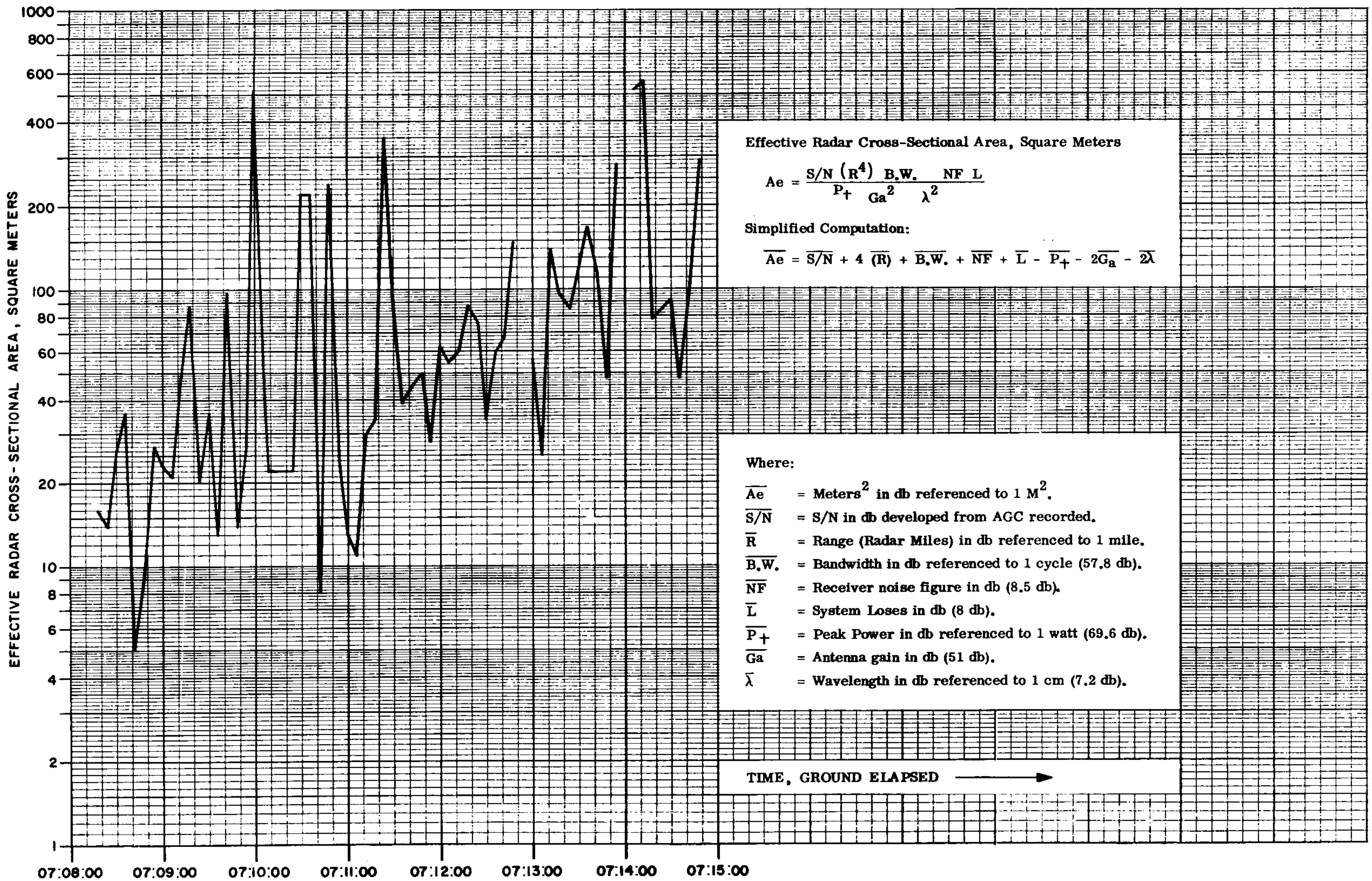


Figure 7. SA-8 Payload (Pegasus) Radar Reflectivity Based on Rev 14 CRO FPQ-6 C-Band

4. COMPUTING SYSTEM PERFORMANCE

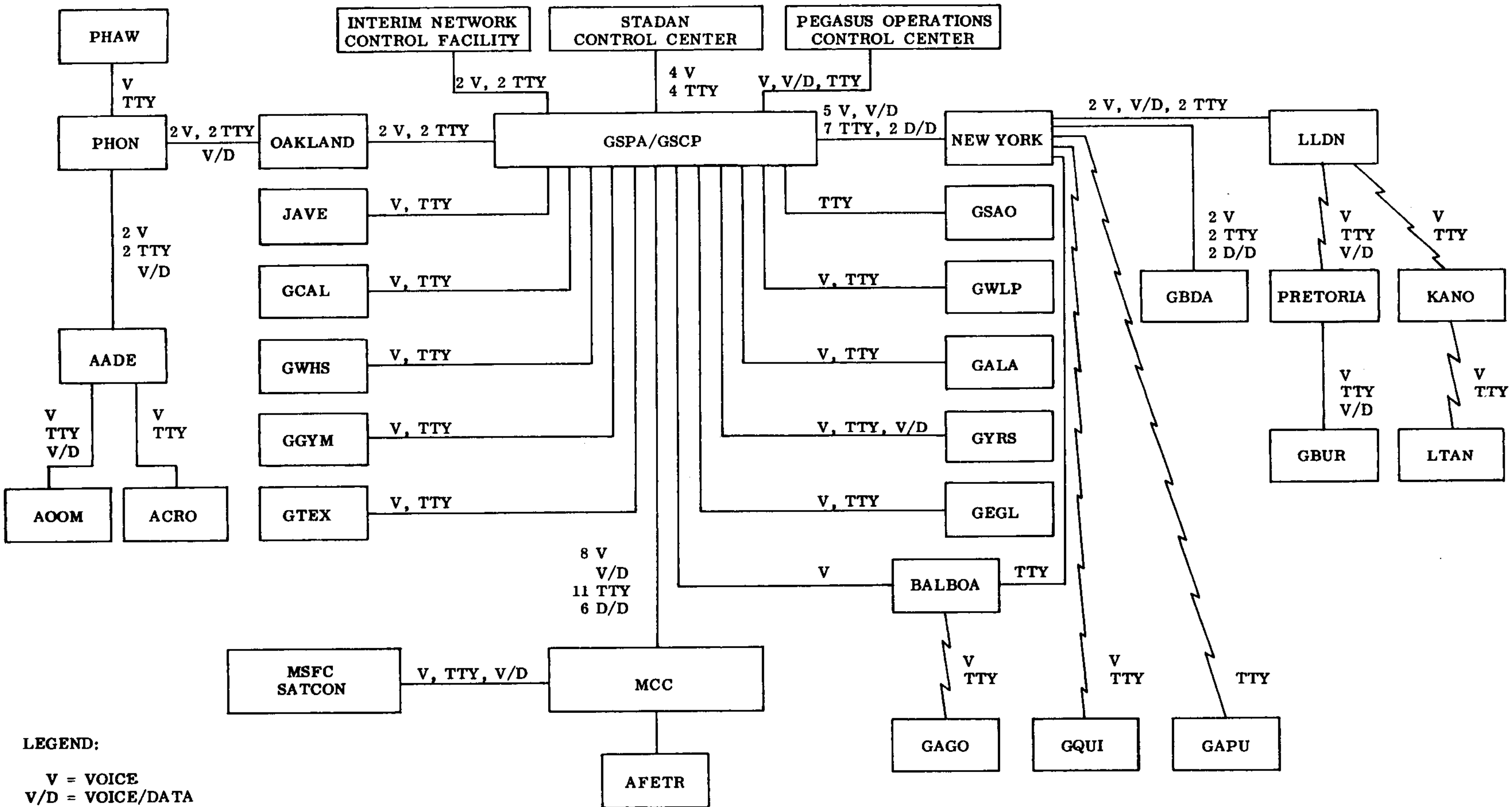
4.1 At 1140Z (T-7 hours and 55 minutes) on May 24, 1965, the SA-8 countdown commenced at Goddard. No problems were experienced in the countdown. All CADFISS tests were successfully run and the network was GREEN at liftoff. Launch and insertion conditions were nominal. Orbital elements achieved at insertion are shown in the following table:

Sustainer engine cutoff (SECO)	624.1 sec
Velocity	25,178 ft/sec
Flight path angle	.0012°
Height	278.2 nmi
Apogee	403.6 nmi
Perigee	274 nmi
Period	97.25 min
Inclination	31.78°
Eccentricity	.0172

4.2 The insertion conditions were so accurate that the precomputed acquisition data transmitted to the stations was usable during the mission. At 0811Z, on the first revolution, the C-band beacon failed over Pretoria, South Africa, and from that point on the stations skin tracked the vehicle. During the launch and subsequent real-time orbital phases, the real-time system operated normally and without incident. GSFC terminated real-time computing support at 1130Z.

5. NASCOM PERFORMANCE

The portions of NASCOM (NASA Global Communications Network) that were used are shown in figure 8. The teletype and voice network performed [illegible]



LEGEND:

V = VOICE
V/D = VOICE/DATA
TTY = TELETYPE
D/D = DIGITAL DATA
~ = HF RADIO

NOTE: Circuit quantity is one (1) unless otherwise indicated.

Figure 8. NASCOM Network Ground Communications Facilities

6. DATA HANDLING

6.1 SUMMARY

MSFN stations shown in table 5 were required to record and ship data in the form indicated. Except as noted, the required data were received within acceptable time frames and in good condition. A total of 35 direct write strip charts, 32 telemetry magnetic tapes, 10 radar digital magnetic tapes, and 42 operator's logs were received from stations of the MSFN. From these data a total of 140 direct write strip charts, 96 telemetry magnetic tapes, and 168 operator's logs were reproduced by the MFOB Data Services Group.

6.2 DATA IDENTIFICATION AND ANNOTATION

The following stations had discrepancies in the annotation and identification of their data.

6.2.1 Tel II

The magnetic tape recorded on the mincon recorder for pass No. 1 did not have start or stop times on the label.

6.2.2 Merritt Island

Radar events records were not marked with recorder start and stop times or revolution numbers.

6.2.3 Grand Turk

a. Radar function records were not marked with revolution number or start and stop times.

b. Radar events records were not marked with revolution number or start and stop times.

6.2.4 Bermuda

Telemetry direct-write strip charts did not have the data or time of the recording indicated.

6.2.5 Antigua

a. Radar function records were not marked with recorder start and stop times or revolution numbers.

Table 5. SA-8 Data Requirements

Station	Telemetry			Radar			Acquisition Aid	
	Direct-Write Strip Charts	Magnetic Tapes	Operator's Logs	Direct-Write Strip Charts	Magnetic Tapes (Digital)	Operator's Logs	Direct-Write Strip Charts	Operator's Logs
BDA	X	X	X	X		X	X	X
TAN	X	X	X	X			X	X
CRO	X	X	X		X	X	X	X
HAW	X	X	X				X	X
CAL	X	X	X				X	X
GYM	X	X	X				X	X
TEX	X	X	X				X	X
WHS				X	X	X	X	X
WLP				X	X	X	X	X
MLA				X	X	X		
TEL	X	X	X					
GTK	X	X	X	X	X	X		
ANT	X	X	X	X	X	X		
ASC	X	X	X	X	X	X		
PRE	X	X	X	X	X	X		

b. Radar events records were not marked with recorder start and stop times or revolution numbers.

c. Telemetry magnetic tape was identified only by the Operations Directive (2460) item number.

6.2.6 Ascension

a. Telemetry magnetic tapes were not marked with recorder start or stop times or revolution numbers.

b. Radar events records were identified only by the Operations Directive (2460) item number.

6.2.7 Tananarive

Neither the telemetry direct-write strip charts nor magnetic tapes had recorder start times, revolution numbers, or pass numbers.

6.2.8 Hawaii

Identification labels were used to prevent direct-write strip charts from unrolling. The use of labels for this purpose results in either the record becoming torn or the label lost when the record is unrolled for processing.

6.2.9 White Sands

Radar function records did not have proper system identification indicated.

6.3 DATA DISCREPANCIES

6.3.1 MSFN form MPX 528 (TLM Operator's Log) and the Supplementary Radar Data Sheets requested in OR 2460 and committed in OD 2460 have not been received from the following stations:

Merritt Island (Radar)

Ascension (Radar and Telemetry)

Grand Turk (Radar)

6.3.2 Carnarvon's NDR-3 for revolutions 12 and 14 did not arrive at MFOB Data Services Group until July 12, 1965.

APPENDIX A

OTHER SUPPORTING NETWORKS

A.1 STADAN DATA

A summary of the STADAN data received on launch day May 25, 1965, is contained in table 6. No Minitrack Optical Tracking System (MOTS) or Smithsonian Astrophysical Observatory (SAO) data was recorded on launch. The minitrack beacon will continue to transmit for approximately 18 months and the STADAN network has assumed complete tracking responsibility for this period.

Table 6. STADAN Data

Station	First Observation (hr:min:sec)	Last Observation (hr:min:sec)
Johannesburg	08:12:21Z	08:13:57Z
Mojave	09:14:44Z	09:15:24Z
Fort Myers	09:23:57Z	09:24:29Z
Johannesburg	09:56:57Z	09:57:20Z
Quito	11:10:03Z	11:10:25Z
Johannesburg	11:40:07Z	11:40:30Z
Lima	12:54:29Z	12:55:55Z
Johannesburg	13:22:21Z	13:24:21Z
Santiago	14:41:44Z	14:42:06Z
Santiago	16:25:05Z	16:25:27Z
Santiago	18:08:22Z	18:08:38Z

A.2 NORAD DATA

North American Air Defense Command (NORAD) data, table 7, summarizes the sightings reported by NORAD on launch day May 25, 1965.

Table 7. NORAD Data

Station	First Observation (hr:min:sec)	Last Observation (hr:min:sec)	Lines of Data
Trinidad	09:25:11Z	09:34:51Z	54
Moorestown	09:23:57Z	09:24:40Z	4
Trinidad	11:12:52Z	11:14:32Z	11