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JOHN F. KENNEDY
SPACE CENTER

SKYLAB
CONSOLIDATED INSTRUMENTATION PLAN
FOR
SL-1/SL-2
PRELIMINARY

KHB 8410.X

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FOR

SL-1/SL-2

PRELIMINARY

April 15, 1972

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LIST OF ABBREVIATIONS

ACE	Acceptance Checkout Equipment
ACQ	Acquisition
AFETR	Air Force Eastern Test Range
ALDS	Apollo Launch Data System
ALSEP	Apollo Lunar Surface Experiment Package
AM	Airlock Module
ARIA	Apollo Range Instrumentation Aircraft
AS	Apollo Saturn
ASAP	Auxiliary Storage and Playback Assembly
ATM	Apollo Telescope Mount
ATM APCS	ATM Altitude and Pointing Control System
BDA	Bermuda
BH	Blockhouse
BRL	Ballistic Research Laboratory
c	centi (10^{-2})
C-Band	3900 to 6200 MHz
CADDAC	Central Analog Data Distribution and Computer System
CBW	Constant Bandwidth
CCATS	Communications, Command and Telemetry System
CCS	Command and Communications System
CIF	Central Instrumentation Facility
CKAFS	Cape Kennedy Air Force Station
C	Center Line
CM	Command Module

LIST OF ABBREVIATIONS (Continued)

CRT	Cathode Ray Tube
CSM	Command Service Module
DARTS	Digital Automated Radar Tracking System
DCU	Digital Control Unit
DDAS	Digital Data Acquisition System
deg	Degree
EASEP	Early Apollo Scientific Experiments Package
EBW	Exploding Bridge Wire
EMA	Electromagnetic Analysis
EMC	Electromagnetic Control
ETR	Eastern Test Range
EVA	Extravehicular Activity
F.A.	Flight Azimuth
FAS	Fixed Airlock Shroud
FCA	Frequency Control and Analysis
FM	Frequency Modulation
GBI	Grand Bahama Island (AFETR Station)
GBM	Grand Bahama Island (NASA Station)
GCTA	Ground Commanded Television Assembly
G.E.T.	Ground Elapsed Time
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center (Greenbelt, Md.)
GTK	Grand Turk Island

LIST OF ABBREVIATIONS
(Continued)

H_2	Hydrogen
hr	Hour
HRT	High Resolution Tracker
Hz	Hertz (Cycle per second)
I.E.C.O	Inboard Engine Cut-off
IGM	Inertial Guidance Mode
IGOR	Intercept Ground Optical Recorder
IP	Impact Prediction
IR	Infrared
IU	Instrument Unit (Saturn Vehicle)
IVA	Internal Vehicular Activity
k	Kilo (10^3)
kbs	Kilobits Per Second
KSC	Kennedy Space Center
LBNP	Lower Body Negative Pressure
LC	Launch Complex
LCC	Launch Control Center
LCRU	Lunar Communications Relay Unit
LES	Launch Escape System
LH_2	Liquid Hydrogen
LIEF	Launch Information Exchange Facility
LM	Lunar Module
LOS	Loss of Signal
LOX	Liquid Oxygen

LIST OF ABBREVIATIONS (Continued)

LPLWS	Launch Pad Lightning Warning System
LRV	Lunar Roving Vehicle
LTDS	Launch Trajectory Data Subsystem
LUT	Launch Umbilical Tower (ML-Mobile Launcher)
LV	Launch Vehicle
LVDA	Launch Vehicle Data Adapter
LVDC	Launch Vehicle Digital Computer
m	Milli (10^{-3})
m	Meter
M	Mega (10^{6})
MCC-H	Mission Control Center-Houston
MDA	Multiple Docking Adapter
METS	Meteorological System
MIL	MILA USB
MILA	Merritt Island Launch Area
min.	Minute
MITTS	Mobile IGOR Tracking Telescope System
ML	Mobile Launcher (formerly LUT)
MPC	Meteorological Prediction Center
MRTS	Meteorological Real-Time System
MSC	Manned Spacecraft Center (Houston, Texas)
MSFC	Marshall Space Flight Center (Huntsville, Ala.)
MSFN	Manned Space Flight Network
MSOB	Manned Spacecraft Operations Building

LIST OF ABBREVIATIONS
(Continued)

MSS	Mobile Service Structure
NASA	National Aeronautics and Space Administration
NR	North American Rockwell
n.mi.	Nautical Mile
NO.	Number
OD	Operations Directive
O.E.C.O	Outboard Engine Cut-off
OTV	Operational Television System
OWS	Orbital Workshop
PAFB	Patrick Air Force Base
PAMS	Pad Abort Measuring System
PCM	Pulse Code Modulation
P&FS	Particles and Fields Subsatellite
PM	Phase Modulation
PRN	Pseudo Random Noise
PS	Payload Shroud
PSRD	Program Support Requirements Document
PTS	Points
Q	Dynamic Pressure
rf	Radio Frequency
ROTI	Recording Optical Tracking Instrument
RS	Rawinsonde
RT	Real Time
RSO	Range Safety Officer

LIST OF ABBREVIATIONS
(Continued)

RTCC	Real-Time Computer Complex (Houston)
RTCS	Real-Time Computer System (ETR)
SA	Saturn Apollo
S-Band	1550 to 5200 MHz
SC	Spacecraft
SD	Support Document
sec	Second
SIM	Scientific Instrument Module
SLA	Spacecraft LM Adapter
SLDS	Skylab Launch Data System
SMG	Spaceflight Meteorology Group (U.S. Weather Bureau)
SRS	Secure Range Safety
STA	Station
STDN	Spaceflight Tracking and Data Network (formerly MSFN)
SWS	Saturn Workshop = OWS + AM + MDA + ATM + FAS
TACS	Thruster Attitude Control
TBD	To Be Determined
TBS	To Be Supplied
TEL	Telemetry
TLM	Telemetry
TTY	Teletype Communications
TV	Television
TW	Thermal Wire

LIST OF ABBREVIATIONS
(Continued)

UHF	Ultra High Frequency (300 to 3000 MHz)
USB	Unified S-Band
USNS	United States Naval Ship
UV	Ultraviolet
VAB	Vertical Assembly Building
VIB	Vertical Integration Building
VHF	Very High Frequency (30 to 300 MHz)
vs	Versus
WE	AFETR Staff Meteorologist
WINDS	Weather Information Network and Display System
WS	Windsonde
X-Band	5200 to 10,900 MHz

SECTION I

INTRODUCTION

This report presents the consolidated instrumentation plan for employing optical and electronic data acquisition systems to monitor the performance and trajectory of Skylab 1 (SL-1) and Skylab 2 (SL-2) vehicles during the launch phase. Telemetry, optical, and electronic tracking equipment on board the vehicles, and data acquisition systems monitoring the flights are discussed. Flight safety instrumentation, vehicle data transmission systems, and instrumentation geography are also described.

This plan reflects the general instrumentation requirements set forth in NASA PSRD No. 20000 for Skylab and is not intended to conflict with or supersede that document.

The information presented in this document reflects planning concepts developed prior to April 15, 1972.

SECTION II
MISSION PROFILE

2.1 SL-1 VEHICLE CONFIGURATION

2.1.1 SATURN V LAUNCH VEHICLE (SA-513)

2.1.1.1 S-IC 513. The S-IC stage carries the following instrumentation: Two telemetry links and a dual command/destruct system.

2.1.1.2 S-II 513. The S-II stage carries the following instrumentation: Three telemetry links and a dual command/destruct system.

2.1.1.3 S-IVB Interstage. No instrumentation is carried.

2.1.2 SL-1 SATURN WORKSHOP (SWS)

2.1.2.1 Orbital Workshop (OWS). The OWS carries the following instrumentation: Experiment M509 transmitter.

2.1.2.2 IU 513. The IU carries the following instrumentation: Two VHF telemetry links, two C-band radar transponders, and the CCS transponder (S-band).

2.1.2.3 Airlock Module (AM). The AM carries the following instrumentation: Three telemetry links, a VHF ranging system, and a dual UHF uplink command system.

2.1.2.4 Multiple Docking Adapter (MDA). The MDA carries the following instrumentation: Only passive experiment instrumentation is carried.

2.1.2.5 Apollo Telescope Mount (ATM). The ATM carries the following instrumentation: Two telemetry systems and a redundant UHF uplink command system.

2.2 SL-2 VEHICLE CONFIGURATION

2.2.1 SATURN IB LAUNCH VEHICLE (SA-206)

2.2.1.1 S-IB 206. The S-IB stage carries the following instrumentation: Two telemetry links and a dual command/destruct system.

2.2.1.2 S-IVB 206. The S-IVB stage carries the following instrumentation: One telemetry link and a dual command/destruct system.

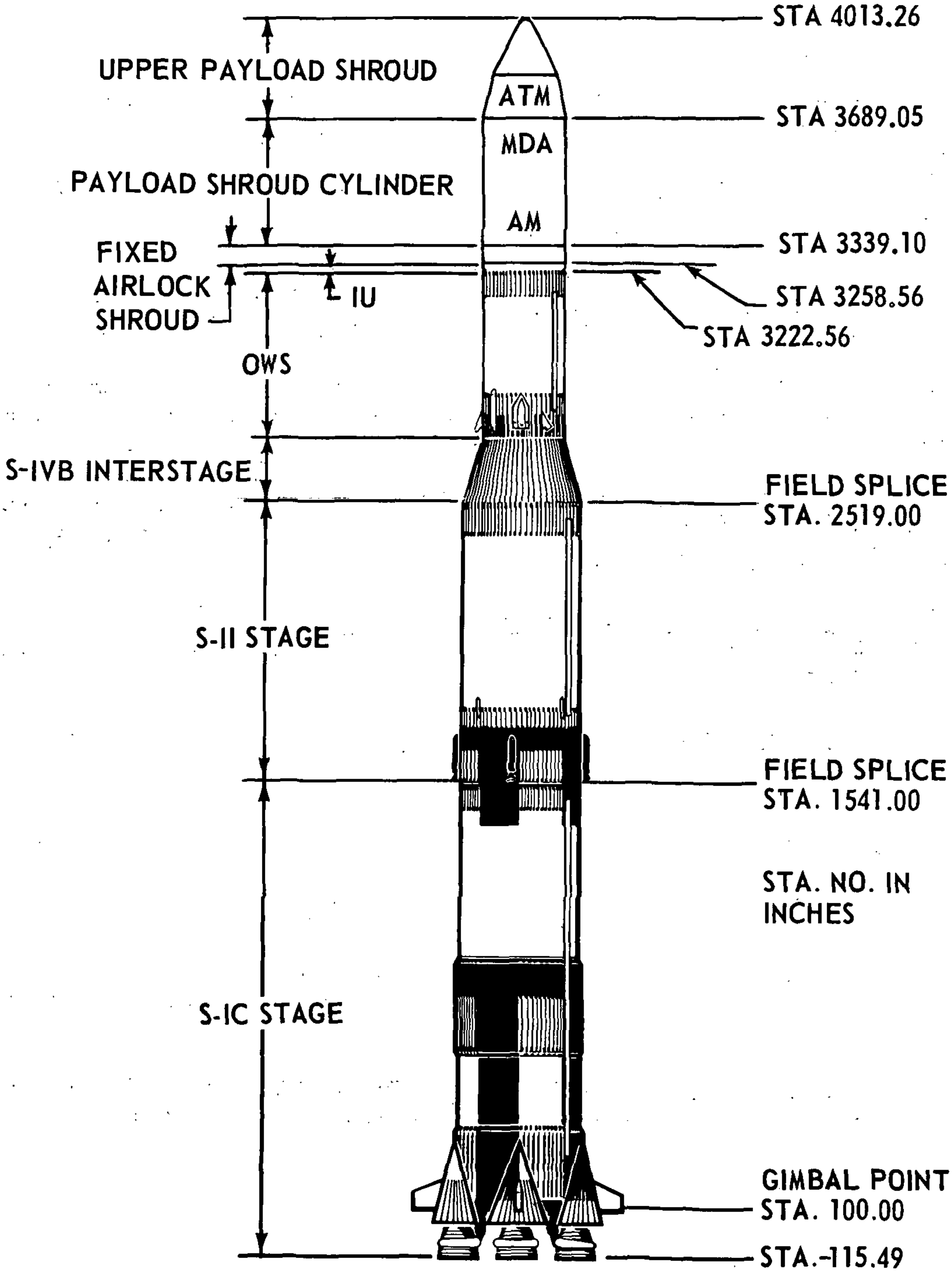


FIGURE 2-1 SKYLAB I VEHICLE CONFIGURATION

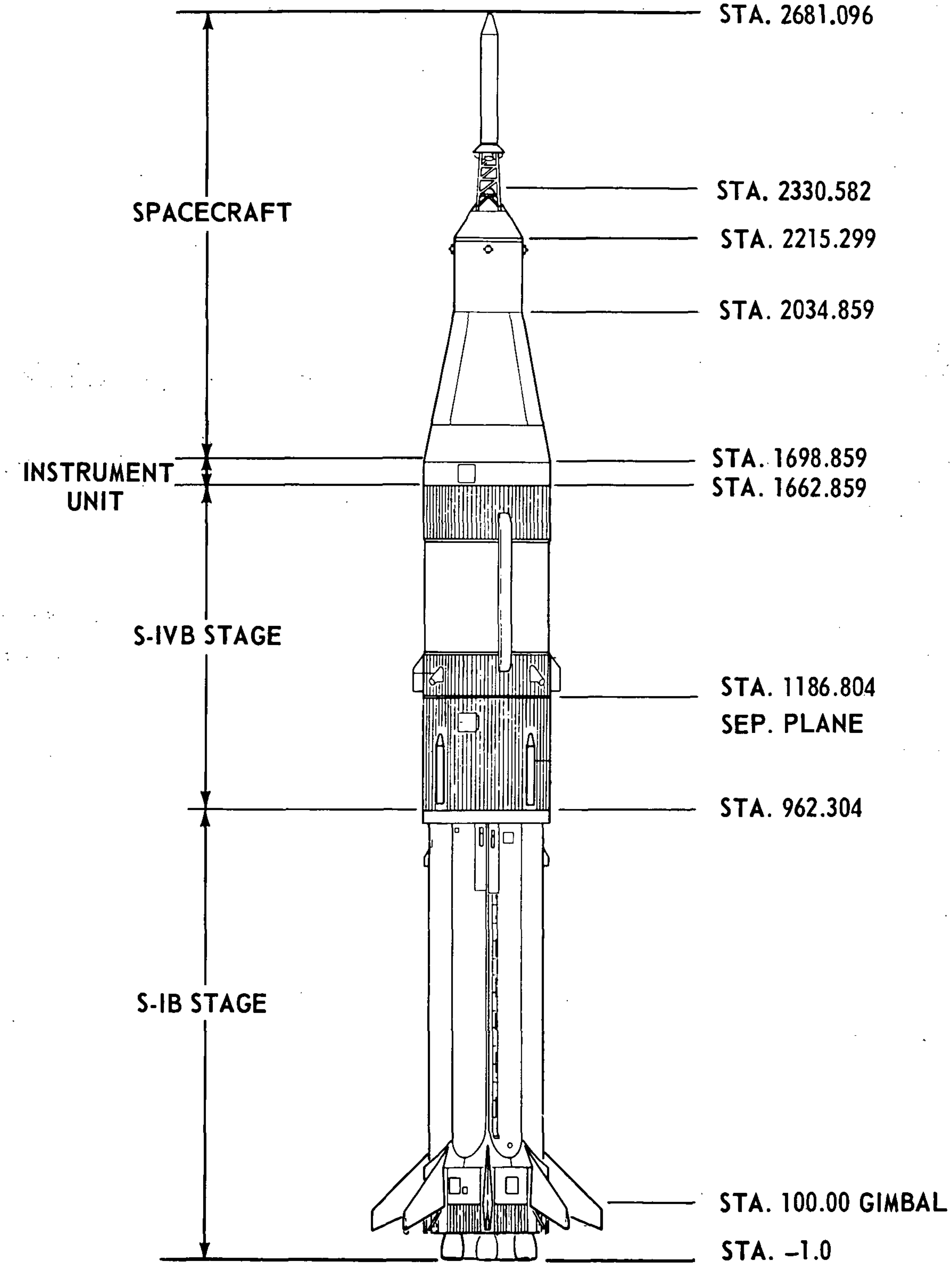


FIGURE 2-2 SKYLAB 2 VEHICLE CONFIGURATION

2.2.1.3 IU 206. The IU carries the following instrumentation: Two telemetry links, two C-band radar beacons, and one VHF command link (updata).

2.2.2 SL-2 APOLLO SPACECRAFT

2.2.2.1 CSM 206. The CSM carries the following instrumentation: Two USB Systems, dual VHF transceivers for voice/ranging, a VHF recovery beacon, a VHF survival beacon-transceiver, a beacon light, a swimmer umbilical, and dye marker.

2.3 SL-1/SL-2 MISSION DESCRIPTION

2.3.1 MISSION OBJECTIVES

2.3.1.1 SL-1 in Earth Orbit

a. Operate the Orbital Assembly (SWS plus CSM) as a habitable space structure for up to 28 days after the SL-2 launch.

b. Obtain data for evaluating the performance of the orbital assembly.

c. Obtain data for evaluating crew mobility and work capability in both intravehicular and extravehicular activity.

2.3.1.2 Medical Data.

a. Obtain medical data for determining the effects on the crew which result from a space flight of up to 28 days duration.

b. Obtain medical data for determining if a subsequent Skylab mission of up to 56 days duration is feasible and advisable.

2.3.1.3 In-Flight Experiments

a. Obtain solar astronomy data for continuing and extending solar studies beyond the limits of earth-based observations.

b. Obtain earth resources data for continuing and extending multisensor observation of the earth from low earth orbit.

c. Perform the assigned scientific, engineering, technological, and Department of Defense (DoD) experiments.

2.3.2 SL-1

a. Launch Pad - LC-39A.

b. Flight Azimuth - 40.88° (E of N). Subject to some revision, but is expected to be within the 40-45° range.

c. Launch Date - 30 April 1973. Launch opportunities exist each succeeding day.

d. Launch Time - 1330 hours EDT.

e. Launch Window - 1330 to 1500 hours EDT.

f. Window Duration - 1.5 hours.

g. Trajectory - Table 2.1 is a summary of the SL-1 launch phase mission events. The two-stage Saturn (SA-513) boosts an unmanned payload to a 235-nautical-mile circular orbit inclined 50° with respect to the equatorial plane. Key events in SL-1 orbital coast are listed in Table 2.2.

2.3.3 SL-2

a. Launch Pad - LC-39B.

b. Flight Azimuths:

Nominal	- 45.8° (E of N) (for rendezvous with nominal SL-1)
Start of Window	- 51.8°
End of Window	- 37.7°

c. Launch Date - 1 May 1973. Assumes SL-1 launched April 30. Launch opportunities exist on days 1, 2, 6, and 7 after SL-1 launch.

d. Launch Time - 1301 hours EDT.

e. Window Duration - 10 minutes.

f. Table 2.3 is a summary of SL-2 launch phase events. The two-stage Saturn IB (SA-207) boosts the S-IVB/IU/CSM into an 81/120 NM eccentric orbit coplanar with the SL-1 orbit. The CSM propulsion system and reaction control system will be used to achieve orbit changes including rendezvous and docking with SL-1. Table 2.4 lists some key SL-2 orbital events.

TABLE 2.1 SL-1 LAUNCH PHASE MISSION EVENTS (F.A. 40.88°)

EVENT	TIME FROM FIRST MOTION (sec)	EARTH-FIXED VELOCITY (m/sec)	ALTITUDE (km)	GROUND RANGE (km)
First Motion	0.0	0.0	0.1	0.0
Initiate Tilt	11.0	30.7	0.2	0.0
Max. Q	75.3	452.1	12.4	4.3
S-IC C.E.C.O.	142.1	2003.5	63.8	55.3
S-IC O.E.C.O.	158.3	2538.4	85.4	84.4
S-II Eng. Ignit.	161.7	2533.9	90.3	91.5
IGM Enable	196.0	2657.2	137.0	165.6
S-II Eng. C.O.	578.1	7327.0	443.7	1737.6
Earth Orbit Insertion	588.1	7332.4	443.8	1806.1

TABLE 2.2 SL-1 ORBITAL EVENTS
(Prior to SL-2 Launch)

EVENT	SL-1 TIME (G.E.T.)	
	Hr.	Min.
Start Pitch to Retrograde Attitude	0	10
Jettison Payload Shroud	0	15
Start Deployment ATM	0	16
Start Deployment ATM Solar Arrays	0	25
Activate ATM Telemetry	0	37
Start Acquisition Solar Inertial Attitude	0	44
Start Deployment OWS Solar Arrays	0	45
End of Guaranteed IU Life	7	30
MCC-H Transmit TTY to MSFC and KSC of RCA-110 SL-2 Target Load	11	30
MSFC Confirm SL-2 Launch Vehicle Performance	11	45
KSC Load SL-2 LVDC	15	30
MCC-H Send KSC and MSFC Final Target Load and TL	22	55
Final TL Adjustment, Launch Vehicle Performance	23	15
SL-2 Liftoff	23	30

TABLE 2.3 SL-2 LAUNCH PHASE MISSION EVENTS (F. A. 45.8°)

EVENT	TIME FROM FIRST MOTION (sec)	EARTH-FIXED VELOCITY (m/sec)	ALTITUDE (km)	GROUND RANGE (km)
First Motion	0.0	0.0	0.1	0.0
Initiate Tilt	10.2	-	-	-
(Data Point)	10.0	30.5	0.2	0.0
Max. Q	73.6	462.0	12.4	4.8
S-IB I.E.C.O.	137.7	1916.0	54.8	59.2
S-IB O.E.C.O.	140.7	1975.5	57.7	64.4
S-IVB Eng. Start	143.4	1965.4	60.3	69.2
Active Guidance Initiate	170.7	-	-	-
(Data Point)	171.0	2085.3	83.8	120.2
S-IVB Guidance C.O.	581.9	7581.5	158.4	1759.4
Earth Orbit Insertion	591.9	7588.8	158.6	1832.9

TABLE 2.4 SL-2/SWS ORBITAL EVENTS

EVENT	SL-2 TIME (G.E.T.)	
	Hr.	Min.
Rendezvous	7	21
CSM/OWS Docking	8	0
SWS Activation Complete	28	59
ATM Activation Complete	28	59
EVA Times	594	40
SWS Deactivation Complete	661	32
CSM/OWS Undocking	661	55
Splashdown	668	32

2.3.4 SL-1/SL-2 EXPERIMENTS

Tables 2.5 and 2.6 list SL-1 and SL-2 experiments.

TABLE 2.5 SL-1 EXPERIMENTS

	Experiment	Operational Position
D024	Thermal Control Coatings	AM/EXT
M071	Mineral Balance	OWS
M073	Bioassay of Body Fluids	OWS
M074	Specimen Mass Measurement	OWS
M092	In-flight LBNP	OWS
M093	Vectorcardiogram	OWS
M112	Man's Immunity - In Vitro Aspects	OWS
M113	Blood Volume and Red Cell Life Span	OWS
M114	Red Blood Cell Metabolism	OWS
M115	Special Hematologic Effects	OWS
M131	Human Vestibular Function	OWS
M133	Sleep Monitoring Experiment	OWS
M151	Time and Motion Study	OWS
M171	Metabolic Activity	OWS
M172	Body Mass Measurement	OWS
M479	Zero Gravity Flammability	MDA
M487	Habitability/Crew Quarters	OWS
M509	Astronaut Maneuvering Equipment	OWS
M512	Materials Processing Facility	MDA
M516	Crew Activities and Maintenance Study	OWS
M551	Metals Melting	MDA
M552	Exothermic Brazing	MDA
M553	Sphere Forming	MDA
M554	Composite Casting	MDA
S009	Nuclear Emulsion	MDA
S019	UV Stellar Astronomy	OWS
S020	UV/S-Ray Solar Photography	OWS
S052	White Light Coronagraph	ATM
S054	X-Ray Spectrographic Telescope	ATM
S055	UV Scanning Polychromator/ Spectroheliometer	ATM
S056	Dual X-Ray Telescopes	ATM
S063	UV Airglow Horizon Photography	OWS
S073	Gegenschein/Zodiacal Light	OWS
S082	UV Spectrograph/Heliograph	ATM
S149	Particle Collection	OWS
S183	UV Panorama	OWS

TABLE 2.5 SL-1 EXPERIMENTS
(Continued)

	Experiment	Operational Position
S190	Multispectral Photographic Facility	---
S190A	Multispectral Photographic Cameras	MDA
S190B	Earth Terrain Camera	OWS
S191	Infrared Spectrometer	MDA
S192	Multispectral Scanner	MDA
S193	Microwave Scatterometer/Radiometer and Altimeter	ATM Deployment Assembly
S194	L-Band Radiometer	MDA
T002	Manual Navigation Sightings (B)	OWS
T003	In-flight Aerosol Analysis	OWS
T013	Crew-Vehicle Disturbance	OWS
T020	Foot-Controlled Maneuver Unit	OWS
T025	Coronagraph Contamination Measurement	OWS
T027	ATM Contamination Measurement	OWS

TABLE 2.6 SL-2 EXPERIMENTS

	Experiment	Operational Position
D008	Radiation in Spacecraft	CM
M071	Mineral Balance	CM
M073	Bioassay of Body Fluids	CM
M078	Bone Mineral Measurement (B)	*
M111	Cytogenetic Studies of Blood	*
M415	Thermal Control Coating	IU
M555	Gallium Arsenide Crystal Growth	MDA
S015	Zero-G Single Human Cells	CM

* (Pre- & Post-flight only)

SECTION III
ONBOARD EQUIPMENT

3.1 ELECTRONIC TRAJECTORY DATA ACQUISITION EQUIPMENT

The electronic trajectory data acquisition equipment carried on SL-1 and SL-2 is listed in Tables 3.1 and 3.2. Locations of the onboard antennas are shown in Figures 3-3 and 3-4 for SL-1 and Figures 3-5 and 3-6 for SL-2.

TABLE 3.1 SL-1 ONBOARD ELECTRONIC TRACKING DATA ACQUISITION EQUIPMENT

SYSTEM	FREQUENCIES (MHz) Receive	FREQUENCIES (MHz) Transmit	LOCATION	REMARKS
C-Band Transponders	5690	5765	IU	The IU contains two transponders. Each accepts a double pulse signal, with 8 microseconds between pulses, and transmits a single pulse reply. Each transponder radiates through its own antenna system. The transponders will operate simultaneously.
Command & Communication System (CCS)	2101.8	2282.5	IU	The CCS is a composite system designed to: Transmit and receive phase-modulated PRN Range Code; receive command/update functions; and transmit PCM/PM telemetry.
VHF Ranging System	259.7	296.8	AM	Provide ranging between CSM and SWS.

3.2 OPTICAL DATA ACQUISITION EQUIPMENT

3.2.1 SL-1 OPTICAL TARGETS. Optical targets, painted on the SL-1 vehicle to aid in the determination of first motion and vertical motion, are shown in Figure 3-1.

3.2.2 SL-2 OPTICAL TARGETS. Optical targets, painted on the vehicle to aid in the determination of first motion, vertical motion, and sway, are shown in Figure 3-2. The location of the vertical and sway motion targets on the vehicle are TBD.

TABLE 3.2 SL-2 ONBOARD ELECTRONIC TRACKING DATA ACQUISITION EQUIPMENT

SYSTEM	FREQUENCIES (MHz) Receive	Transmit	LOCATION	REMARKS
C-Band Transponders	5690	5765	IU	The IU contains two transponders. Each accepts a double pulse signal, with 8 microseconds between pulses. and transmits a single pulse reply. Each transponder radiates through its own antenna system. The transponders will operate simultaneously.
VHF Ranging System	296.8	259.7	CSM	Provide ranging between CSM and SWS or MSFN.
USB	2106.4	2272.5 2287.5	CSM	A composite system designed to transmit and receive voice communication and phase-modulated ranging code; receive updata/commands; and transmit PCM telemetry, television, and tape playback (CSM only) of telemetry and voice.

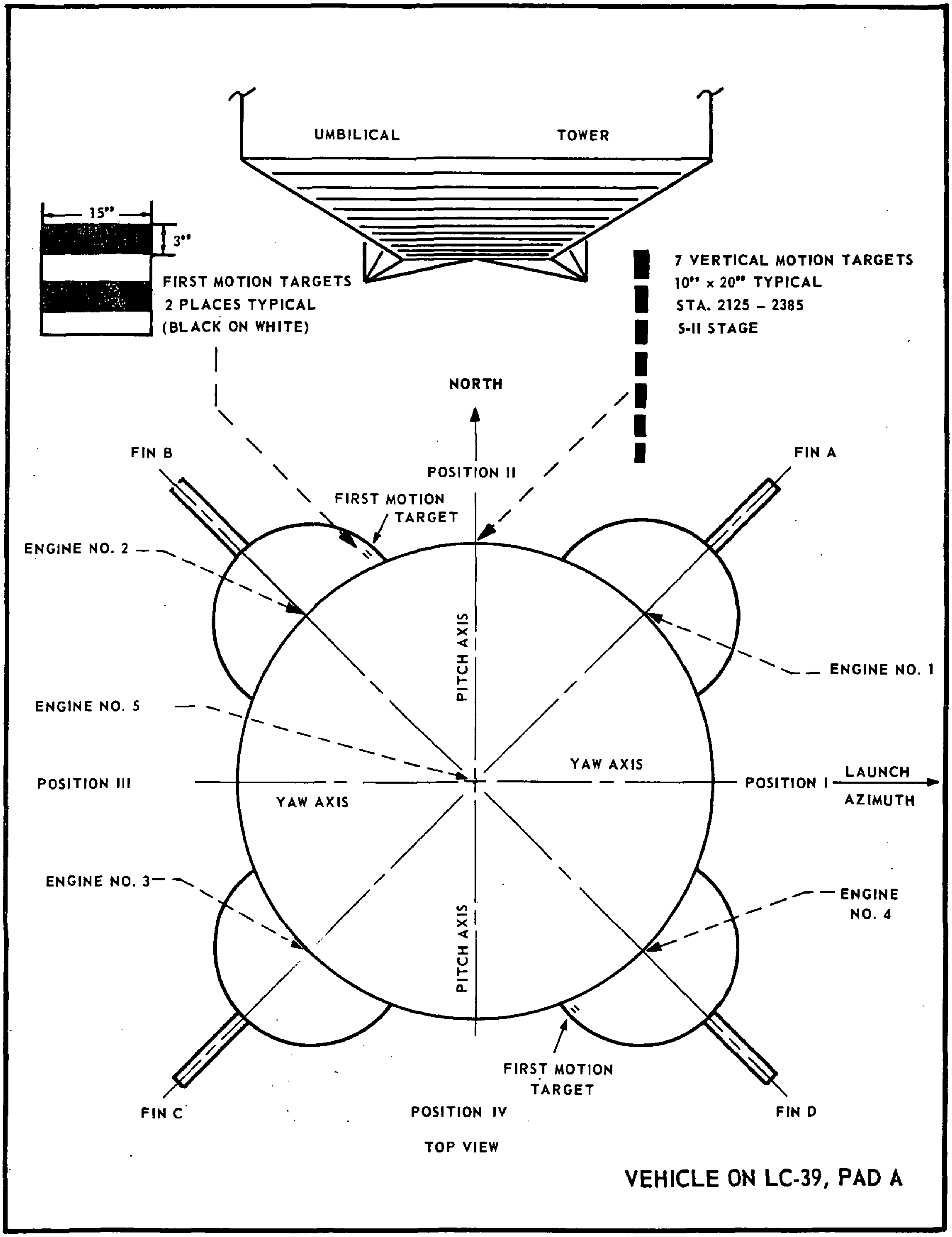


FIGURE 3-1 SKYLAB I ORIENTATION AND CAMERA TARGET LOCATIONS

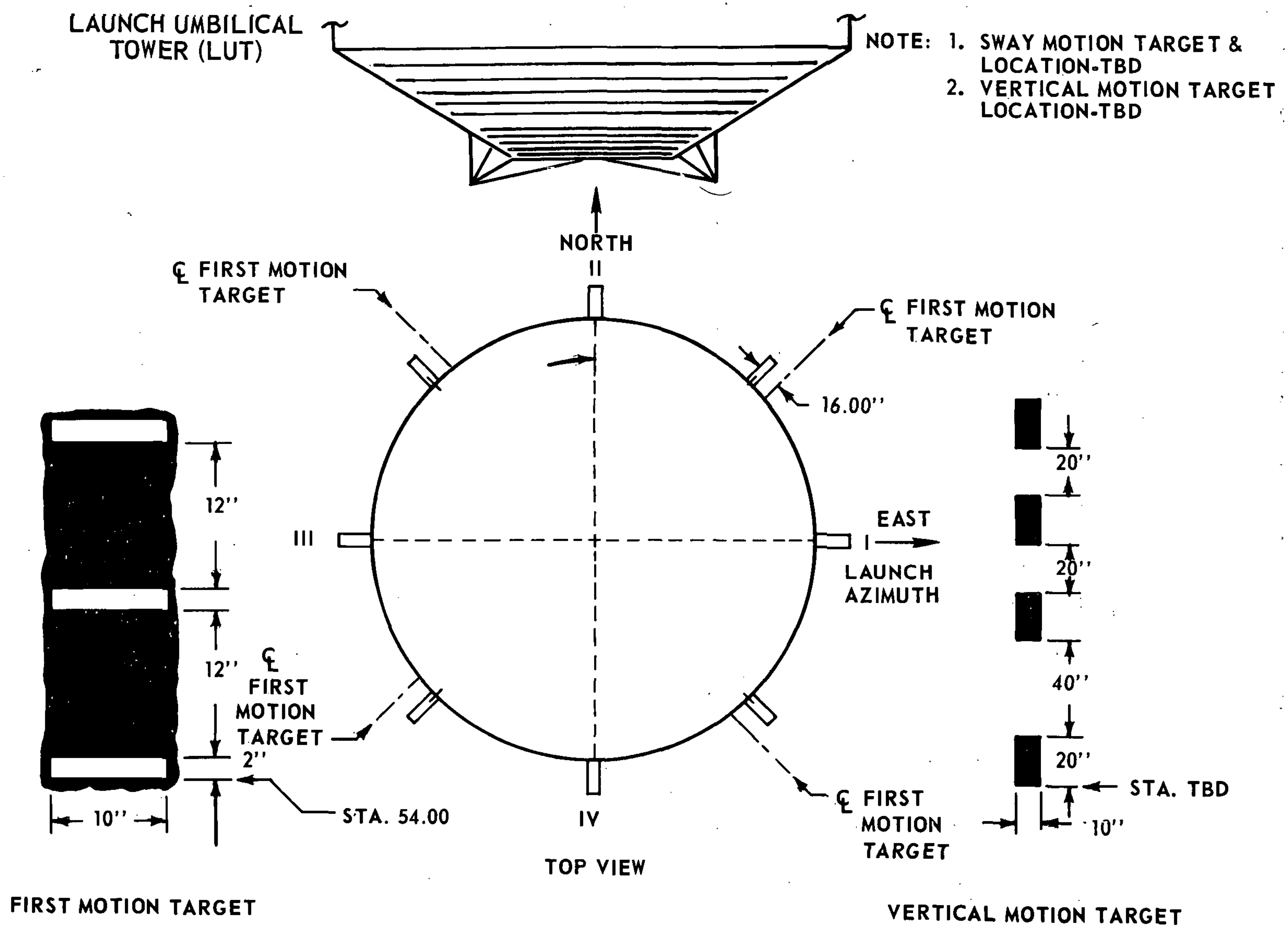


FIGURE 3-2 SL-2 VEHICLE ORIENTATION AND CAMERA TARGET LOCATIONS

TABLE 3.3 SL-1 TELEMETRY SYSTEMS

LINK NO.	FREQUENCY (MHz)	MODULATION	TRANSMITTED POWER (Watts)	LOCATION
AF-1	256.2	FM/FM	20	S-IC
AP-1	244.3	PCM/FM	15	
BF-1	240.2	FM/FM	20	S-II
BF-2	232.9	FM/FM	20	
BP-1	248.6	PCM/FM	15	
DF-1	250.7	FM/FM	20	IU
DP-1	245.3	PCM/FM	15	
DP-1B	2282.5	CCS	15	
AM	230.4	*	2 or 10**	AM
AM	246.3	*	10	
AM	235.0	*	10	
OWS	25.925 - 26.075	FSK***	--	OWS
ATM	231.9	****	10	ATM
ATM	237.0	****	10	

REMARKS:

* Seven different modulations can be used.

** 2-watt transmitter during launch phase only.

*** Experiment No. M509. Internal to OWS only.

**** Two different modulations can be used.

TABLE 3.4 SL-2 TELEMETRY SYSTEMS

LINK NO.	FREQUENCY (MHz)	MODULATION	TRANSMITTED POWER (Watts)	LOCATION
GF-1	240.2	FM/FM	20	S-IB
GP-1	256.2	PCM/FM	15	
CP-1	258.5	PCM/FM	15	S-IVB
DP-1	245.3	PCM/FM	15	IU
DF-1	250.7	FM/FM	20	
USB	2287.5	USB-PM	5 or 20	CSM
USB	2272.5	USB-FM	0.25,5,20	

3.3 SL-1/SL-2 TELEVISION SYSTEM

The television system is provided for obtaining TV in each of the modules including the ATM and CSM. Images from the ATM telescope are viewable via the system. The ATM has five black and white TV cameras. A single TV color camera with attached color monitor may be used in the following locations: OWS - 3 places, AM - 1 place, MDA - 1 place, and CSM - 1 place. The CSM S-band system provides real-time TV and video recorder downlink capability to the STDN (previously MSFN).

3.4 SL-1/SL-2 TELEMETRY SYSTEMS

3.4.1 SL-1/SL-2. The telemetry links carried on the SL-1 and SL-2 vehicles are listed in Tables 3.3 and 3.4.

3.4.2 SWS. The SWS telemetry system is comprised of the AM VHF system, the ATM VHF system, and the CSM S-band system.

3.4.2.1 AM. The AM PCM telemetry system has four VHF transmitters operating at three frequencies. The 2-watt 230.4 MHz transmitter emits only during the launch phase. Present plans are to operate one link only in real time during launch and on-orbit.

3.4.2.2 ATM. The ATM PCM telemetry system provides two VHF transmitters. Either can operate in the RT or Auxiliary Storage and Playback Assembly Mode (ASAP).

3.4.3 CSM. The CSM S-band system provides downlink capability including telemetry, voice, and TV.

3.5 TAPE RECORDERS

3.5.1 AM TAPE RECORDER. Three recorders with data and voice record capability on two separate channels are provided; however, simultaneous playback of two channels requires two telemetry links.

3.5.2 ATM TAPE RECORDER. Two tape recorders are provided with playback capability; however, no voice record capability is provided. Only one recorder will normally be used at a time in the playback mode over the two VHF links available.

3.5.3 CSM TAPE RECORDER. The CSM Data Storage Equipment (DSE) provides data and voice record and playback capability. Playback is accomplished over the CSM USB system.

3.5.4 MDA TV TAPE RECORDER. The recorder will provide video recording from the OWS/MDA/AM/ATM/CSM including color from non-ATM TV source on the SWS. Playback will be accomplished via the USB system.

3.6 RADIO COMMAND CONTROL SYSTEM

3.6.1 SL-1/SL-2 LAUNCH VEHICLE RANGE SAFETY DIGITAL COMMAND/DESTRUCT SYSTEM. On SL-1, the S-IC and S-II stages carry dual Secure Range Safety (SRS) command systems operating at 450 MHz. On the SL-2, S-IB and S-IVB stages carry the dual SRS systems. On SL-1/SL-2, three commands may be transmitted through the SRS. They are as follows:

a. ARM/FUEL CUTOFF - Terminates thrust and arms the EBW firing unit charge circuits.

b. DESTRUCT - Firing of the ABW.

c. SAFE - Disconnects the command decoding equipment from the battery.

3.6.2 SL-1 SPACE VEHICLE COMMAND/CONTROL SYSTEMS

3.6.2.1 Command and Communication System (CCS). The IU carries the CCS which provides guidance system data update, guidance system closed-loop testing initiation, and other vehicle command data for 7.5 hours after T-0. The IU Digital Command System (DCS) access to these functions is through the Launch Vehicle Guidance Digital Computer (LVDC). The CCS uplink operates at 2101.8 MHz and the downlink at 2282.5 MHz. This system provides PRN ranging and backup capability only for preprogrammed commands in the IU. After depletion of the IU batteries, DCS functions are transferred to the AM/DCS.

3.6.2.2 AM UHF Command System. The AM UHF Digital Command System (DCS) provides OWS, AM, and MDA uplink capability. The system is used to control on-off, set-reset functions by ground command. A teleprinter in the AM provides the command printout capability. The system operates at 450 MHz. Only one of the redundant subsystems is used at a time.

3.6.2.3 ATM UHF Command System. The ATM UHF Digital Command System provides two completely independent receiver-decoder subsystems. Either or both may be selected by the MSFN. The system provides uplink capability for controlling the ATM subsystems and experiments after ATM Solar Array deployment during manned and unmanned portions of the mission. The system operates at 450 MHz.

3.6.3 SL-2 SPACE VEHICLE COMMAND/CONTROL SYSTEMS

3.6.3.1 S-IB IU UHF Command Link. The S-IB IU UHF Command Link provides guidance system data update and guidance system closed-loop testing initiation.

3.6.3.2 CSM USB Command System. The CSM Command System, operating on a frequency of 2106.4 MHz, provides CSM uplink capability for voice, data, commands, and ranging code.

3.7 VHF RANGING SYSTEMS

3.7.1 SL-1/SL-2 VHF RANGING SYSTEMS. The VHF ranging system provides CSM to AM ranging. The VHF transceiver on the AM provides ranging only (no voice). The two CSM transceivers provide ranging and voice capability.

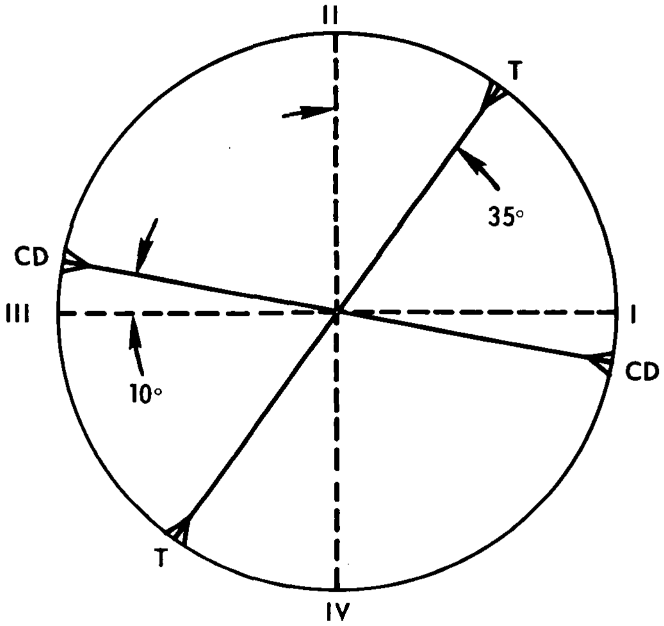
3.8 VOICE COMMUNICATIONS

The CSM S-band and VHF S-band systems provice voice communication with the STDN (MSFN). A voice downlink backup mode through the AM telemetry system can be implemented on-orbit. The teleprinter through the AM Digital Control System (DCS) provides an alternate uplink system.

3.9 EXPERIMENT EQUIPMENT

Experiment data will be transmitted via RF links on the AM, ATM, and CSM either as telemetry, TV, or voice. Film data will be returned via CSM.

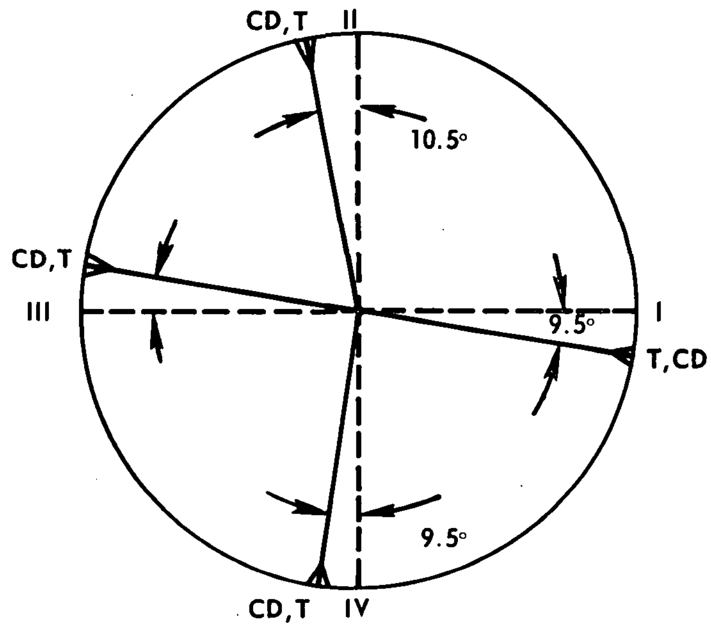
3.9.1 EXPERIMENT M509, ASTRONAUT MANEUVERING EQUIPMENT. During IVA a telemetry link operating at approximately 26 MHz will transmit data to the OWS data system to be recorded and retransmitted.



S-IC STAGE

T – TELEMETRY ANTENNAS – STA. 1459

CD – COMMAND DESTRUCT ANTENNAS – STA. 1503

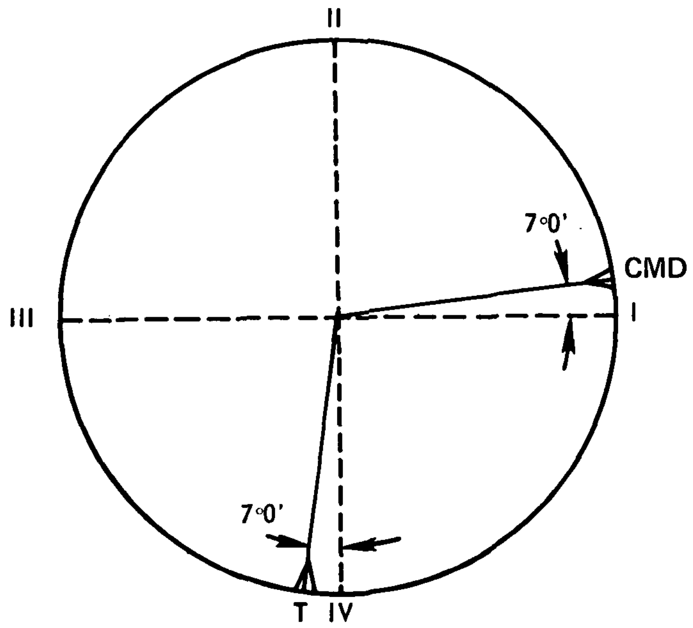


S-II STAGE

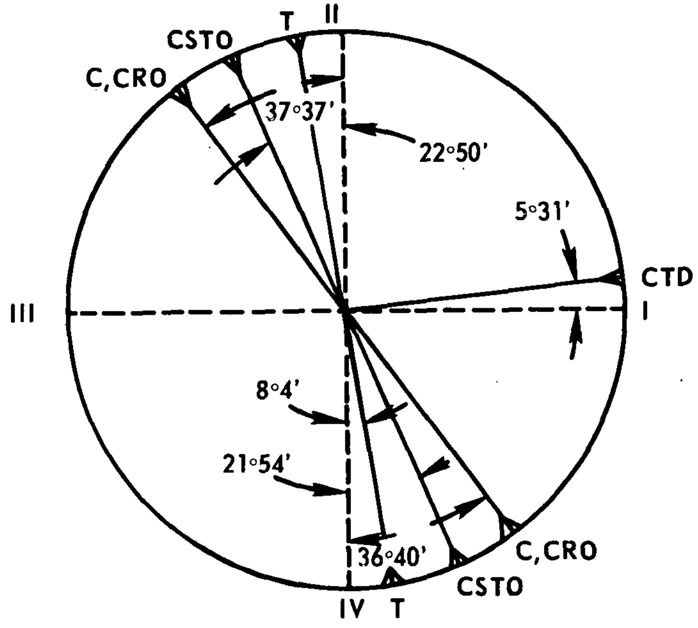
T – TELEMETRY ANTENNAS – STA. 2466

CD – COMMAND DESTRUCT ANTENNAS – STA. 2487

FIGURE 3-3 LOCATION OF S-IC AND S-II ONBOARD ANTENNAS (SL-1)



FAS



INSTRUMENT UNIT (IU)

T – TELEMETRY ANTENNA (LAUNCH) STA. 3269

CMD – AM COMMAND ANTENNA Sta. 3269

C.C – BAND RADAR ANTENNAS – STA. 3236

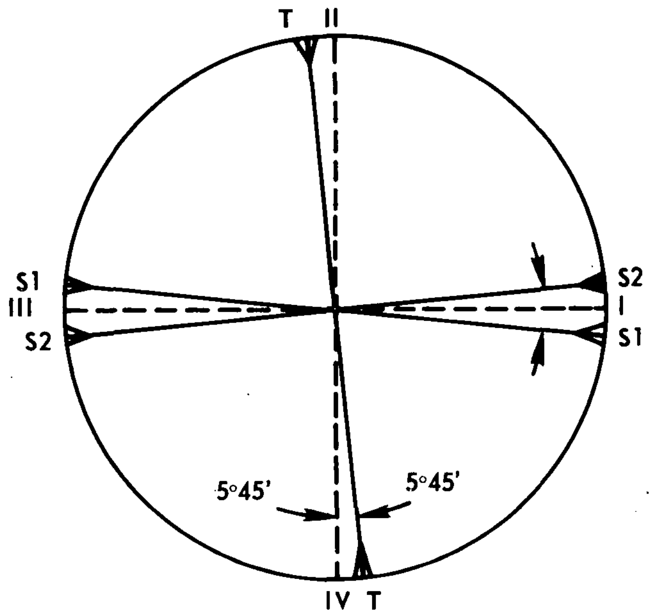
CRO – CCS RECEIVING OMNI ANTENNAS – STA. 3252

CSTO – CCS TRANSMITTING OMNI ANTENNAS – STA. 3252

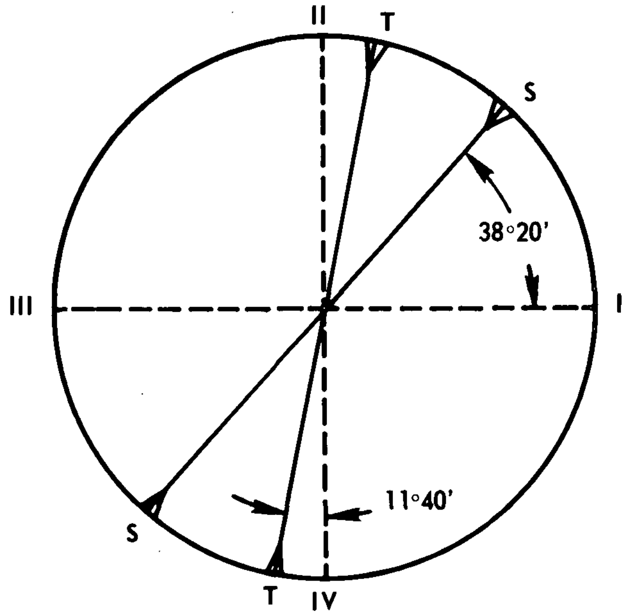
CTD – CCS TRANSMITTING DIRECTIONAL ANTENNA – STA. 3245

T – VHF TELEMETRY – STA. 3242

FIGURE 3-4 LOCATION OF IU AND FAS ONBOARD ANTENNAS (SL-1)



S-IB STAGE



S-IVB STAGE

T – TELEMETRY ANTENNAS – STA. 889

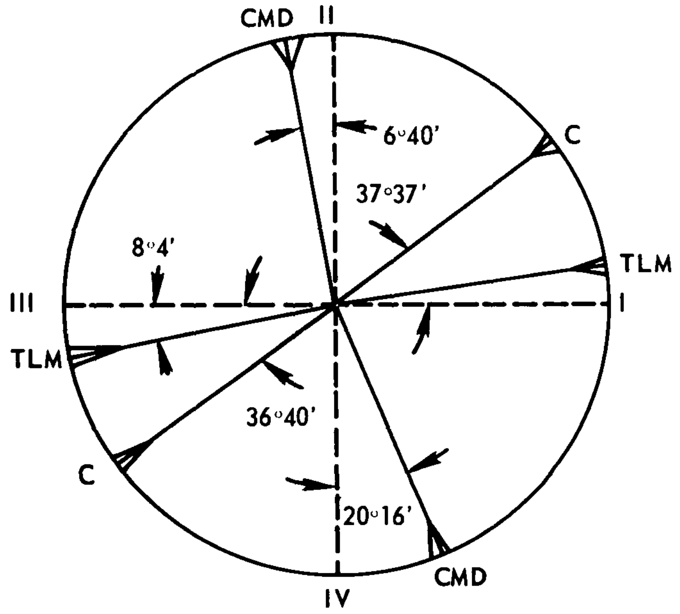
S1 – SECURE RANGE SAFETY ANTENNAS (SYSTEM I) STA. 847

S2 – SECURE RANGE SAFETY ANTENNAS (SYSTEM II) STA. 847

T – TELEMETRY ANTENNAS – STA. 1610

S – SECURE RANGE SAFETY ANTENNAS STA. 1618

FIGURE 3-5 LOCATION OF S-IB & S-IVB ONBOARD ANTENNAS (SL-2)

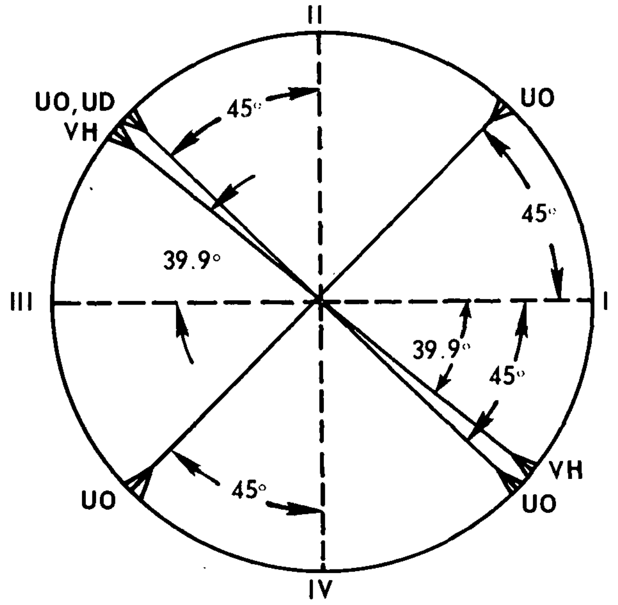


IU

CMD - COMMAND ANTENNA - STA. 1675

TLM - VHF TLM ANTENNA - STA. 1674

C - C-BAND ANTENNAS - STA. 1676



COMMAND SERVICE MODULE

UD - USB, HIGH GAIN ANTENNA - STA. 2035

UO - USB, OMNI ANTENNAS - STA. 2218*

VH - VHF/AM ANTENNAS - STA. 2116*

VHF RECOVERY ANTENNAS - TIP OF CM(2)
(EXTENDED AFTER PARACHUTE DEPLOYMENT. VHF/AM OR
SURVIVAL TRANSCEIVER - BEACON EQUIPMENT MAY BE CONNECTED

*APPROXIMATE STATION NO'S.

FIGURE 3-6 LOCATION OF IU AND COMMAND SERVICE MODULE ONBOARD ANTENNAS (SL-2)

SECTION IV
DATA ACQUISITION SYSTEMS

4.1 ELECTRONIC TRACKING DATA ACQUISITION SYSTEMS

4.1.1 C-BAND RADAR SUPPORT

4.1.1.1 SL-1/SL-2 Space Vehicle Launch-Phase Trajectory Coverage

a. Tracking Point

(1) SL-1. C-band antenna on the IU (see Figure 3-4).

(2) SL-2. C-band antenna on the IU (see Figure 3-6). The radars are preassigned to track the CSM and Launch Vehicle in the event of launch-phase abort.

b. Frequency

The radars will interrogate the transponders on 5690 MHz and will receive the returned signal on 5766 MHz.

c. Measured Parameters

Azimuth angle, elevation angle, and slant range vs time are the measured parameters.

d. Coverage

Figures 4-37, 4-38, 7-1, and 7-2 indicate the expected flight time coverage for metric and range safety data, respectively. Elevation angles, as seen from each radar, are shown in Figures 4-6 through 4-9.

e. Real-Time/Near-Real-Time Support

Data from all the radars listed in paragraph d. above will be transmitted to the RTCS at the AFETR in real time.

TABLE 4.1 SL-1/SL-2 LAUNCH-PHASE TRAJECTORY RADAR COVERAGE

RADAR STATION	RADAR TYPE	DATA RATE Pts/Sec	INTERVAL OF TRACK	REMARKS
1.16 CKAFS	FPS-16	10	Acq. to LOS	Estimated position accuracies are given for each radar. See Figures 4-10 through 4-36.
19.18 KSC	TPQ-18	20	Acq. to LOS	
0.18 PAFB	FPQ-6	20	Acq. to LOS	
3.13 GBI	FPQ-13	10	Acq. to LOS	
7.18 GTK	TPQ-18	20	Acq. to LOS	
67.18 BDA	FPQ-6	20	Acq. to LOS	
67.16 BDA	FPS-16	10	Acq. to LOS	
WLPS	FPS-16	TBD	Acq. to LOS	
WLPS	FPQ-6	TBD	Acq. to LOS	

4.1.1.2 SL-1/SL-2 Meteorological Balloon Support

a. Tracking Point

The radar will track Jimspheres released at CKAFS.

b. Frequency

5660 - 5825 MHz

c. Measured Parameters

Azimuth angle, elevation angle, and slant range vs time are the measured parameters.

d. Coverage

Radar 1.16 will be used to track each balloon for approximately one hour. Radars 0.18 or 19.18 may be used if Radar 1.16 is not available.

e. Real-Time/Near-Real-Time Support

The data will be transmitted to the CIF during the balloon ascent for each balloon released in support of the mission.

4.1.2 UNIFIED S-BAND SUPPORT

a. Tracking Point

The following are the tracking points:

(1) SL-1. The CCS transponder antennas on the SL-1 IU (see Figure 3-4).

(2) SL-2. The USB transponder antennas on the CSM (see Figure 3-6).

b. Frequency

PRN code will be transmitted from the ground station to the CSM transponder on a frequency of 2106.4 MHz and will be returned to the ground station on a frequency of 2287.5 MHz. The SL-1 CCS receive-and-transmit frequencies are 2101.8 and 2282.5 MHz, respectively.

c. Measured Parameters

Azimuth angle, elevation angle, and slant range vs time are the measured parameters.

d. Coverage

The KSC and Bermuda USB stations will support SL-1/SL-2 during the launch phase of the mission. The USB stations provide tracking, telemetry, communication, and updata support.

e. Real-Time/Near-Real-Time Support

USB data will be transmitted to MCC-H in real time by GSFC.

4.2 OPTICAL DATA ACQUISITION SYSTEMS

4.2.1 METRIC OPTICAL DATA ACQUISITION SUPPORT

4.2.1.1. <u>SL-1/SL-2 Vertical Motion Cameras</u>

a. Tracking Point

The camera is locked in position to record the passage of the vertical motion target (See Figures 3-1 and 3-2) through the field of view. Data are referenced to this target.

b. Camera Size

35mm

c. Reduced Data

Vertical motion vs time

d. Coverage

(1) <u>SL-1</u>. One camera at the 160-foot level of the umbilical tower, positioned to include a fixed reference target in the field of view, will provide coverage during the first 5 to 7 meters of vehicle ascent. The frame rate is 96 frames per second.

(2) <u>SL-2</u>. One camera at the <u>TBD</u>-level of the umbilical tower, positioned to include a fixed reference target in the field of view, will provide coverage during the first 5 to 7 meters of vehicle ascent. The frame rate is 96 frames per second.

e. Real-Time/Near-Real-Time Support

Not applicable

4.2.1.2 <u>First Motion Cameras</u>

a. Tracking Point

The cameras are locked in position to view the first motion targets (see Figures 3-1 and 3-2).

b. Camera Size

16mm

c. Reduced Data

Time of vehicle first motion

d. Coverage

(1) SL-1. Two cameras, located at the zero level of the umbilical tower, will view first-motion targets The cameras operate at 400 frames per second.

(2) SL-2. Four cameras, located the the TBD-level of the umbilical tower, will view first-motion targets. The cameras operate at 400 frames per second.

e. Real-Time/Near-Real-Time Support

Not applicable

4.2.1.3 SL-2 Sway Motion Camera. Requirements TBD.

4.2.2 PHOTOGRAPHIC SUPPORT

4.2.2.1 Documentary Coverage. A documentary history of the mission will be recorded on film. Detailed information concerning this coverage may be obtained from IS-DOC-2, Photographic Branch (telephone: 867-6002).

4.2.2.2 Engineering Sequential Coverage. The engineering sequential coverage will be described in the KSC Photographic Acquisition-Disposition Document (PADD). Devices providing long-range high-resolution optical coverage are listed below:

a. IGOR Tracking Telescopes

Three IGOR systems will support the SL-1/SL-2 launches. MITTS locations will be at Ponce de Leon Inlet and Flagler Beach near St. Augustine. The Fixed IGOR system at PAFB will provide TV video coverage to the RSO, LCC, and the LC-39 press site.

b. ROTI Tracking Telescopes

None in current planning.

4.2.3 TELEVISION SUPPORT

4.2.3.1 ETR Television Support

4.2.3.1.1 Range Safety Television Support. One Flightline and one Program TV camera will provide the RSO visual coverages of the vehicle launch. The Flightline camera is located at TBD. The Program camera is located at TBD.

4.2.3.1.2 Launch Vehicle Coverage. The PAFB IGOR tracking telescope will be equipped with a TV Camera. Display will include the RSO, Abort Advisory Console at the LCC, and the LC-39 press site.

4.2.3.2 <u>GSFC Television Support</u>. The KSC USB Ground Station will monitor the prelaunch TV transmissions originating in the SWS and CM. The TV systems are inactive during the launch phase.

4.2.3.3 <u>KSC Television Support</u>

4.2.3.3.1 Abort System Television Coverage. Five cameras will view the vehicle to provide abort advisory information: Two located on the ML, two in the pad area, and one remote long-range camera (ETR supplied) located on KSC at <u>TBD</u> (see Figure 4-4). In addition, the IGOR with TV at PAFB provides long-range coverage with display at the Abort Advisory Console.

4.2.3.3.2 Operational Television (OTV) Support

a. <u>SL-1</u>

Pad A Area - 35 (Cameras)
(Pad proper, ML, MSS)

VAB - 1

VIB or VAB - 1 color

Firing Room - 2 (1 color)

b. <u>SL-2</u>

Pad B Area - 45 (Cameras)
(Pad proper, ML, MSS)

VAB - 1

VIB or VAB - 1 color

Firing Room - 2 (1 color)

4.3 TELEMETRY SYSTEMS

4.3.1 ETR TELEMETRY SUPPORT. The following ETR facilities are expected to provide coverage of the VHF telemetry links listed in Tables 3.3 and 3.4.

a. Airborne TLM Coverage - Two ARIA aircraft will support the mission after the launch phase.

b. Uprange TLM Stations - Station 19 (TEL IV) - This station will route certain data in real time to the ETR for range safety purposes.

c. Downrange Telemetry Stations - No ETR downrange telemetry support is presently planned.

d. Shipborne Coverage - No ETR ship coverage is planned.

4.3.2 GSFC TELEMETRY SUPPORT. The following GSFC STDN (MSFN) facilities will provide launch-phase telemetry coverage of certain selected VHF links on the launch vehicles and the S-band links on the IU (SL-1) and CSM:

S-Band	VHF
KSC	KSC
Bermuda	Bermuda
	Wallops Island
	St. John's, Newf. (SL-1 only)

4.3.3 KSC TELEMETRY SUPPORT. The following KSC facilities will monitor the VHF and S-band telemetry links in support of space vehicle checkout operations:

a. LC-39 Telemetry GSE - Launch vehicle data (RF and hardline) are acquired by the DDAS during checkout and during the countdown until T-0. They are displayed in the LCC and are routed to the Data Core in the CIF.

b. CIF TLM Station - VHF and S-band RF data are received at the CIF Ground Station using either the CIF Antenna Site or the MILA USB Station. The open loop data are routed to Data Core for local CIF recording, display, and retransmission to MSFC, LC-39, and MSOB. The hardline data are routed to MSFC and MILA USB site.

c. CIF Antenna Field Receivers - VHF and S-band TLM receivers at the CIF Antenna Field will acquire the radiated telemetry data. They will be routed to the CIF Data Core.

d. MSOB ACE Station - Acceptance Checkout Equipment located in the MSOB will receive CSM and SWS hardline or RF data. The Quick-Look Data System (QLDS) at the MSOB also receives, processes and displays RF and hardline TLM data.

e. MILA USB Station - S-band and VHF equipment will acquire, process, and retransmit CSM and SWS launch vehicle data.

4.4 FREQUENCY CONTROL AND ANALYSIS

4.4.1 C-Band Beacon Checkout. The IU C-band Beacons 1 and 2 are checked out prior to launch by EMA vans and in conjunction with Radar 1.16.

4.4.2 Spurious Emission Search. The EMC van will provide the RFI search and record coverage from 100 MHz to 10 GHz.

4.4.3 Command Link Monitoring. The UHF command link will be monitored and recorded from the roof of the VAB.

4.5 SURFACE INSTRUMENTATION SUMMARY

Locations of the data acquisition systems planned to support this mission are shown in Figures 4-1 through 4-5. Elevation angles from the major land-based tracking stations for the launch phase are shown in Figures 4-6 through 4-9. The expected flight time coverage for metric trajectory coverage is given in Figures 4-37 and 4-38. The estimated accuracies of the C-band radars are given in Figures 4-10 through 4-36.

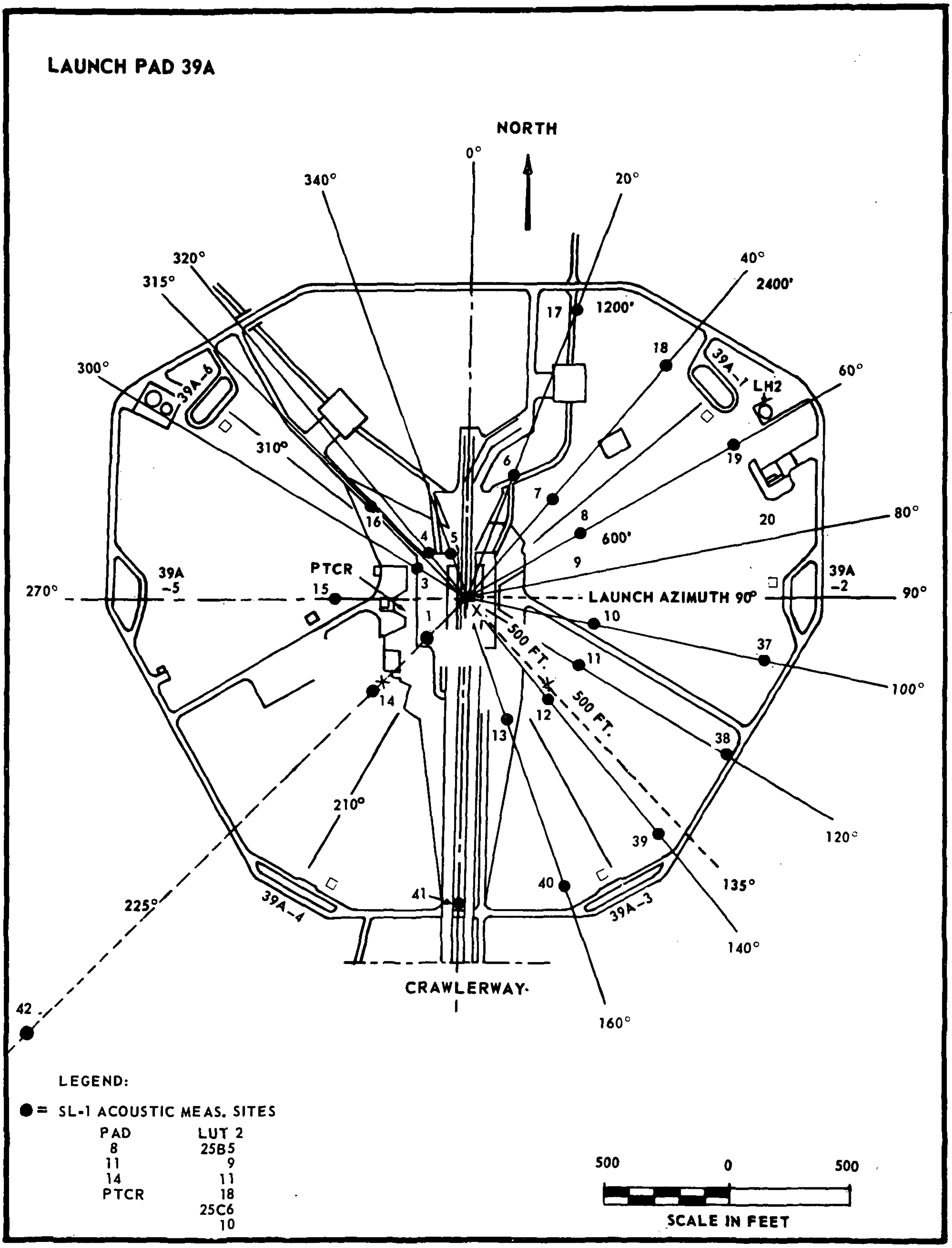


FIGURE 4-1 SL-1 CLOSE-IN INSTRUMENTATION

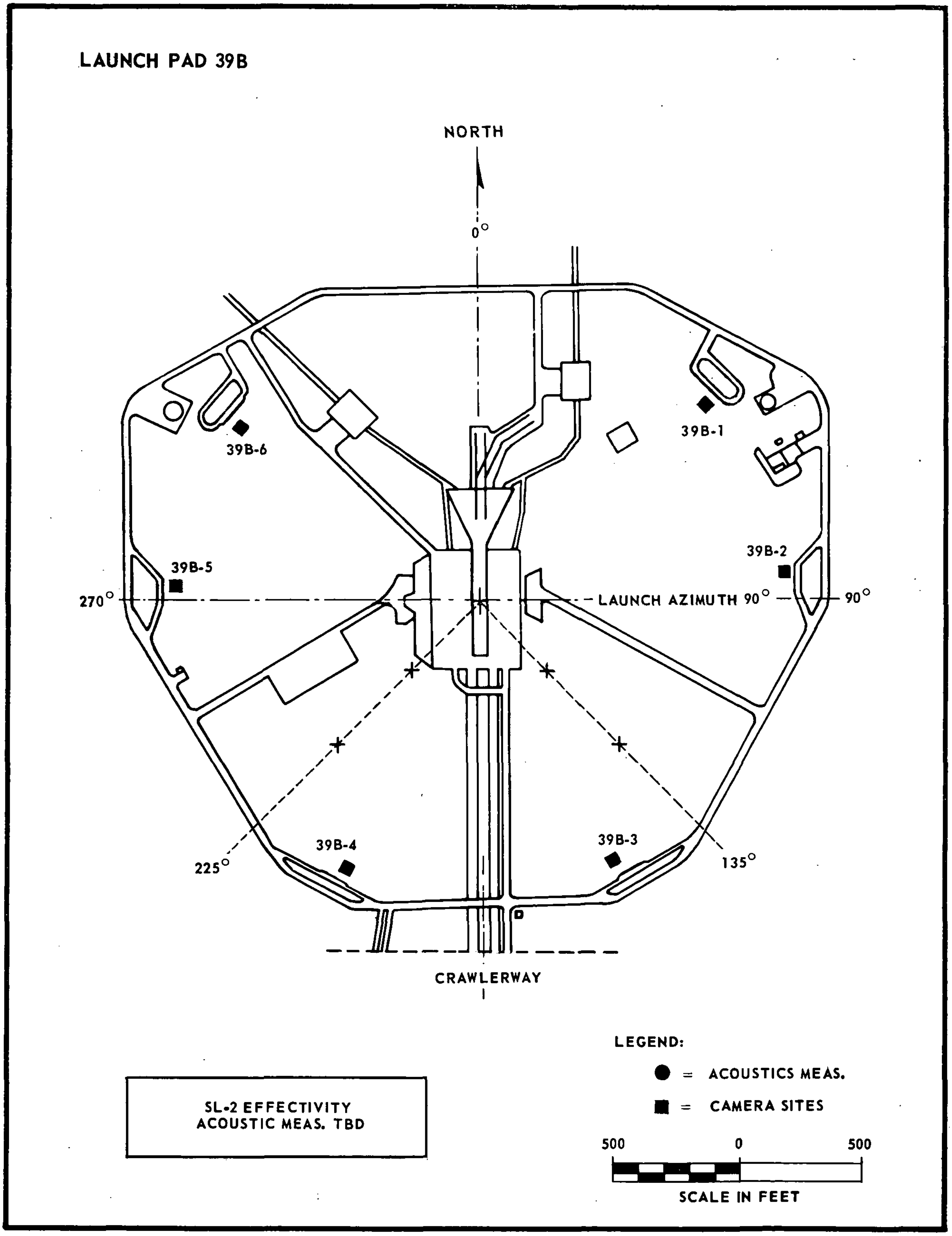


FIGURE 4-2 SL-2 CLOSE-IN INSTRUMENTATION

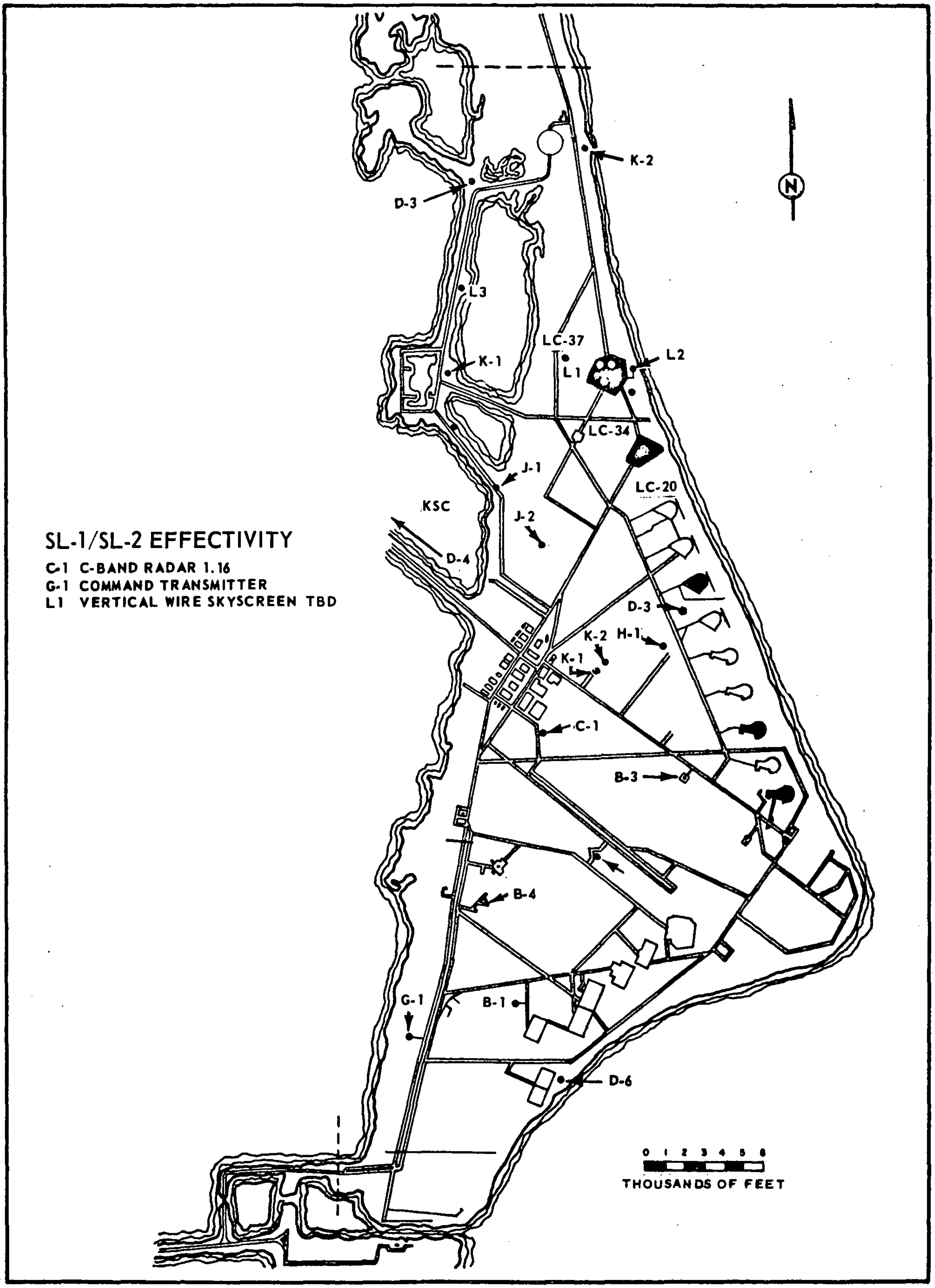


FIGURE 4-3 SL CAPE INSTRUMENTATION

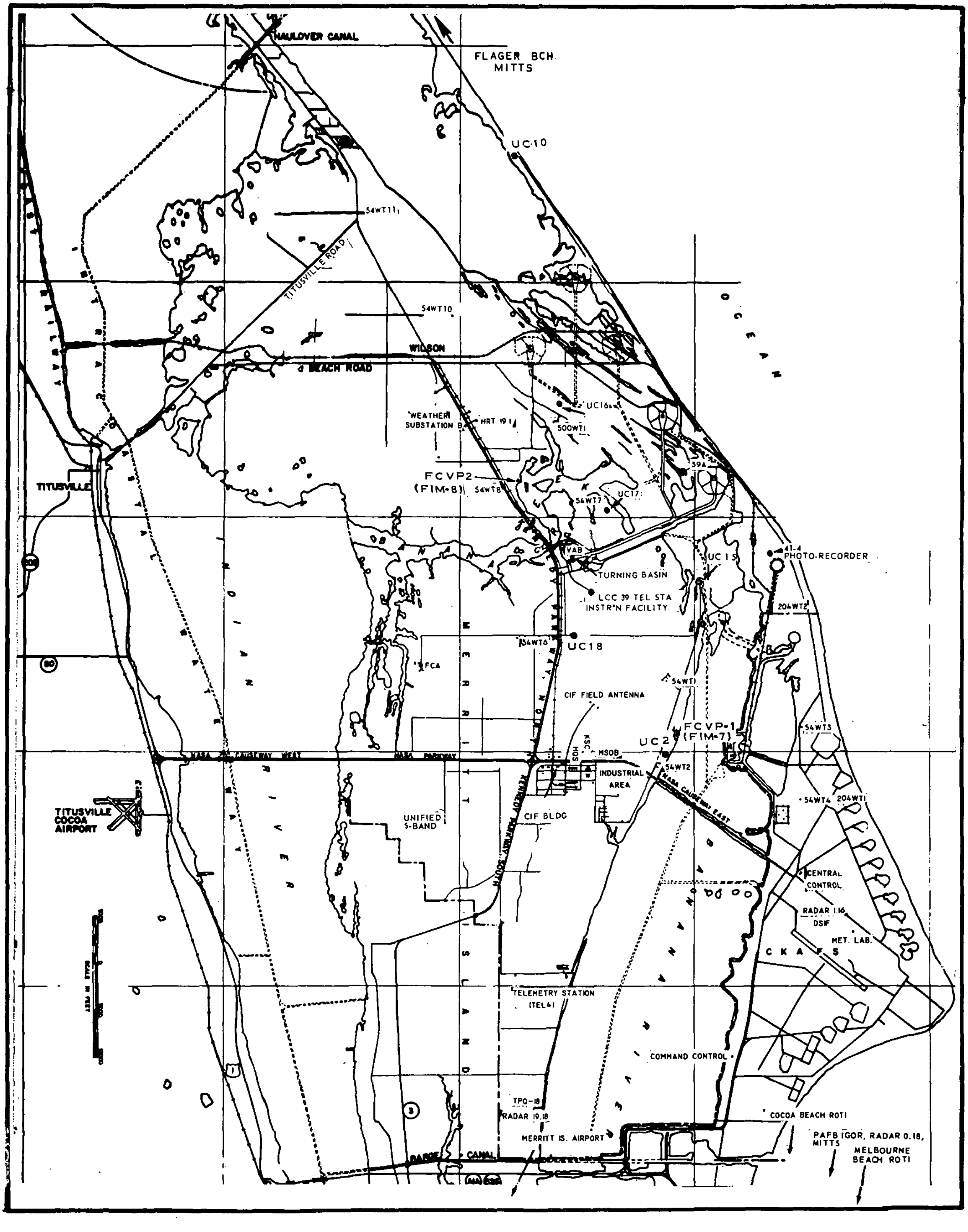


FIGURE 4-4 SL UPRANGE INSTRUMENTATION

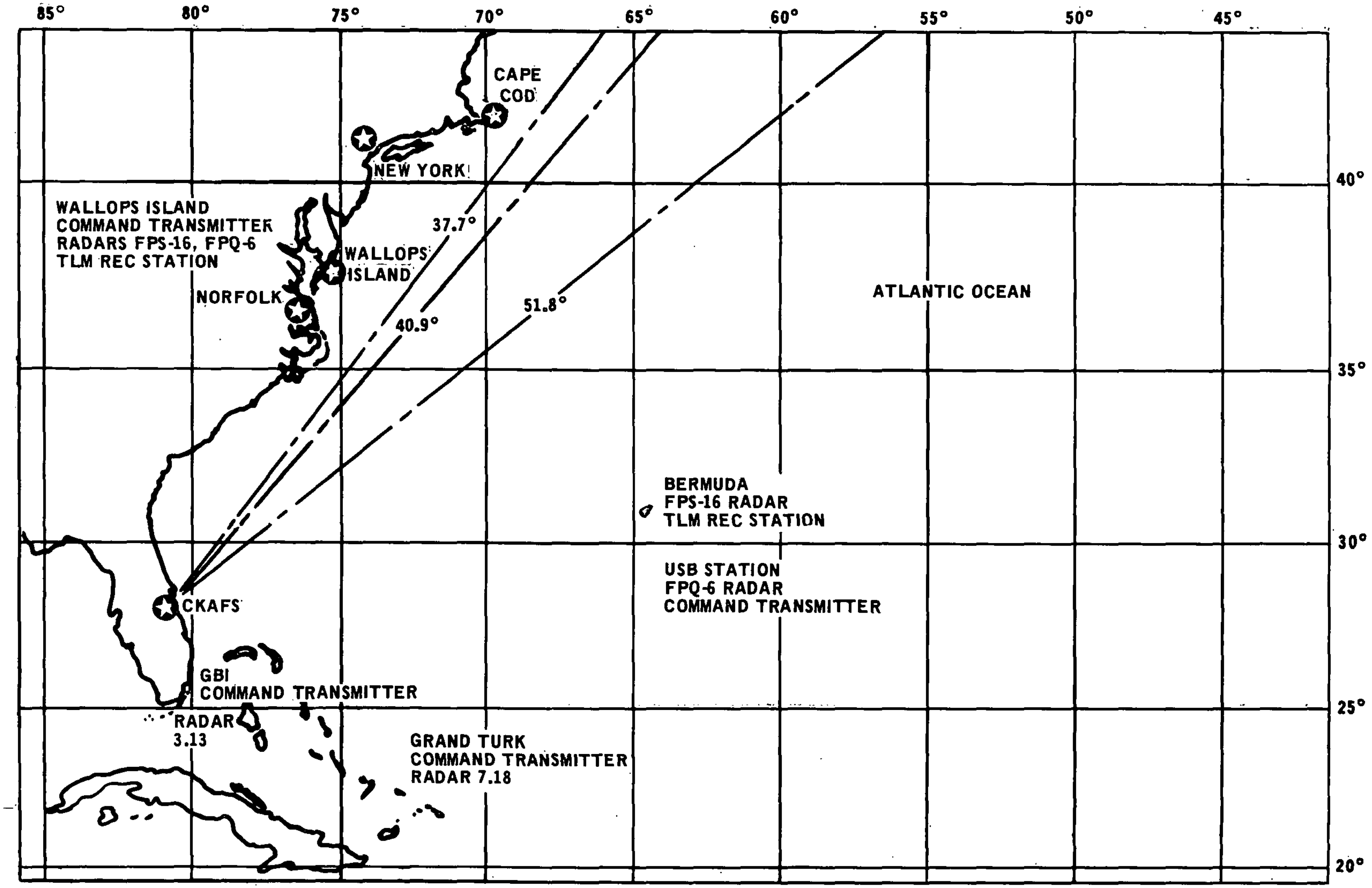


FIGURE 4-5 EXTENDED RANGE INSTRUMENTATION

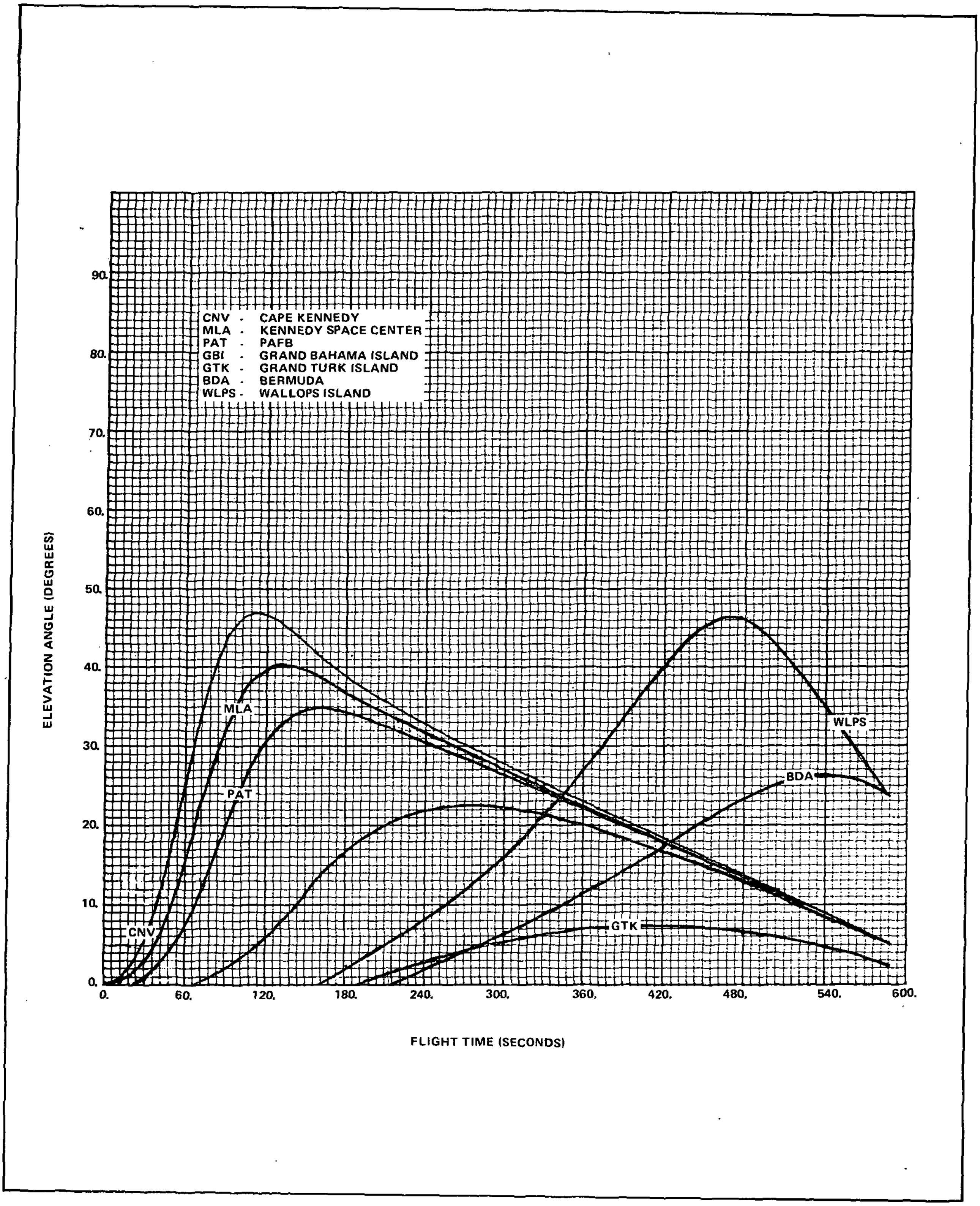


FIGURE 4-6 SL-1 ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, (F.A. 40.88°)

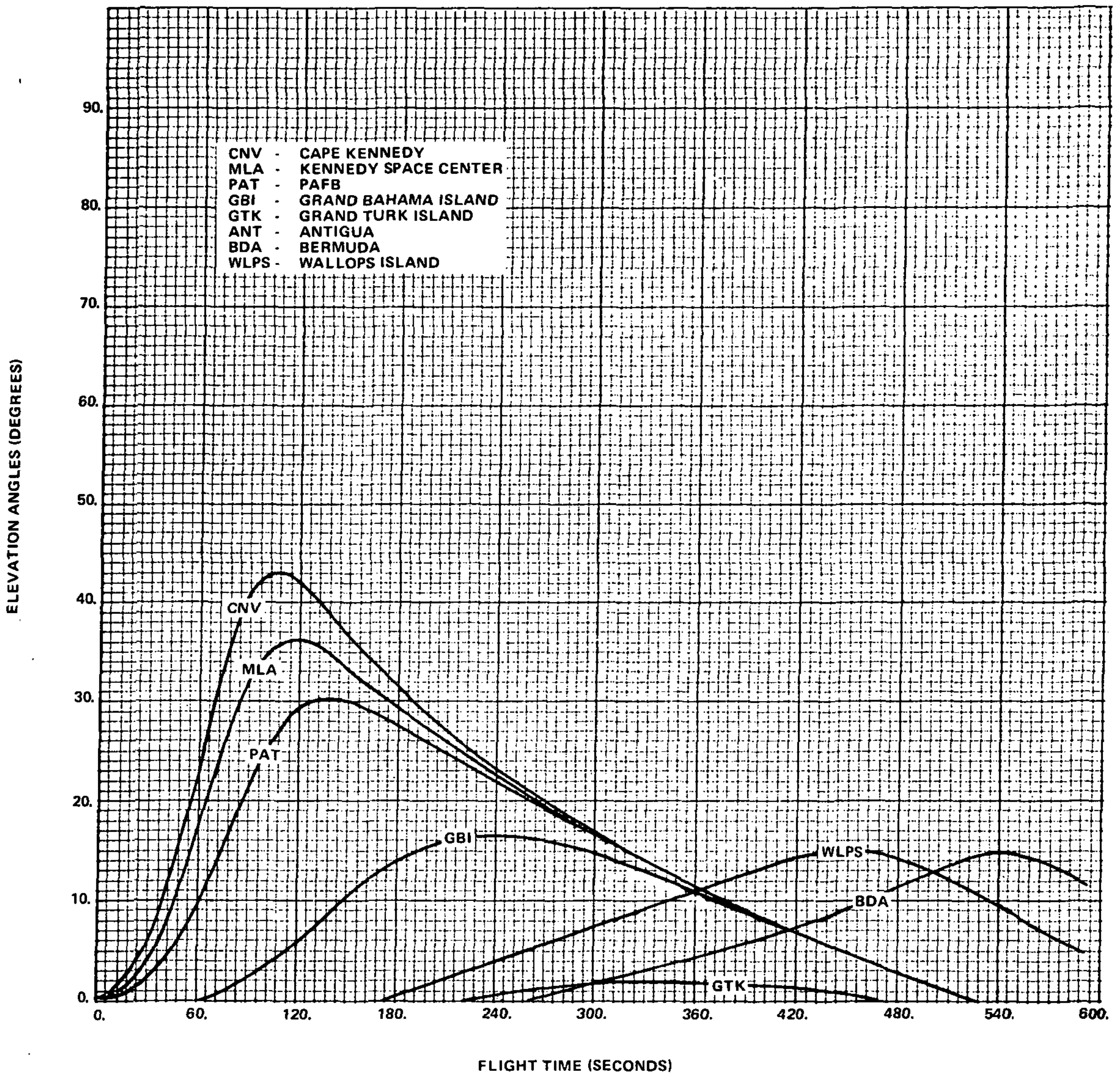


FIGURE 4-7 SL-2 ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, (WINDOW OPENING F.A. 51.82°)

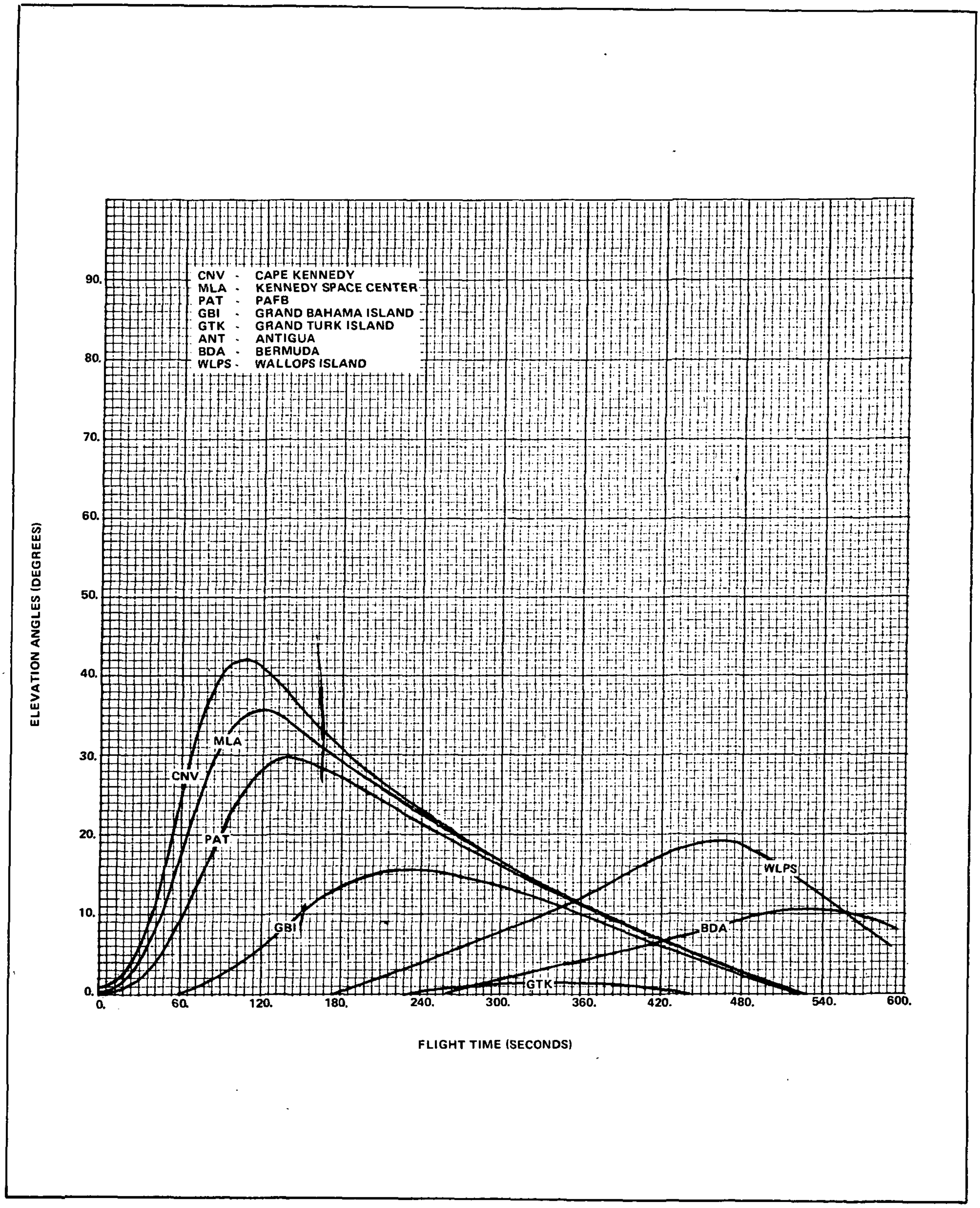


FIGURE 4-8 SL-2 ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, (NOMINAL F.A. 45.7997°)

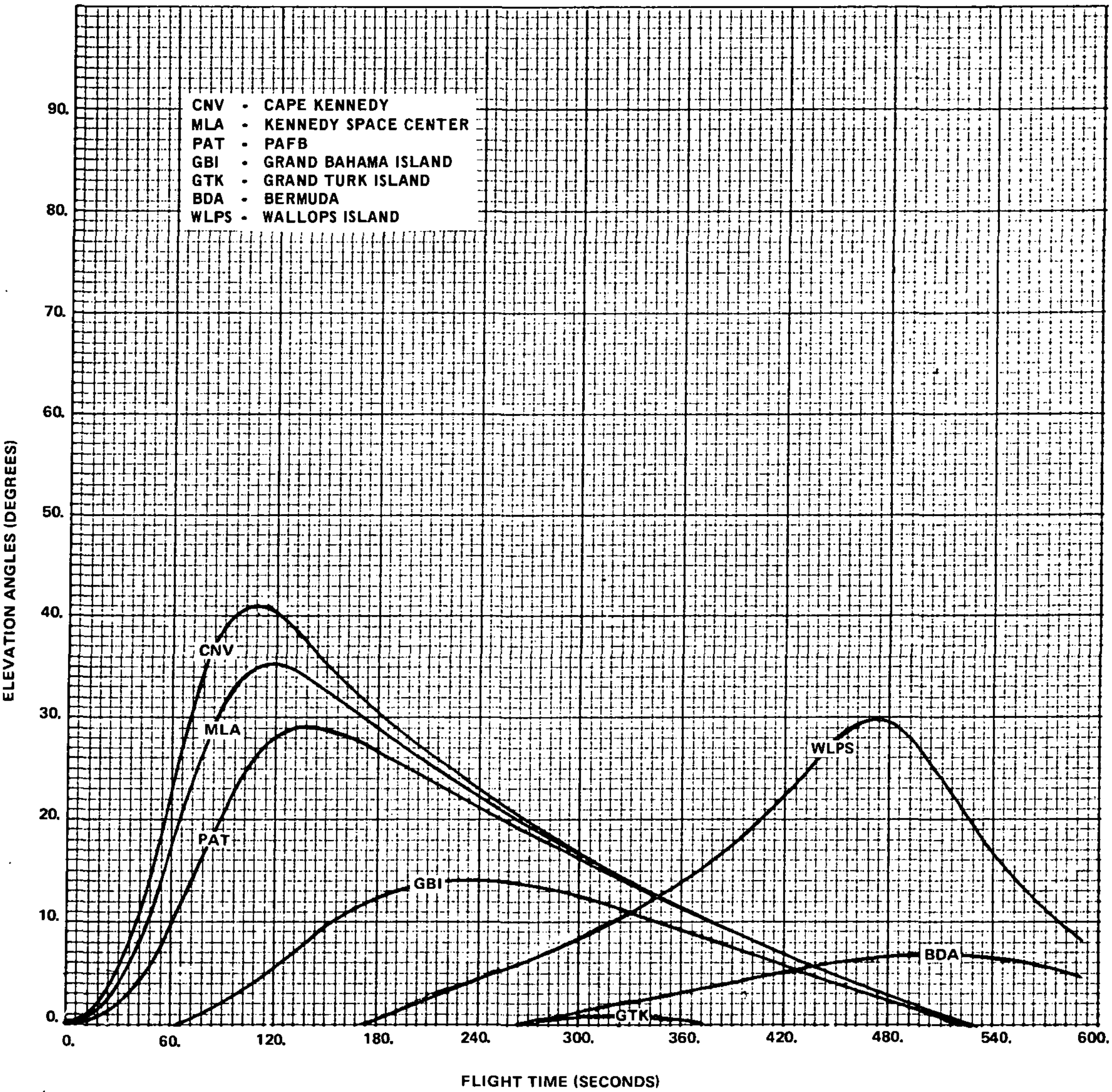


FIGURE 4-9 SL-2 ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, (WINDOW CLOSING F.A. 37.68°)

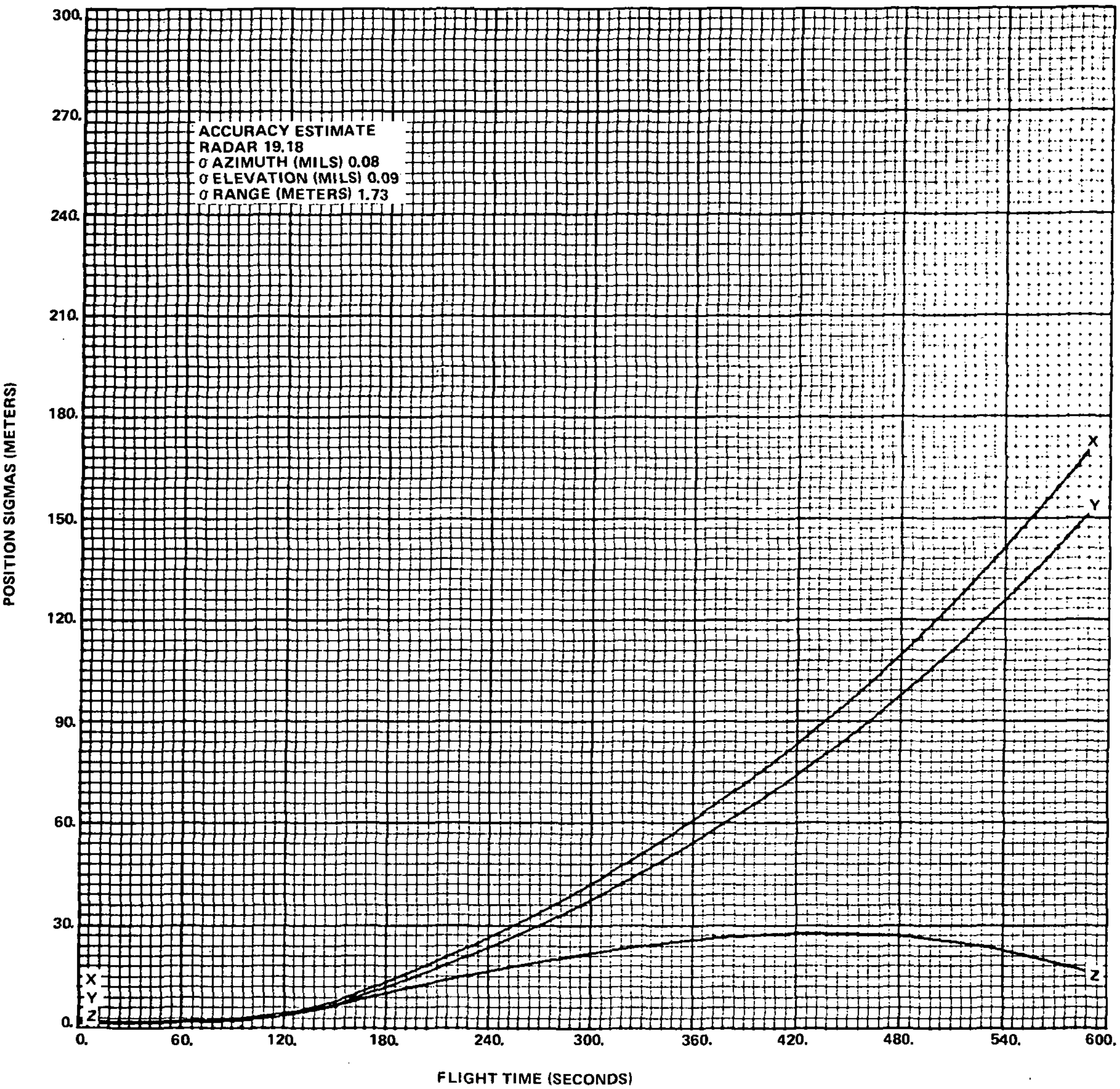


FIGURE 4-10 SL-1 ESTIMATES OF KSC C-BAND RADAR 19.18 POSITION ACCURACIES, (F.A. 40.88°)

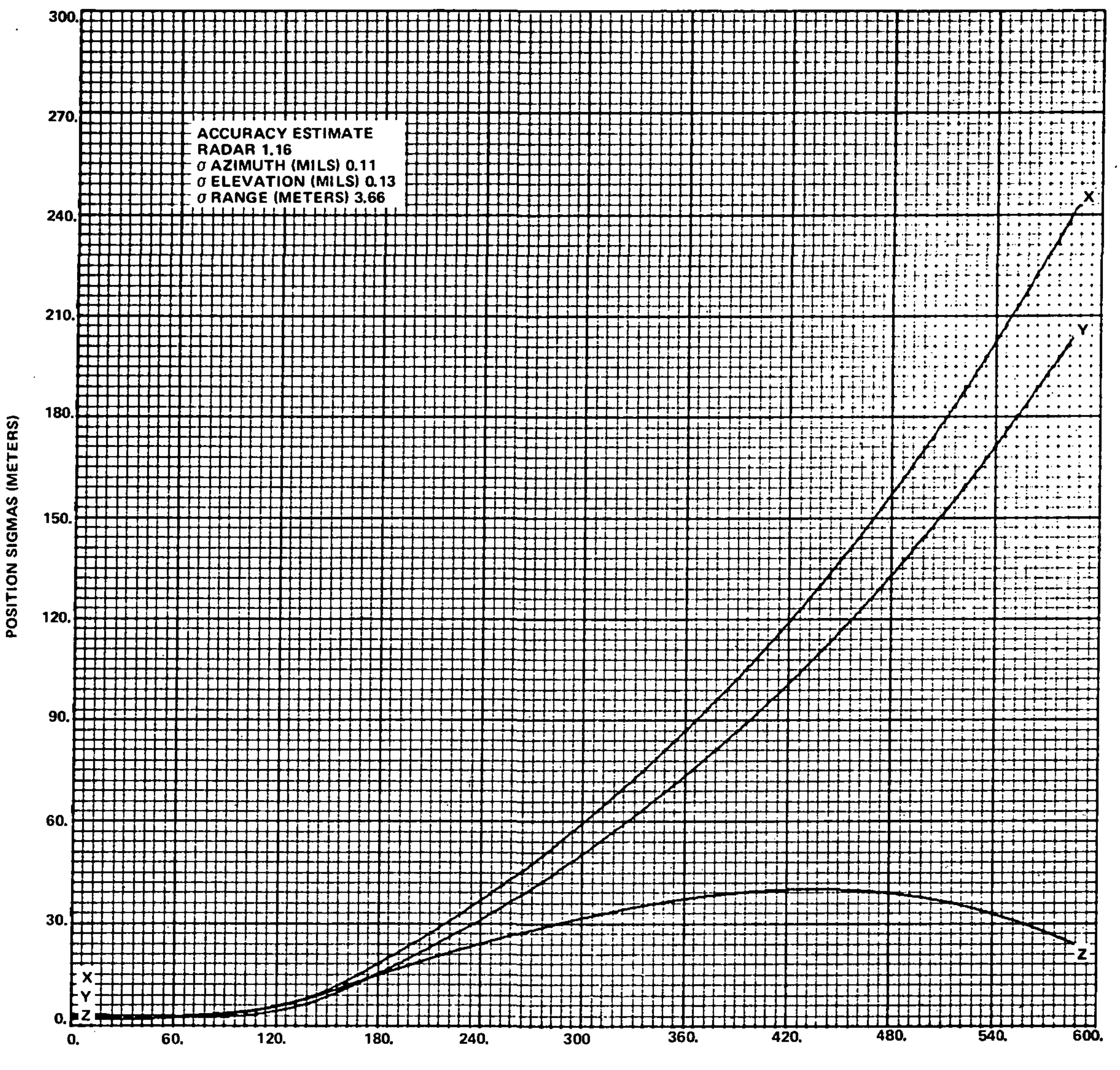


FIGURE 4-11 SL-1 ESTIMATES OF CAPE KENNEDY C-BAND RADAR 1.16 POSITION ACCURACIES, (F.A. 40.88°)

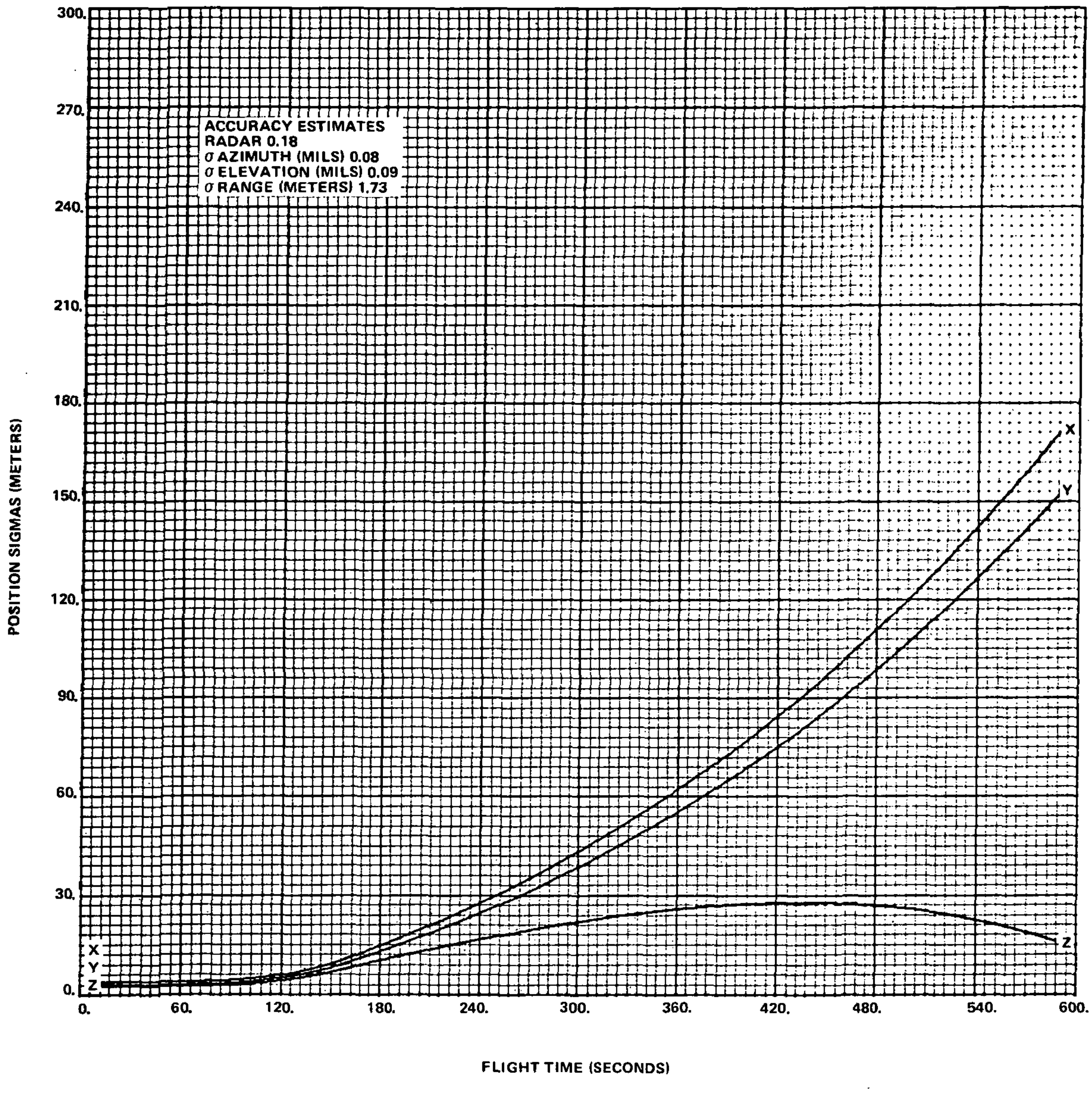


FIGURE 4-12 SL-1 ESTIMATES OF PAFB C-BAND RADAR 0.18 POSITION ACCURACIES, (F.A. 40.88°)

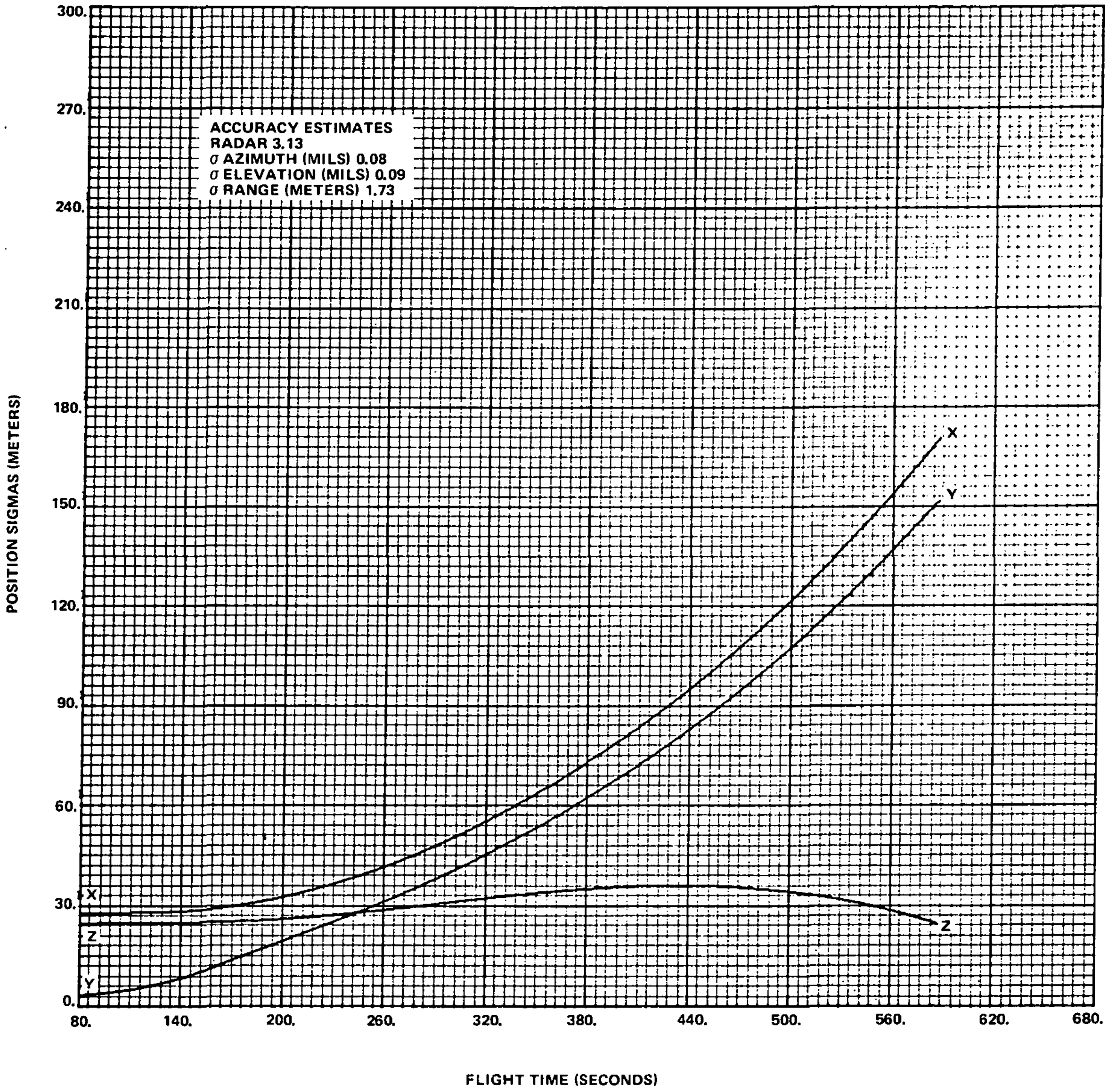


FIGURE 4-13 SL-1 ESTIMATES OF GBI C-BAND RADAR 3.13 POSITION ACCURACIES, (F.A. 40.88°)

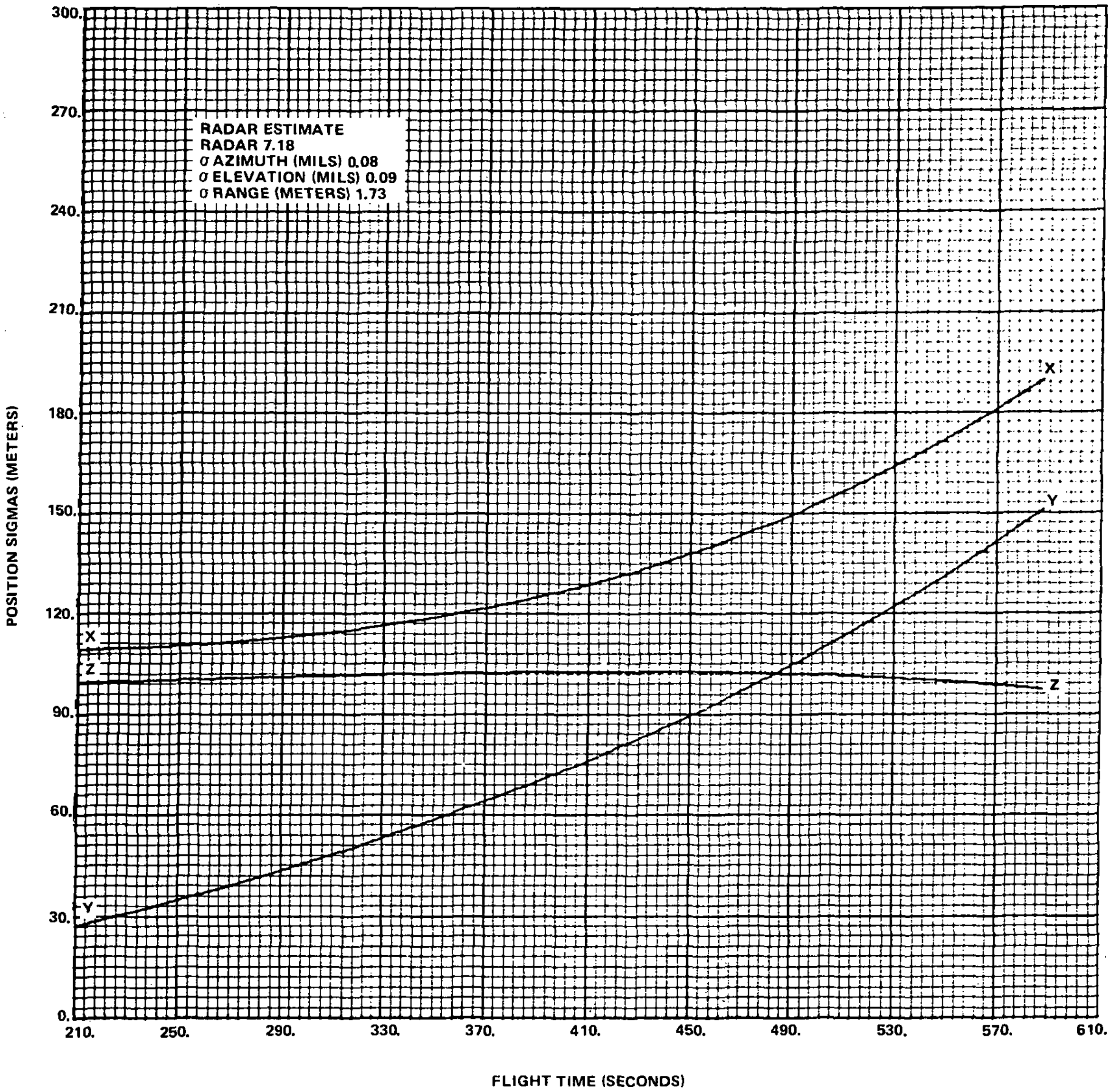


FIGURE 4-14 SL-1 ESTIMATES OF GRAND TURK ISLAND C-BAND RADAR 7.18 POSITION ACCURACIES, (F.A. 40.88°)

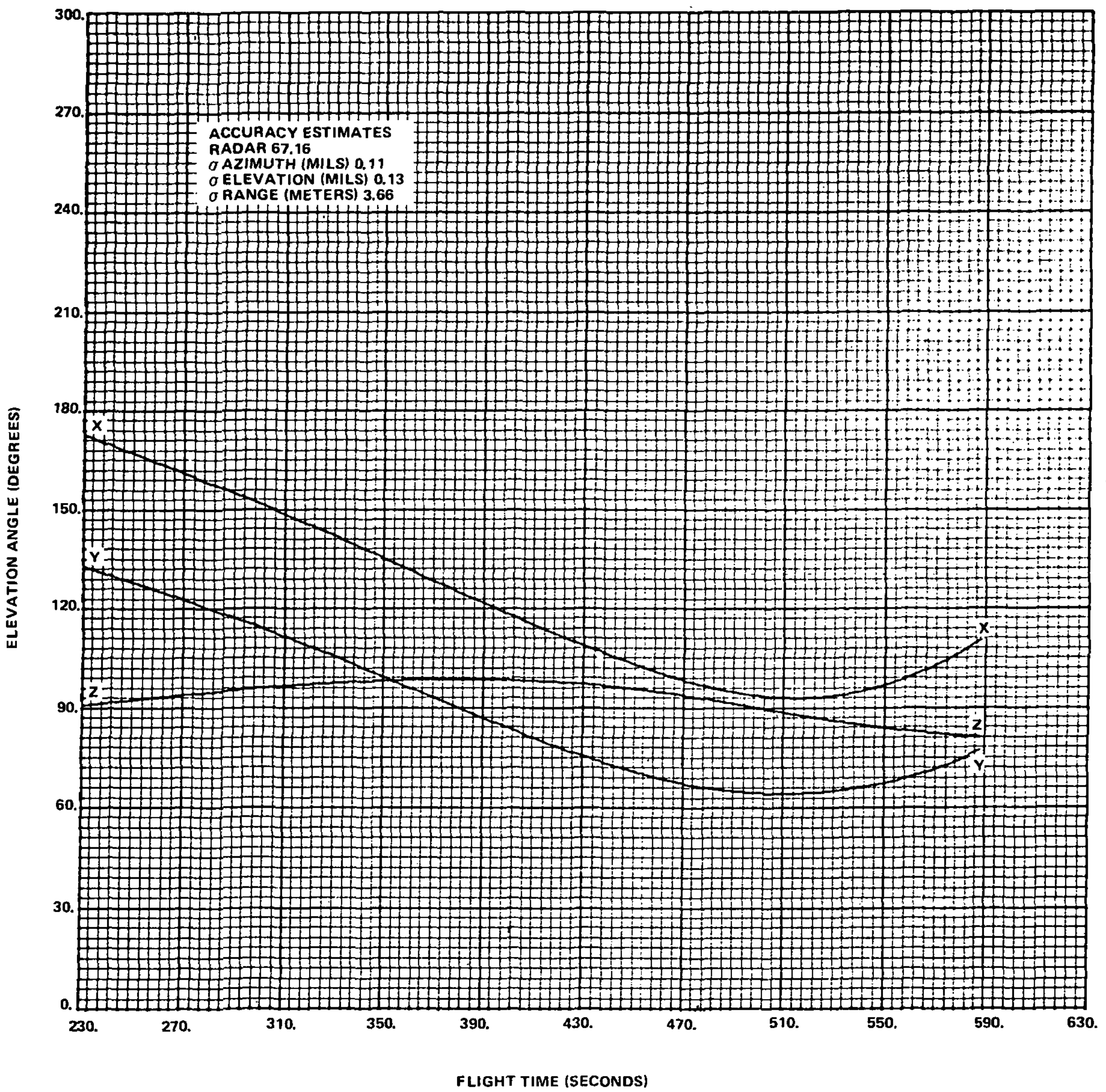


FIGURE 4-15 SL-1 ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES, (F.A. 40.88°)

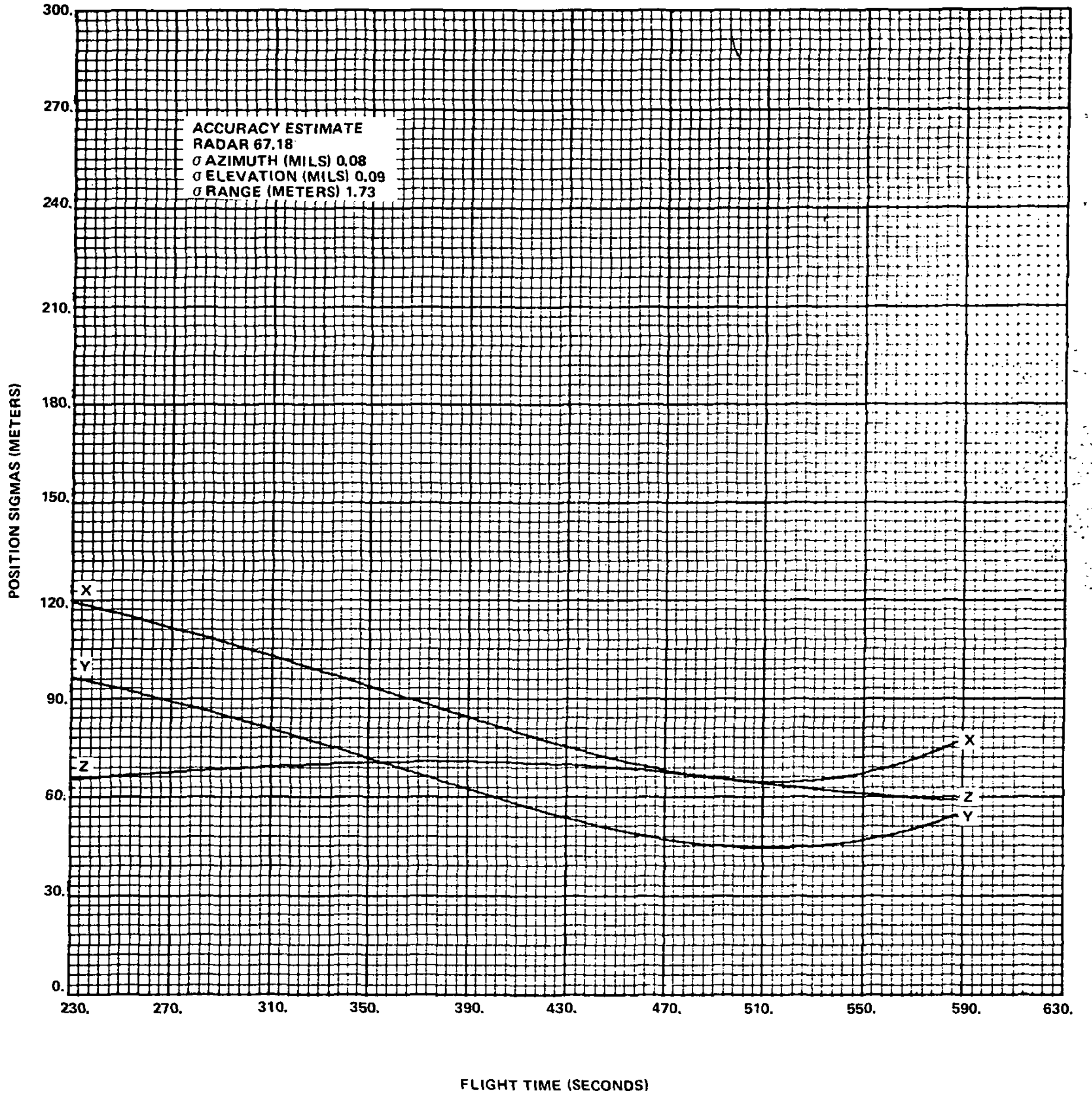


FIGURE 4-16 SL-1 ESTIMATES OF BERMUDA C-BAND RADAR 67.18 POSITION ACCURACIES, (F.A. 40.88°)

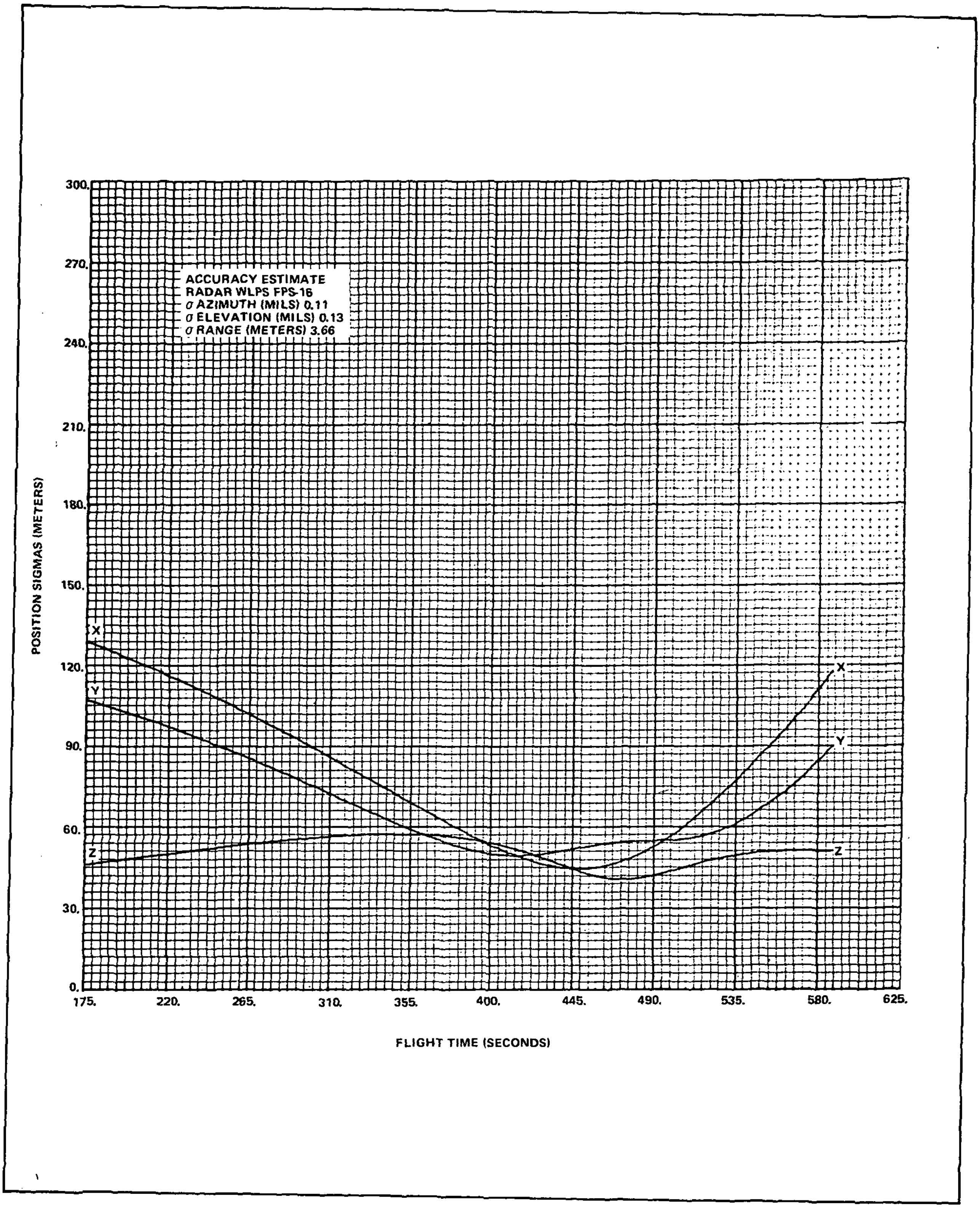


FIGURE 4-17 SL-1 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPS-16 POSITION ACCURACIES, (F.A. 40.88°)

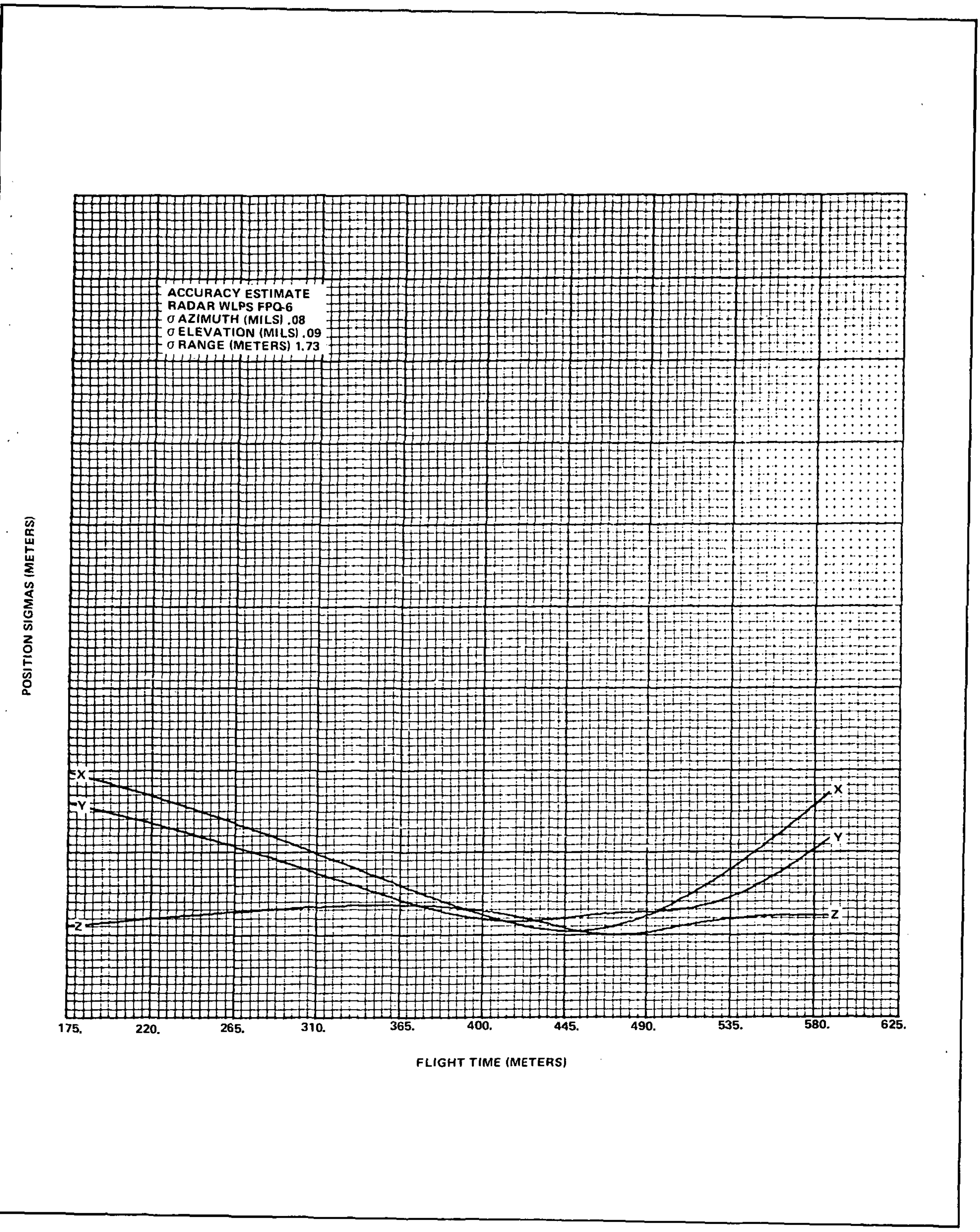


FIGURE 4-18. SL-1 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPQ-6 POSITION ACCURACIES, (F.A. 40.80°)

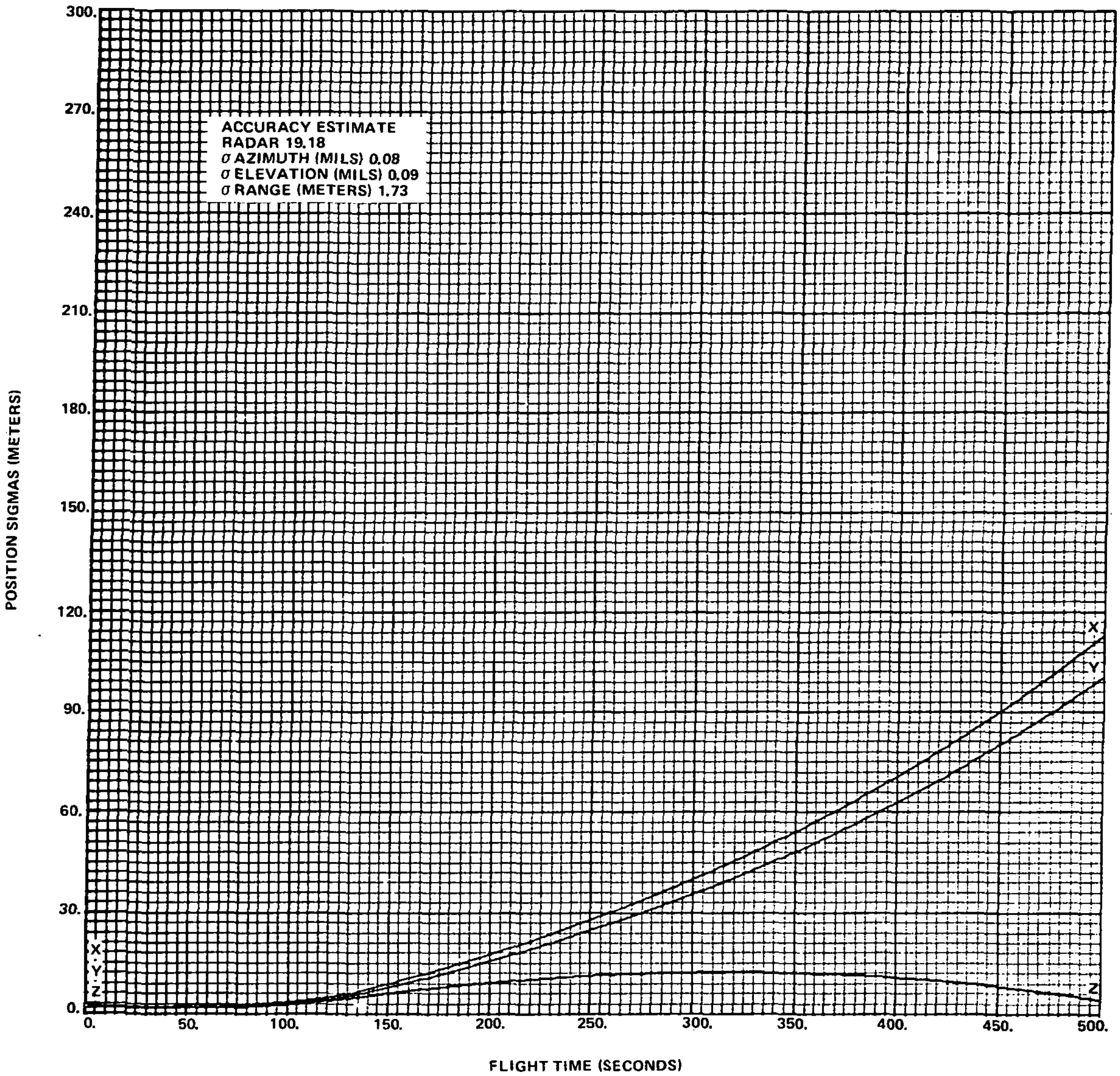


FIGURE 4-19 SL-2 ESTIMATES OF KSC C-BAND RADAR 19.18 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

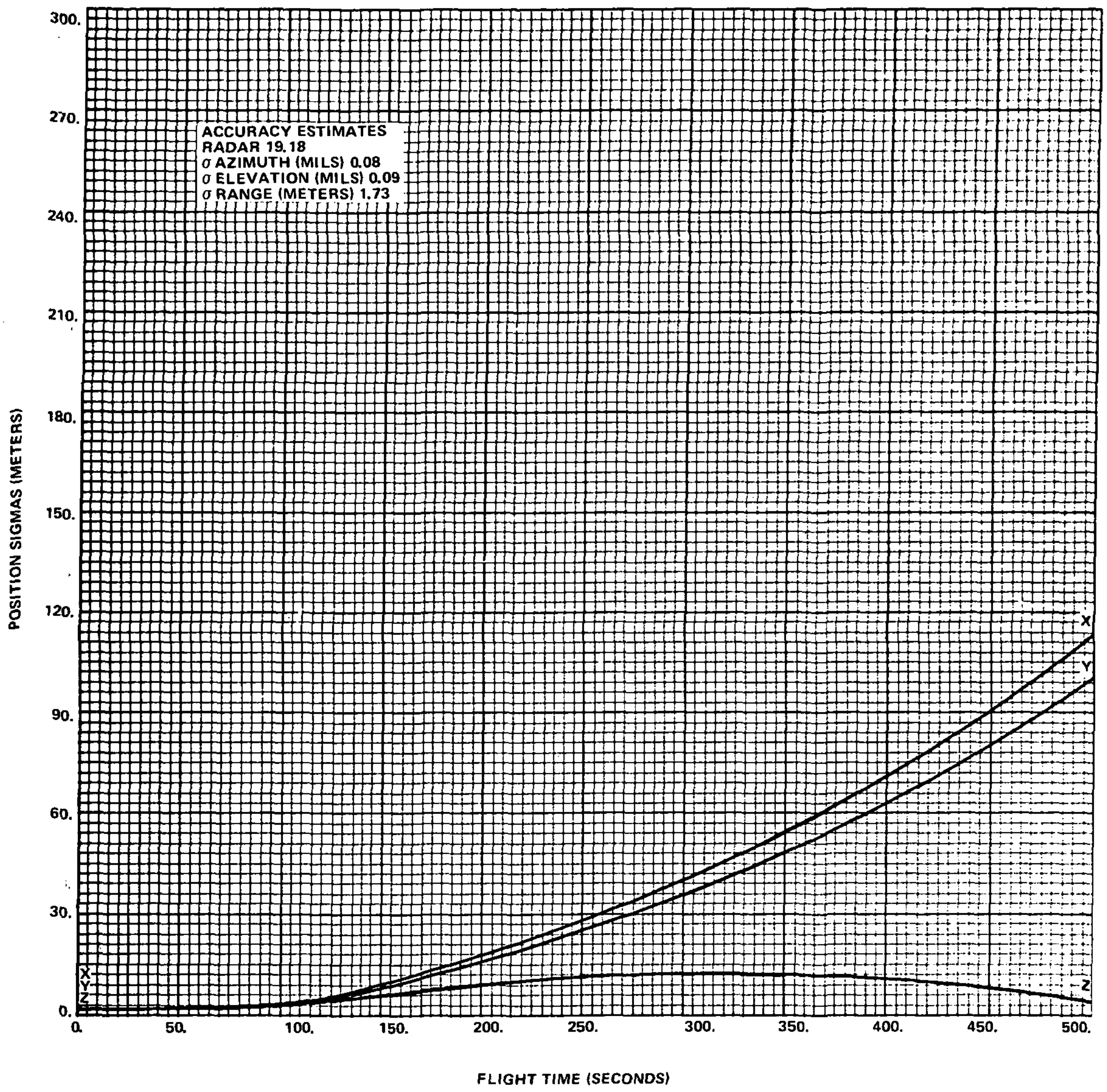


FIGURE 4-20 SL-2 ESTIMATES OF KSC C-BAND RADAR 19.18 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

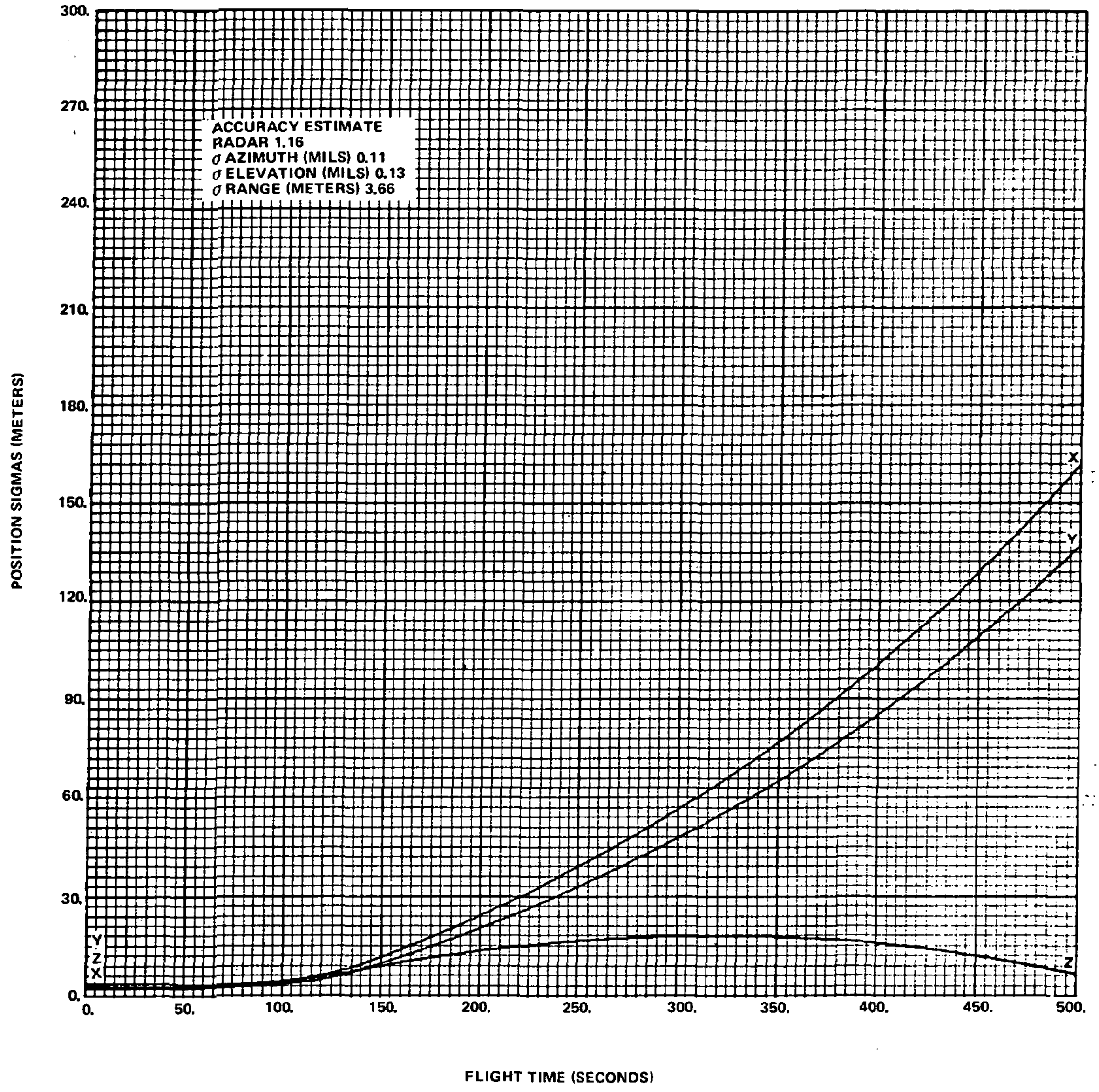


FIGURE 4-21 SL-2 ESTIMATES OF CAPE KENNEDY C-BAND RADAR 1.16 POSITION ACCURACIES, (WINDOW OPENING F.A. 51.82°)

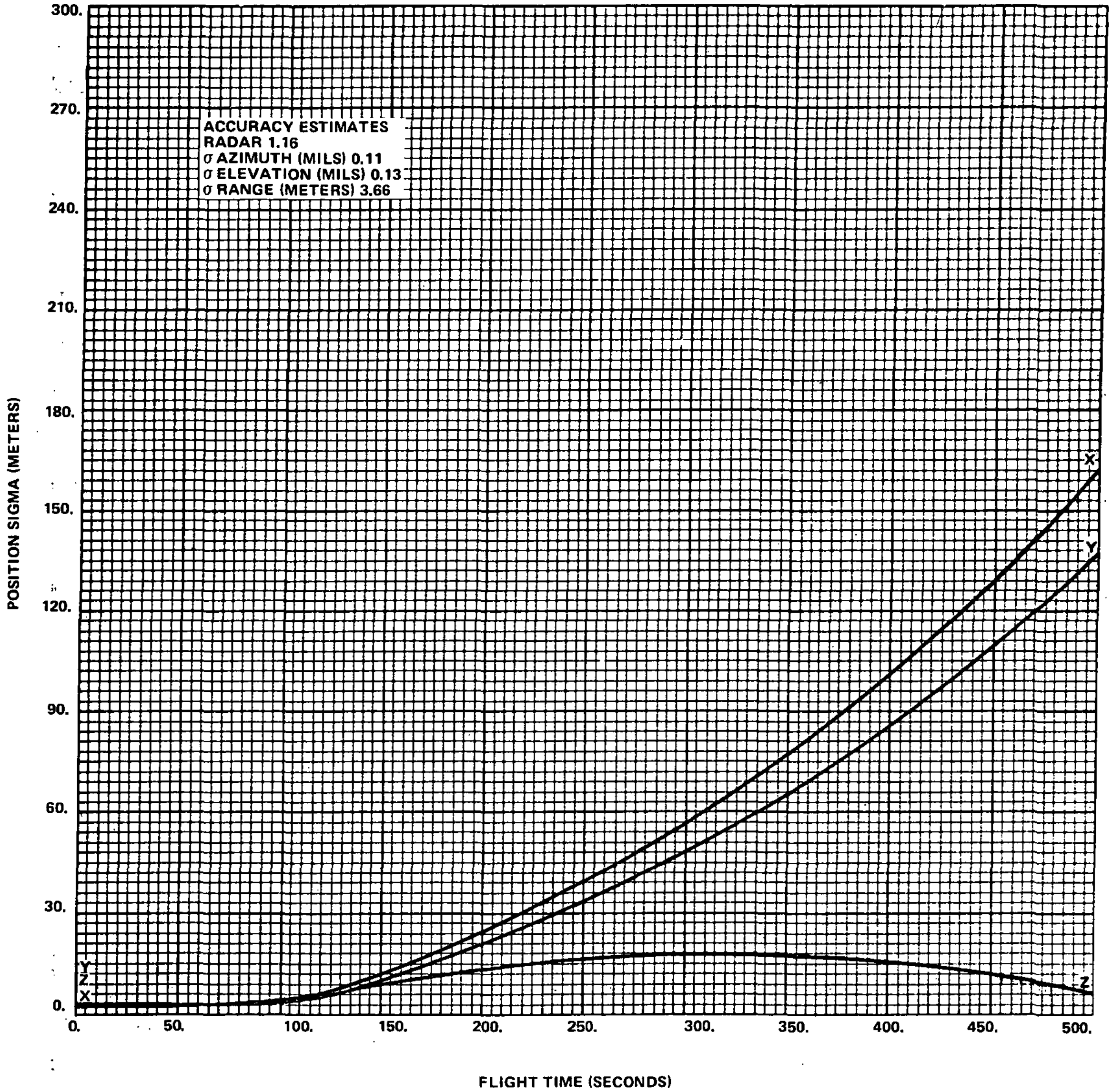


FIGURE 4-22 SL-2 ESTIMATES OF CAPE KENNEDY C-BAND RADAR 1.16 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

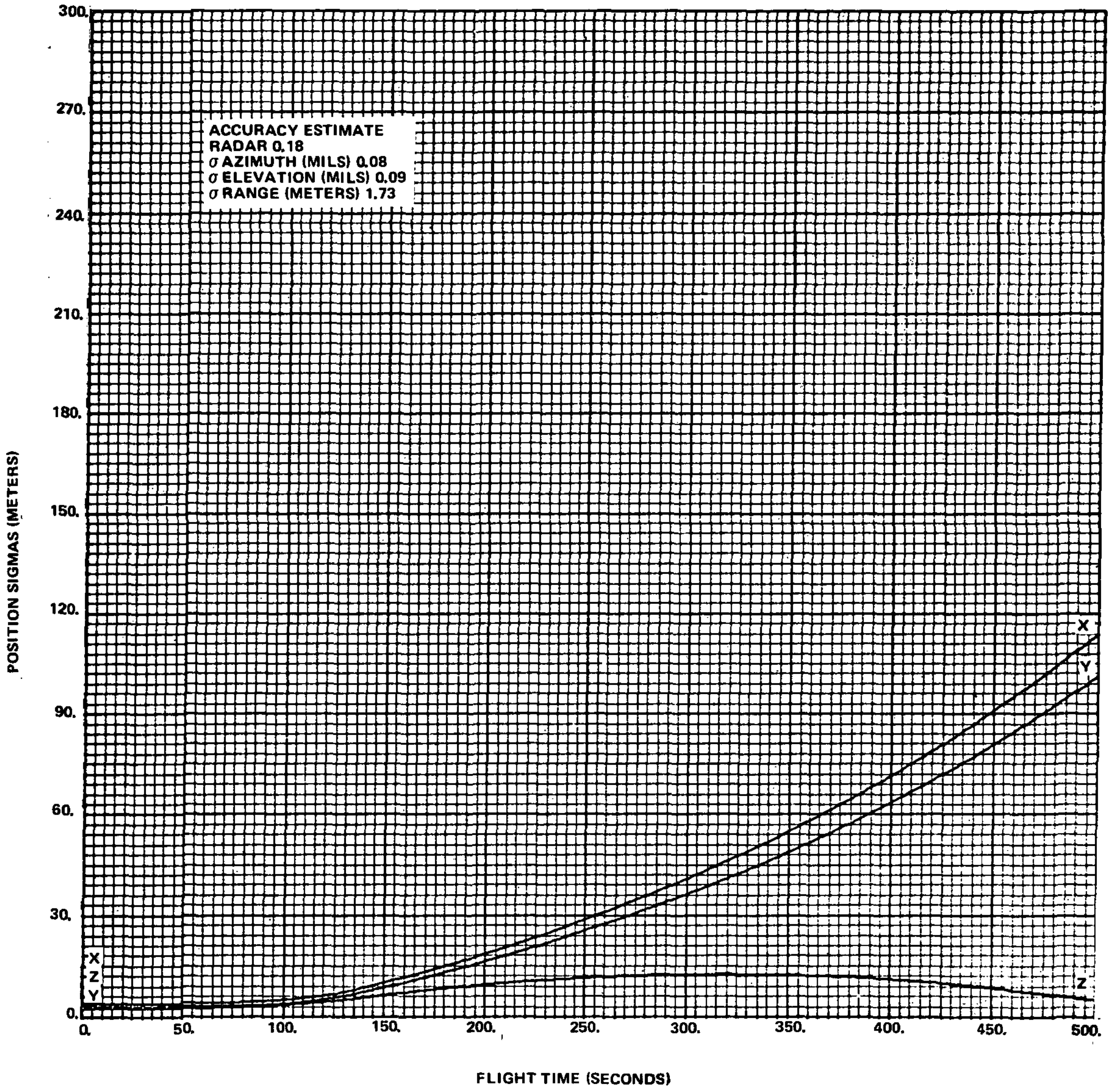


FIGURE 4-23 SL-2 ESTIMATES OF PAFB C-BAND RADAR 0.18 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

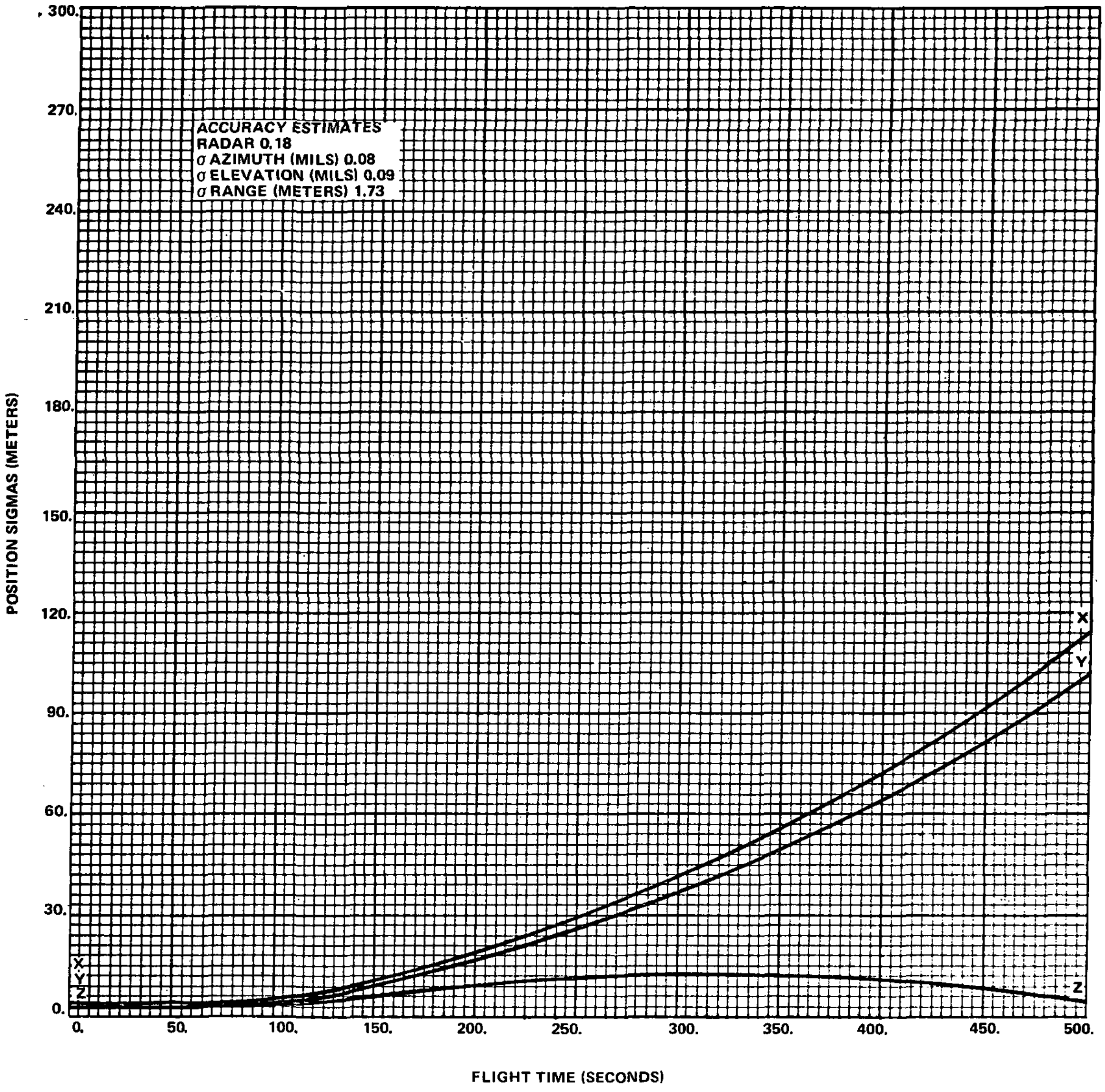


FIGURE 4-24 SL-2 ESTIMATES OF PAFB C-BAND RADAR 0.18 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

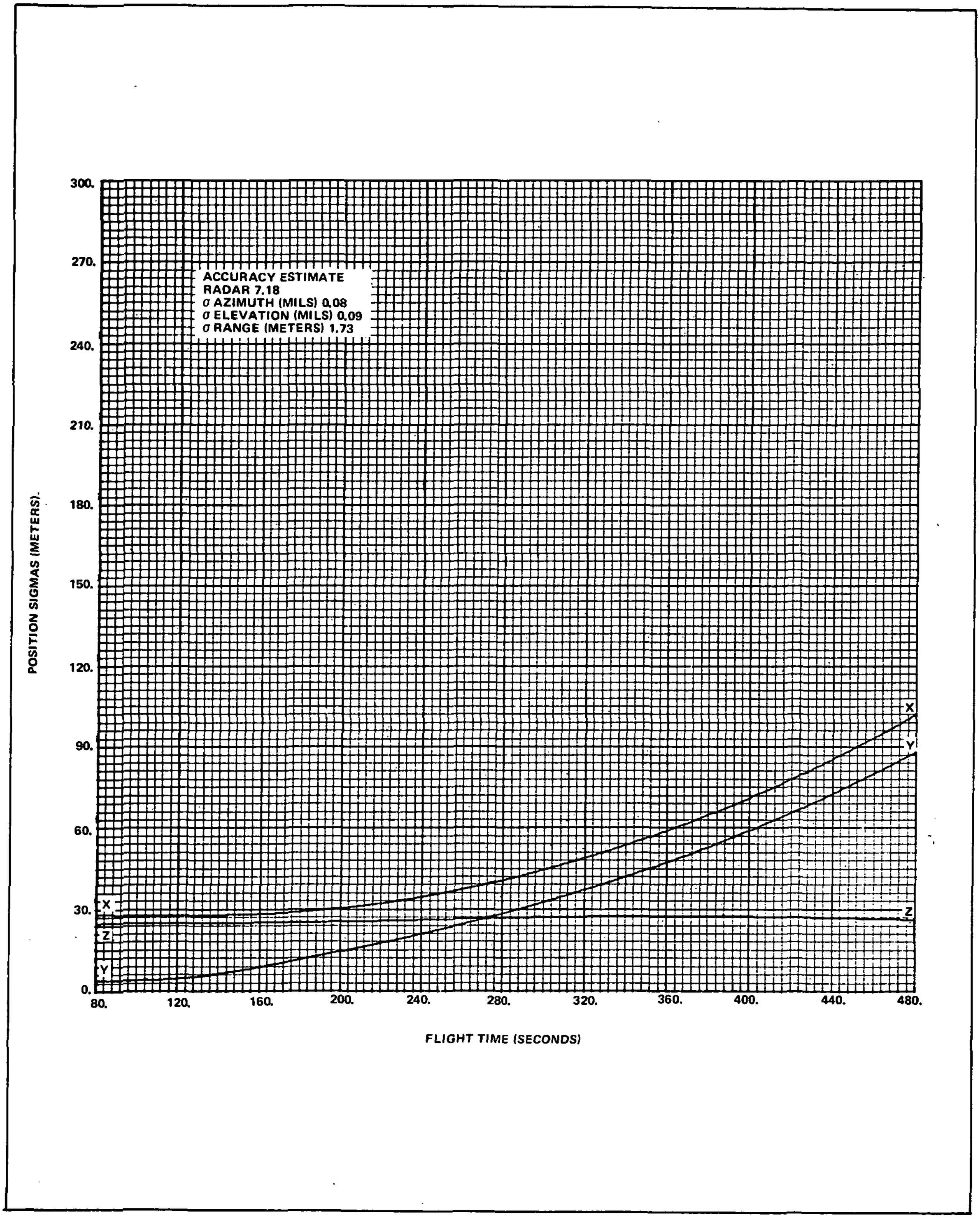


FIGURE 4-25 SL-2 ESTIMATES OF GBI C-BAND RADAR 3.13 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

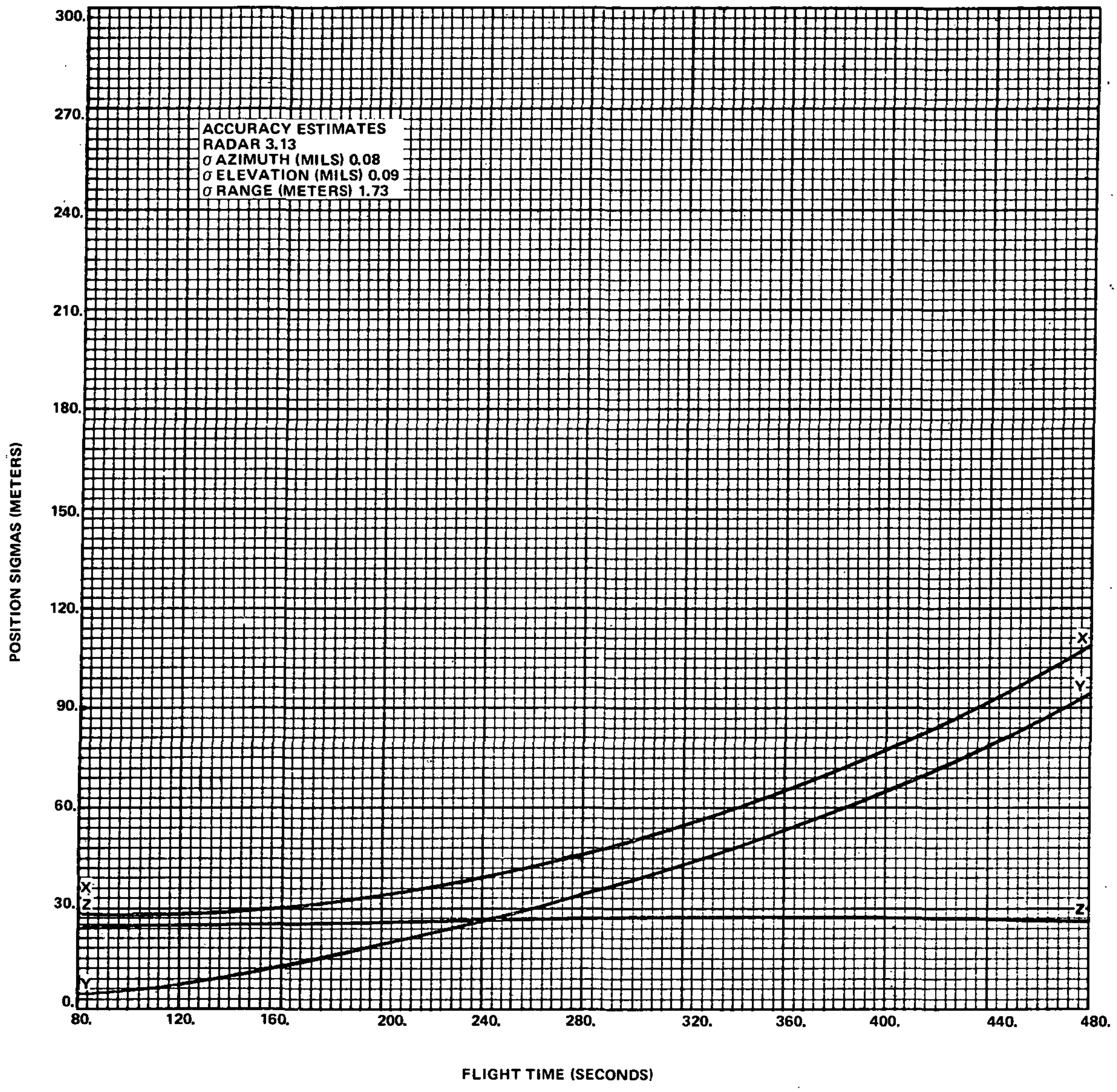


FIGURE 4-26 SL-2 ESTIMATES OF GBI C-BAND RADAR 3.13 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

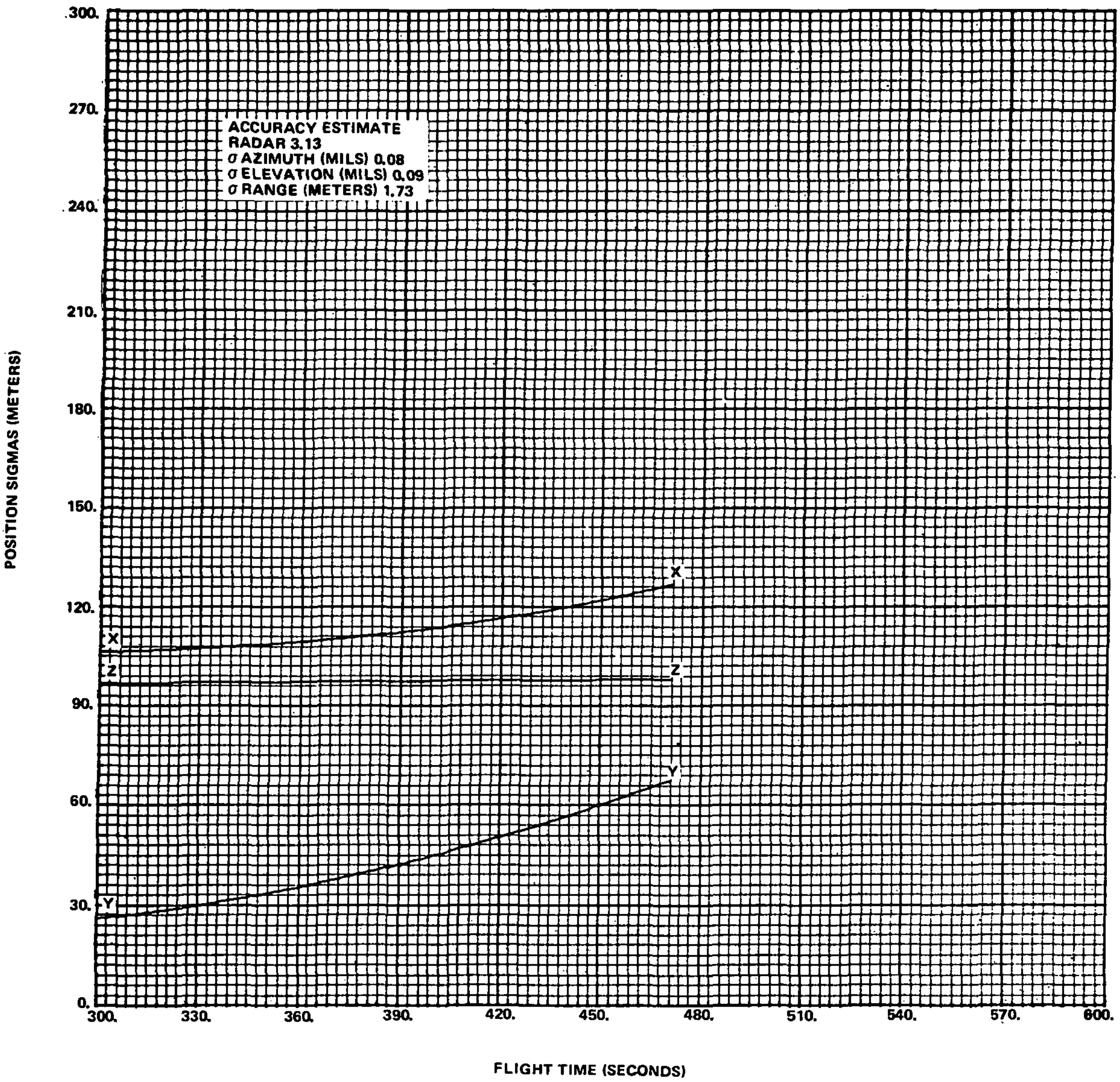


FIGURE 4-27 SL-2 ESTIMATES OF GRAND TURK ISLAND C-BAND RADAR 7.18 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

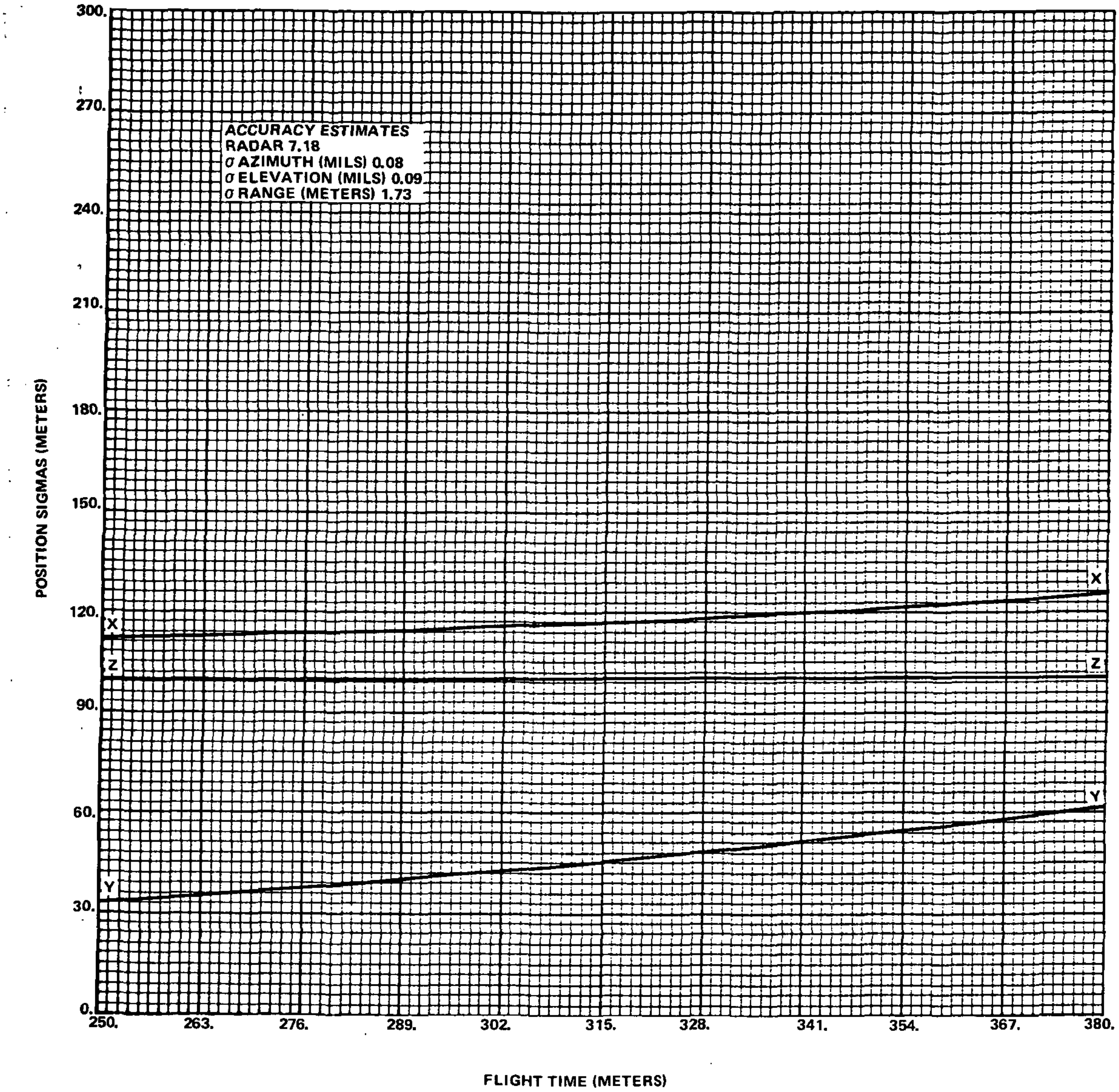


FIGURE 4-28 SL-2 ESTIMATES OF GRAND TURK ISLAND C-BAND RADAR 7.18 POSITION ACCURACIES (CLOSING F.A. 37.68°)

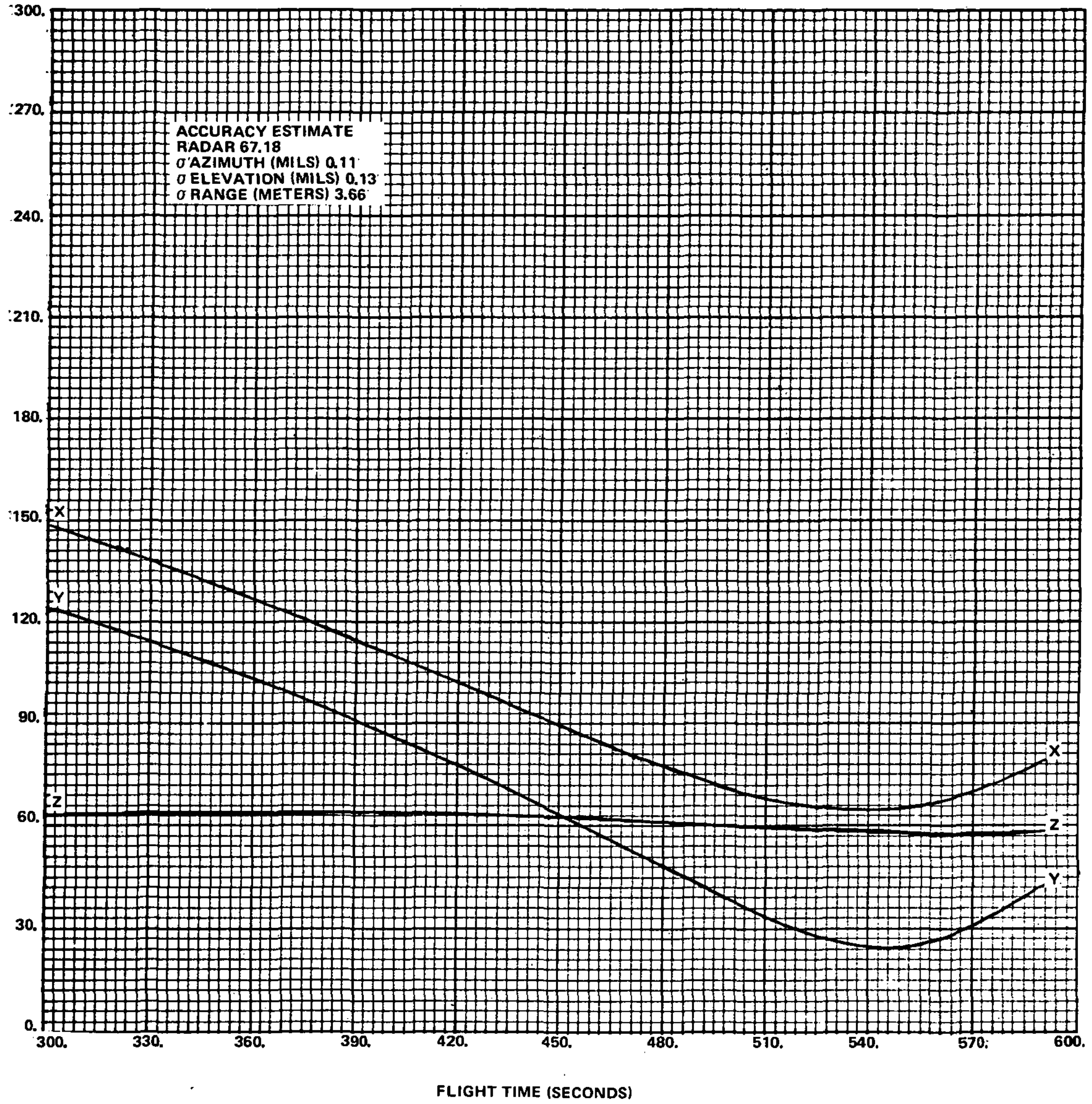


FIGURE 4-29 SL-2 ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

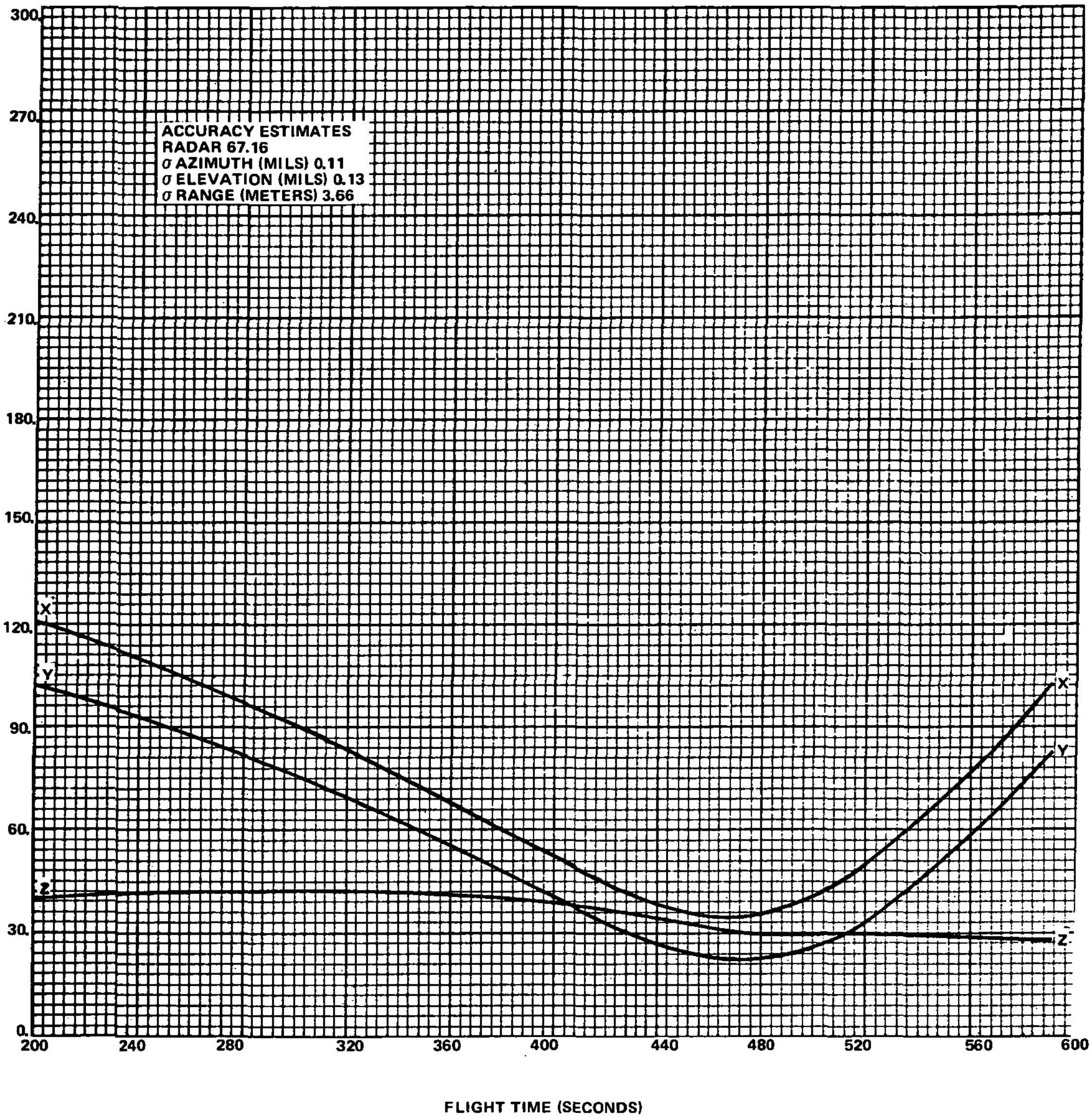


FIGURE 4-30 SL-2 ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

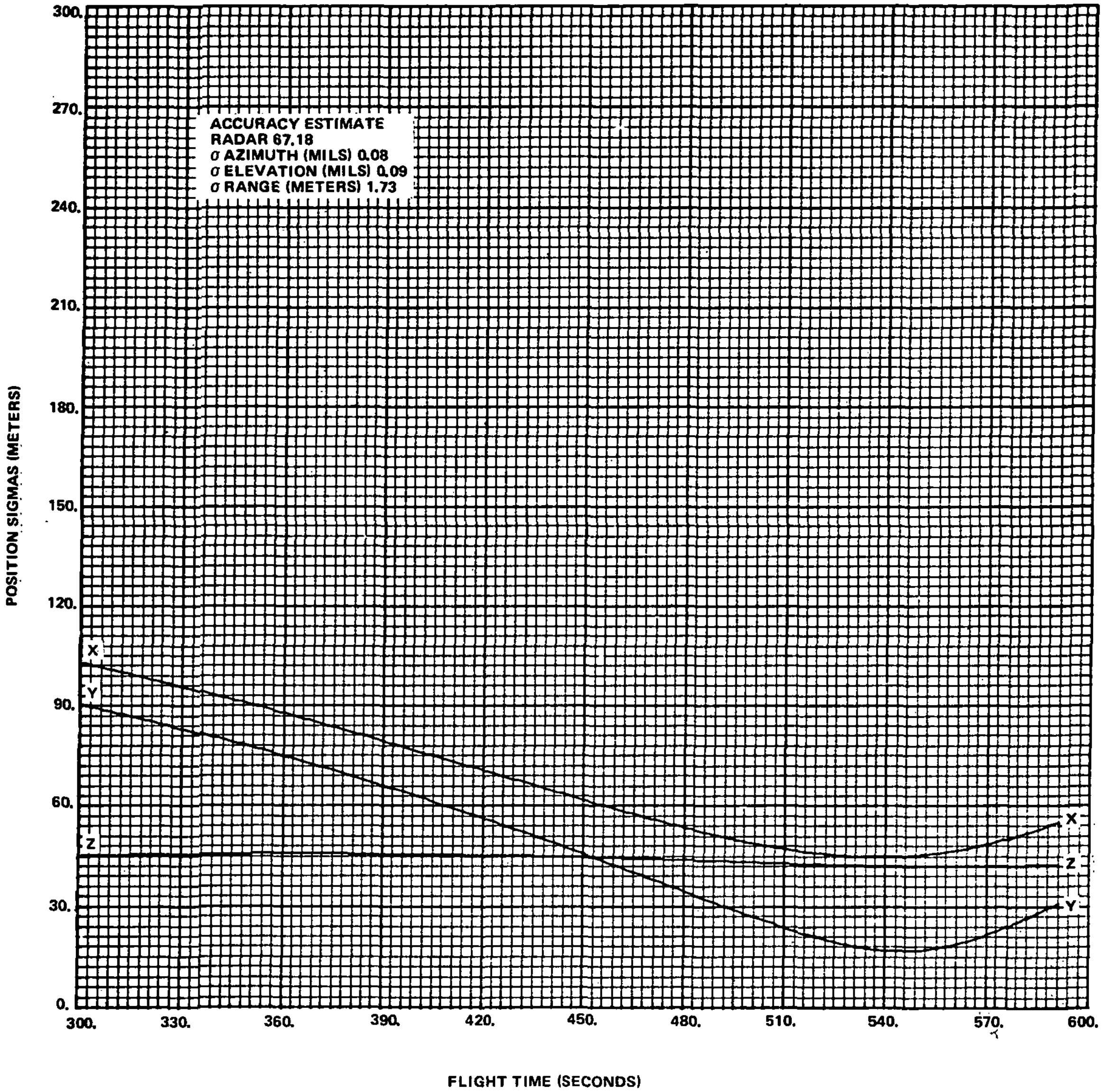


FIGURE 4-31 SL-2 ESTIMATES OF BERMUDA C-BAND RADAR 67.18 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

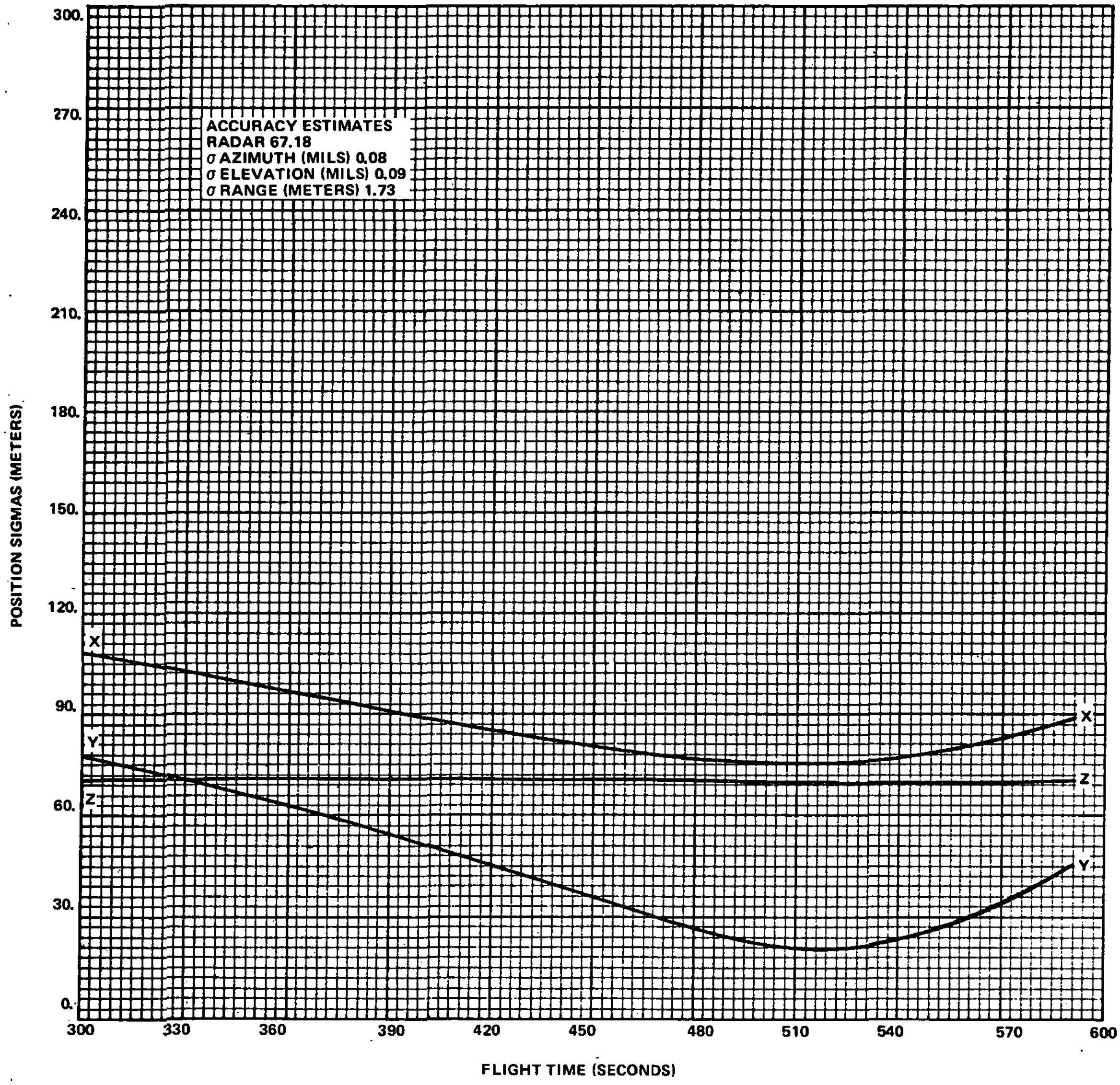


FIGURE 4-32 SL-2 ESTIMATES OF BERMUDA C-BAND RADAR 67.18 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

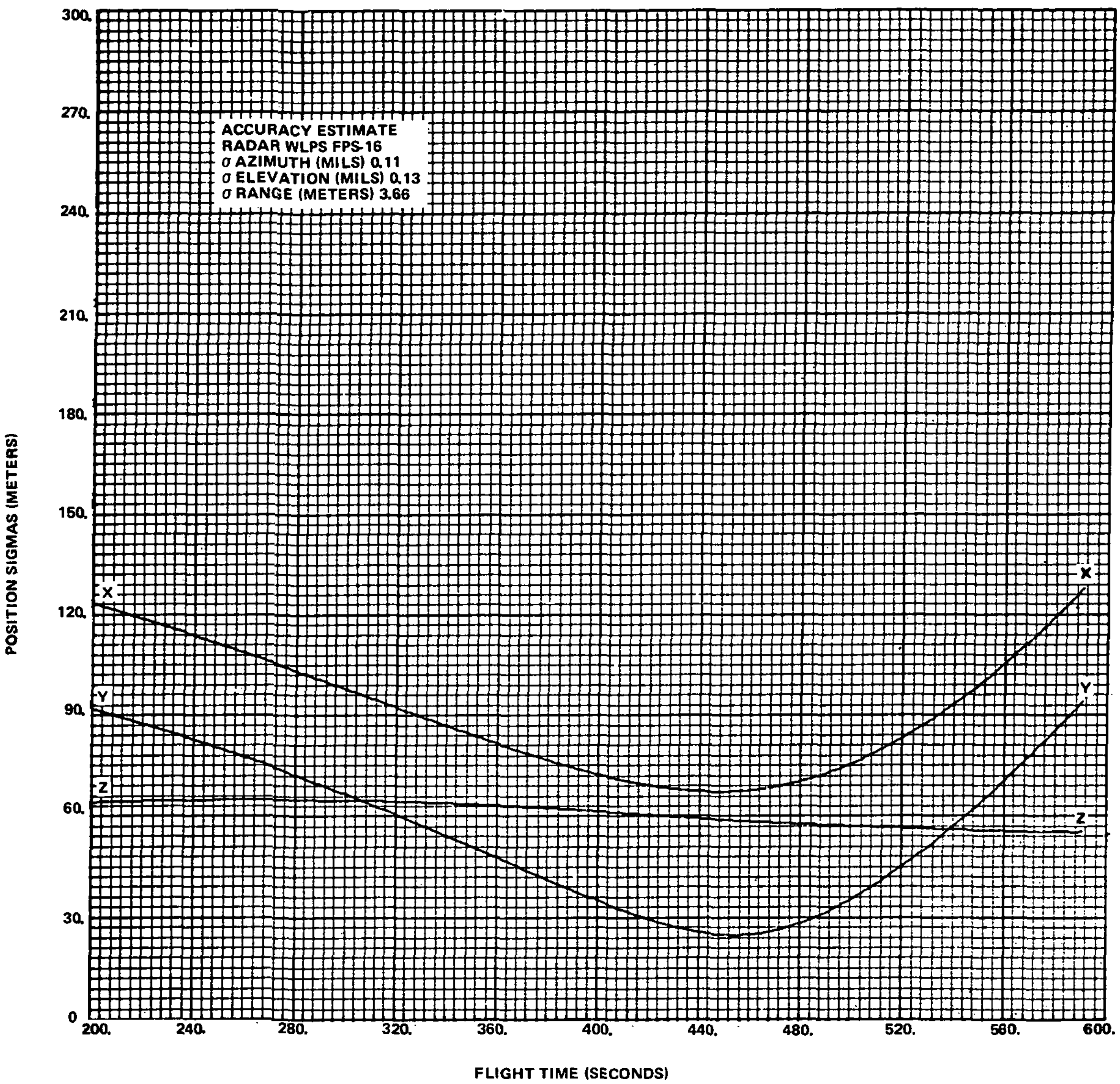


FIGURE 4-33 SL-2 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPS-16 POSITION ACCURACIES, (WINDOW OPENING 51.82°)

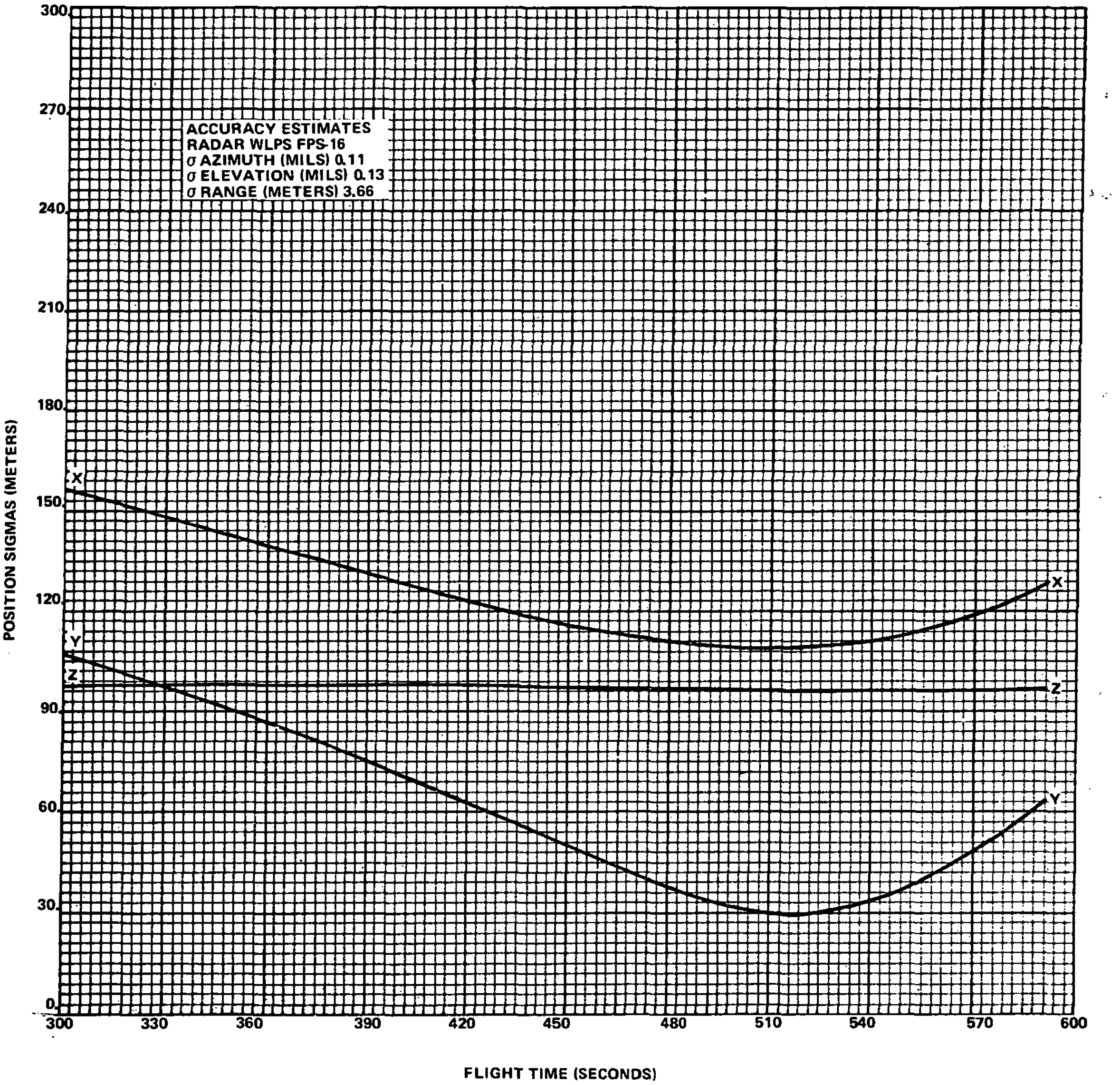


FIGURE 4-34 SL-2 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPS-16 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

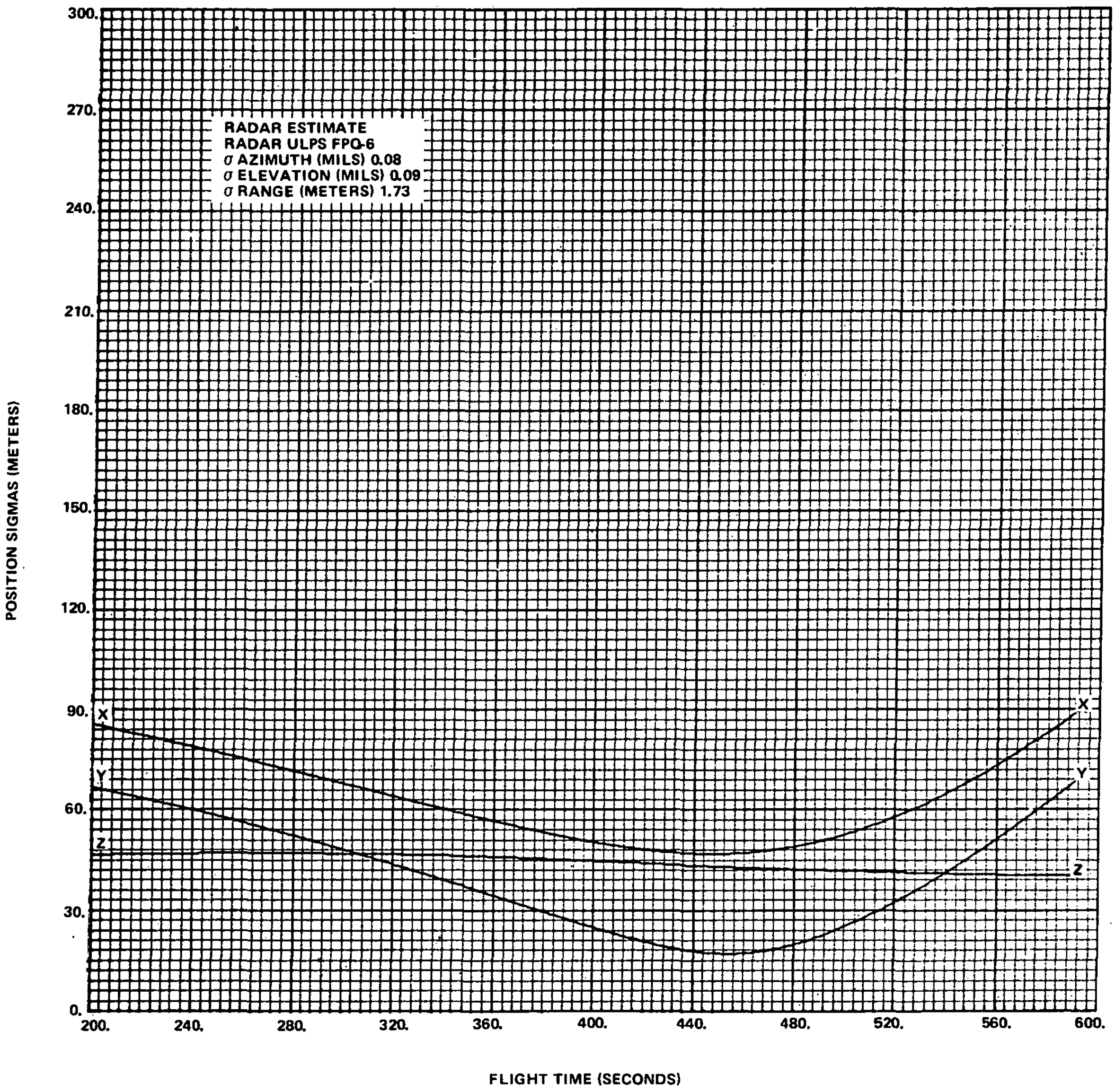


FIGURE 4-35 SL-2 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPQ-6 POSITION ACCURACIES,(WINDOW OPENING F.A. 51.82°)

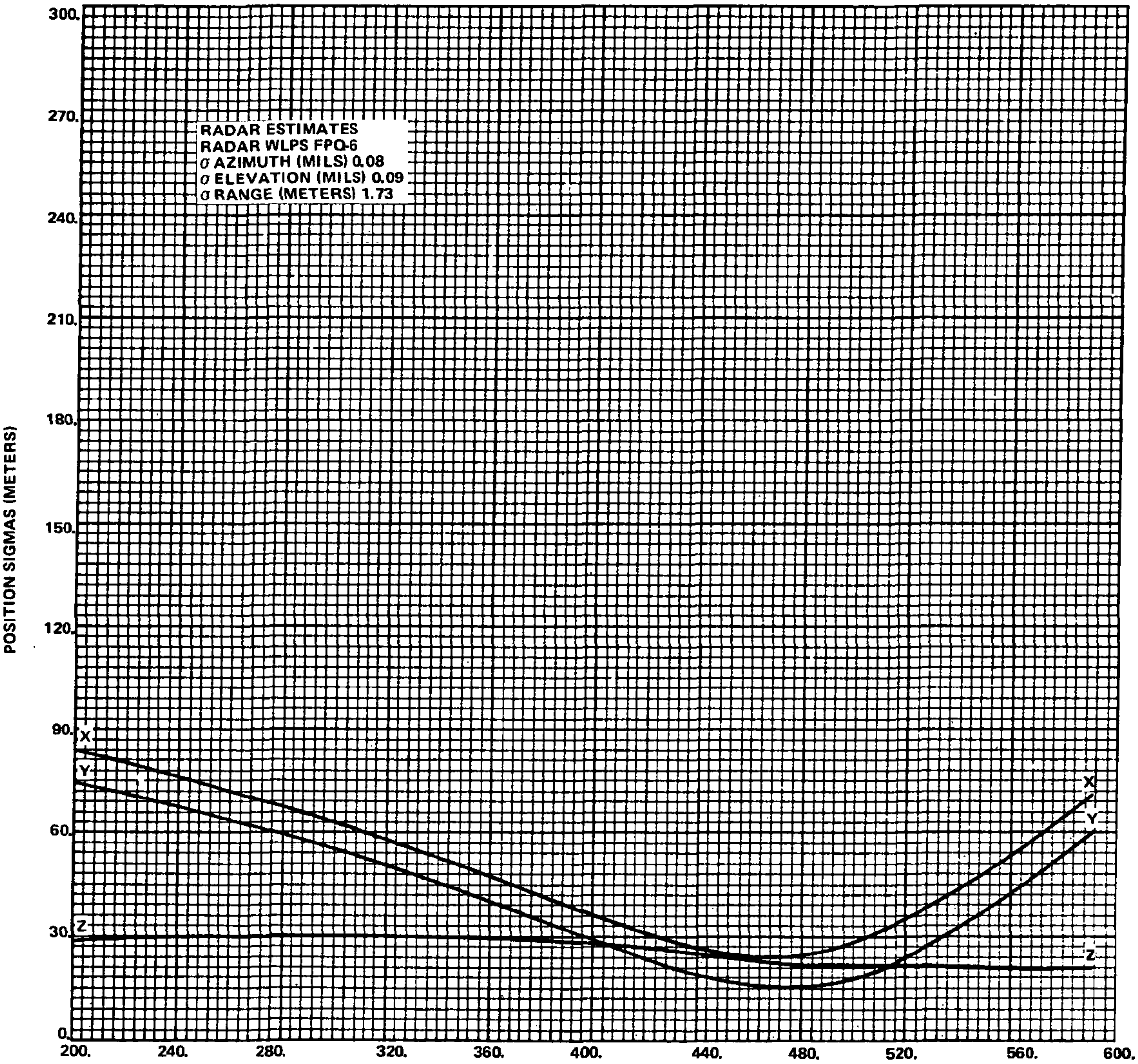


FIGURE 4-36 SL-2 ESTIMATES OF WALLOPS ISLAND C-BAND RADAR FPQ-6 POSITION ACCURACIES. (CLOSING F.A. 37.68°)

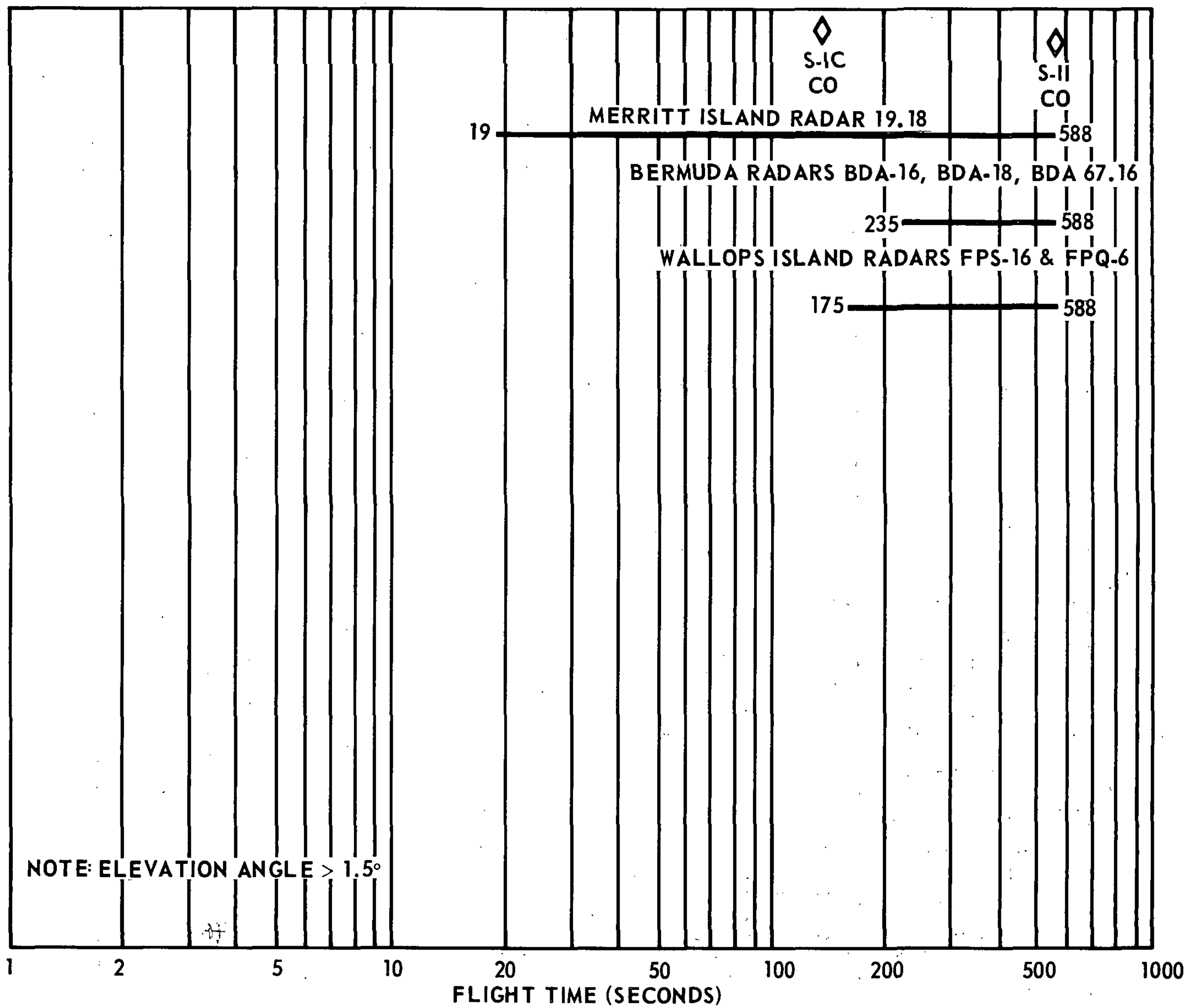


FIGURE 4-37 SL-1 METRIC DATA INSTRUMENTATION COVERAGE (F.A. 40.88°)

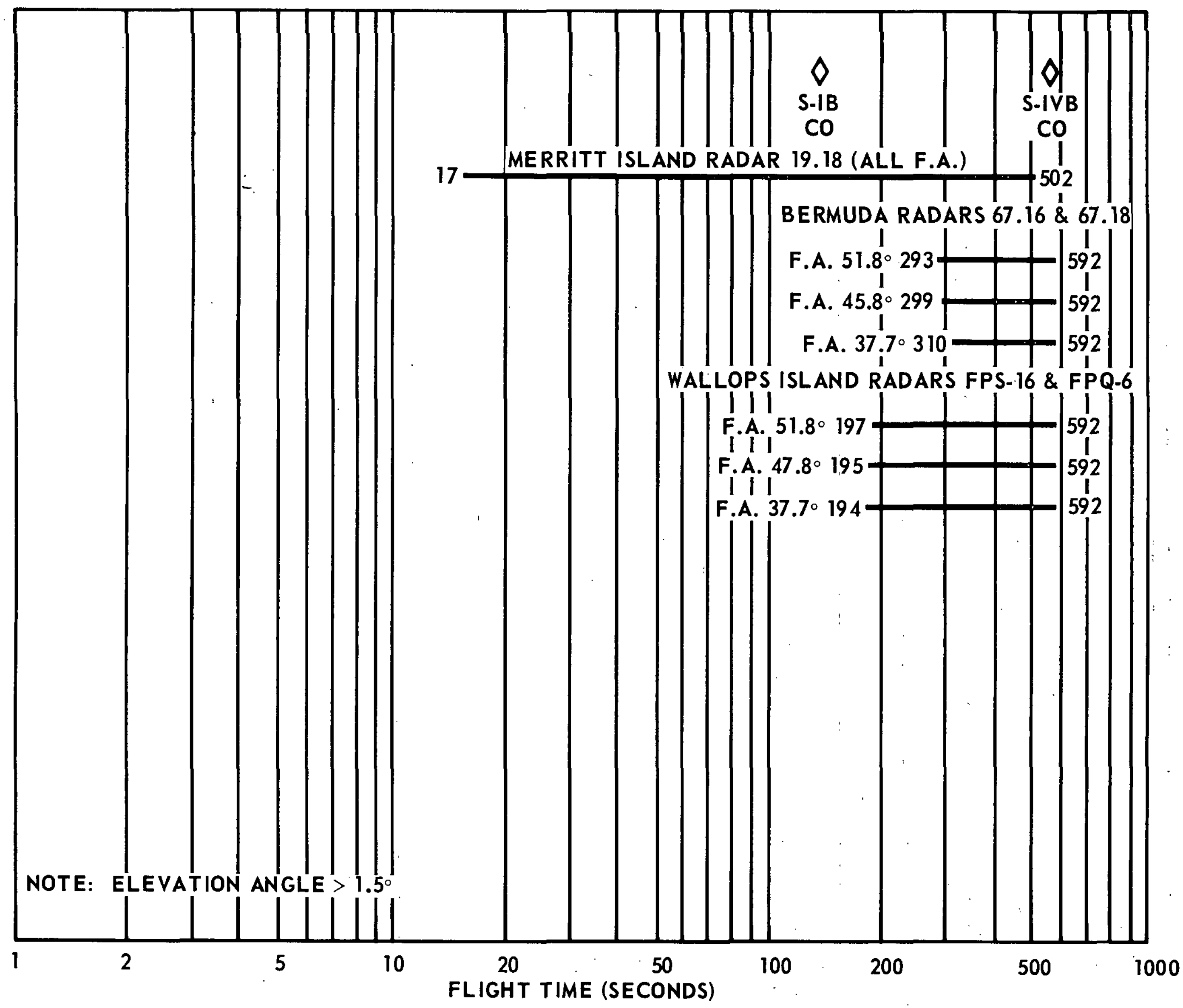


FIGURE 4-38 SL-2 METRIC DATA INSTRUMENTATION COVERAGE (F.A. 51.8, 45.8, 37.7)

SECTION V
ENVIRONMENTAL DATA SUPPORT

5.1 METEOROLOGICAL FORECASTS

5.1.1 LAUNCH AREA WEATHER WARNING SERVICES. The AFETR Staff Meteorologist (WE) will provide weather warning services when surface winds in excess of a specified level (TBD knots) are forecast or when electrical storm activity is forecast within five nautical miles of the launch complex. Twenty-four-hour surface and upper wind forecasts will be provided upon request. The WE will provide diffusion forecasts for the launch area as requested by the RSO.

From F-5 days to T-0, an Assistant Staff Meteorologist will be available to provide continuous advisory service, including lightning and atmospheric electrical activities. The FPS-77 Radar will be used to survey the CKAFS-KSC area for severe weather conditions.

5.1.2 PRELAUNCH FORECASTS. Weather forecasts of both surface and upper-air conditions will be provided by Spaceflight Meteorology Group (SMG) and WE. Forecasts valid from F-3 days and longer validity periods through T-0 will be provided.

5.1.3 WEATHER BRIEFING. SMG will present a weather briefing at the LCC at T-24 hours and at T-12 hours.

5.2 ENVIRONMENTAL OBSERVATIONS

5.2.1 SURFACE ENVIRONMENTAL OBSERVATIONS

5.2.1.1 <u>AFETR Meteorological Observations</u>

5.2.1.1.1 Weather Information Network and Display System (WINDS). Automatic remote meteorological sensors are used for surface measurements. The ETR operates eight weather tower stations on Cape Kennedy (six 54-foot and two 204-foot) and eight at KSC (seven 54-foot and one 500-foot). Surface measurements are transmitted to WINDS at Central Control and used in a UNIVAC 1218 computer to compute other parameters. The data are distributed via teletype at 30- or 15-minute intervals, except during prime test time when distribution is made at 5-minute intervals.

5.2.1.1.2 Weather Satellite Imagery. High-quality and IR satellite photos are available from a Muirhead 115B/1 recorder. Satellites are tracked from AFETR and NASA networks to give worldwide real-time satellite imagery that is gridded geographically by the AFETR Staff Meteorologist.

5.2.1.1.3 ECHO Cell Motion Program. The ECHO program permits tracking of thunderstorms with the FPS-77 Radar and cell prediction by the UNIVAC 1218 computer. Thunderstorm movement predictions are provided to the radar operator in real time for operational use in providing weather warnings to range users. This radar echo ephemeris can also be provided directly to meteorological users at the AFETR.

5.2.1.1.4 Launch Pad Lightning Warning System (LPLWS). The LPLWS provides the capability of detecting and monitoring lightning at a particular launch complex. The system consists, basically, of eight field mill sensors, two A.D. Little flash counter systems, a data acquisition system, and an alarm system. This LPLWS system allows the duty forecaster to monitor, in real time, the electrostatic field and lightning phenomena from eight major launch and operational complexes at Cape Kennedy.

5.2.1.1.5 Digital Automated Radar Tracking System (DARTS). The AFETR Staff Meteorologist schedules the Range Tracking Radar which manually scans along the programmed flight path of the launch vehicle. Verbal reports of cloud returns are relayed to the Staff Meteorologist which enables him to provide short-range forecasts of cloud cells affecting the launch pad. DARTS also provides real-time advisory service, as well as quantitative permanent data records for post-test analysis.

5.2.1.2 KSC Meteorological Observations

5.2.1.2.1 Launch Complex Wind Measuring and Recording System. The wind measuring system located at LC-39 consists of anemometers mounted on the umbilical tower and on two poles located near Pads A and B. Wind speed and direction data are displayed and recorded in the Launch Control Center and are transmitted in real time to the Meteorological Prediction Center (MPC) in the MSO Building and to MSFC via LIEF.

5.2.1.2.2 NASA 150-Meter Meteorological Tower. The facility provides information for meteorological statistical analysis and planning in NASA. In addition, wind speed and direction are provided to the Air Force WINDS at the Cape and to the MPC at the MSO Building. Starting at L-30 hours, the tower is continuously manned for verbal readout to MSFC and other organizations as required.

5.2.1.2.3 Lightning Warning System. The lightning warning net consists of forty-three remote sites which measure the electric field. The data are processed in the CIF and the resultant analysis is displayed at the MPC. Two sferics sites (one at HRT site 19.1 and one at the MSO Building) will use radio direction-finding techniques to detect lightning strokes. Data from the sferics sites will be transmitted to the MPC.

5.2.1.2.4 NASA-6 Geophysical Measuring System (Airborne). The NASA-6 aircraft (Twin Beech) is equipped with electric field measuring devices. The aircraft, under control of the KSC Meteorologist, gathers real-time weather and cloud electrification data during launch operations. Data are relayed to the MPC.

5.2.1.2.5 Lightning Detection Systems. The instrumentation on the ML and the MSS includes: Stroke counter, stroke current waveform, stroke current amplitude, and corona current measuring instrumentation. The data display of the ML stroke amplitude instrumentation is in the LCC.

5.2.1.2.6 KSC Weather Radar. An X-band radar with vertical resolution will be located at Weather Station Site "B" north of the VAB (see Figure 4-4). The weather radar will be used for various weather functions primarily in connection with evaluating the lightning threat of weather formations. Display will be in the MPC.

5.2.1.3 <u>KSC Environmental Measurements</u>

5.2.1.3.1 Acoustic Data. The acoustic data acquisition system is designed to measure the acoustic environment produced by large launch vehicles. Simultaneous near-field and far-field measurements of sound-pressure levels and frequencies are recorded for analysis in the wave analysis laboratory in the CIF.

a. Near-Field Measurements - Measurements in the pad area are indicated on Figures 4-1 and 4-2.

b. Far-Field Measurements - Portable equipment will be used to measure and record data at approximately nine sites located several miles from the launch pad.

5.2.1.3.2 Blast Gauges. BRL blast gauges will be installed and operated in the pad areas. The data will be reduced only in case of an explosion.

5.2.1.3.3 Facilities and Environmental Measurements. Approximately nine-hundred measurements for SL-1/SL-2 located in the

LC are monitored and/or recorded during prelaunch checkout and launch to evaluate the facility performance and to determine the effect of the launch vehicle on its environment.

5.2.2 UPPER AIR METEOROLOGICAL OBSERVATIONS

5.2.2.1 Meteorological Balloon Data. Jimsphere balloons, released periodically throughout the countdown, are tracked by radar (see Section 4.1.1.2) through altitudes of approximately 60,000 feet. The data are transmitted to MSFC and MSC (see Sections 6.2.3 and 6.2.6). These data are processed by an MSC/MSFC team to determine if the wind environment is suitable for launch. The results of the evaluation will be provided to KSC via LIEF.

5.2.2.2 Upper Air Soundings. AFETR will provide upper air data obtained by Rawinsonde (RS), rocket sonde, and windsonde (WS) equipment.

5.2.3 WEATHER AIRCRAFT. Two ETR aircraft (WC-135 and WC-130) will perform weather surveillances within a 50 n.mi. radius of LC-39.

SECTION VI
SPACE VEHICLE DATA HANDLING

6.1 AFETR REAL-TIME DATA PROCESSING SYSTEMS

6.1.1 REAL-TIME COMPUTER SYSTEM (RTCS). Real-time tracking data from the C-band radars are processed in the CDC 3600 computer to generate Range Safety data and to satisfy real-time data requirements. All input tracking data are processed to determine the best data source, which is then used to compute present position and velocity, instantaneous impact point, and acquisition data. The RTCS output will be as follows:

a. Primary IP data to CADDAC for Range Safety plotting board display.

b. Present-position data to CADDAC for Range Safety and LCC plotting board display.

c. Reduced data and raw and smoothed radar measured parameters to the LTDS (see Section 6.1.2) for routing to the CIF, MCC-H, GSFC, and USB.

d. Acquisition data for use by various instrumentation sites.

The RTCS will also provide alternate IP data to CADDAC for Range Safety display from the second best data source.

Data from Radar 19.18 will be reformatted into the standard TBD-character TTY format by AN/UYK computers at the site and transmitted to the RTCS. At the RTCS, this data will be patched through to GSFC in real/near-real time.

SL-1 and SL-2 IU guidance data from the CIF TLM Station, and CSM guidance from the KSC USB site will be transmitted to the RTCS via the Skylab Launch Data System (SLDS) for Range Safety and/or launch recovery application. The ETR TLM Station TEL IV will provide analog and discrete launch vehicle parameters (other than guidance) which are then transmitted through the RTCS for Range Safety application.

6.1.2 LAUNCH TRAJECTORY DATA SYSTEMS (LTDS). Tracking data will be routed from the RTCS to MCC-H, GSFC, and the CIF Data Core via two Digital Control Units (DCU). Present position and velocity data will be provided.

6.2 KSC REAL-TIME DATA PROCESSING SYSTEMS

6.2.1 CIF DATA CORE. The Data Core is basically an electronic system that receives various analog and digital input data from a number of asynchronous sources and processes these data into a common 26-bit digital format for direct use by high-speed digital computers, data transmission equipment, and quick-look data display devices. The Data Core will receive data from the following sources: CIF Ground Station, CIF Antenna Field VHF and S-band TLM receivers, LTDS, CCATS (selected TLM parameters from Houston via MSFC), DDAS, and the MILA USB Station (S-band and VHF).

The Data Core provides data to the following points: SLDS, LIEF, Central Computer Facility, CIF Ground Station (selected parameters for display), MSOB ACE Station (CSM and SWS data for display), DDAS (LV data for display after LOS by DDAS at T-0), and MILA USB (unprocessed video signal).

6.2.2 TELEVISION DATA DISPLAY SYSTEM. Launch Vehicle and/or Facility data are displayed at ten monitor positions in the Firing Rooms (LCC). Out-of-tolerance data as detected by the Central Computer are displayed on one of the two adjacent CRTs at the monitoring position. An audible alarm feature is also provided.

6.2.3 METEOROLOGICAL REAL-TIME SYSTEM (MRTS). Raw data from the AFETR radar assigned to track the Metro. Balloon (see Section 4.1.1.2) will be received in real time, during the balloon ascent (for approximately one hour for each run), at the CIF. The data will be recorded in digital format and delivered to the KSC Central Computer Facility at the conclusion of the balloon track. The measured radar parameters will also be transmitted to MSFC in real time via the LIEF system.

6.2.4 KSC CENTRAL COMPUTER FACILITY. The Central Computer Facility receives TLM (up to 3,000 measurements) and tracking data from multiple asynchronous sources via the Data Core (see Section 6.2.1 above). The TLM data are converted to engineering units for display and storage. TLM data representing up to 52 minutes of vehicle history are also stored raw on mass storage disks for "real-time" history display.

6.2.4.1 Data Distribution. The real-time data are displayed on CRTs, Eidophor screens, recorders, or printed out locally in the CIF, in the Firing Rooms, and other operational rooms of LC-39.

6.2.4.2 Launch Vehicle Guidance Data. Launch vehicle guidance checkout data from the Data Core are processed in a guidance reduction program (LVDC/LVDA) several times during the countdown to provide launch critical data.

6.2.4.3 Launch Vehicle Strain Gauge Data. The data are accepted by the Data Core after Mobile Service Structure (MSS) rollback. The GE-635 computer calculates vehicle bending moments during possible adverse fuel loading - wind velocity conditions for immediate evaluation by LV personnel.

6.2.4.4 Trajectory Data Reduction. The GE-635 accepts real-time trajectory data from the RTCS via the Data Core and provides data for a dynamic display of vehicle flight and comparison to the nominal trajectory.

6.2.4.5 Radar-Balloon Determined Wind Reduction. The METS in the CIF records radar-tracked balloon data. The data are processed in near-real time to determine wind velocity and direction vs altitude. These data are transmitted to MSFC via the LIEF tape-to-tape transceiver. Reduced data from selected balloon releases are also transmitted to MSC via a tape-to-tape and a card-to-card transceiver.

6.2.4.6 Atmospheric Transport Program. The GE-635 accepts data relating to wind speed and direction/temperature vs altitude and calculates downwind air and ground concentration of particulates or gaseous material.

6.2.4.7 Vehicle Data Limit Check Program. The GE-635 continuously compares TLM data to preassigned limits. Display and control of this function are accomplished via the Television Data Display System (see Section 6.2.2) at several locations in the Firing Rooms at LC-39.

6.2.5 SKYLAB LAUNCH DATA SYSTEM (SLDS)

The SLDS receives CCATS (50 kbs) data from MSFC via LIEF circuits. The SDS-930 Computers preprocess for GE-635 input. An additional function of the SLDS is preprocessing SL-1 and SL-2 LV guidance data prior to input to the GE-635. Output for the above functions of the SLDS is via the CIF Data Core. The CSM and LV guidance parameters at 2.4 kbs are output directly to the RTCS (see Section 6.2.1).

6.2.6 LAUNCH INFORMATION EXCHANGE FACILITY (LIEF). The LIEF network contains, in addition to a number of voice circuits, the following data circuits:

a. A 50.0 kbs data circuit and a 2.4 kbs data request circuit. MSFC is supplied selected real-time telemetry and/or tracking data via the 50.0 kbs circuit. Parameter selection is controlled by MSFC via the 2.4 kbs data circuit (see Section 6.2.1).

b. A second 50.0 kbs circuit. MSFC retransmits MSC generated CCATS data to the SLDS (see Section 6.2.5).

c. One OTV Circuit. Any one of the OTV cameras (see Section 4.2.3.3.2) may be monitored at MSFC. Camera selection is controlled by MSFC by verbal request.

d. One Countdown Clock Circuit.

e. One Tape-to-Tape Circuit.

f. One Facsimile Circuit.

6.3 AFETR POST-EVENT DATA HANDLING

All AFETR data are released to the KSC Data Office.

6.4 KSC POST-TEST DATA HANDLING

KSC post-test data handling and disposition are described in the Data Disposition Document.

6.4.1 KSC POSTLAUNCH DATA DISPLAY ROOMS. All requested data for evaluation generated during the launch phase of SL-1 and SL-2 will be displayed in the data display rooms as soon as the data 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 2296 and 2299 of the MSOB. Launch vehicle data will be displayed in Room 3R17 of LC-39.

SECTION VII
FLIGHT SAFETY INSTRUMENTATION

7.1 RANGE SAFETY INSTRUMENTATION

7.1.1 COMMAND/CONTROL SYSTEMS. The Range Safety Command/Control transmitters which may be used to transmit commands to the SRS Destruct System (see Section 3.6.1) are listed below:

Station No.	Station Name	Transmitter
1	CKAFS	Low-Power
1	CKAFS	High-Power
3	GBI	High-Power
67	Bermuda	High-Power
-	Wallops	High-Power

The CKAFS Command System will receive STDN command data in parallel with the CMD System at the KSC USB site.

7.1.2 IMPACT PREDICTION. Plots of the instantaneous impact point and present position are generated by the RTCS (see Section 6.1.1) for use by the RSO.

7.1.3 SKYSCREENS

7.1.3.1 TV Skyscreens. Video monitors will display images from the Range Safety video skyscreens (see Section 4.2.3) for use by the RSO. A Flightline and a Program system are provided. Locations TBD.

7.1.3.2 Wire Skyscreen. Wire skyscreen TBD will be used to provide program deviation. Location TBD.

7.1.4 SELECTED TLM PARAMETERS. Selected TLM parameters from the SL-1 and SL-2 IU and CSM guidance systems are used for computation of instantaneous impact points. Station 19 (TEL IV) and 67 (Bermuda) and Wallops Island provide Launch Vehicle parameters for Range Safety decisions (see Section 6.1.1.d).

7.1.5 SURVEILLANCE RADARS

7.1.5.1 Range Surveillance Radars. MOD II Radar 1.5, located at Central Control, will provide sea surveillance. The SPS-35V (1.35V) will provide additional range surveillance.

7.1.6 SURVEILLANCE AIRCRAFT. One helicopter will perform launch area sea surveillance.

7.1.7 SURVEILLANCE BOAT. One Port Canaveral Coast Guard boat will monitor the launch danger area.

7.1.8 RANGE SAFETY INSTRUMENTATION SUMMARY. The estimates of instrumentation flight time coverage which are expected for Range Safety are summarized in Figures 7-1 and 7-2.

7.2 PAD SAFETY INSTRUMENTATION

7.2.1 HYDROGEN HAZARDS MONITORING SYSTEM

7.2.1.1 Hydrogen Leak Detection Systems

7.2.1.1.1 Fixed System. Sensor heads are located at predetermined points to monitor critical areas for the presence of H_2.

7.2.1.1.2 Portable System. Each detector consists of a probe connected to an instrument box. The detectors are used by launch personnel to investigate suspicious areas.

7.2.1.2 Hydrogen Fire Detection Systems

7.2.1.2.1 Thermal Wire (TW) System. The TW detection element is a cable which may be wrapped around a potential leakage point to monitor the temperature for indication of H_2 fire.

7.2.1.2.2 Ultraviolet (UV) System. The UV sensors are located at predetermined points to detect the UV radiation of hydrogen flames.

7.2.2 HYPERGOLIC HAZARDS MONITORING SYSTEM. Portable vapor detectors, designed to detect and monitor the concentration of toxic propellant vapors in the atmosphere, display the fuel (aerozine 50) and oxidizer (nitrogen tetroxide) vapor levels on separate meters. Aural and visual alarms are generated when the detected levels of these propellants exceed previously selected limits.

7.3 ABORT-EGRESS ADVISORY SYSTEM

An egress or abort request may be issued to the flight crew from the Launch Operation Manager's console. The console is equipped with two TV monitors to monitor the abort system TV cameras (see Section 4.2.3.3.1) and with status lights designed to alert the operator to impending catastrophic conditions. Observers will advise the console operator of unusual indications of hazardous or catastrophic conditions.

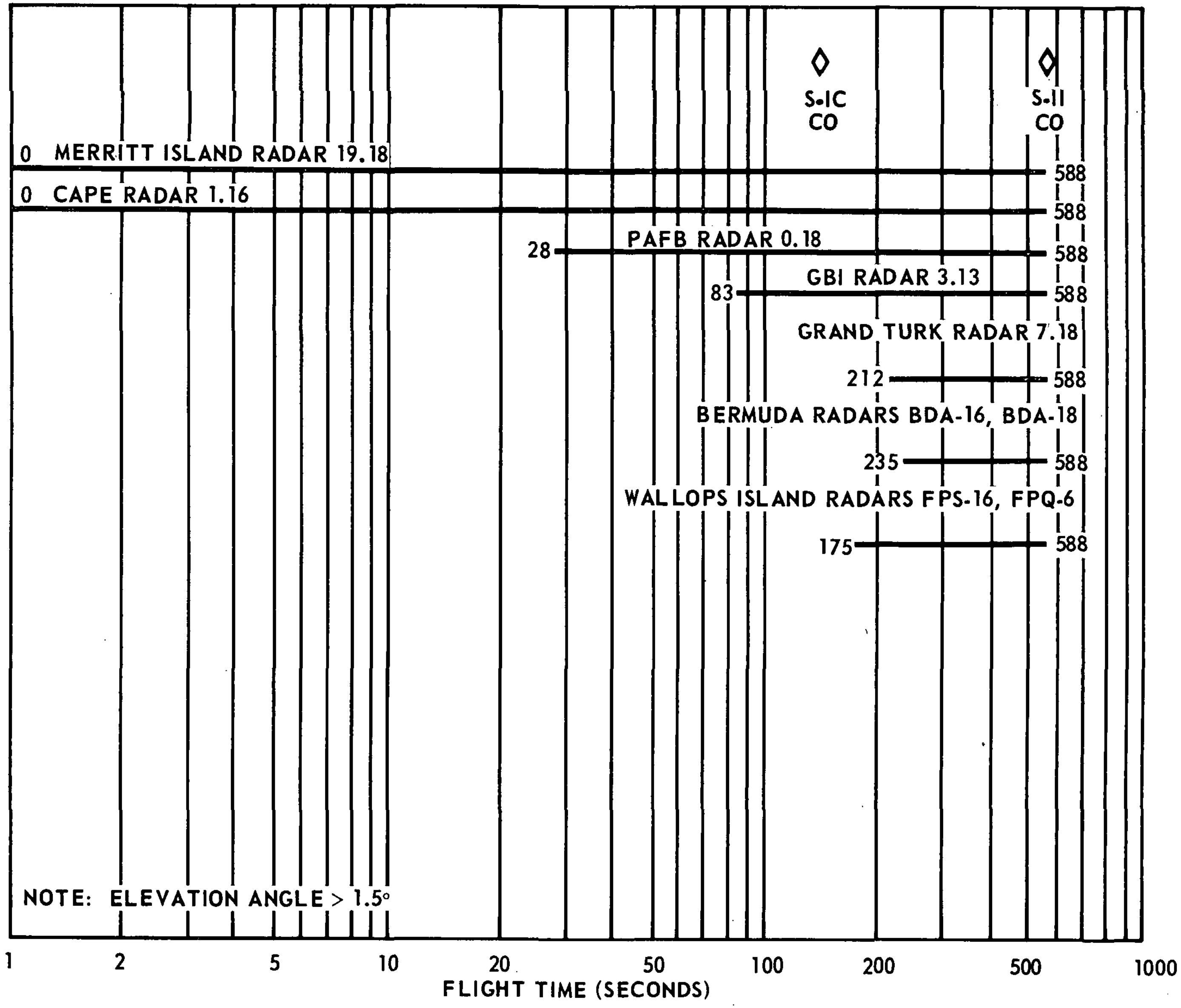


FIGURE 7-1 SL-1 RANGE SAFETY INSTRUMENTATION COVERAGE (F.A. 40.88°)

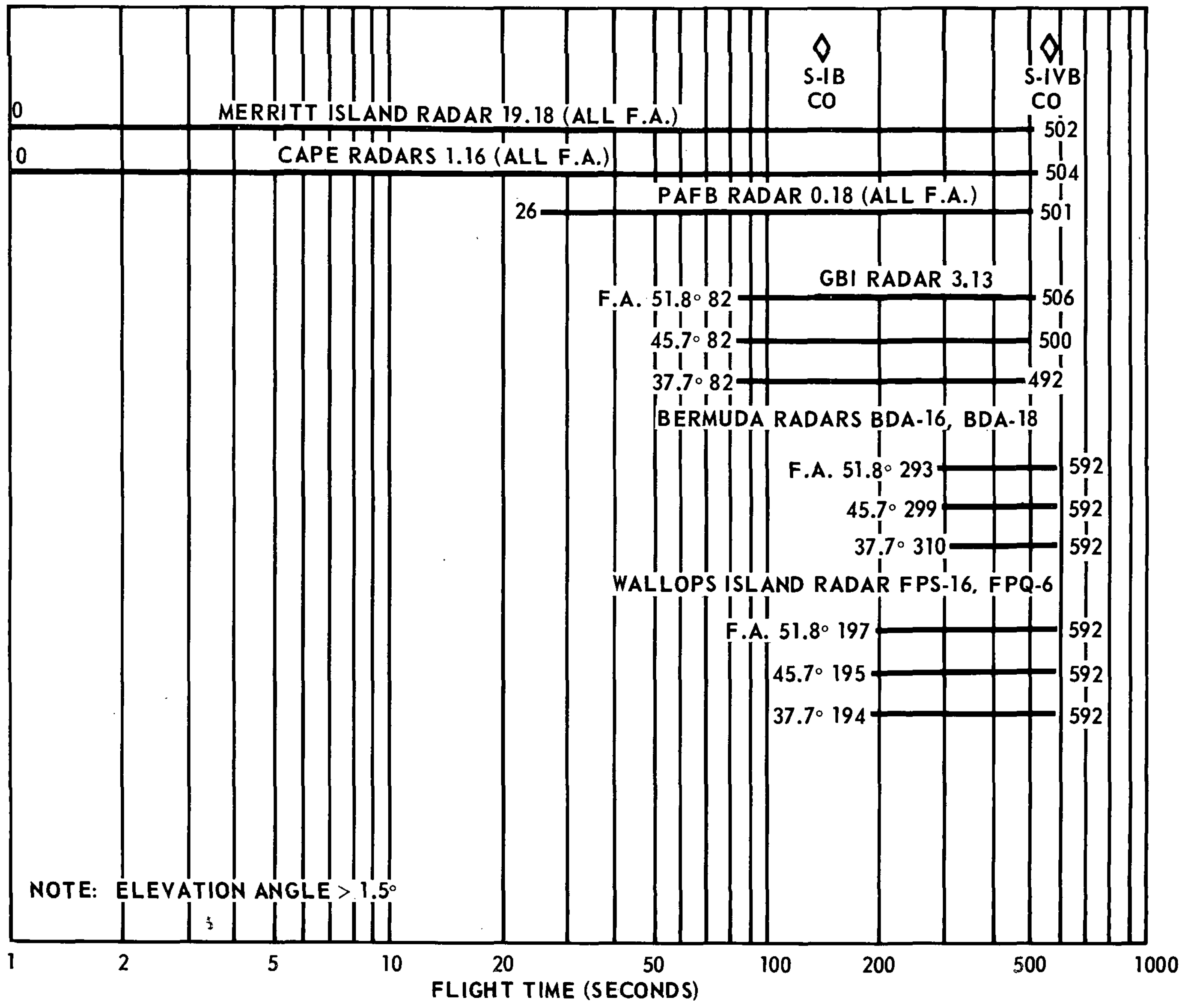


FIGURE 7-2 SL-2 RANGE SAFETY INSTRUMENTATION COVERAGE

SECTION VIII
SL-1/SL-2 FREQUENCY UTILIZATION SPECTRUM

8.1 Table 8.1 provides a frequency utilization list for SL-1 and SL-2.

TABLE 8.1 SL-1/SL-2 FREQUENCY UTILIZATION

SYSTEM	TRANSMITTER FREQUENCY (MHz)	TRANSMITTER LOCATION
Experiment M509	26	SL-1, OWS
VHF Telemetry	230.4	SL-1, AM
	231.9	SL-1, ATM
	232.9	SL-1, S-II
	235.0	SL-1, AM
	237.0	SL-1, ATM
	240.2	SL-1, S-II; SL-2, S-IB
Recovery Beacon	243.0	SL-2, CSM
Survival Transmitter	243.0	SL-2, CSM
VHF Telemetry	244.3	SL-1, S-IC
	245.3	SL-1, IU; SL-2, IU
	246.3	SL-1, AM
	248.6	SL-1, S-II
	250.7	SL-1, IU; SL-2, IU
	256.2	SL-1, S-IC; SL-2, S-IB
	258.5	SL-2, S-IVB
VHF Voice and Ranging	259.7	SL-2, CSM; MSOB; MILA USB Site
	296.8	SL-1, AM (ranging only); SL-2, CSM; MSOB; MILA USB site
Range Safety Receiver Locations: SL-1 S-IC, S-II SL-2 S-IB, S-IVB	450.0	CMD Transmitters at Stas. 1, 3, 6, 7, Wallops Is.
VHF Command Receiver Locations: SL-1 AM, ATM SL-2 IU	450.0	CMD Transmitters at Sta. 1, MILA USB, LCC IU C/O equip.

TABLE 8.1 SL-1/SL-2 FREQUENCY UTILIZATION (Continued)

SYSTEM	TRANSMITTER FREQUENCY (MHz)	TRANSMITTER LOCATION
CCS Receiver Location: SL-1 IU	2101.8	MILA USB
USB Command Receiver Location: SL-2 CSM	2106.4	MILA USB
S-Band Telemetry	2272.5	SL-2, CSM
CCS	2282.5	SL-1, IU
S-Band Telemetry	2287.5	SL-2, CSM
C-Band Radars	5690	Radar Ground Stations at Stas. 19, 1, 0, 3, 7, 67, Wallops Is.
C-Band Transponder	5765	SL-1, IU SL-2, IU

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TABLE 2.3 SL-2 LAUNCH PHASE MISSION EVENTS (F. A. 45.8°)

EVENT	TIME FROM FIRST MOTION (sec)	EARTH-FIXED VELOCITY (m/sec)	ALTITUDE (km)	GROUND RANGE (km)
First Motion	0.0	0.0	0.1	0.0
Initiate Tilt	10.2	-	-	-
(Data Point)	10.0	30.5	0.2	0.0
Max. Q	73.6	462.0	12.4	4.8
S-IB I.E.C.O.	137.7	1916.0	54.8	59.2
S-IB O.E.C.O.	140.7	1975.5	57.7	64.4
S-IVB Eng. Start	143.4	1965.4	60.3	69.2
Active Guidance Initiate	170.7	-	-	-
(Data Point)	171.0	2085.3	83.8	120.2
S-IVB Guidance C.O.	581.9	7581.5	158.4	1759.4
Earth Orbit Insertion	591.9	7588.8	158.6	1832.9

TABLE 2.4 SL-2/SWS ORBITAL EVENTS

EVENT	SL-2 TIME (G.E.T.)	
	Hr.	Min.
Rendezvous	7	21
CSM/OWS Docking	8	0
SWS Activation Complete	28	59
ATM Activation Complete	28	59
EVA Times	594	40
SWS Deactivation Complete	661	32
CSM/OWS Undocking	661	55
Splashdown	668	32

2.3.4 SL-1/SL-2 EXPERIMENTS

Tables 2.5 and 2.6 list SL-1 and SL-2 experiments.

TABLE 2.5 SL-1 EXPERIMENTS

	Experiment	Operational Position
D024	Thermal Control Coatings	AM/EXT
M071	Mineral Balance	OWS
M073	Bioassay of Body Fluids	OWS
M074	Specimen Mass Measurement	OWS
M092	In-flight LBNP	OWS
M093	Vectorcardiogram	OWS
M112	Man's Immunity - In Vitro Aspects	OWS
M113	Blood Volume and Red Cell Life Span	OWS
M114	Red Blood Cell Metabolism	OWS
M115	Special Hematologic Effects	OWS
M131	Human Vestibular Function	OWS
M133	Sleep Monitoring Experiment	OWS
M151	Time and Motion Study	OWS
M171	Metabolic Activity	OWS
M172	Body Mass Measurement	OWS
M479	Zero Gravity Flammability	MDA
M487	Habitability/Crew Quarters	OWS
M509	Astronaut Maneuvering Equipment	OWS
M512	Materials Processing Facility	MDA
M516	Crew Activities and Maintenance Study	OWS
M551	Metals Melting	MDA
M552	Exothermic Brazing	MDA
M553	Sphere Forming	MDA
M554	Composite Casting	MDA
S009	Nuclear Emulsion	MDA
S019	UV Stellar Astronomy	OWS
S020	UV/S-Ray Solar Photography	OWS
S052	White Light Coronagraph	ATM
S054	X-Ray Spectrographic Telescope	ATM
S055	UV Scanning Polychromator/ Spectroheliometer	ATM
S056	Dual X-Ray Telescopes	ATM
S063	UV Airglow Horizon Photography	OWS
S073	Gegenschein/Zodiacal Light	OWS
S082	UV Spectrograph/Heliograph	ATM
S149	Particle Collection	OWS
S183	UV Panorama	OWS