AS-204

X1.8
X111.6

JOHN F. KENNEDY
SPACE CENTER

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REVISION NO. 2
OCTOBER 16, 1967

APOLLO/SATURN

CONSOLIDATED INSTRUMENTATION PLAN

FOR AS-204/LM-1

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ORIGINATORS:

INSTRUMENTATION ANALYSIS OFFICE

C. R. Berghult, IN-DAT-2

W. T. Cooper, IN-DAT-2

TECHNICAL APPROVALS:

Dr. R. H. Bruns
Chief, Data Systems Division

K. Sendler
Director, Information Systems

(800-39-0008)

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A/C	Aircraft
ALDS	Apollo Launch Data System
ANT	Antigua (AFETR Station)
APS	Ascent Propulsion System
AQN	Acquisition
ARIA	Apollo Range Instrumented A/C
A-S	ARCAS Rocket with sonde payload
ASC	Ascension (AFETR Station)
ATF	Atlantic Field
BDA	Bermuda
BP	Boiler Plate
CADDAC	Central Analog Data Distribution and Computer
CAL	Pt. Arguello, Calif.
CAR	Little Carter Cay (Glotrac)
C-Band	Approx 5000 to 6500 MHz
CDDT	Countdown Demonstration Tests
CIF	Central Instrumentation Facility
CKAFS	Cape Kennedy Air Force Station
CM	Command Module
CNV	Cape Kennedy, Florida

CRO	Carnarvon
CSM	Command Service Module
CSQ	Coastal Sentry Quebec (Ship)
CTN	Canton Island
CW	Continuous Wave
CYI	Canary Island
CZR	Metric Ribbon Frame Camera
DAC	Douglas Aircraft Company, Inc.
DCU	Data Control Units
DDAS	Digital Data Acquisition System
Deg	Degrees
DFI	Development Flight Instrumentation
DOD	Department of Defense
DOVAP	Doppler Velocity and Position
DPS	Descent Propulsion System (LM)
EBW	Exploding Bridgewire
ECS	Environmental Control Subsystem
EGL	Eglin Air Force Base, Fla.
ELSSE	Electronic Skyscreen Equipment
ELU	Eleuthera
EPS	Electrical Power System

ETR	Eastern Test Range
ETZ	AFETR Staff Meteorologist
FITH	Fire In the Hole
fps	Frames per second
GBI	Grand Bahama Island
GCS	Guidance Cutoff Signal
GLAD	Glotrac Adjustment
G&N	Guidance & Navigation
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GTK	Grand Turk Island
GWM	Guam
GYM	Guaymas, Mexico
HAW	Hawaii
HOSC	Huntsville Operations Support Center
HRT	High Resolution Tracker
IECO	Inboard Engine Cutoff
IGOR	Intercept Ground Optical Recorder
IP	Impact Predictor, Impact Point
IU	Instrumentation Unit
JUP	Jupiter, Fla. (Glotrac Sta.)

km	Kilometers
KNO	Kano, Nigeria
KSC	Kennedy Space Center
LC	Launch Complex
LCC	Launch Control Center
LES	Launch Escape System
LH_2	Liquid Hydrogen
LIEF	Launch Information Exchange Facility
LM	Lunar Module
LMP	LM Mission Programmer
LOS	Loss Of Signal
LOX	Liquid Oxygen
LTDS	Launch Trajectory Data System
LV	Launch Vehicle
m	Meters
MCC-H	Mission Control Center - Houston
MCC-K	Mission Control Center - Kennedy
MDF	Mild Detonating Fuse
MHz	Megahertz
M. I.	Merritt Island
MIL	MSFN USB Station on Merritt Island

MITTS	Mobile IGOR
MLA	AFETR Radar on Merritt Island
MLB	Melbourne Beach
mm	Millimeter
μs	Microseconds
m/s	Meters Per Second
MSFN	Manned Space Flight Network
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration
NIPS	Near-In Impact Prediction Support
NSB	New Smyrna Beach, Florida
OD	Operations Directive
ODOP	Offset-Doppler
OECO	Outboard Engine Cutoff
PAFB	Patrick Air Force Base
PAT	Patrick Air Force Base, Fla.
PCM	Pulse Code Modulation
PRE	Pretoria
PSRD	Program Support Requirements Document
PU	Propellant Utilization

LIST OF ABBREVIATIONS (Cont)

RC-5	Metric Ribbonframe Camera
RCS	Reaction Control System
RKV	Rose Knot Victor (Ship)
ROTI	Recording Optical Tracking Instrument
RS	Rawinsonde
RSO	Range Safety Officer
RTCF	Real-Time Computer Facility
RTK	Range Tracker (Ship)
SA	Saturn Apollo
S-Band	Approx 1550 to 5200 MHz
SC	Spacecraft
SCS	Stabilization and Control Subsystem
SLA	Spacecraft Lunar Module Adapter
SM	Service Module
SMG	Spaceflight Meteorology Group, U.S. Weather Bureau
SPS	Service Propulsion System
TAN	Tananarive (Madagascar Island)
TEX	Corpus Christi, Texas
TM, TLM	Telemetry
TT	Triple Theodolite
TTI	Teletype Instruction
TV	Television

UDOP	Ultra-High-Frequency DOVAP
UHF	Ultra High Frequency (300-3000 MHz)
USB	Unified S-Band
VAN	Vanguard (Ship)
VHF	Very High Frequency (30-300 MHz)
WHS	White Sands, New Mexico
WINDS	Weather Information and Display System
X-Band	Approx 5200 to 10,900 MHz
Z-Time	Greenwich Mean Time

SECTION I
INTRODUCTION

This report represents the consolidated instrumentation plan for employing optical and electronic data acquisition systems to monitor the performance and trajectory of the Apollo/Saturn IB vehicle, AS-204/LM-1, during powered flight. Telemetry and electronic tracking equipment on board the vehicle, and data acquisition systems monitoring the flight are discussed. Flight safety instrumentation and vehicle data transmission are described, and geophysical information is provided.

This plan reflects the general instrumentation coverage requirements set forth in the NASA Program Support Requirements Document (PSRD) for Apollo/Saturn IB, and the commitments of Eastern Test Range (ETR) Operations Directive (OD) No. 4206, dated 16 August 1967. This plan is not intented to conflict with or to supersede either document.

The information presented in this document reflects planning concepts developed prior to October 1, 1967.

SECTION II
MISSION PROFILE

2.1 OBJECTIVES

The Saturn launch vehicle, SA-204L, with the Lunar Module (LM), LM-1, and a nose cone instead of the Command Service Module (CSM) will be launched from the Air Force Eastern Test Range (AFETR), Cape Kennedy, Florida.

2.1.1 PRIMARY OBJECTIVES.

The primary objectives of Mission AS-204/LM-1 are to:

a. Verify LM subsystems operation after launch vehicle boost and during and after LM propulsion system operation.

b. Evaluate flight control systems (Guidance and Navigation, Stabilization and Control, Reaction Control System) performance and operation at design inertias.

c. Determine performance and operational characteristics of the Electrical Power System (EPS), Environmental Control System (ECS), and operational instrumentation subsystems in earth orbit.

d. Determine LM communications subsystem performance and operation, and Manned Space Flight Network (MSFN) compatibility.

e. Evaluate Descent Propulsion System (DPS) and Ascent Propulsion System (APS) operations, including throttle and gimbal control, following orbital soaks; demonstrate DPS and APS restart.

f. Demonstrate Fire-In-The-Hole (FITH) abort and evaluate the in-flight dynamics (staging characteristics), pressure distribution, and thermal distribution of the ascent/descent stages during staging.

g. Demonstrate LM structural integrity, and determine ascent/descent stage interaction loads, LM/SLA interaction loads, and dynamic loads on pressurant storage and ascent/descent stage engine propellant tanks.

h. Evaluate performance and operational characteristics of ECS in earth orbital environment.

i. Demonstrate ullage settling time for Ascent Propulsion Subsystem and DPS operation.

j. Determine vibration environment in critical equipment areas, including engine induced vibration environment during Ascent Propulsion Subsystem and DPS operation.

2.1.2 SECONDARY OBJECTIVES. The secondary objectives of Mission AS-204/LM-1 are to:

a. Demonstrate DPS and APS operation at low propellant quantities.

b. Demonstrate operation of the LM Mission Programmer (LMP).

2.2 DESCRIPTION

2.2.1 LAUNCH. AS-204/LM-1 will be launched from LC-37 on a trajectory which will insert the S-IVB/IU/payload configuration in a near-earth (88/123 nautical mile) elliptical orbit. The flight azimuth will be 72 degrees True. After a 10-second vertical rise, the launch vehivle will begin its roll and tilt maneuver. Approximately 65 seconds after reaching maximum dynamic pressure, inboard engine cutoff (IECO) will occur, with outboard engine cutoff (OECO) occuring 3 seconds later. The S-IB and the interstage adapter will be separated from the S-IVB, whose J-2 engine will be ignited to drive the S-IVB, the IU, and payload into orbital insertion. Approximately 11 seconds after S-IVB ignition, the ullage rocket cases will be jettisoned. Approximately T + 598 seconds, S-IVB guidance cutoff signal (GCS) will occur, with orbital insertion defined as occurring 10 seconds later.

2.2.2 ORBITAL COAST. The nose cone will be jettisoned 35 seconds after orbital insertion. To enhance communications between MSFN and the LM, the S-IVB/IU/payload is to be maneuvered so that the spacecraft centerline will lie in the plane of the local horizontal. This attitude will be maintained by the S-IVB in an orbital rate mode until a short time before LM separation from the IVB/IU/SLA at T +54 minutes and 17 seconds.

2.3 SUMMARY OF EVENTS

A summary of launch vehicle events, the times at which they occur, and associated parameters is provided in Table 2-1.

Table 2-2 lists the various spacecraft events and the time at which each event begins.

Table 2-1. SA-204 Mission Events

NOTE: Selected Key Events and their associated parameters are taken from the SA-204/LM-1 Launch Vehicle Operational Trajectory, (Revision 1) Issue No. 3; dated July 1967.

EVENT	TIME FROM FIRST MOTION (Seconds)	EARTH-FIXED VELOCITY (Meters/Seconds)	EARTH-FIXED FLIGHT PATH ANGLE (Degrees)	ALTITUDE (Kilometers)	GROUND RANGE (Kilometers)
First Motion	0.000	0.000	0.000	.0345(1)	0.000
Lift-Off Signal (Time Base 1)	0.200				
Initiate Pitch & Roll	10.200	28.531	89.691	.171	0.001(2)
MACH 1	60.000	319.90	68.857	7.496	1.480
Max. Dynamic Pressure	74.000	458.12	59.984	12.343	3.827
Activate Level Sensor (Time Base 2)	136.044	1852.67	34.088	55.485	50.485(2)
Inboard Engine Cutoff	139.144	1968.30	33.241	58.817	55.439
Outboard Engine Cutoff (Time Base 3)	142.144	2025.09	32.559	62.079	60.429
S-IB/S-IVB Separation	143.523	2024.94	32.271	63.579	62.766
S-IVB Ign. Command	144.844	2018.54	31.996	65.002	65.005
Activate PU System	150.844	2011.73	30.730	71.289	75.196
Jettison Ullage Motors	155.444	2021.43	29.774	75.968	83.116
Initiate Active Guid.	159.250	2031.82	28.996	79.758	89.756
IGM Sensed EMR Shift	475.750	5077.19	-01.583	176.999	1062.701
Guidance Cutoff Signal	598.152	7415.70	-.004	163.193	1796.200
S-IVB/SLA/LM Orbital Insertion	608.152	7422.79	.008	163.217	1868.548

Remarks: (1) Tracking point used in Operational Trajectory
(2) Parameters to nearest second

Table 2-2. Spacecraft Mission Events

FLIGHT (1) TIME	EVENT
M:S*	
09:50.7	S-IVB/SLA/LM Orbital Insertion
10:25.7	Jettison Nose Cone
11:10.7	S-IVB Aligned with X-Axis Along Orbital Path
19:40.7	SLA Panel Deployment
30:41.1	Terminate LH_2 Venting
53:55.0	RCS Ignition
54:00.0	Sever Restraining Straps. Begin LM Withdrawal from SLA
54:05.0	RCS Shutdown
54:10.0	RCS Ignition
54:15.0	RCS Shutdown
M:S*	**LM Orbital Coast**
55:52.0	Begin Attitude Maneuver
H:M:S*	**LM First DPS Burn**
03:59:54.1	RCS Ignition
04:00:01.6	First Descent Engine Ignition
04:00:02.1	RCS Shutdown
04:00:40.0	Descent Engine Guidance Cutoff Command
04:00:40.4	Insertion into Hohmann Transfer Ellipse
H:M:S*	**Second DPS Burn/FITH Abort Test/First APS Burn**
04:33:22.4	Establish Second DPS Burn Attitude
04:36:45.6	RCS Ignition
04:36:53.2	Second Descent Engine Ignition
04:36:53.7	RCS Shutdown
04:48:54.3	Descent Engine Shutdown/FITH/First APS Ignition
04:48:59.4	First APS Shutdown
H:M:S*	**Second APS Burn**
06:09:31.9	Establish Second APS Burn Attitude
06:13:31.9	RCS Ignition
06:13:35.4	Second Ascent Engine Ignition (Burn to Depletion)
06:13:35.9	RCS Shutdown
06:20:42.7	APS Propellant Depletion – Begin Final Orbital Coast
09:33:19.4	End of Mission Profile

NOTES: M:S* = Flight Time of T-0 plus Minutes and Seconds listed.
H:M:S* = Flight Time of T-0 plus Hours, Minutes, and Seconds listed.
(1) Times shown are based on earlier LV Trajectory. Latest LV Operational Trajectory (Revision 1), Issue No. 3 of July 1967 gives time of insertion as 10:08.152. Sequence of spacecraft mission events remains essentially the same.

2.4 CONFIGURATION

The Apollo/Saturn space vehicle, AS-204/LM-1, consists of Saturn launch vehicle SA-204L, a spacecraft lunar module adapter (SLA), lunar module (LM-1), and a nose cone instead of the usual CSM stack (Figure 2-1).

2.4.1 SATURN LAUNCH VEHICLE, SA-204L. The SA-204L launch vehicle consists of the S-IB stage, and S-IVB stage, and an unpressurized Instrument Unit (IU).

2.4.1.1 S-IB Stage. The S-IB stage is powered by eight Rocketdyne (H-1) 200,000-pound-thrust engines using LOX and RP-1 propellants. The eight engines are clustered in inboard and outboard square patterns, with the engines of each square equidistant from the centerline of the vehicle. The four inboard engines are canted outward 3 degrees from the centerline. The four outboard engines are canted outward 6 degrees from the centerline and can swivel through an 8-degree angle for control during powered flight. The S-IB stage carries telemetry, offset-Doppler (ODOP) equipment, and a command/destruct system.

2.4.1.2 S-IVB Stage. The S-IVB stage is powered by a Rocketdyne (J-2) 200,000-pound-thrust engine using LOX and LH_2 propellants. The S-IVB stage carries telemetry equipment and a command/destruct system.

2.4.1.3 Instrument Unit. The IU is mounted atop the S-IVB stage and carries the guidance and control system, measuring and telemetry systems, transponders for electronic tracking systems, electrical power and distribution equipment, emergency detection system (EDS), and Secure Range Safety Command System.

2.4.2 SPACECRAFT. The payload of this space vehicle consists of the lunar module, LM-1, installed in a spacecraft LM adapter, SLA-7, which is topped with a nose cone.

2.4.2.1 Spacecraft/Lunar Module Adapter. The SLA is designed to house the LM and, in later missions, to mate the Service Module (SM) to the IU. The lower portion of the adapter (Sta. 1699-1780) remains in one piece, attached to the IU. The four panels of the upper portion of the adapter are strap-hinged to the lower portion of the adapter and have mild detonating fuse (MDF) explosive trains around the periphery of each panel. After the nose cone is jettisoned, detonation of the shaped charges separates the panels, which open out to an angle of 45 degrees from the vertical (as positioned on the launch pad). The SLA-7 subsystems include the nose cone jettison controller which commands nose cone/SLA separation, SLA panels deployment and LM-1 separation from the S-IVB/IU/SLA configuration, an antenna system for updata- and downdata-links, and electric power consisting of pyro and logic batteries.

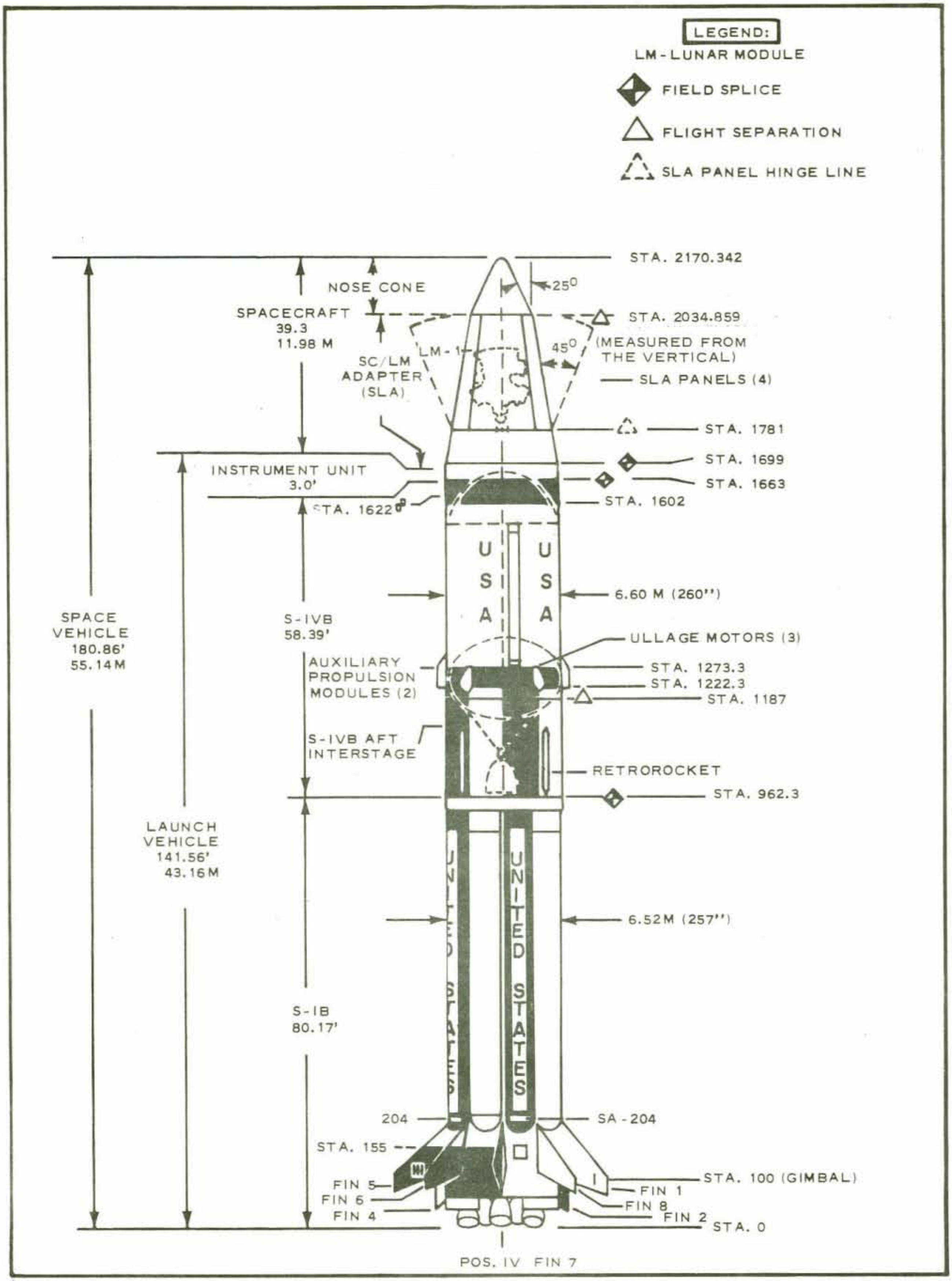

Figure 2-1. AS-204/LM-1 Configuration

2.4.2.2 Lunar Module, LM-1. The LM-1 is a two-stage vehicle (an ascent stage and a descent stage) with a four-legged landing gear. The landing gear will not be carried on LM-1. The ascent stage contains the cockpit, docking tunnel, most of the LM electronics and communications equipment, four Reaction Control System (RCS) motors, and the Ascent Propulsion System. The ascent stage measures approximately 10.2 feet high by 14 feet wide. The descent stage contains the Descent Propulsion System and descent control instrumentation. The descent stage with landing gear extended measures approximately 9.8 feet high with a radius of about 14.8 feet. (See figure 3-2.)

2.4.2.3 Nose Cone. This aerodynamic fairing for the space vehicle will be jettisoned after orbital insertion, when a shaped charge will cut restraining straps and springs will push it away from the SLA.

SECTION III
ONBOARD EQUIPMENT

3.1 UNIFIED S-BAND (USB) SYSTEM

On this flight the USB system will be used for telemetry and for ranging. Only one of the S-band in-flight antennas (No.1) will be used on LM-1. Its location is shown in the upper portion of Figure 3-1.

3.2 VHF TELEMETRY

3.2.1 DATA TRANSMISSION. During this flight, telemetry data will be transmitted on 18 VHF links. Thirteen links will be carried on the launch vehicle and five on the spacecraft. The LM telemetry, development flight instrumentation (DFI), will be carried on LM-1, -2, and -3 as part of the development test program to gather a maximum of data during the boost phase and other critical times. Two scimitar antennas, 180 degrees apart, on the lower part of the SLA panel, will transmit LM telemetry data and receive commands until LM separation, at which time switchover to the LM antennas will take place.

SLA-7: All flight measurements such as SLA panel temperatures and monitoring of the jettison controller's time-sequenced events will be telemetered by the IU.

Table 3-1 lists the space vehicle telemetry links. Figure 3-1 depicts locations of antennas on the LM, and Figure 3-2 shows the location of launch vehicle and SLA telemetry antennas.

3.2.2 ONBOARD RECORDERS. The Saturn launch vehicle will carry three tape recorders to record data generated during the staging intervals. One tape recorder, located in the S-IB stage, will record links GF-1 and GF-2 and will play back shortly after S-IB/S-IVB separation. Another tape recorder, in the S-IVB stage, will record data during S-IVB staging and retrorocket firing. Playback in the analog mode will be made through telemetry systems CF-1, CF-2, and CF-3. During earth orbit, this recorder will be used in the digital mode to collect reduced sampling-rate data from the PCM link, CP-1. Playback, initiated by the switch selector, provides a 144 kilobits/second (kbs) (NRZ-L) PCM output. The third tape recorder, located in the IU, will record links DF-1 and DF-2. The S-IVB tape recorder and the IU tape recorder will begin playback after S-IVB cutoff.

Table 3-1. Space Vehicle VHF Telemetry System

LINK NO.	FREQUENCY (MHz)	MODULATION	POWER (WATTS)	LOCATION
GF-1	240.2	PAM/FM/FM	20	S-IB
GF-2	244.3	PAM/FM/FM	20	S-IB
GS-1	252.4	SS/FM	20	S-IB
GP-1	256.2	PCM/FM	15	S-IB
CF-1	258.5	PAM/FM/FM	20	S-IVB
CF-2	246.3	PAM/FM/FM	20	S-IVB
CF-3	253.8	PAM/FM/FM	20	S-IVB
CS-1	226.2	SS/FM	20	S-IVB
CP-1	232.9	PCM/FM	20	S-IVB
DF-1	250.7	FM/FM	20	IU
DF-2	245.3	PAM/FM/FM	20	IU
DS-1	259.7	SS/FM	20	IU
DP-1	255.1	PCM/FM	15	IU
A*	230.9	CBW/FM/FM		LM
B	237.8	PCM/FM	10	LM
C*	241.5	PAM/FM/FM		LM
D	247.3	PAM/FM/FM		LM
E	257.3	PAM/FM/FM		LM

NOTES: A – CBW = Constant Bandwidth C – Proportional Bandwidth

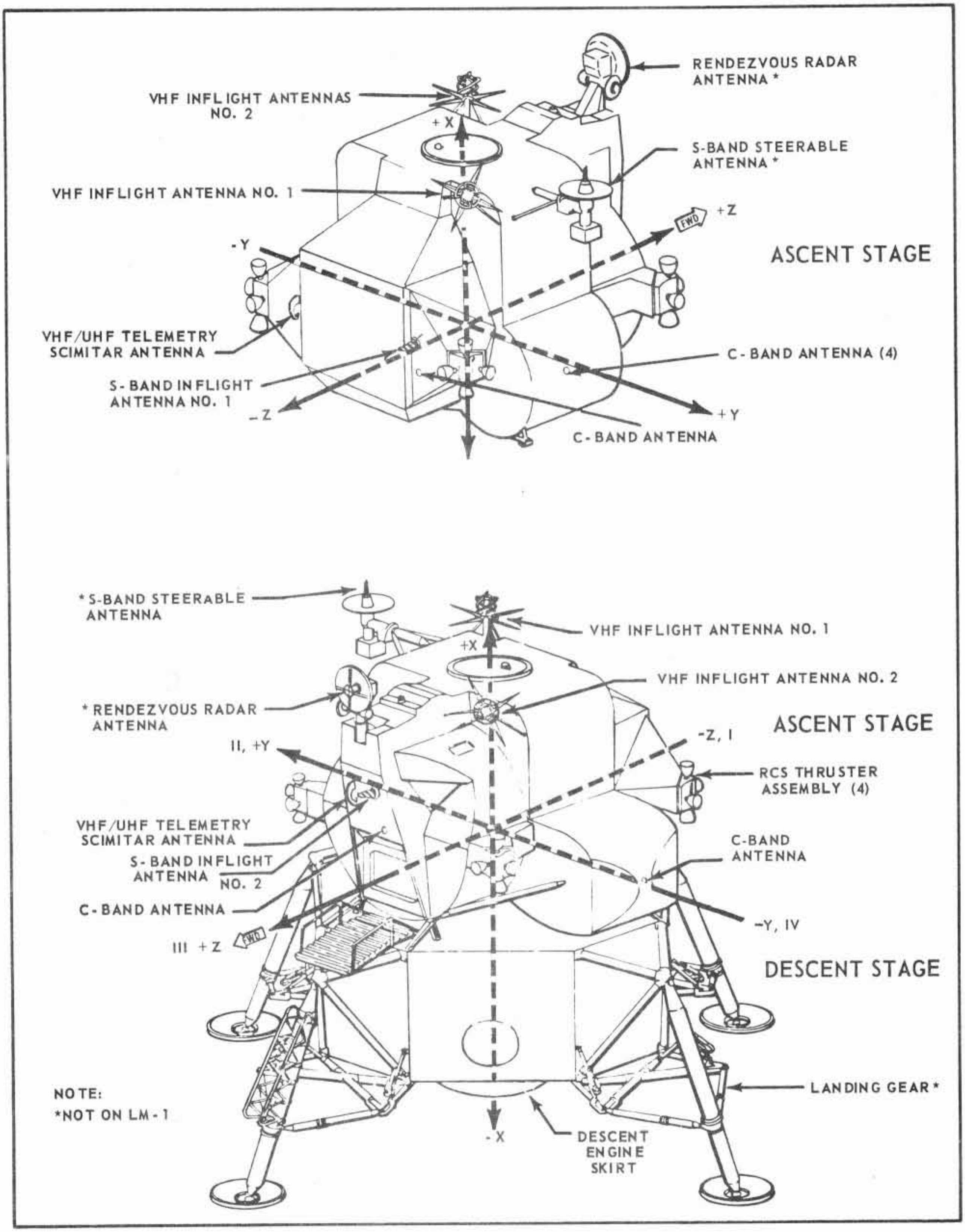

Figure 3-1. Lunar Module Configuration - With Coordinates and Antenna Locations

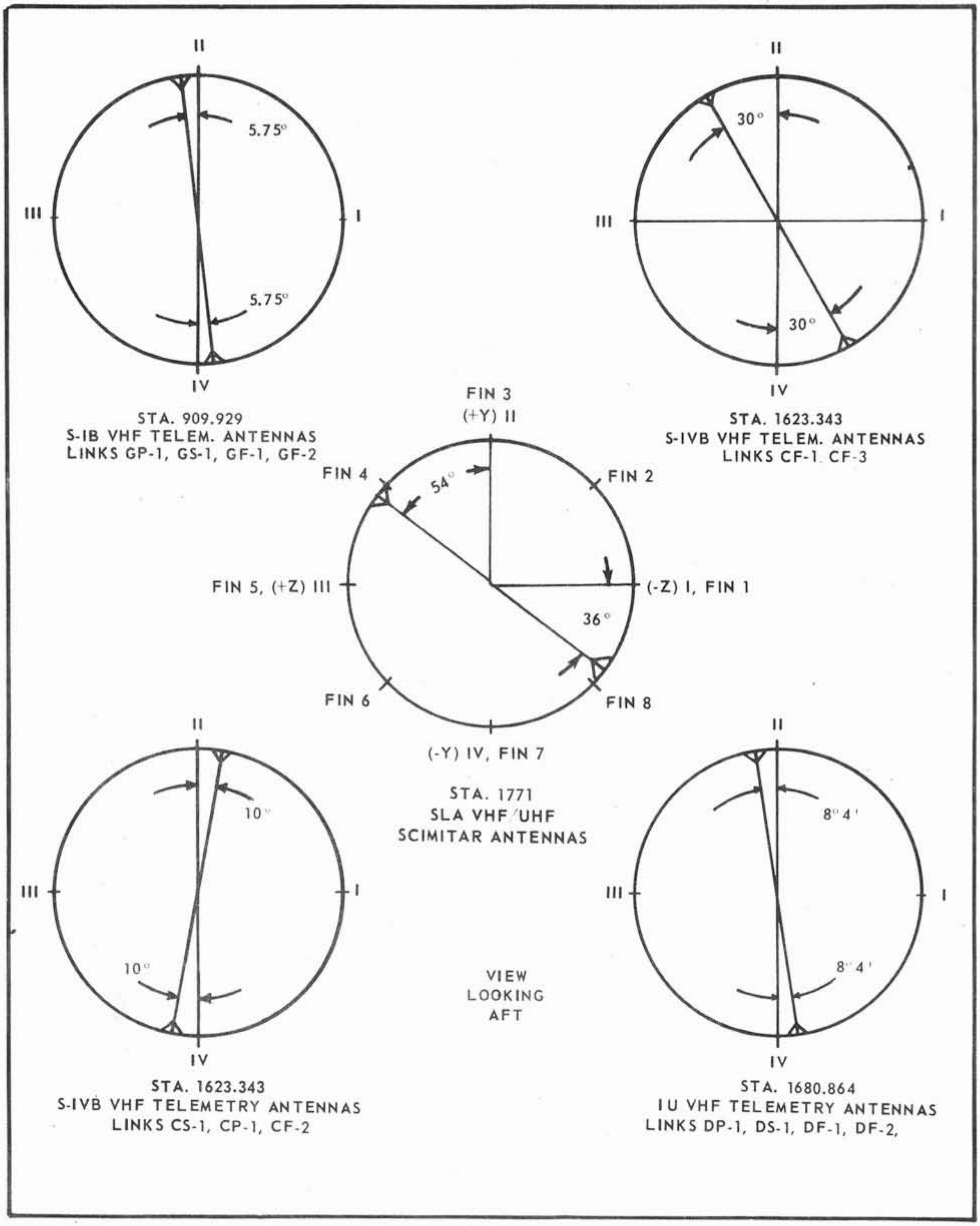

Figure 3-2. Locations of Onboard Telemetry Antennas

3.3 OPTICAL DATA ACQUISITION AIDS

3.3.1 PAINT PATTERN AND CAMERA TARGETS.

The overall Saturn paint pattern is shown in Figure 2-1. The first motion targets on the S-IB stage and the vertical motion targets on the S-IVB stage are shown in Figure 3-3.

3.4 ELECTRONIC DATA ACQUISITION EQUIPMENT

The electronic data acquisition equipment carried on board is presented in Table 3-2. Locations of the tracking antennas are shown in Figure 3-4.

3.4.1 C-BAND TRANSPONDERS.

The two C-band radar transponders located in the IU accept a double-pulse interrogation with 8 microseconds between pulses. The delay of the transponders will be 3 microseconds. They transmit a single-pulse reply. The transponders can be commanded from the ground or programmed into the onboard computer to provide optimum reception by the ground station. The C-band transponders in the LM Ascent Stage accept double-pulse interrogation, with 3.5 microseconds between pulses, and transmit a single-pulse reply. The transponder delay is 3 microseconds.

3.4.2 AZUSA (GLOTRAC) TRANSPONDER.

This CW transponder, located in the IU, receives the ground-transmitted signal on 5060.194 MHz, offsets it to 5000 MHz, and retransmits it to the tracking stations.

3.4.3 ODOP TRANSPONDER.

The ODOP transponder is the S-IB link of the ODOP tracking system. It receives the ground-transmitted 890-MHz signal and retransmits a 960-MHz signal to the ground tracking stations.

Table 3-2. Onboard Electronic Data Acquisition Equipment

System	Transponders	Frequencies (MHz)		Location
		Receiving	Transmitting	
Odop	1	890	960	S-IB
C-band radar	2	5690	5765	IU
C-band radar	2	5690	5765	LM Ascent Stage
Azusa (Glotrac)	1	5060.194	5000.00	IU
Unified S-band	1	2101.8	2282.5	LM

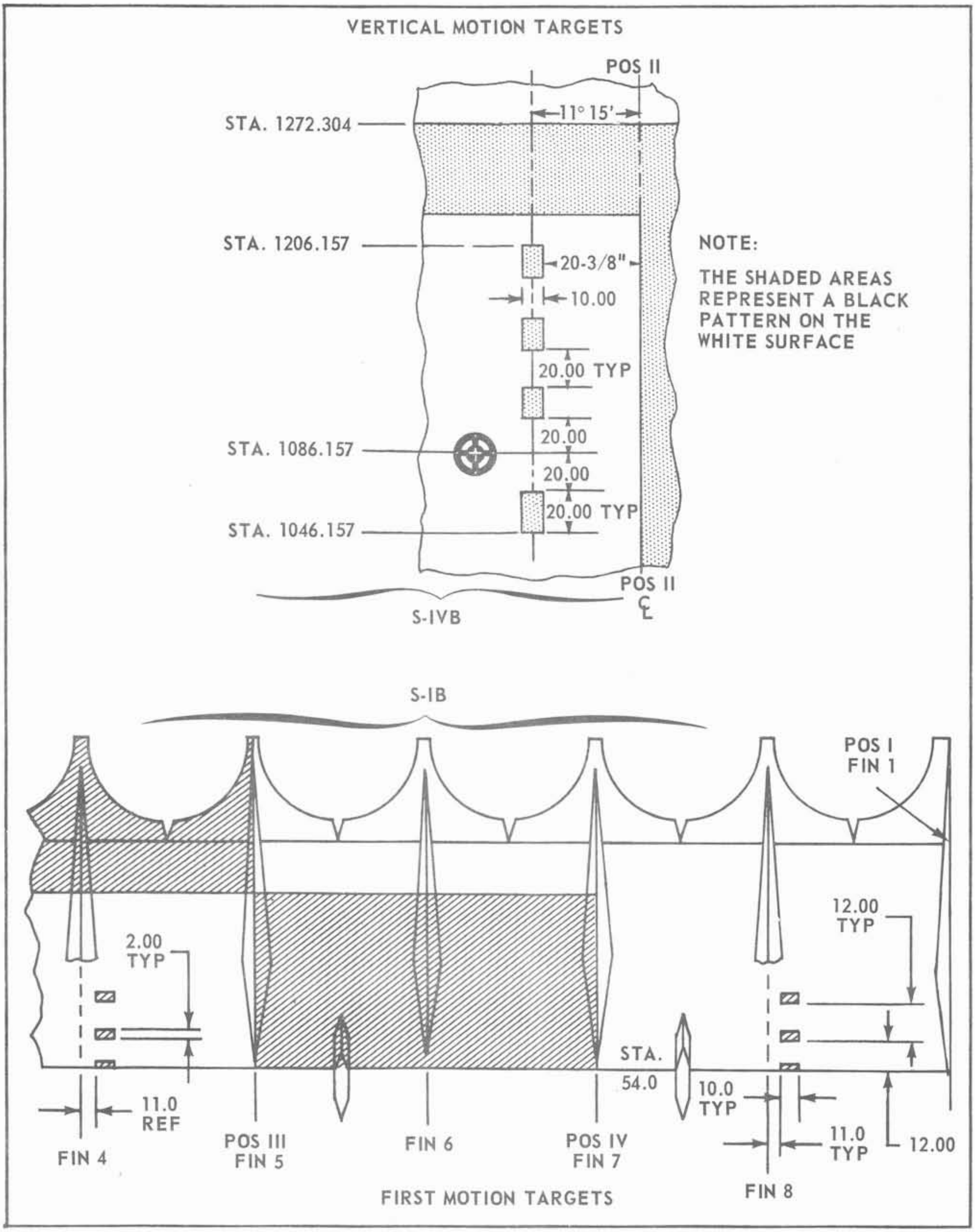

Figure 3-3. Saturn First Motion and Vertical Motion Targets

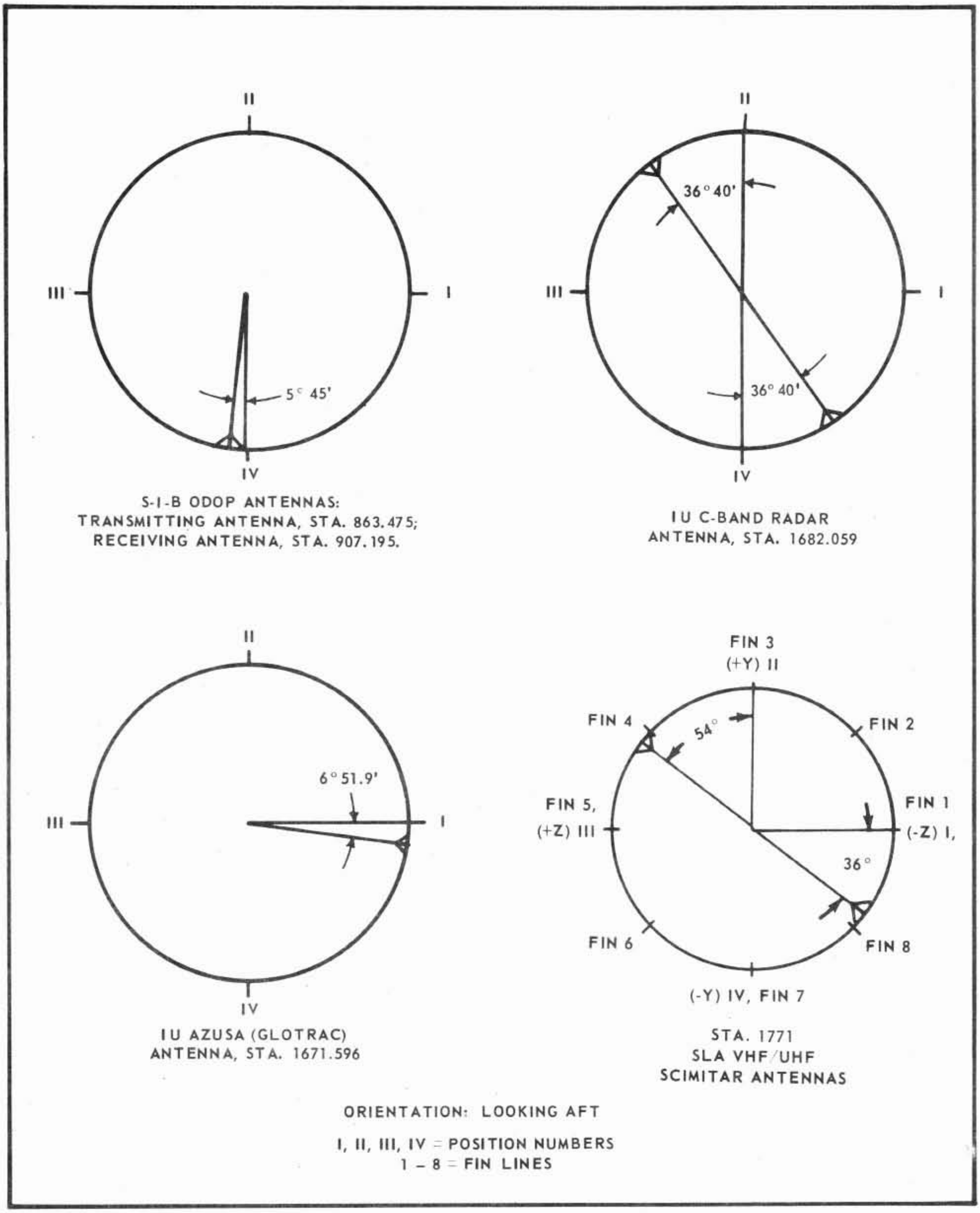

Figure 3-4. Locations of Electronic Tracking Antennas

SECTION IV
DATA ACQUISITION SYSTEMS

4.1 GENERAL

Telemetry, optical, and electronic data acquisition systems may be located in aircraft, on ships, and on land to monitor the performance and trajectory of AS 204/LM-1. The elevation angles from the major land-based tracking stations for the vehicle powered flight are shown in Figure 4-1.

4.2 UNIFIED S-BAND SYSTEMS

The USB system uses a single carrier frequency in each direction for the transmission of all tracking and communications data between the vehicle and the USB ground station.

In the ground station the update data are modulated onto subcarriers and then combined with the ranging data. This composite information is used to phase-modulate the transmitted carrier frequency. The received and transmitted carrier frequencies are coherently related. This permits measurements of the carrier Doppler frequency by the ground station for determination of the radial velocity of the spacecraft. In the transponder, the subcarriers are extracted from the RF carrier and detected to produce the command information. The binary ranging signals, modulated directly onto the carrier, are detected by the wide-band phase detector and translated to a video signal.

The telemetry data to be transmitted from the vehicle are modulated onto subcarriers, combined with the video ranging signals, and used to phase-modulate the down-link carrier frequency. The transponder transmitter can also be frequency-modulated for the transmission of television information or recorded data instead of ranging signals.

The USB ground station measures range, range rate, and two angles; it transmits updata (Guidance and Command) and receives telemetry data. The KSC and Bermuda USB stations will support AS-204/LM-1 during powered flight.

4.3 VHF TELEMETRY

The following VHF telemetry facilities will operate to provide data.

a. NASA-KSC:

Launch Control Center (LCC) 37 - Telemetry GSE
Central Instrumentation Facility (CIF)

Telemetry data from the Digital Data Acquisition Systems (DDAS) located at LCC 37 are transmitted to the CIF Data-Core via hardlines during prelaunch checkout and during launch countdown. After lift-off, data from the CIF ground station are transmitted to the Data-Core.

b. NASA-GSFC: Bermuda

c. ETR Stations:

Uprange - Station 19 (Tel 4)
Downrange - Station 3 (Grand Bahama Island)

Telemetry data from Tel 4 and Station 3 will be routed to the Data-Core at the CIF.

4.4 OPTICAL SYSTEMS

4.4.1 OPTICAL DOCUMENTARY COVERAGE. A documentary history of the mission will be recorded by cameras of assorted frame rates and focal lengths. Detailed information concerning optical documentary coverage may be obtained from IS-DOC-2, Photographic Branch (telephone 867-6002).

4.4.2 FIRST MOTION AND VERTICAL MOTION OPTICAL COVERAGE. This information is provided by 16mm Milliken and 35mm Mitchell cameras. The two Milliken (DBM-4) cameras are located on holddown arms, 180 degrees apart, looking at first-motion targets near the base of the launch vehicle. They will operate at a frame rate of 400 frames per second (fps). A 35mm Mitchell camera will be sited at the 110-foot level of the umbilical tower, centered on the motion targets (Figure 3-3) located on the Position II (Fin 3) centerline of the S-IB/S-IVB interstage. The cameras will provide pictures showing first motion and the first 3 to 5 meters of the vertical movement of the space vehicle.

4.4.3 OPTICAL ENGINEERING SEQUENTIAL COVERAGE. Engineering sequential camera coverage, to be described on the OD and KSC Photographic Test Plan, will be provided by 16mm, 35mm, and 70mm cinecameras exposing both color and black-and white film at various frame rates and focal lengths.

4.4.3.1 Camera Timing. A time-to-frame reference will be provided on each roll of engineering sequential film produced from the following types of cameras: Flight Research (70mm), Photo-Sonic (70mm), and Mitchell (70mm, 35mm, and 16mm). The following types of cameras have a constant timing reference distance which can not be varied, and, except for the Flight Research camera, do not provide a time-to-frame reference at the beginning of each roll of film.

a.	Flight Research (70mm)	Timing mark appears exactly 8 inches before the center of the frame to which it applies.
b.	Full Frame Fastax (35mm)	Timing mark appears exactly 2 inches after the center of the frame to which it applies.
c.	Fastax (16mm)	Timing mark appears exactly 1-1/2 inches before the center of the frame to which it applies.
d.	Photo-Sonic (16mm)	Timing mark appears exactly 1-1/8 inches after the center of the frame to which it applies.

The Milliken (16mm) camera does not have a constant timing reference or a method for exposing the reference; the timing mark appears on the film 3-15/16 inches after the center of the frame to which it applies. This distance should never vary more than a full frame. Detailed information concerning optical engineering sequential coverage may be obtained from RH-2.

4.4.4 TRACKING TELESCOPES. Long-focal-length tracking telescopes are used at the ETR to provide high-resolution optical coverage of vehicles at long range.

4.4.4.1 IGOR Tracking Telescopes. The Intercept Ground Optical Recorder (IGOR) system is an 18-inch, aperture-corrected, Newtonian telescope with a focal length of 90 inches. Amplifiers give focal lengths of 180, 360, and 500 inches. The system provides high resolution over a flat focal plane of 2-1/4 x 2-1/4 inches. Either a 70mm Flight Research cinecamera or a 35mm Mitchell cinecamera may be used to record the image. Two mobile IGOR systems (MITTS) will support this launch, one at Patrick Air Force Base (PAFB) and one at Universal Camera Pad 9. A third IGOR, at PAFB, equipped with a real-time TV system, will provide video signals to the News Network Coordinator.

4.4.4.2 ROTI Tracking Telescopes. The Recording Optical Tracking Instrument (ROTI) uses a long-focal-length Newtonian optical system with a 24-inch aperture. The focal length is variable in 100-inch increments from 100 inches to 500 inches. The ROTI tracking telescopes at Cocoa Beach and Melbourne Beach will support this mission; they will use 70mm cinecameras to record the image.

4.4.5 METRIC CAMERAS. The launch vehicle will be monitored by metric cameras to record trajectory data for flight evaluation. These cameras will make exposures with reference to angular displacement and time. The position, velocity, and acceleration of the vehicle can be determined by triangulation.

4.4.5.1 Cinetheodolites. One Askania cinetheodolite (operating at five samples per second) and five Contraves will provide metric coverage during the early launch phase of this mission, from T +10 to T +60 seconds.

The Contraves cinetheodolite is a metric tracking instrument which uses a 35mm single-frame camera movement with automatic exposure control for recording data. One operator tracks the target in both azimuth and elevation, with a joystick to control an angle-speed-acceleration type of power-driven tracking system. The output, digital angular data, is recorded on film. The sampling rate is 20 samples per second. Locations of the cinetheodolites will be as follows:

Location	Focal Length (cm)	Type	Site*
1.40	100	Askania	D-1
U435L285	300	Contraves	D-2
U334L163	150	Contraves	D-3
U349L1	150	Contraves	D-4
U195L15	150	Contraves	D-5
U19R169	300	Contraves	D-6

* Refer to sites shown in Figures 4-12 and 4-14.

4.4.5.2 Close-In Fixed Photo-Recorders. Four unmanned ribbon-frame fixed photorecorders with 150mm lenses will be located on the perimeter road of the launch complex. The cameras will be locked in position to provide a fixed field of view and will be started remotely. They will be operated at 30 frames per second. The cameras will provide position, velocity, and acceleration data for the first 12 seconds of flight. They may also be used to derive attitude date. The cameras will be located at camera sites 37AB-1, -2, -3, and -5.

4.5 ELECTRONIC METRIC TRACKING SYSTEMS

4.5.1 ODOP. ODOP is a continuous-wave RF system, of the Dovap-Udop family, used to determine position, velocity, and acceleration. The system consists of a ground transmitter, vehicle transponder, and multiple ground receivers. The receivers compare ground transmitter reference frequency with the frequency received from the vehicle transponder to determine the doppler shift due to vehicle motion. Integration of the frequency shift measured at a given site will provide loop distance from the transmitter, to the transponder, to the receiver. Three loop distances measured simultaneously from different sites establish vehicle position. KSC will operate two ODOP systems to monitor the trajectory of the S-IB stage. A close-in system for early launch coverage, consisting of seven receivers, is located at the launch complex. The standard system with nine receiver sites and one transmitter site will be located on the Cape, Merritt Island, and the mainland. The system will monitor the trajectory as geometry permits. The vehicle transponder will be interrogated on 890 MHz and will transmit on 960 MHz.

4.5.1.1 Close-In ODOP System. The locations of the close-in system receiver sites on LC-37 are shown in Figure 4-13.

Receivers
1.15.3
1.15.4
1.15.5
1.15.6
1.15.7
1.15.8
1.15.10

4.5.1.2 Standard ODOP System. The standard ODOP transmitter 1.3.7 (or 1.3.5 backup) will be used during the entire S-IB flight. ODOP receivers will be located as follows:

ODOP Site No.	Location
1.4	Site C
1.19	CIF (receive and record)
1.10	Merritt Island Airport
1.20	KSC near VAB
1.40	Molly Site at Cape Kennedy
1.16	Corner of Lighthouse Road and Blockhouse 56 Road
1.17	15 miles west of Cocoa on State Road 520
1.21	CIF antenna field
1.15	LCC 37

Data will be sampled at the rate of 10 points per second. Estimates of position accuracies which the standard ODOP system is expected to produce are provided in Figure 4-2.

4.5.2 C-BAND RADARS. C-band radars will interrogate the onboard beacons on 5690 MHz and receive the beacon signal on 5765 MHz. The stations will share the beacons. If the radars are switched to skin track, each radar will operate on 5690 MHz. The following radars will track the launch vehicle during powered flight:

Station	Radar No.	Data pts/sec	Radar Type
CKAFS	1.16	10	FPS-16
PAFB	0.18	20	FPQ-6
KSC	19.18	20	TPQ-18
GBI	3.18	20	TPQ-18
GTK	7.18	20	TPQ-18
Bermuda 16		10	FPS-16
Bermuda 6		20	FPQ-6

Radar 1.16 will be used to provide spherical balloon meteorological data prior to the launch and after T +320 seconds. Radars 0.18 and 19.18 will be available as backup for 1.16.

The estimates of position accuracies which the C-band radars are expected to produce are shown in Figures 4-3 through 4-9. They are based on the AFETR Accuracy Bulletin No. 21, dated 30 December 1966.

4.5.3 MOD IV RADARS. Two Mod IV, X-band radars, 1.1 and 1.2, will operate to provide plotting board displays for Range Safety and for the launch complex. Radar 1.2 will operate under a limited data commitment.

4.5.4 GLOTRAC STATION 1. Glotrac Station 1 (Azusa Mark II) on Cape Kennedy will interrogate the onboard Azusa transponder on 5060.194 MHz and receive the transponder signal on 5000.00 MHz. Data will be sampled at a rate of 20 points per second. Switchover time from Glotrac Station 1 transmitter will occur at approximately T +470 seconds with a possible loss of 10 seconds of data. Estimates of Glotrac Station 1 accuracies are provided in Figure 4-10.

4.5.5 GLOTRAC SEGMENT 1. Glotrac Segment 1 will use, in addition to Glotrac Station 1, three sites which measure range rate, and two sites capable of measuring range and range rate. The sites capable of measuring both range and range rate are equipped with a transmitter and a receiver. A site will not measure range unless its transmitter is interrogating the onboard Azusa/Glotrac transponder. The measured parameters at all sites are sampled at the rate of 10 points per second. The Glotrac Segment 1 sites are listed below:

Station	Equipment Type	Measured Parameters
Atlantic Field, N. C.	Modified Azusa Mark II receiver	Range rate
Bermuda	Modified Azusa Mark II receiver and transmitter	Range and range rate
Grand Turk	Modified Azusa Mark II receiver and transmitter	Range and range rate
Jupiter, Fla.	Modified Azusa Mark II receiver	Range rate
Little Carter Cay	Modified Azusa Mark II receiver	Range rate

Data acquired from the Glotrac Segment 1 sites will be used in a Glotrac Adjustment (GLAD) computer program, in combination with data acquired from pulsed radar systems, to provide vehicle position, velocity, and acceleration. No estimates of accuracy for the Glotrac Segment 1 system will be provided, since it is not treated as an independent metric data acquisition system.

4.6 SURFACE INSTRUMENTATION SUMMARY

Locations of the data acquisition systems planned to support this mission are shown in Figures 4-12 through 4-15. The estimates of expected coverage are provided in Figure 4-11.

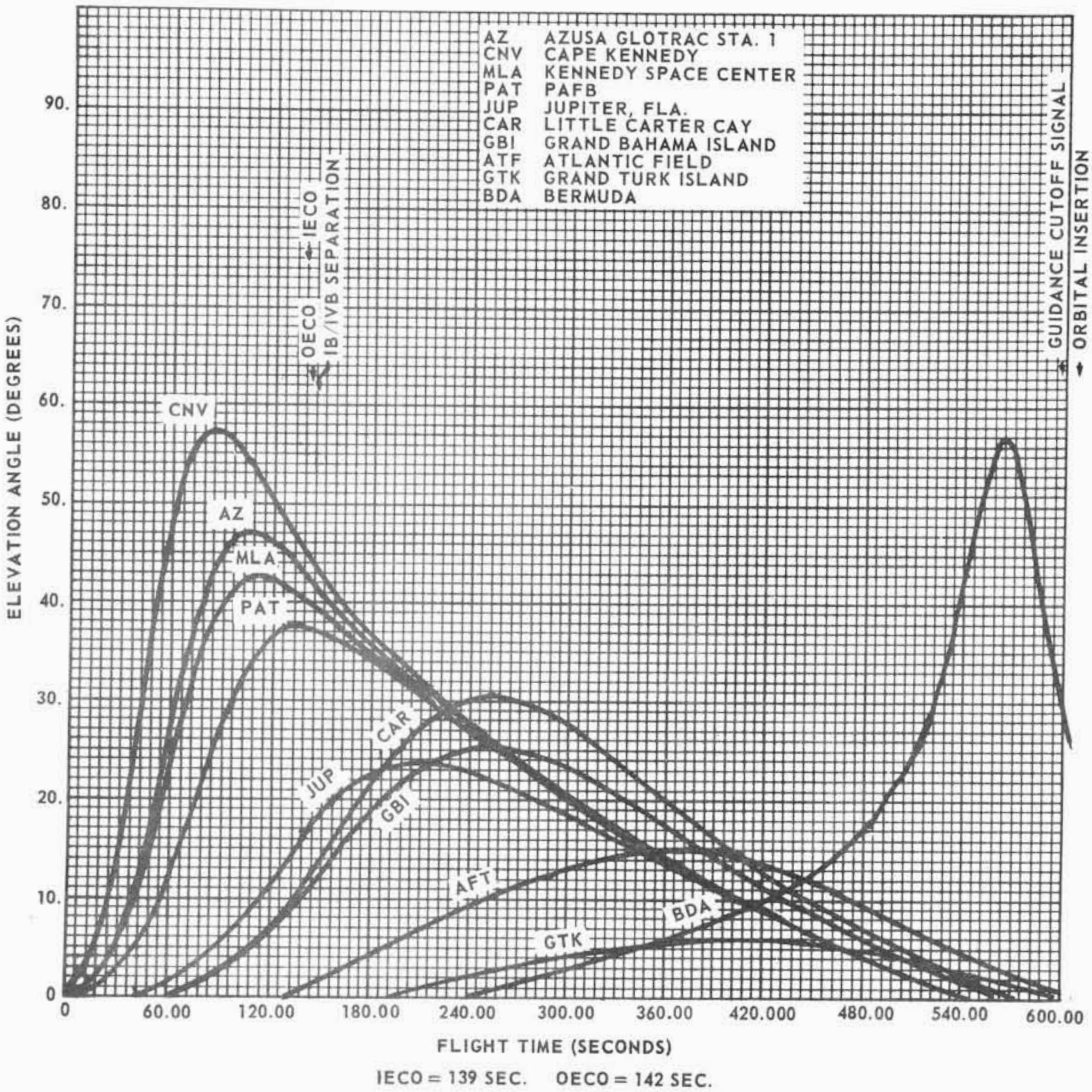

Figure 4-1. Elevation Angles From Major Land-Based Tracking Stations for Launch Vehicle SA-204/LM-1

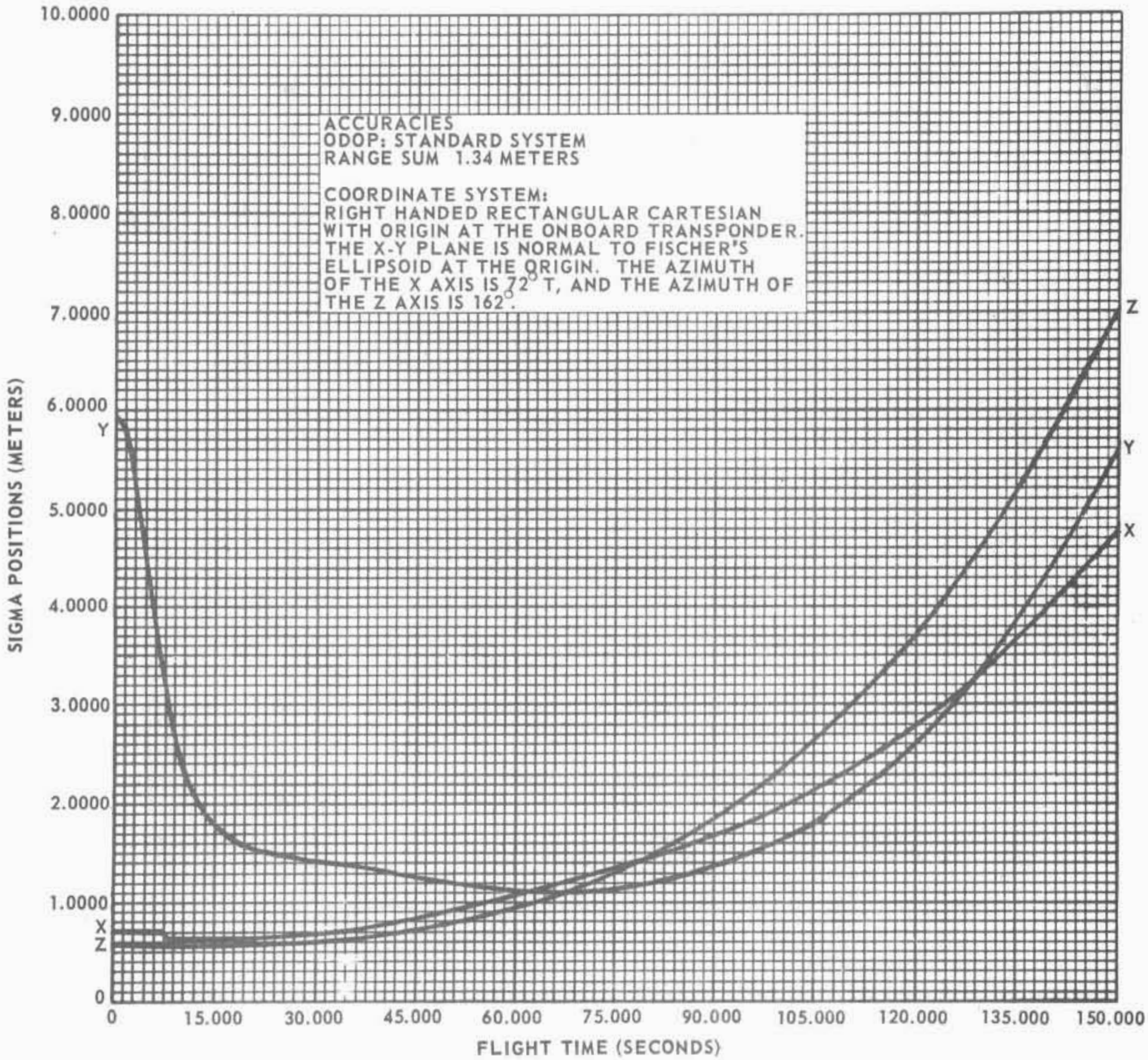

Figure 4-2. Estimates of ODOP Position Accuracies for AS-204
(Standard Transmitter and Receivers)

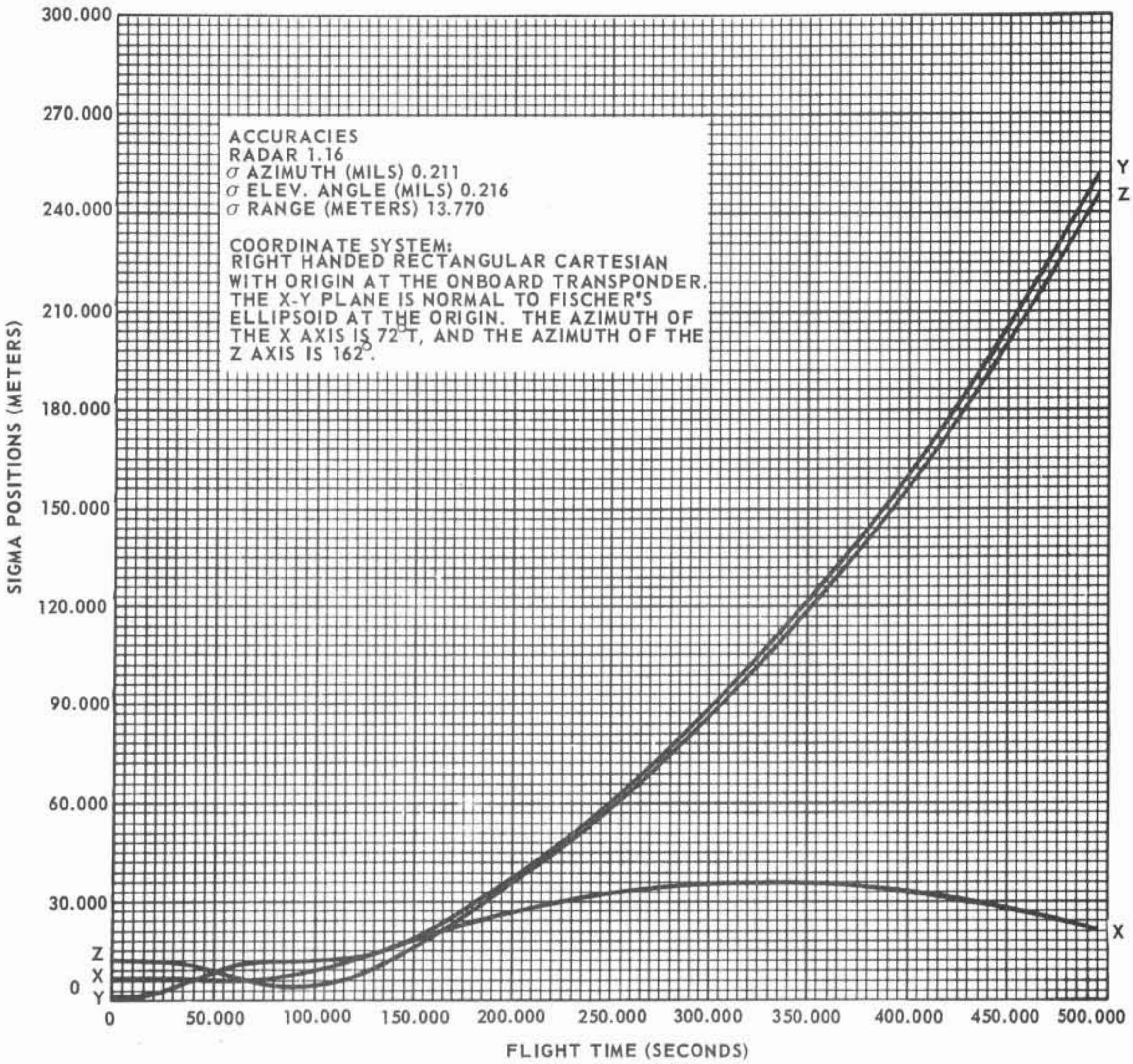

Figure 4-3. Estimates of Cape Kennedy C-Band Radar 1.16 Position Accuracies for AS-204

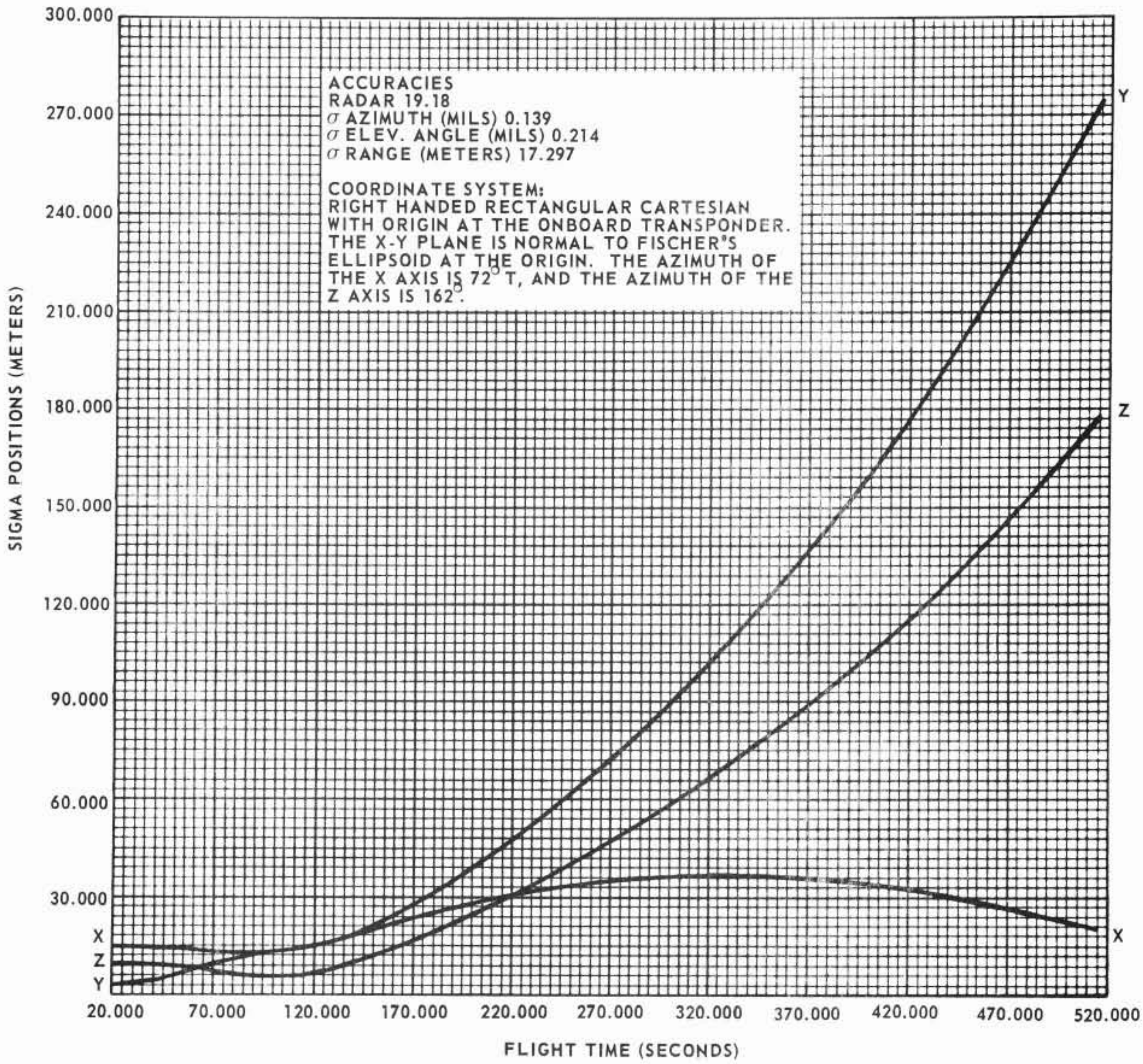

Figure 4-4. Estimates of KSC C-Band Radar 19.18 Position Accuracies for AS-204

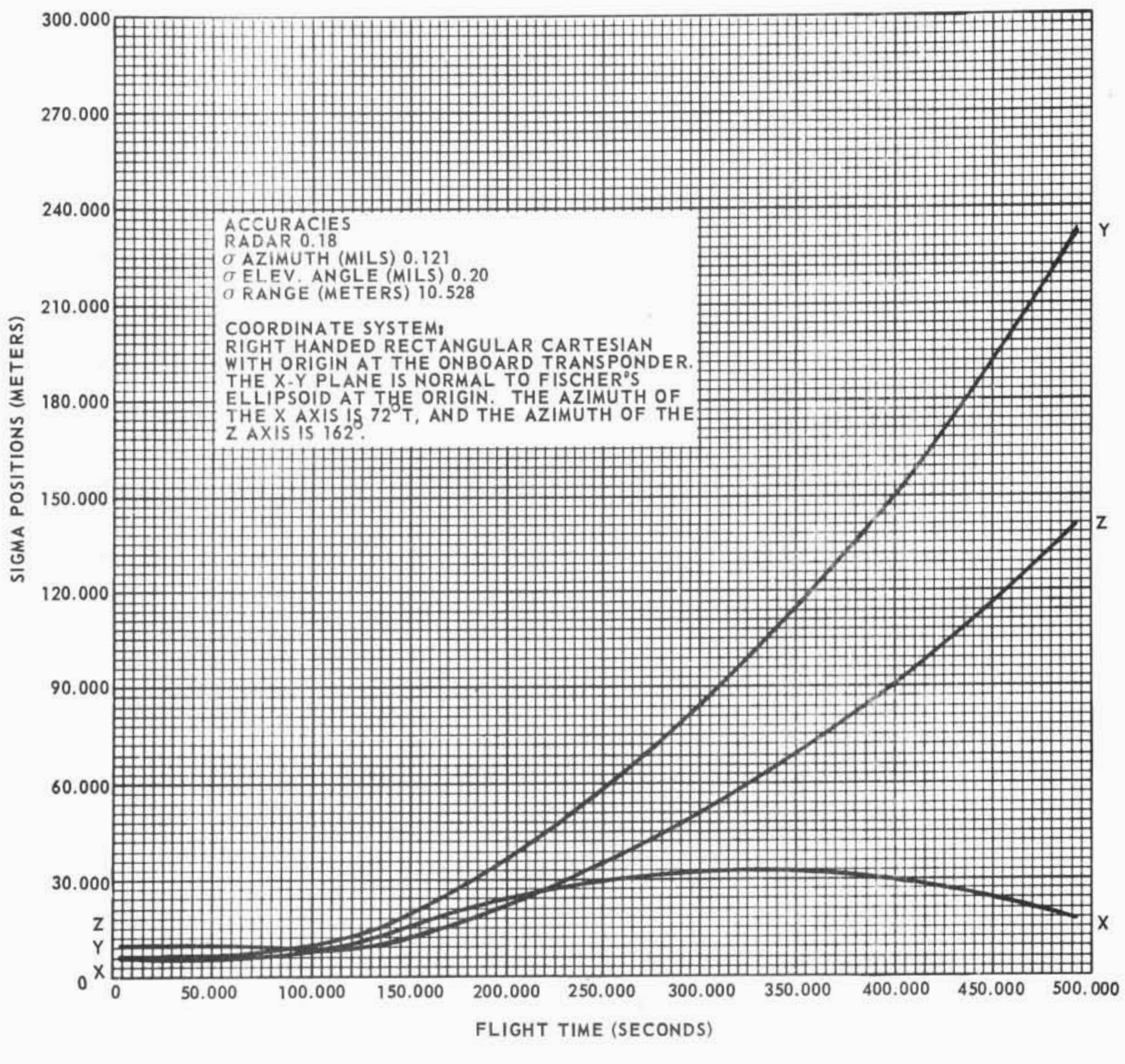

Figure 4-5. Estimates of PAFB C-Band Radar 0.18 Position Accuracies for AS-204

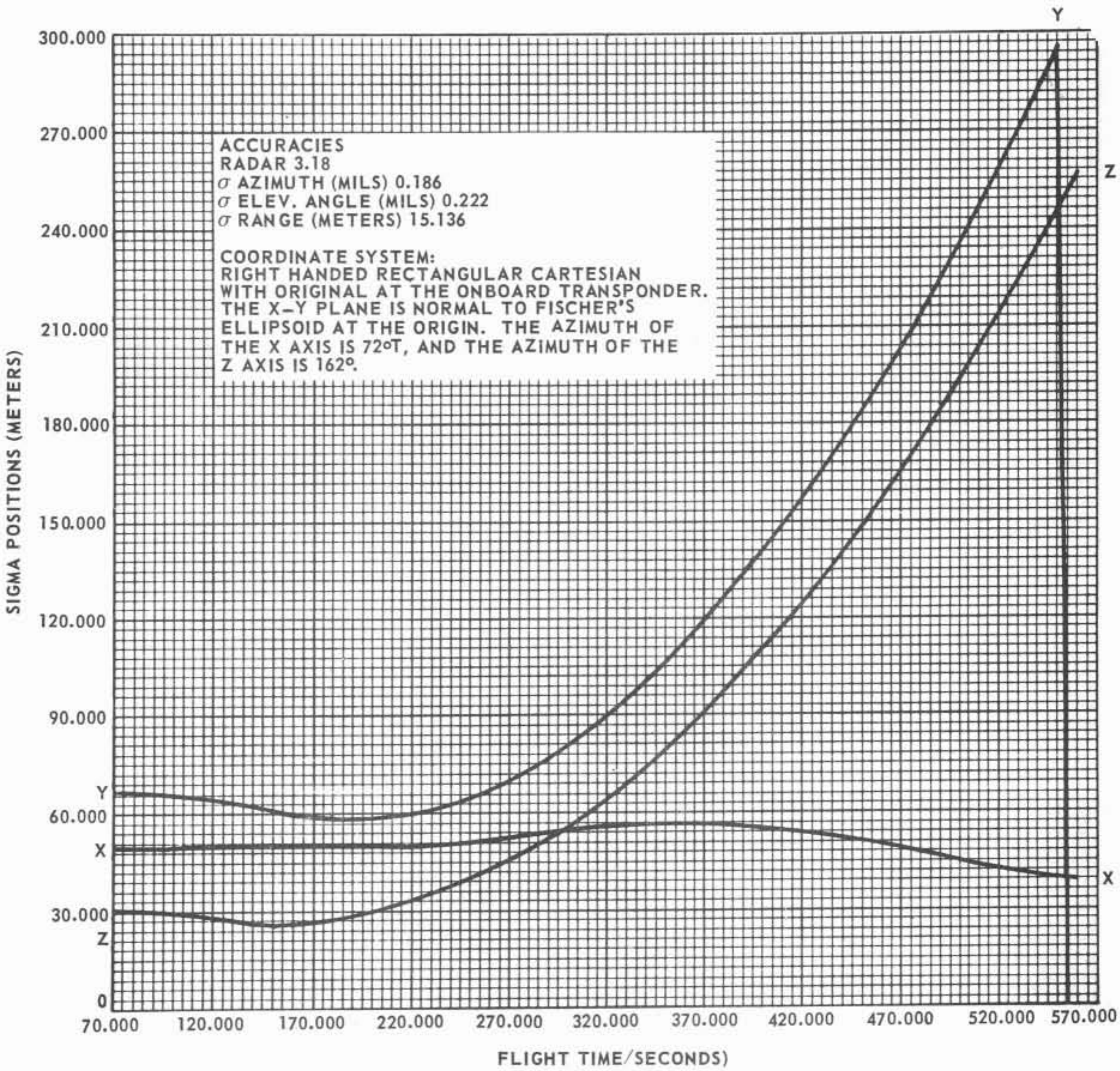

Figure 4-6. Estimates of GBI C-Band Radar 3.18 Position Accuracies for AS-204

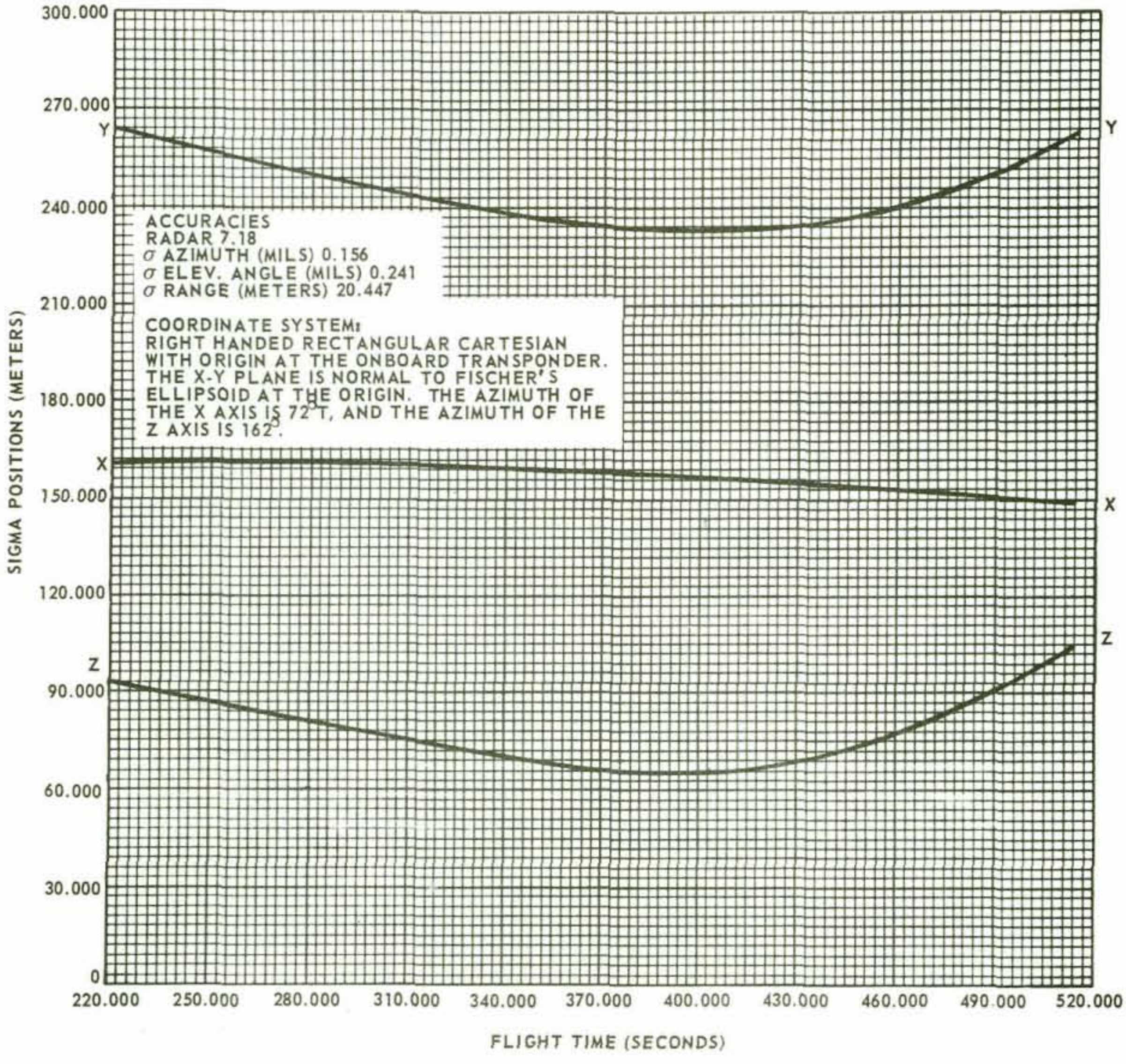

Figure 4-7. Estimates of Grand Turk C-Band Radar 7.18 Position Accuracies for AS-204

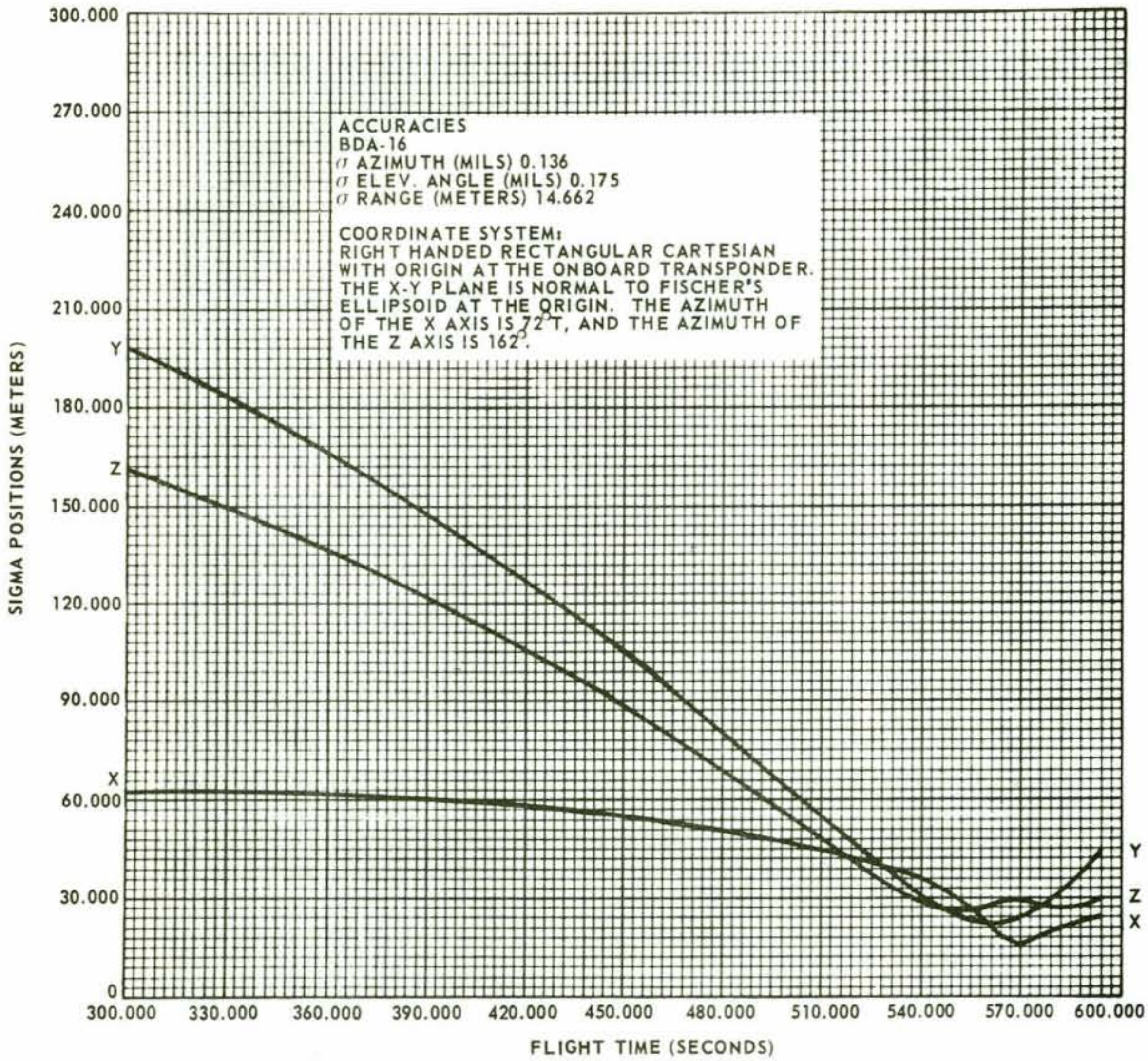

Figure 4-8. Estimates of Bermuda FPS-16 C-Band Radar Position Accuracies for AS-204

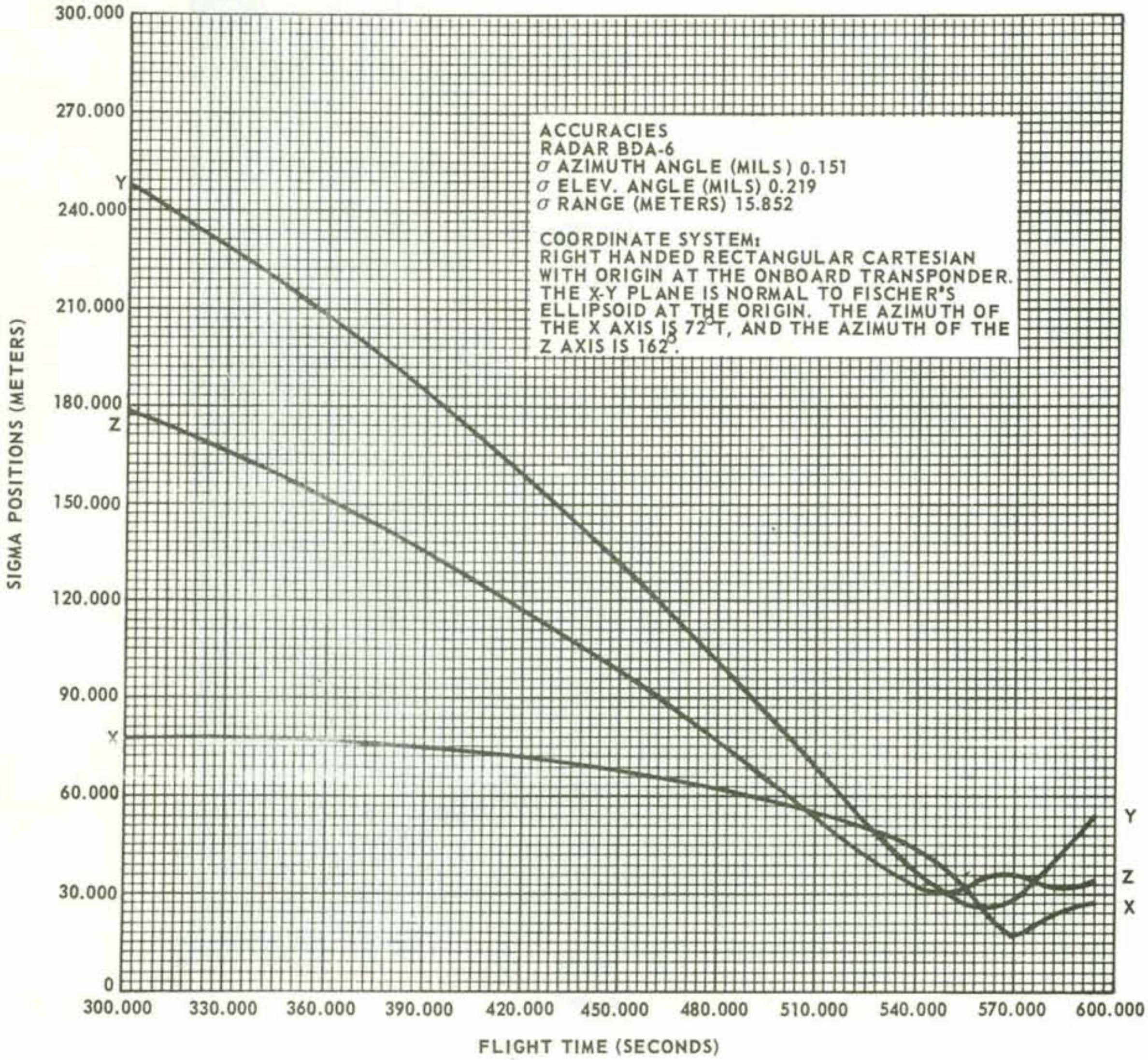

Figure 4-9. Estimates of Bermuda FPQ-6 C-Band Radar Position Accuracies for AS-204

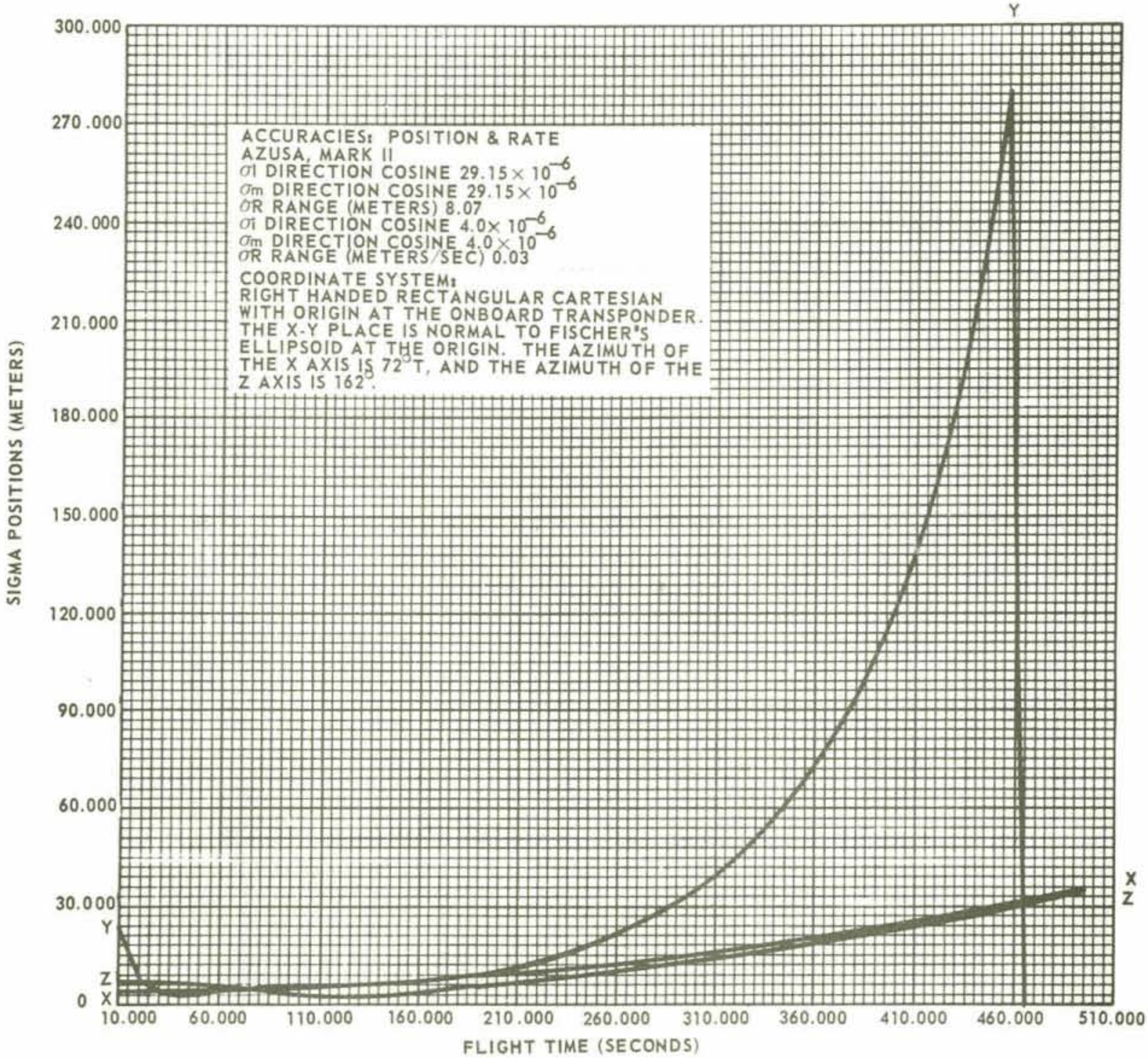

Figure 4-10. Estimates of GLOTRAC Station 1 Position Accuracies for AS-204

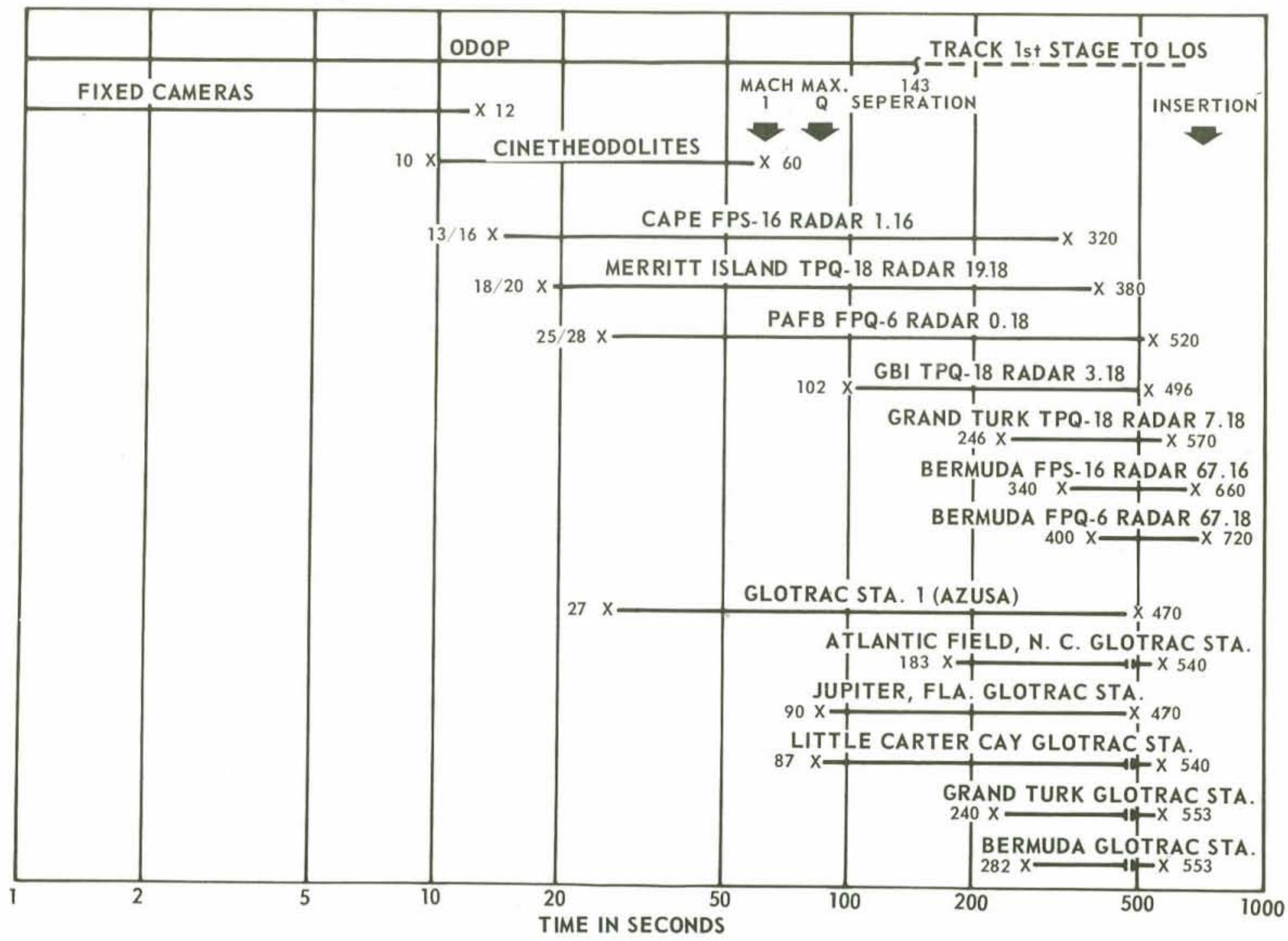

Figure 4-11. Metric Data Instrumentation Coverage

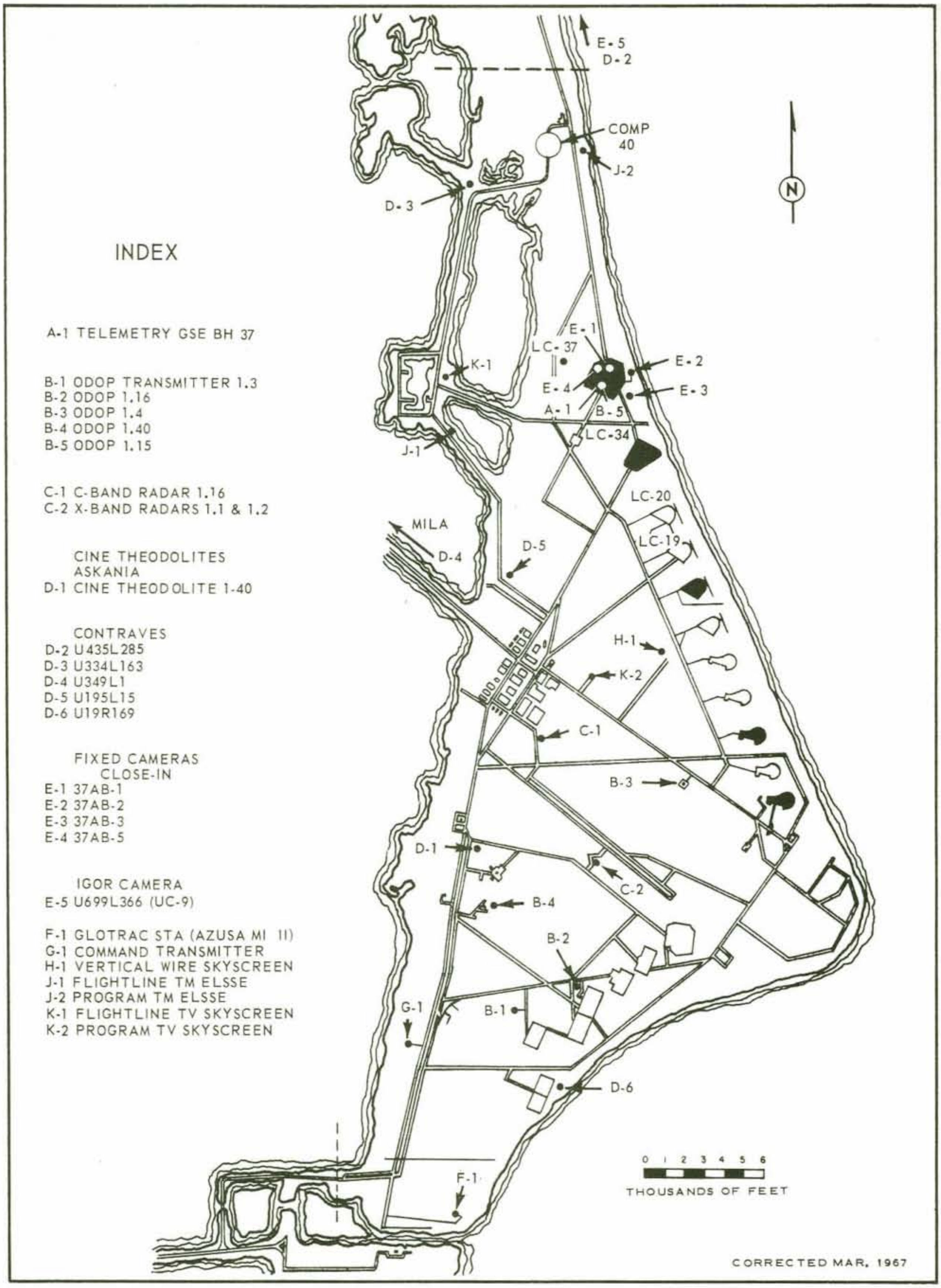

Figure 4-12. Cape Instrumentation

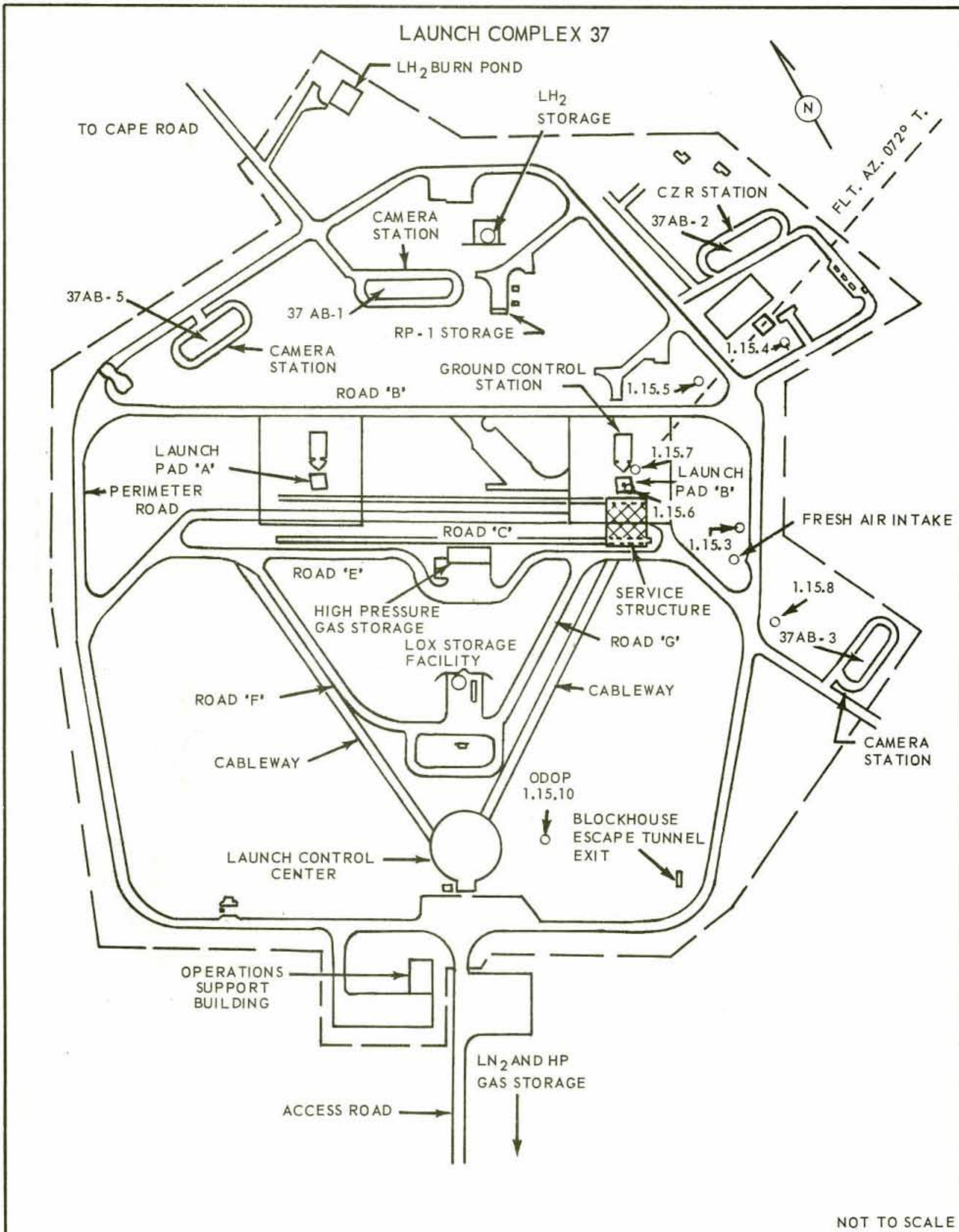

Figure 4-13. Close-In Instrumentation, LC-37

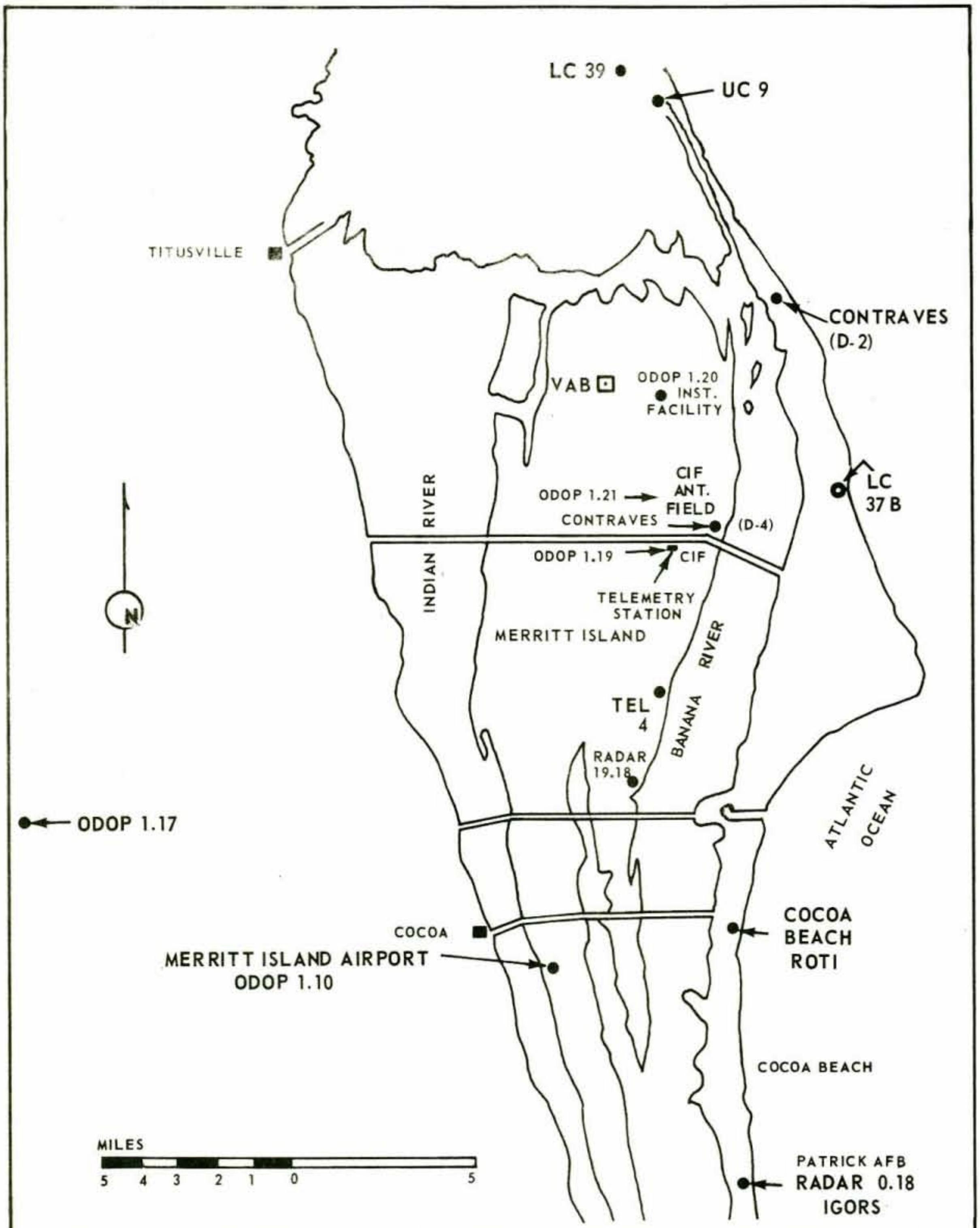

Figure 4-14. Uprange Instrumentation

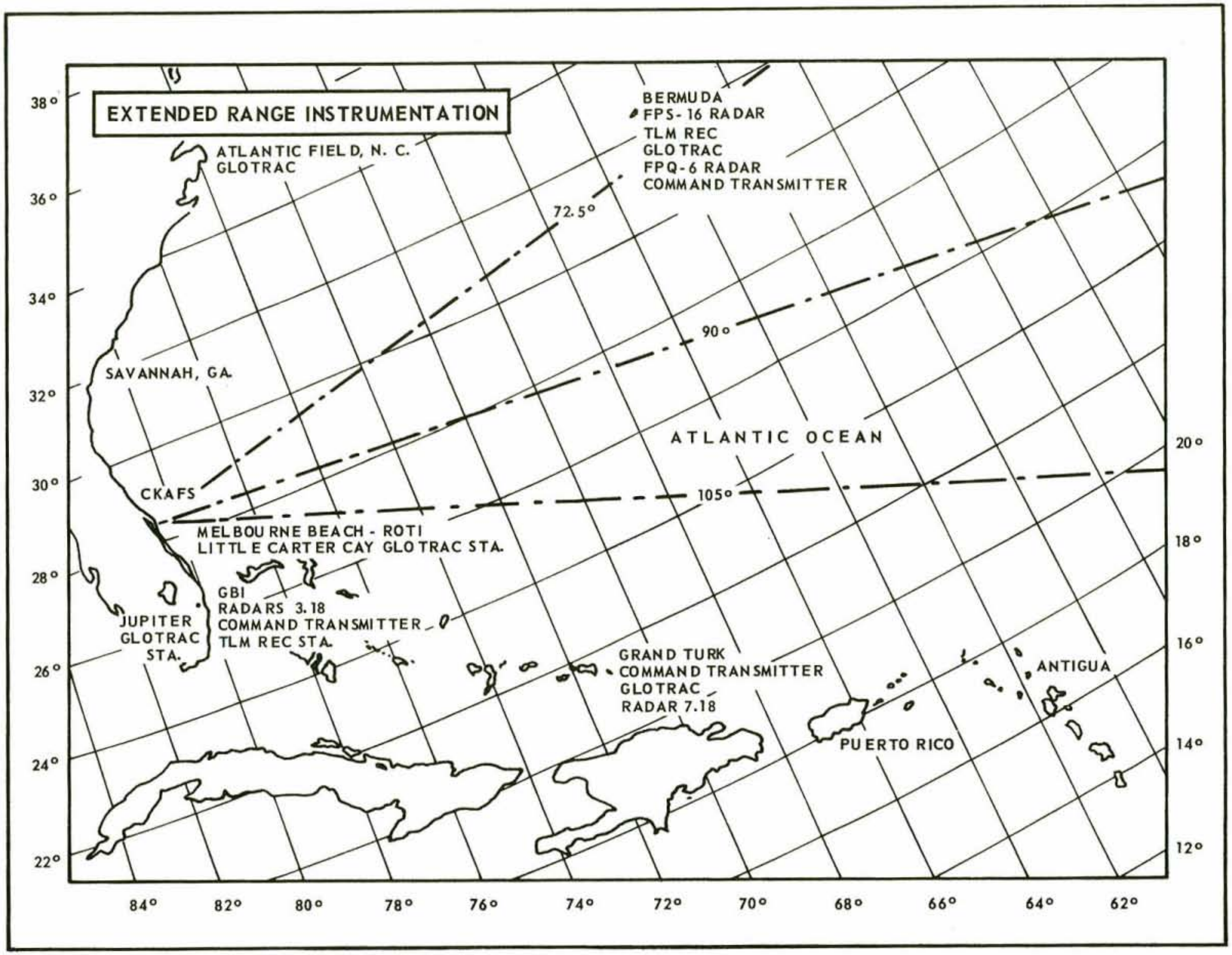

Figure 4-15. Extended Range Instrumentation

SECTION V
GEOPHYSICAL INFORMATION

5.1 METEOROLOGICAL FORECASTS

Meteorological forecasts which will be provided during the mission are described as follows:

Standard Launch Area Surveillance	The ETZ will provide weather warning services when surface winds in excess of 34 knots are forecast or electrical storm activity is forecast within 5 nautical miles of the launch complex. Twenty-four-hour surface and upper wind forecasts will be provided upon request. The ETZ will provide diffusion forecasts for the launch area as requested by the RSO.
F -5 days	Weather forecasts as required by NASA will be provided by SMG from F -5 days through spacecraft retrieval. These will include wind, sky condition, temperature, and surface precipitation for the ETR stations 1, 3, 12, and possibly abort and impact areas (for recovery purposes); valid from F -5 days through T -0. A forecast of maximum winds in the 10- to 14-km altitude region which are expected to exceed 30 meters per second (58.2k) will also be provided. The SMG will provide a forecast of sea surface conditions including significant wave height, wave period, sea temperature, surface wind speed and direction, visibility, precipitation, sky condition, and air temperature for the planned landing area valid for potential landing times through spacecraft retrieval. An Assistant ETZ will be available from F -5 days to T -0 to provide continuous advisory service, including forecasts of lightning and other atmospheric electrical activities.
F -3 days	The SMG will provide the same forecast provided on F -5 days, but valid from F -3 days through T -0.

F -2 days	The ETZ will provide SMG a forecast of the launch area winds aloft valid for T -0 by 1600Z. This forecast will include as much of the following data as possible at 1600Z; predicted wind direction and speed for each 1-km level to 20 km and for each 10-km level to 90 km.
	The ETZ will provide the RSO a forecast of the CKAFS-KSC weather conditions valid for T -0 by 1600Z. This forecast will include the surface conditions and the winds aloft at 1,000-foot intervals to 80,000 feet. The winds aloft forecast will be rotated to the azimuth specified by the RSO.
	The SMG will provide the same type forecast provided on F -5 days plus specific identification of cloud levels and forecast winds for levels at 1-km intervals to 20-km altitude; and for each 10-km interval from 20-km to 90-km altitudes valid from F -2 days to T -0.
F -1 day	The ETZ will modify or confirm the F -2 day forecast provided to SMG by 1600Z. In addition, the forecast for SMG will include the temperature, pressure, and relative humidity for the same levels as the upper wind forecast.
	The ETZ will furnish data to the RTCS on up-to-date rotated winds to 80,000 feet at T -4.5 hours.
	The ETZ forecasts will be revised as necessary through T -1 hours.
	The SMG will provide the same forecast provided on F -2 days, plus temperature, relative humidity, and pressure of the upper air for the launch area.

T -24 hours and T -12 hours	The SMG will present weather briefings at the LCC to include state of the sea and upper winds at 1-km intervals to a 30-km altitude in the impact area.
T -6 hours	At T -6 hours and twice daily until spacecraft retrieval, SMG will provide a forecast of the surface sea conditions, including significant wave height, wave period, sea temperature, surface wind speed and direction, visibility, precipitation, sky condition, and air temperature for the planned landing area, valid for potential landing time through spacecraft retrieval.

5.1.1 RELIABILITY OF FORECASTS. Forecasts beyond 3 days normally require extrapolations of weather parameters beyond the present ability of meteorological science. During certain unusual weather situations, general conditions can be forecast with little confidence. A 3-day forecast can be made with some confidence if the parameters are limited to general conditions; 2-day forecasts can be made with a fair degree of confidence; 1-day forecasts can be made with reasonable reliability. No accurate method is available to forecast electrical potential clouds or lightning discharge hazard. The weather radar (AN/CPS-9) will be used to follow weather echoes; from their movement and intensity, a 3- or 4-hour forecast of the possibility of lightning discharge can be made with some certainty.

5.2 GEOPHYSICAL OBSERVATIONS

5.2.1 SURFACE METEOROLOGICAL OBSERVATIONS

5.2.1.1 AFETR Observations. Automatic remote meteorological sensors are used for surface measurements. The AFETR operates eleven weather tower stations on Cape Kennedy (three 12-foot, five 54-foot, and three 204-foot) and eleven at KSC (ten 54-foot and one 500-foot).

Measurements of temperature, temperature differential, wind direction and speed, and dewpoint temperature are transmitted to WINDS at Central Control where they are fed to a Packard-Bell 250 computer. The computer samples data from the sites at various intervals. Other parameters are derived from these basic measurements. Calculations are made of mean wind deviation and of predicted gas diffusion in ppm at X distances from the source point. Meteorological data are distributed and printed out by teletype at 30-minute intervals except during "prime" test support when they go out at 5-minute intervals.

Reports on ground-site observations are provided also. At T -24 hours, a microbarograph (pressure in millibars) and a hygrothermograph (temperature and relative humidity) will be installed at LCC-39, and a rain gauge will be installed at Station 19. The chart will be checked at T -24, T -6, and T +1 hours and corrections applied. Surface observations from Station 19 will be provided as follows:

Times	Interval
T -24 hr to T -4 hr	60 min
T -4 hr to T -1 hr	30 min
T -1 hr to T +15 min*	15 min

*The T -0 observations will note whether the space vehicle does or does not pass through clouds or precipitation.

Pressure, temperature, and relative humidity readings are available from T -24 hours to T +1 hour. Standard weather observations will be provided from Stations 3 and 7.

5.2.1.2 KSC Meteorological Observations. KSC operates a wind measuring and recording system and lightning instrumentation systems at Launch Complex 37. It also measures and transmits from LC-39 to the Meteorological Prediction Center (MPC) at the MSOB, temperature, humidity, and atmospheric pressure data.

5.2.1.2.1 Launch Complex Wind Measuring and Recording System. Wind Measuring and Recording Systems located at LC-37 consist of annemometers located on the umbilical tower, service structure, and two poles. Speed and direction data are displayed and recorded in the launch control center.

5.2.1.2.2 Lightning Instrumentation Systems. Lightning Instrumentation Systems at LC-37 consist of lightning warning and lightning detection systems. The lightning warning system consists of potential gradient- and corona current- measuring systems with displays and recording equipment in the launch control center. These systems provide information relevant to possible lightning hazards. The lightning detection system consists of stroke counters, peak-reading voltmeters, and magnetic links which record the effects of lightning strokes. Corona current and potential gradient data will be transmitted from LCC-37 to the MPC.

5.2.2 UPPER AIR METEOROLOGICAL OBSERVATIONS.

5.2.2.1 Balloon Tracking Wind Data. Thoughout the countdown, analyses are made of the wind environment, especially in the region of high dynamic pressures. Assessments are made on the basis of wind data provided from tracking balloons (Jimspheres) through altitudes of 60,000 feet. An uprange radar will track the balloons to be released by the Cape Weather Station. Processing and transmission of the data are described in paragraph 6.2.1. Balloons will be released periodically throughout the countdown.

The Wind Monitoring Team (MSC-MSFC) at Huntsville will transmit reports to KSC through the LIEF communicator. Approximately 2-1/2 to 3 hours is estimated as time required from balloon release to time that the Wind Monitoring Team's report is given to KSC. Balloon rise time is approximately 1 hour.

5.2.2.2 Other Upper Air Data. The AFETR will provide upper air data obtained by the RS system, sonde equipment launched by ARCAS rockets, and by WS equipment. The times of release, altitudes covered, and types of data to be provided are listed in table 5-1. On launch-day morning, an airborne observer in an ETR launch area reconaissance plane will make observations for transmission by UHF or VHF to the CKFF.

5.2.3 SOLAR RADIATION.

Reduced solar radiation data (total horizontal and normal incident) are required for heat transfer studies of LOX and LH_2 boiloff from F -2 days to T +1 hour. These data will be provided by AFETR.

5.2.4 IONOSPHERIC DATA.

Electron density data for Station 3 for the period from T -2 hours to T +2 hours will be provided in the form of soundings, scaling notes, and logs.

5.2.5 ACOUSTIC DATA.

The KSC Acoustic Data Acquisition system is designed to measure noise produced by large launch vehicles. Recording systems are located in the blockhouse at LC-37. Simultaneous measurements are made in the immediate area of the launch pad (near field) and at distances of several miles (far field). Sound pressure levels and frequencies are recorded on multichannel tape recorders, and the data are analyzed in the Wave Analysis Laboratory at the CIF Building. Portable acoustic measuring and recording equipment is used in areas outside the boundaries of KSC.

5.2.5.1 Near Field. Acoustic measurements will be made at eight near field stations located on the umbilical tower.

5.2.5.2 Far Field. Measurements will also be taken at approximately ten far field locations.

Table 5-1. Upper Air Data

LOCATION	TYPE EQUIP	ALTITUDE FT	PARAMETERS	RELEASE TIMES
CKAFS	RS	131,000	Wind Data, Temperature, Pressure, Relative Humidity	1200Z & 0000Z On F-3 days
CKAFS	A-S	160,000	Wind Data, Temperature	F-3 days
CKAFS	RS	131,000	Wind Data, Temperature, Pressure, Relative Humidity	1200Z & 0000Z On F-2 days
CKAFS	A-S	160,000	Wind Data, Temperature	F-2 days
CKAFS	RS	131,000	Wind Data, Temperature, Pressure, Relative Humidity	1200Z & 0000Z On F-1 day
CKAFS	A-S	160,000	Wind Data, Temperature	F-1 day
KSC		65,000	Wind Data	T-14 Hrs.
CKAFS	A-S	160,000	Wind Data, Temperature	T-14 Hrs.
KSC		65,000	Wind Data	T-10 Hrs.
KSC		100,000	Wind Data	T-7.5 Hrs.
KSC		65,000	Wind Data	T-5.5 Hrs.
KSC	RS	131,000	Wind Data, Temperature, Pressure, Relative Humidity	T-0
KSC	WS	6,000	Wind Data	T-0
CKAFS	A-S	160,000	Wind Data, Temperature	T + 1 Hr.
KSC	RS	131,000	Wind Data, Temperature, Pressure, Relative Humidity	T + 6 Hrs.

A-S = Arcas Rocket with Sonde payload
RS = Rawinsonde
WS = Windsonde

SECTION VI
RANGE SAFETY INSTRUMENTATION

6.1 COMMAND/DESTRUCT SYSTEMS

AS-204/LM-1 will carry a Digital Command System for Range Safety use.

6.1.1 DIGITAL COMMAND/DESTRUCT SYSTEM. The LV carries in each powered stage a dual digital command/destruct system (Secure Range Safety Command System) which uses Motorola MCR-503 receivers. The frequency used will be 450 MHz. The system is designed to provide a high degree of protection against inadvertent activation. Two identical code plugs, one in the ground encoder and one in the flight decoder, establish each address character. Command messages contain 11 characters, 9 for the address word and 2 for the function word. When proper address characters are transmitted, the receiver output activates circuitry that enables reception of the function word. The function word then activates the desired decoder output.

If it becomes necessary for the RSO to terminate a flight, two coded messages may be sent to the onboard system. The first message initiates engine shutdown and arms the exploding bridgewire (EBW) firing-unit charge circuits. The second message, the propellant dispersion (destruct) command (if required), may be transmitted no earlier than 3-1/2 seconds after the arming command. Each message will be transmitted continuously by the ground transmitter to ensure reception. After S-IVB engine cutoff, when flight termination is no longer required, the switch selector enables the secure range safety system "off" circuitry to receive a "safe" command from the RSO. Bermuda will be used to transmit this command. Stations 1, 3, 7, and Bermuda will provide command coverage through S-IVB cutoff. (See Figure 6-1 for antenna locations.)

6.1.2 COMMAND/CONTROL SYSTEMS. Command systems in the SLA, LM, and in the IU will respond to command transmitters. (See Figure 6-1 for antenna locations.)

6.2 OPTICAL SKYSCREENS

6.2.1 TV SKYSCREENS. TV Skyscreens will monitor the trajectory of this mission during the launch phase. A flight line camera will monitor deviation from the planned flight path during the launch phase. Program cameras will monitor the downrange programming of the vehicle. The camera coverage will be displayed on video monitors located on the RSO console and on 21-inch wall monitors. Figure 4-12 shows TV Skyscreen sites.

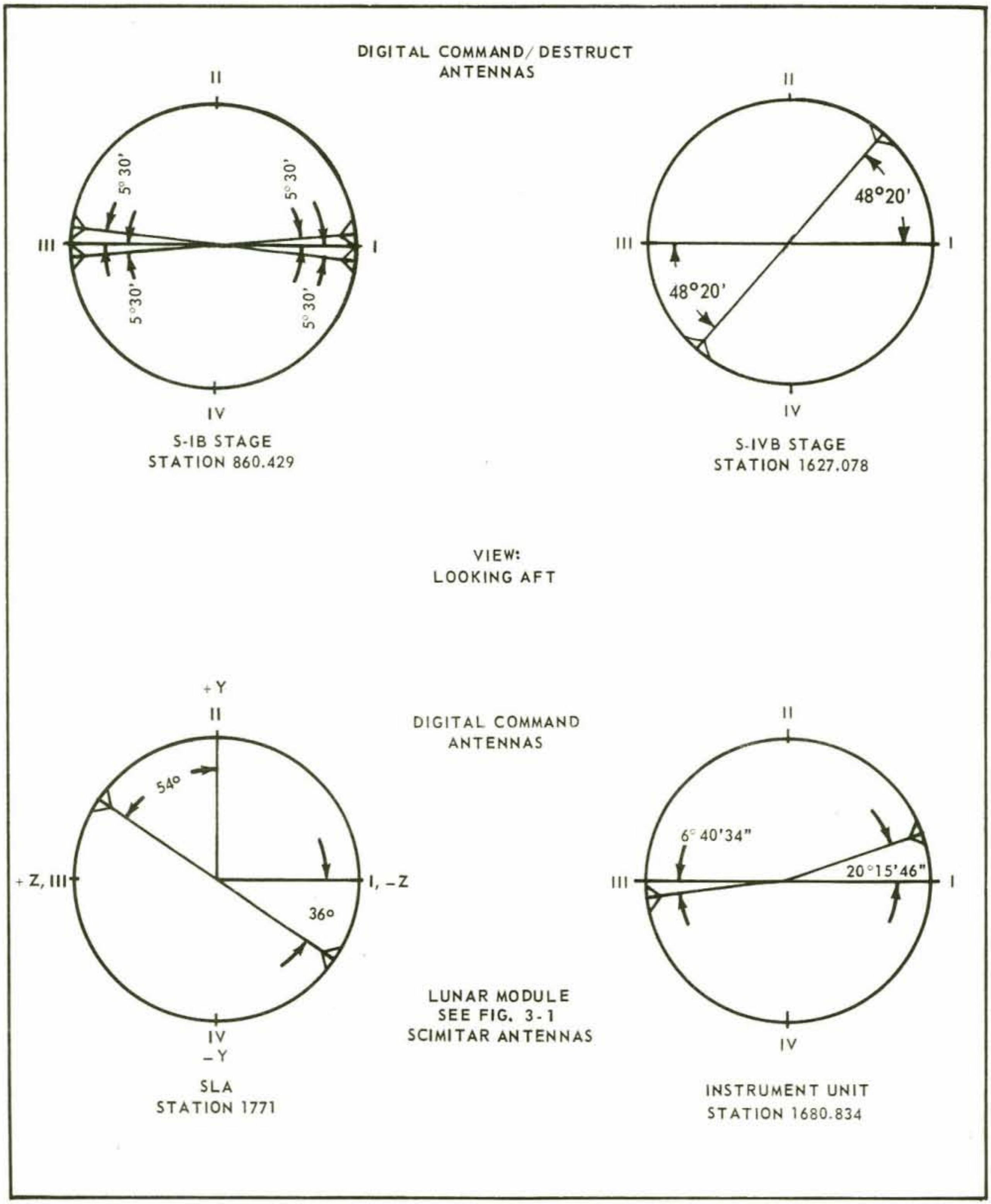

Figure 6-1. Locations of Digital Command Antennas

6.2.2 WIRE SKYSCREENS. Vertical wire skyscreen 1.9 will be used to monitor the vehicle from liftoff to detect possible program deviation of the vehicle from its nominal trajectory.

6.3 TELEMETRY ELSSE

Telemetry Electronic Skyscreen Equipment (ELSSE), flightline site 37-72F and telemetry ELSSE program site, 20-107P, will be used to track the 245.3 MHz telemetry link in the IU to monitor the trajectory of this vehicle. The perpendicular bisector of the flightline ELSSE will be oriented at 72 degrees True to monitor any deviation from the intended flightline. The perpendicular bisector of the program ELSSE will be through the launch pad to monitor any downrange deviation.

6.4 PRESENT POSITION PLOTTING BOARDS

Inputs to the blockhouse plotting board charts will be the most accurate available data from radars 1.16, 0.18, 19.18, or Mod IV.

6.5 IMPACT PREDICTOR (IP)

A CDC 3600 Computer calculates the vehicle instantaneous impact point for display on plotting board charts. The Real-Time Computer Facility (RTCF) will be provided high-density inputs from radars 1.16, 0.18, 19.18, 3.18, and Bermuda; Mod IV radars 1.1 and 1.2; and Glotrac Station 1. The radar inputs to be used in the CDC 3600 Computer Automatic Data Select Program to provide range safety requirements will be specified by teletype instruction (TTI) prior to the launch.

6.6 NEAR-IN IMPACT PREDICTION SUPPORT (NIPS)

The Odop System will provide the RTCF with five channels of digitized data for near-in impact prediction support for launch complex facilities protection. This will be on an engineering evaluation basis for this launch.

6.7 SEA SURVEILLANCE

One helicopter will provide launch area surveillance from T -60 minutes until T -5 minutes.

6.8 RANGE SAFETY INSTRUMENTATION SUMMARY

The estimates of instrumentation coverage which will be provided for Range Safety are summarized in Figure 6-2.

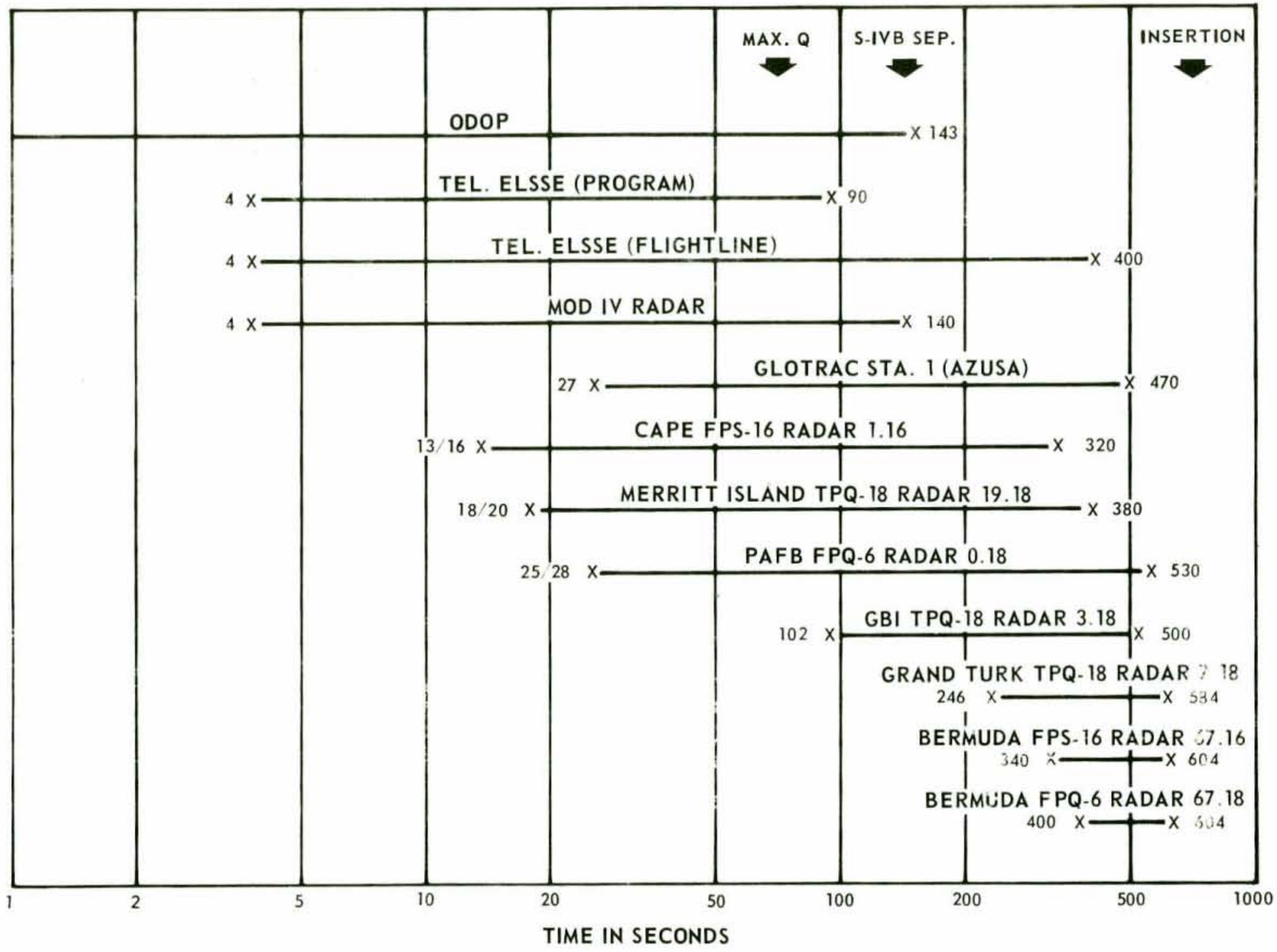

Figure 6-2. Range Safety Instrumentation Coverage

SECTION VII
VEHICLE DATA HANDLING

7.1 GENERAL

Data will be processed, transmitted via landline communication systems, and displayed to Support Launch Operations and Mission Evaluation.

7.2 PRELAUNCH DATA HANDLING

Data are required during the countdown to monitor the prelaunch operations and to evaluate launch wind constraints.

7.2.1 METEOROLOGICAL RADAR OPERATIONS. Meteorological radar data will be processed by KSC for transmission to MSFC and MSC. Spherical balloons, released at designated times, will be tracked by one of the uprange C-band radars to determine wind direction and velocity versus altitude. The data from the radar will be transmitted by hardlines to the KSC ground station. The raw data (aximuth, elevation, and slant range) will be transmitted to MSFC via the LIEF circuits in real time and will be recorded at the ground station. Immediately after termination of radar tracking, a digitized tape of the raw data will be routed to the KSC Central Computer Facility. The raw data will be reduced, and the reduced parameters (altitude, wind direction, and wind velocity) will be transmitted to MSFC and MSC by transceiver. Wind velocity and direction versus altitude will be provided at 25-meter intervals.

7.2.2 CIF OPERATIONAL SUPPORT CENTER. The CIF Operational Support Center, Room 307 in the CIF Building, is maintained and operated by Information Systems to provide launch vehicle systems engineers with real-time launch vehicle telemetry data. The room contains fifteen CRT data display units, eighteen 8-channel brush recorders, eight 20-pen event recorders, eight TV monitors, four Eidophor projectors, two ODOP strip chart recorders, one Vugraph projector, and one slide projector.

Each of the CRT data display units is equipped with a callup panel which allows the operator to select data in either graphic or alphameric form or to view the data being generated from any of the other callup panels. Any one measurement contained in the Data-Core may be displayed in graphic form at a variable rate with a maximum rate of 12 points per second. Any combination of 16 measurements contained in the Data-Core may be displayed in alphameric form at a variable rate with a maximum rate of 1 point per second. The operator may also choose to display any of several fixed formats, each of which contains 16 measurements (one page). The operator may, if he chooses, monitor the display being generated from any of the other panels; he can not, however, from the unit he is monitoring, alter the format being generated.

The data displayed on the CRT are converted to engineering units by the KSC Central Computer Facility which supplies the requested parameters to the real-time display system.

Fifteen of the eight-channel brush recorders are equipped with a callup capability which allows the operator to display any measurement contained in the Data-Core on any one of the eight channels. The other three brush recorders display fixed measurements hardlined from the ground station through a patch panel contained in the room.

The Eidophor projectors may be used to project either CRT data or television displays.

7.3 LAUNCH DATA HANDLING

Data required during launch to monitor powered flight performance are provided.

7.3.1 ETR REAL-TIME COMPUTER SYSTEM. The RTCS will use real-time tracking data to provide present position and velocity, impact prediction, and acquisition data. Inputs to the RTCS will be from radars 1.16, 0.18, 19.18, 3.18, 7.18, GLOTRAC Station 1, Cape MOD IV, Bermuda FPQ-6, Bermuda FPS-16, KSC ODOP, and CIF telemetry. Selected data sources will be used in the CDC 3600 computer ADASP to generate Range Safety data and satisfy real-time data requirements. The RTCS, using the best ADASP source, will provide the following outputs:

a. Primary and alternate IP data to CADDAC for Range Safety. Instantaneous impact and present position data will be generated for display on both Range Safety and blockhouse plotting boards.

b. Acquisition data for various instrumentation sites.

c. Real-time position and velocity data inputs to two Apollo DCU for transmission to MSC and the CIF.

d. Real-time position and velocity data inputs to one Apollo DCU and the Model 70 Buffer for transmission to GSFC.

Radar teletype data circuits from 0.18, 19.18, 31.8, and 7.18 will be patched through to GSFC at the RTCS teletype. The data will be transmitted in near real time.

The RTCS will compute the IP of the S-IB stage.

7.3.2 LAUNCH TRAJECTORY DATA SYSTEM (LTDS). Trajectory data from the RTCS will be transmitted to MSC and to the CIF ground station in real time through two Apollo DCUs. Smoothed position and velocity data, from the system chosen by the computer as the best source of data, will be transmitted at a rate of 2 points per second. Raw radar data from the radar chosen by the computer as the best source of data will be transmitted at a rate of 10 points per second.

7.3.3 KSC CENTRAL COMPUTER FACILITY. The Central Computer Facility at the CIF will accept real-time position and velocity data from the RTCS routed through the CIF ground station. The data will be stored on magnetic tape for post-flight reduction and analysis.

Telemetry data from the CIF ground station will be routed to the computer, which converts the data to engineering units and supplies the real-time display system with requested measurements. Telemetry data will also be stored on magnetic tapes for postflight analysis and distribution.

7.3.4 LAUNCH INFORMATION EXCHANGE FACILITY (LIEF). The MSFC is supplied real-time telemetry data from either of two Data-Cores in the CIF by a wide-band circuit (40.8 kilobits per second). Parameter selection is controlled by the LIEF real-time data request circuit.

Real-time position and velocity data from the CIF ground station may be transmitted to MSFC if requested through the LIEF real-time data request circuit.

7.3.5 APOLLO LAUNCH DATA SYSTEM (ALDS). Telemetry data will be transmitted to MSC in real time through the ALDS. Telemetry data from the CIF ground station, Tel 4, and GBI will be routed through two of the Data-Cores. Selected telemetry parameters will be transmitted to MCC-H from the Data-Cores at a rate of 40.8 kilobits per second.

7.3.6 CIF OPERATIONAL SUPPORT CENTER. The CIF Operational Support Center described in paragraph 7.2.2 will support MCC-H mission operations during the launch phase.

7.4 POSTLAUNCH DATA DISPLAY ROOMS

All data generated during the launch phase of the mission will be displayed in the data display rooms as soon as they become available. This service is provided to make the data available to all interested parties in the shortest possible time. Post-test records will consist of analog strip chart records, 4020 plots, oscillograph recordings, etc. Spacecraft data will be displayed in Rooms 2701, 2702, and 2703 of the MSOB.

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