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JOHN F. KENNEDY
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(APOLLO 14)

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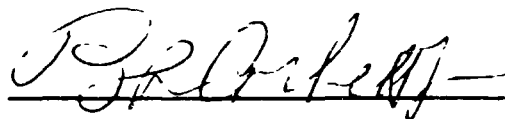
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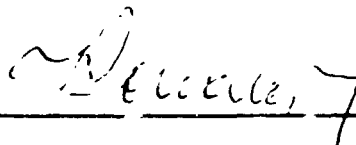


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LIST OF ABBREVIATIONS

ACE	Acceptance Checkout Equipment
ACQ	Acquisition
ADASP	Acquisition Data Automatic Selection Program
AFETR	Air Force Eastern Test Range
ALDS	Apollo Launch Data System
ALSEP	Apollo Lunar Surface Experiment Package
ARIA	Apollo Range Instrumentation Aircraft
AS	Apollo Saturn
BDA	Bermuda
BH	Blockhouse
c	centi (10^{-2})
C-Band	5000 to 6500 MHz/3900 to 6200 MHz
CADDAC	Central Analogue 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
CRT	Cathode Ray Tube
CSM	Command Service Module
DCU	Digital Control Unit

LIST OF ABBREVIATIONS
(Continued)

DDAS	Digital Data Acquisition System
deg	Degree
EASEP	Early Apollo Scientific Experiments Package
EBW	Exploding Bridge Wire
ETR	Eastern Test Range
WE	AFETR Staff Meteorologist
EVA	Extravehicular Activity
FCA	Frequency Control and Analysis
FM	Frequency Modulation
GBI	Grand Bahama Island (AFETR Station)
GBM	Grand Bahama Island (NASA Station)
G.E.T.	Ground Elapsed Time
GH ₂	Hydrogen Gas
GSE	Ground Support Equipment
GSFC	Coddard Space Flight Center (Greenbelt, Md.)
GTK	Grand Turk Island
hr	Hour
Hz	Hertz (Cycle per second)
IGOR	Intercept Ground Optical Recorder
IP	Impact Prediction
IU	Instrument Unit (Saturn Vehicle)

LIST OF ABBREVIATIONS
(Continued)

k	Kilo (10^3)
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
LOS	Loss of Signal
LOX	Liquid Oxygen
LTDS	Launch Trajectory Data Subsystem
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
METS	Meteorological System
MIL	MILA USB
MILA	Merritt Island Launch Area
min.	Minute
MITTS	Mobile Igor Tracking Telescope System
MPC	Meteorological Prediction Center
MRTS	Meteorological Real-Time System

LIST OF ABBREVIATIONS
(Continued)

MSC	Manned Spacecraft Center (Houston, Texas)
MSFC	Marshall Space Flight Center (Huntsville, Ala.)
MSOB	Manned Spacecraft Operations Building
NAR	North American Rockwell
NASA	National Aeronautics and Space Administration
n.mi.	Nautical Mile
NO.	Number
OD	Operations Directive
OTV	Operational Television System
PAFB	Patrick Air Force Base
PAMS	Pad Abort Measuring System
PCM	Pulse Code Modulation
PM	Phase Modulation
PRN	Pseudo Random Noise
PSRD	Program Support Requirements Document
PTS	Points
Q	Dynamic Pressure
rf	Radio Frequency
ROTI	Recording Optical Tracking Instrument
RS	Rawinsonde
RSO	Range Safety Officer
RTCC	Real-Time Computer Complex (Houston)
RTCS	Real-Time Computer System (ETR)

LIST OF ABBREVIATIONS
(continued)

S-Band	1550 to 5200 MHz
SC	Spacecraft
SD	Support Document
sec	Second
SLA	Spacecraft LM Adapter
SMG	Spaceflight Meteorology Group (U. S. Weather Bureau)
SRS	Secure Range Safety
STA	Station
TEL	Telemetry
TLM	Telemetry
TTY	Teletype Communications
TV	Television
TW	Thermal Wire
USB	Unified S-Band
USNS	United States Naval Ship
UV	Ultra Violet
VAB	Vertical Assembly Building
VIB	Vertical Integration Building
VHF	Very High Frequency (30-300 MHz)
vs	Versus
WINDS	Weather Information 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 Apollo Saturn V vehicle 509 during the launch phase of the mission (prelaunch, liftoff to insertion). Telemetry, optical, and electronic tracking equipment on board the vehicle and data acquisition systems monitoring the flight are discussed. Flight Safety instrumentation, vehicle data transmission systems, and geophysical instrumentation are also described.

This plan reflects the general instrumentation requirements set forth in NASA PSRD No. 40000 for Apollo Saturn V, and is not intended to conflict with or supersede that document.

The information presented in this document reflects planning concepts developed prior to December 7, 1970.

SECTION II
MISSION PROFILE

2.1 APOLLO 14 VEHICLE CONFIGURATION. (see Figure 2-1)

2.1.1 SATURN V LAUNCH VEHICLE 509

2.1.1.1 S-IC 509. The S-IC stage carries the following instrumentation: Two telemetry links and a dual command/destruct system.

2.1.1.2 S-II 509. The S-II stage carries the following instrumentation: Three telemetry links and a dual command/destruct system.

2.1.1.3 S-IVB 509. The S-IVB stage carries the following instrumentation: One telemetry link and a dual command/destruct system.

2.1.1.4 IU 509. The IU carries the following instrumentation: Two VHF telemetry links, two C-band radar transponders, and the CCS transponder (S-band).

2.1.2 APOLLO SPACECRAFT

2.1.2.1 CSM 110. The CSM carries the following instrumentation: Unified S-band equipment, X-band rendezvous transponder, a dual VHF/AM transceiver, a VHF recovery beacon, a VHF survival beacon-transceiver, a beacon light, a swimmer umbilical, and dye marker.

2.1.2.2 LM-8. The Lunar Module carries the following instrumentation: Unified S-band equipment, X-band rendezvous radar, X-band landing radar, two VHF/AM transceivers. The ALSEP 4 equipment will be off-loaded on the lunar surface.

2.2 MISSION DESCRIPTION

The AS-509 will fly the "H-3" mission.

2.2.1 MISSION "H-3". The MSF Primary Objectives are:

Perform selenological inspection, survey, and sampling in a highland area.

Develop the capability to conduct a mission to a specific site.

Deploy ALSEP 4 consistent with a seismic net.

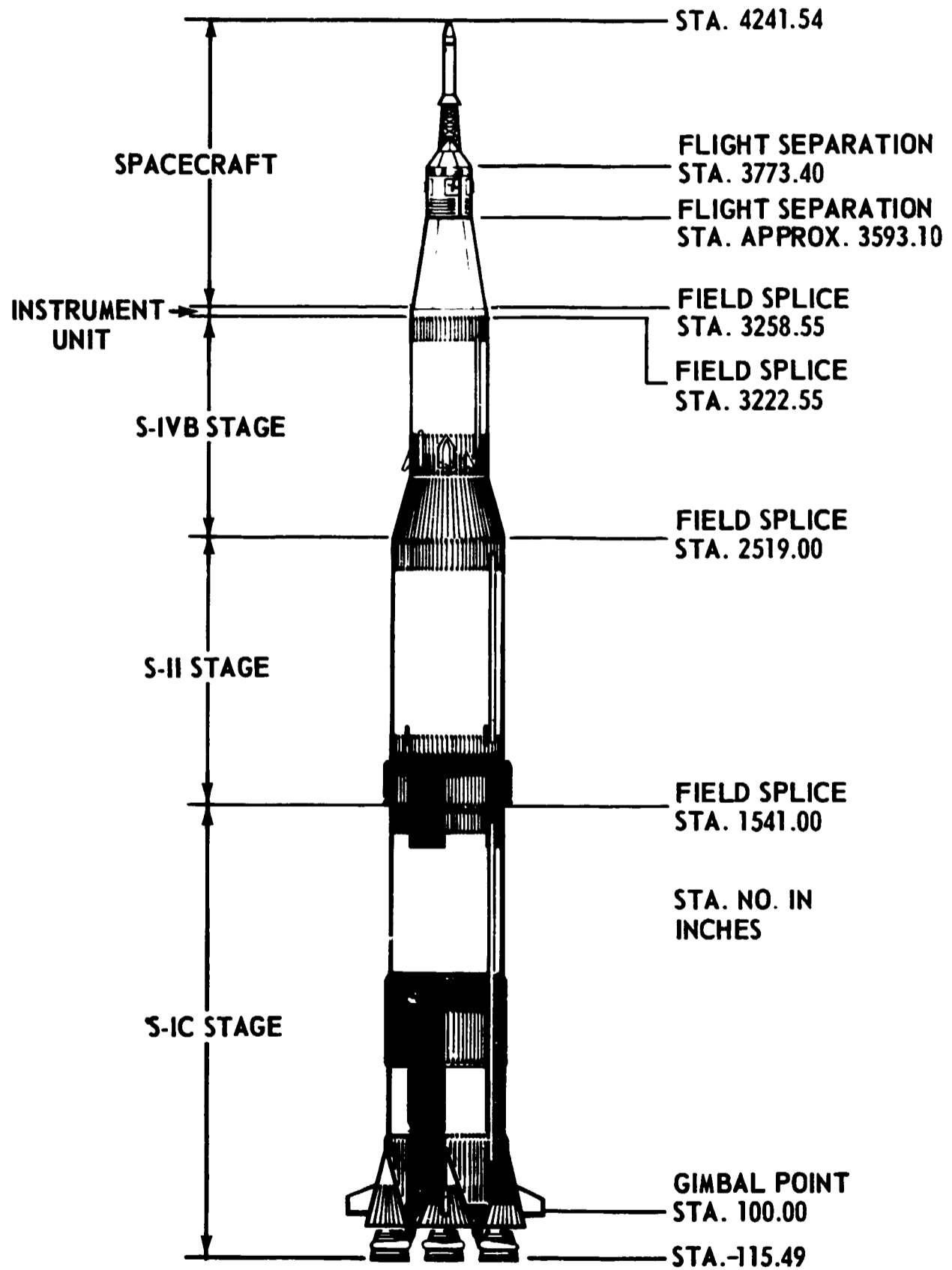


FIGURE 2-1. APOLLO 14 VEHICLE CONFIGURATION

Demonstrate the point landing capability.

Develop man's capability to work in the lunar environment.

- a. Launch Pad - LC-39A.
- b. Flight Azimuth - Variable 72.067° to 96° (0° N), depending upon time within the window.
- c. Launch Opportunities - January 31, 1971
March 1, 2, 3, 1971
- d. Launch Window (Eastern Standard Time):
January 31, 1971 - 1523 to 1913 hours.
Window Duration:
January 31, 1971 - 3 hrs. 50 min.
- e. Injection Opportunities - Pacific translunar opportunities on the 2nd and 3rd orbits are to be utilized for translunar injection (TLI).

f. Trajectory - Table 2.1 gives a summary of the launch phase mission events for a 72.067° flight azimuth. The S-IVB/IU/CSM/LM is injected into a nearly circular 100 nautical-mile orbit with a period of 88.2 minutes. On the 2nd and 3rd orbit after successful checkout of S-IVB/IU/CSM/LM, the S-IVB will be restarted over the Pacific Ocean to place the S-IVB/IU/CSM/LM nominally into a free return translunar trajectory. The S-IVB will then execute maneuvers to assure spacecraft (SC) clearance and result in S-IVB/IU lunar impact. The SC subsequently performs a maneuver which results in a non-free return or hybrid trajectory. Table 2.2 lists launch vehicle orbital events.

At approximately T+82.7 hours, the CSM/LM brakes into Lunar Orbit. After Lunar Orbit is achieved, the LM will separate from the CSM and land on the lunar surface in the Fra Mauro area. The astronauts will perform two lunar extravehicular activity (EVA) excursions. An experiment package (ALSEP 4) will be left on the lunar surface. The LM will ascend from the lunar surface to rendezvous with the CSM and prepare for trans-earth injection (TEI). TEI occurs at approximately T+149.3 hours. The coast period will last approximately 67.2 hours with reentry over the Pacific at approximately T+216.7 hours.

Table 2.1 LAUNCH PHASE MISSION EVENTS (72.067° F.A.)

EVENT	TIME FROM FIRST MOTION (sec)	EARTH-FIXED VELOCITY (m/sec)	ALTITUDE (km)	GROUND RANGE (km)
First Motion	0.0	0.0	0.0	0.0
Initiate Tilt	13.0	28.6	0.2	0.0
Max. Q	85.4	509.6	13.5	6.4
S-IC O.E.C.O.	164.8	2354.8	66.7	94.7
S-II Eng. Start	166.2	2362.3	68.0	97.8
IGM Enable	205.4	2530.2	98.9	186.6
S-II C.E.C.O.	463.8	5259.0	179.2	1102.8
S-II Eng. C.O.	556.7	6565.2	185.5	1634.1
S-IVB Eng. 90% Thr.	563.2	6573.2	186.0	1676.2
S-IVB First Guidance C.O.	703.3	7387.9	188.4	2623.3
S-IVB Parking Orbit Insertion	713.3	7389.5	188.3	2695.0

Table 2.2 LAUNCH VEHICLE ORBITAL EVENTS
(First TLI Opportunity)

EVENT	G.E.T.	
	Hr.	Min.
S-IVB Reignition	2	31
S-IVB 2nd Guidance C.O.	2	37
S-IVB Translunar Injection	2	37
S-IVB H ₂ Continuous Vent Off	2	39

SECTION III
ONBOARD EQUIPMENT

3.1 ELECTRONIC TRAJECTORY DATA ACQUISITION EQUIPMENT

The electronic trajectory data acquisition equipment carried on AS-509 is listed in Table 3.1. Locations of the onboard antennas are shown in Figures 3-2, 3-3, and 3-4.

TABLE 3.1 ONBOARD ELECTRONIC TRACKING DATA ACQUISITION EQUIPMENT

SYSTEM	FREQUENCIES (MHz)		LOCATION	REMARKS
	Receive	Transmit		
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. The system may be shut down by ground command during LM USB operation.

(Continued on next page)

TABLE 3.1 ONBOARD ELECTRONIC TRACKING DATA ACQUISITION EQUIPMENT (Cont'd)

SYSTEM	FREQUENCIES (MHz)		LOCATION	REMARKS
	Receive	Transmit		
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.
	2101.8	2282.5	LM	
Rendezvous Radar	9792.0	9832.8	LM	Designed to facilitate rendezvous of LM and CSM in lunar orbit.
Rendezvous Radar Transponder	9832.8	9792.0	CSM	Designed for use with LM Rendezvous Radar.
Landing Radar		10510(Vel) 9580(Alt)	LM	Designed to provide the LM altitude and velocity data on lunar descent.

3.2 OPTICAL DATA ACQUISITION EQUIPMENT

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

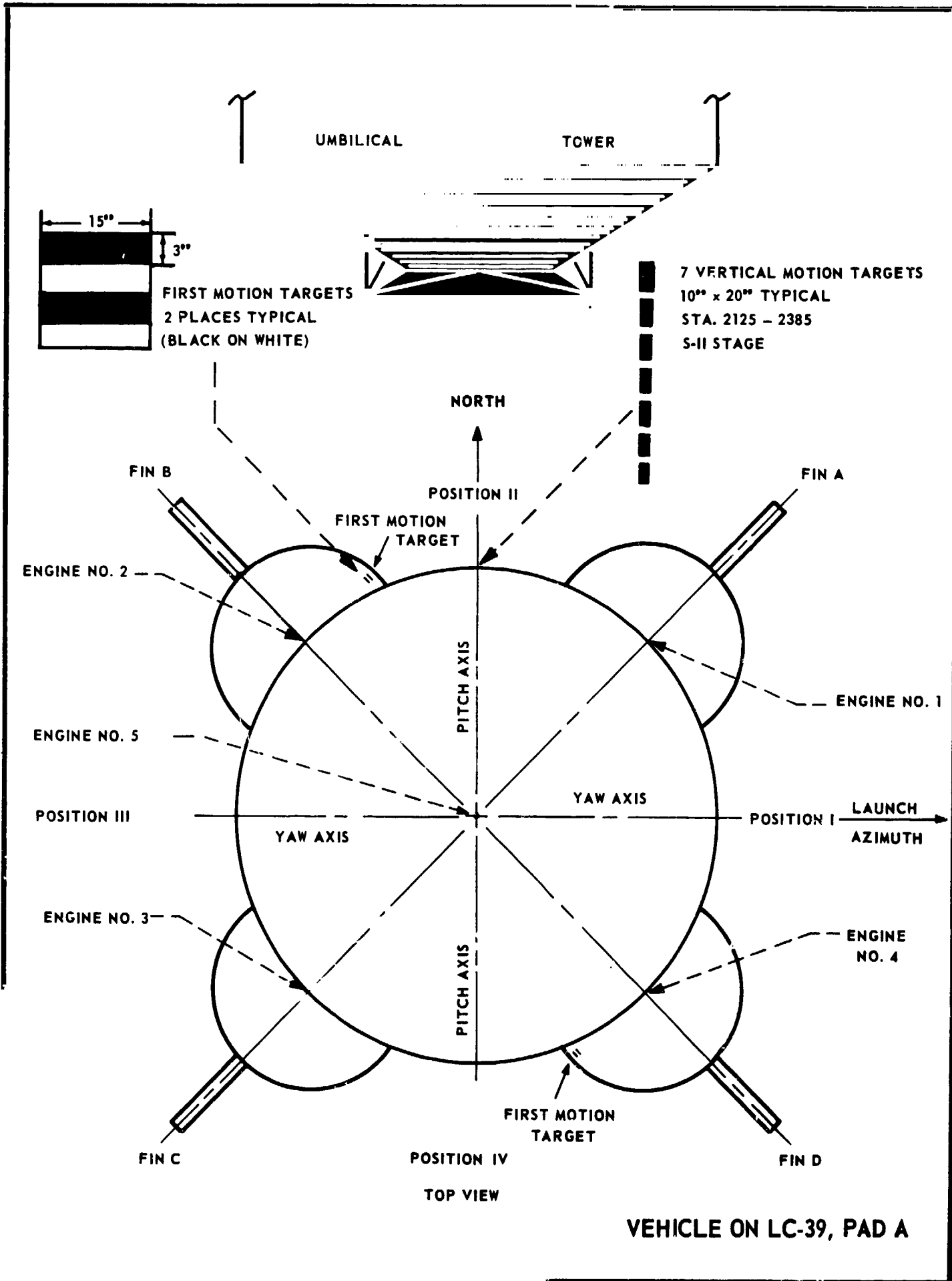


Figure 3-1. Apollo/Saturn V Orientation and Camera Target Locations

3.3 TELEVISION SYSTEMS

3.3.1 COMMAND MODULE TELEVISION SYSTEM. A color television camera will provide real-time video data via the USB system. A twelve-foot cable allows portable use of the camera. Two semistationary locations will allow instrument panel viewing, and a third, a front viewing of the crew. The downlink frequency is 2272.5 MHz.

3.3.2 LUNAR MODULE TELEVISION SYSTEM. A color camera is planned as the primary system with a black and white camera carried for contingencies. The TV cameras will provide real-time video to earth via the LM USB system. A 100-foot cable will permit use of the camera on the lunar surface. The color camera is provided with a zoom lens. Two lenses are available for the black and white cameras: wide angle and lunar day.

The LM USB downlink frequency is 2282.5 MHz. The S-band erectable antenna or the LM S-band steerable antenna may be utilized for USB operations during lunar stay.

3.4 TELEMETRY SYSTEMS

The telemetry links carried on the AS-50g vehicle are listed in Table 3.2.

TABLE 3.2 TELEMETRY SYSTEMS

LINK NO.	FREQUENCY (MHz)	MODULATION	TRANSMITTED POWER (Watts)	LOCATION	REMARKS
AF-1 AP-1	256.2 244.3	FM/FM PCM/FM	20 15	S-IC	
BF-1 BF-2 BP-1	241.5 234.0 248.6	FM/FM FM/FM PCM/FM	20 20 15	S-II	
CP-1	258.5	PCM/FM	15	S-IVB	
DP-1 DF-1 DP-1B (CCS)	245.3 250.7 2282.5	PCM/FM FM/FM PCM/PM	15 20 15	IU	CCS Downlink parallel to DP-1
LM-PCM	2282.5	USB FM or PM	0.75 or 20	LM	This frequency shared with CCS downlink
LM- ALSEP 4	2279.5	PCM/PM		LM/Lunar Surface	ALSEP 4 uplink frequency 2119 MHz
CSM-P/B CSM-R/T	2272.5 2287.5	USB FM Mode USB PM Mode	0.25, 5, 20 5 or 20	CSM CSM	

3.5 TAPE RECORDERS

3.5.1 CSM TAPE RECORDER. The CSM carries one tape recorder. The Operational Recorder provides recording and playback of telemetry and voice data. Playback is accomplished via the USB system. The CSM recorder may be utilized to process LM and EVA voice/data if required. The LM has voice recorder capability.

3.6 RADIO COMMAND CONTROL SYSTEMS

3.6.1 LAUNCH VEHICLE RANGE SAFETY DIGITAL COMMAND/DESTRUCT SYSTEM. The S-IC, S-II, and S-IVB stages carry dual independent Secure Range Safety (SRS) command systems operating at 450 MHz. Three commands may be transmitted through the SRS system; they are:

- a. ARM/FUEL CUTOFF - Terminates thrust and arms the EBW firing unit charge circuits.
- b. DESTRUCT - Firing of the EBW.
- c. SAFE - Disconnects the command decoding equipment from the battery.

3.6.2 SPACE VEHICLE COMMAND/CONTROL SYSTEMS

3.6.2.1 Command and Communications System (CCS). The IU stage carries the CCS which provides guidance system data update, guidance system closed-loop testing initiation, and other vehicle command data. The IU Command System 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.

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

3.6.2.3 LM Updata Link. The LM USB system provides an updata link on 2101.8 MHz with capability for voice, data, commands, and ranging codes. The updata link of the CCS System on the IU also operates at this frequency.

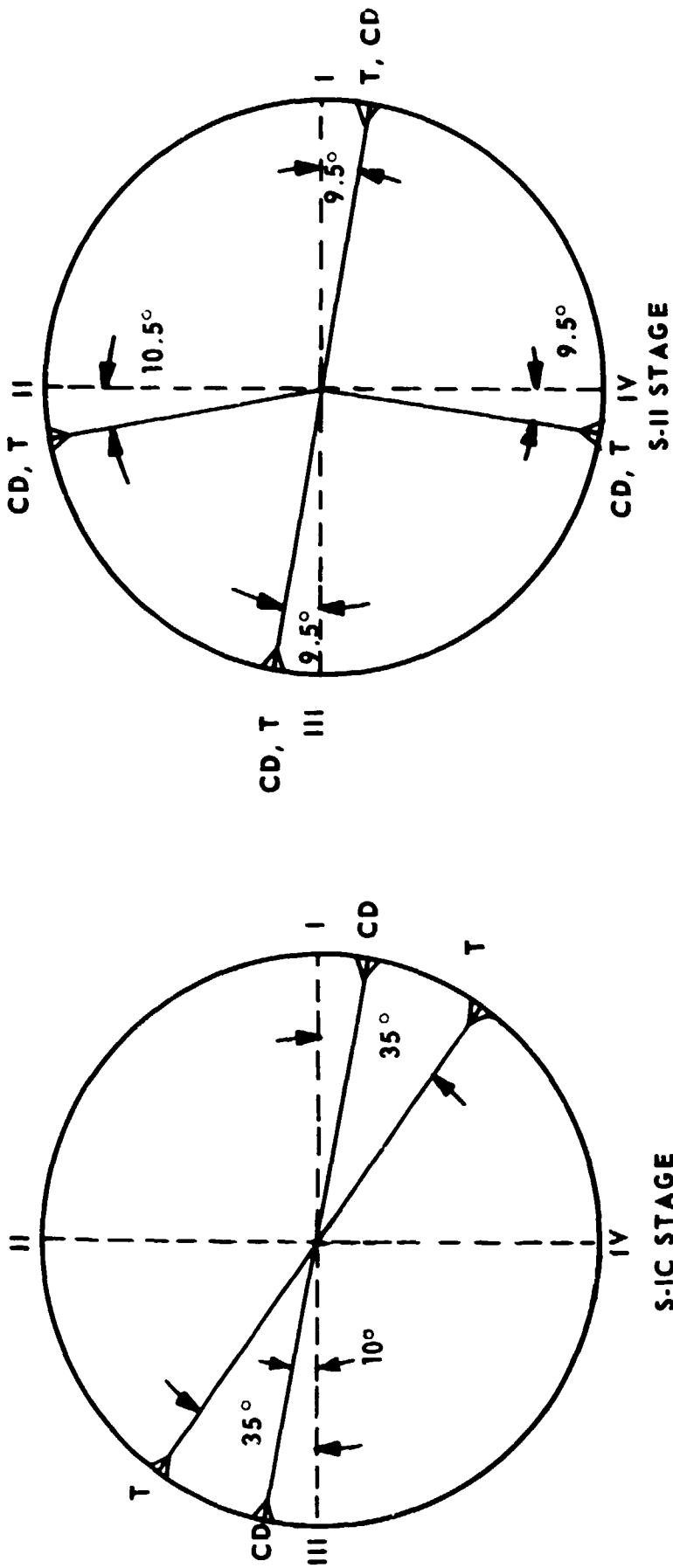
3.6.2.4 ALSEP Updata Link. The USB system provides an updata link on 2119 MHz for ALSEP control on the lunar surface.

3.7 LUNAR EXPERIMENT EQUIPMENT

3.7.1 ALSEP 4. The ALSEP 4 will be off-loaded on the lunar surface. Five experiments will provide data on active and passive seismic phenomena, lunar ionosphere, solar particles, and lunar dust.

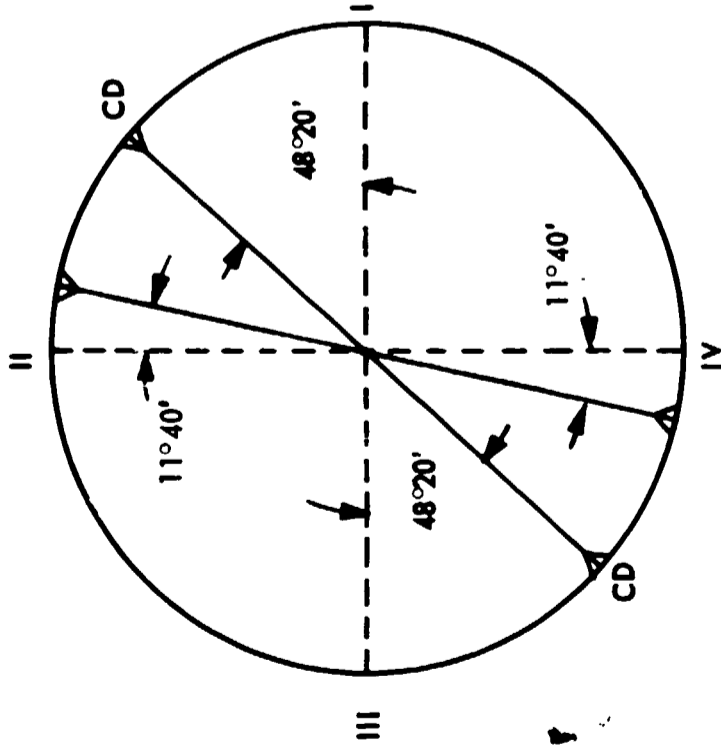
The up and down link frequencies are S-band. MSFN S-band sites will support the experiment.

3.7.2 EVA EQUIPMENT. The EVA suits contain VHF/AM and VHF/FM equipment to provide lunar surface voice/data communication.



T - TELEMETRY ANTENNAS - STA. 1459.00 T - TELEMETRY ANTENNAS - STA. 2465.00
 CD - COMMAND DESTRUCT ANTENNAS - STA. 1503.20 CD - COMMAND DESTRUCT ANTENNAS - STA. 2494.00

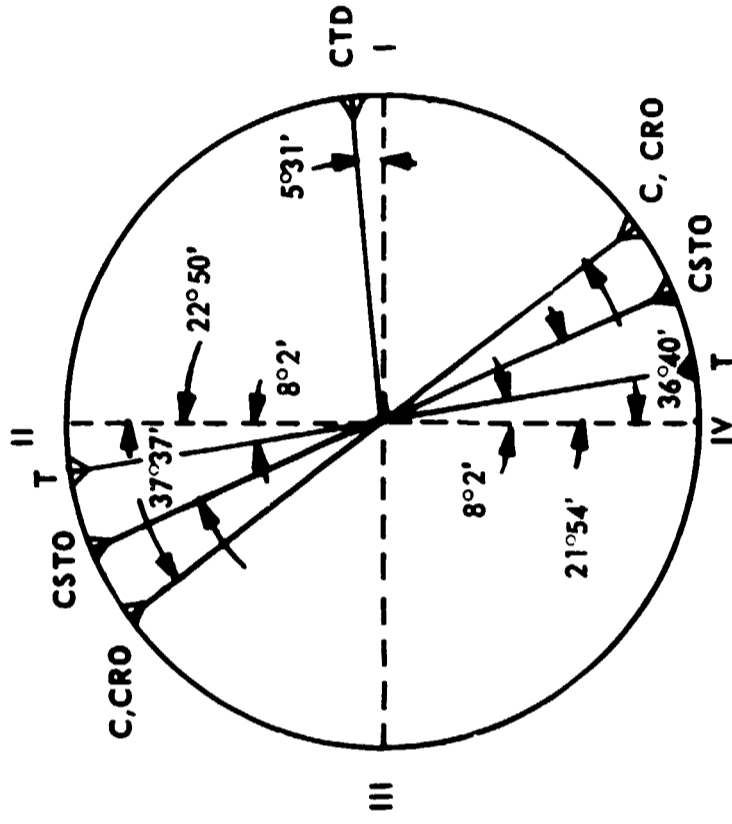
Figure 3-2. Location of S-IC and S-II Onboard Antennas



S-IVB STAGE

T - TELEMETRY ANTENNAS - STA. 3193.55

CD - COMMAND DESTRUCT ANTENNAS - STA. 3193.55



INSTRUMENT UNIT (IU)

C-C - BAND RADAR ANTENNAS - STA. 3234.82

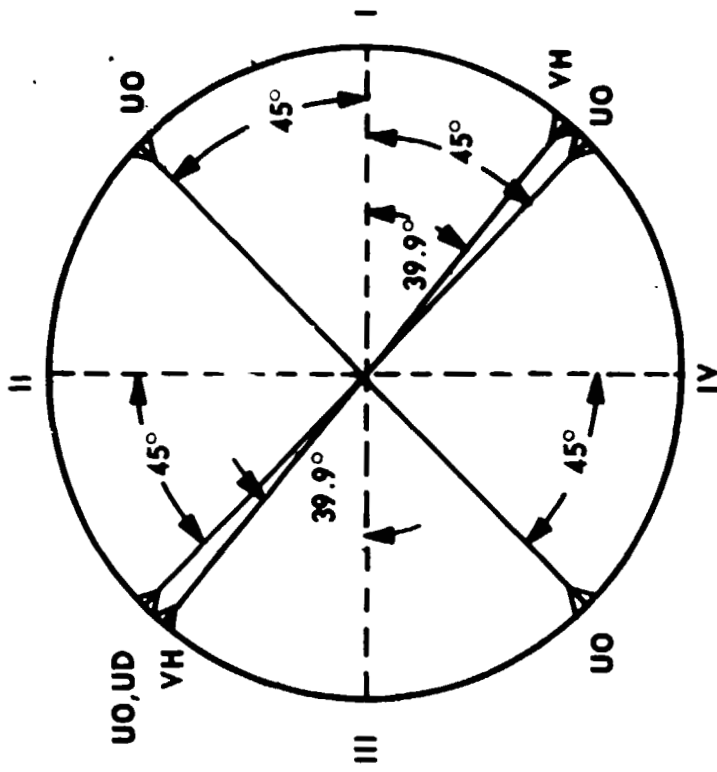
CRO - CCS RECEIVING OMNI ANTENNAS - STA. 3251.98

CSTO - CCS TRANSMITTING OMNI ANTENNAS - STA. 3251.73

CTD - CCS TRANSMITTING DIRECTIONAL ANTENNA - STA. 3246.50

T - VHF TELEMETRY

Figure 3-3. Location of S-IVB and IU Onboard Antennas



COMMAND SERVICE MODULE

UD - USB, HIGH GAIN ANTENNA - STA. 3593

UO - USB, OMNI ANTENNAS - STA. 3776

VH - VHF/AM ANTENNAS - STA. 3674

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

Figure 3-4. Location of Command Service Module Onboard Antennas

SECTION IV
DATA ACQUISITION SYSTEMS

4.1 ELECTRONIC TRACKING DATA ACQUISITION SYSTEMS

4.1.1 C-BAND RADAR SUPPORT

4.1.1.1 Space Vehicle Launch Phase Trajectory Coverage

a. Tracking Point

C-band antenna on the IU (see Figure 3-3). The radars will share the beacons. Radar 0.18 will skintrack only. The radars are preassigned to track the CSM and launch vehicle in event of launch phase abort.

b. Frequency

The radars will interrogate the transponders on 5690 MHz and will receive the returned signal on 5765 MHz. Radar 0.18 will skintrack radiating 5810 MHz. The R&D radar 0.13 will also operate skintrack at 5810 MHz.

c. Measured Parameters

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

d. Coverage

Figures 4-25 and 7-1 indicate the expected flight time coverage for metric and range safety data, respectively. The table below is a summary of radar coverage. Radar 3.13 real-time data will not be available off the ETR.

NOTE: Figure 4-25 and 7-1 coverage times are for AS-508. AS-509 coverage times are expected to be very similar.

TABLE 4.1 LAUNCH PHASE TRAJECTORY RADAR COVERAGE

Radar Station No.	Radar Type	Data Rate Pts/Sec	Interval of Track	Remarks
1.16 CKAFS	FPS-16	10	Acq. to LOS	Estimated position accuracies for each radar are given. See Figures 4-8 through 4-24. *Radar 0.18 will skin-track
19.18 KSC	TPQ-18	20	Acq. to LOS	
*0.18 PAFB	FPQ-6	20	Acq. to LOS	
3.13 GBI	C-Band			
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	
91.18 ANT	FPQ-6	20	Acq. to LOS	

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

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

4.1.1.2 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) The USB transponder antennas on the CSM (see Figure 3-4) and the LM; (2) the CCS transponder antennas on the IU (see Figure 3-3); and the ALSEP 4 S-band antenna on the lunar surface.

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 LM receive and transmit frequencies are 2101.8 and 2282.5 MHz, respectively. The CCS utilizes the same frequencies as the LM USB system. The ALSEP 4 receives on 2119 MHz and transmits on 2279.5 MHz.

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 AS-509 during the launch phase of the mission. The USB stations provide tracking, telemetry, communication, and updata support. The USNS Vanguard will provide USB coverage for insertion and will be located at 25°N, 49°W.

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

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

4.1.3 RENDEZVOUS RADAR SUPPORT. The X-band rendezvous radar is located in the LM and the transponder on the CSM. The system will be inactive during the launch phase and is activated in lunar rendezvous operations.

4.1.4 LANDING RADAR SUPPORT. The lunar landing radar located in the LM and used to provide altitude and velocity data, will be carried. The radar employs 10510 MHz and 9580 MHz for velocity and altitude measurements, respectively. The radar is inactive during the launch phase.

4.2 OPTICAL DATA ACQUISITION SYSTEMS

4.2.1 METRIC OPTICAL DATA ACQUISITION SUPPORT

4.2.1.1 Vertical Motion Cameras

a. Tracking Point

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

b. Camera Size

35 mm

c. Reduced Data

Vertical motion vs. time.

d. Coverage

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.

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

Not applicable

4.2.1.2 First Motion Cameras

a. Tracking Point

The cameras are locked in position to view the first motion targets. (See Figure 3-1.)

b. Camera Size

16 mm

c. Reduced Data

Time of vehicle first motion

d. Coverage

Two cameras, located at the zero 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.

4.2.2 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

Two IGOR systems will support the AS-509 launch. Locations will be at Ponce de Leon Inlet (MITTS) and at PAFB. The fixed IGOR system at PAFB will provide TV video coverage to the RSO, LCC, and LC-39 press site.

b. ROTI Tracking Telescopes

One ROTI located at Melbourne will support the AS-509 launch.

4.2.3 TELEVISION SUPPORT

4.2.3.1 ETR Television Support

4.2.3.1.1 Range Safety Television Support. One Flightline and two Program TV cameras will provide the RSO visual coverages of the vehicle launch. The Flightline camera is located at FCVP-2 (FIM-8) (see Figure 4-3). Program I camera is located just north of UC-2 (FIM-7) on KSC (Figure 4-3). Program II camera is located on the Cape (Figure 4-2).

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 LC-39 press site.

4.2.3.2 GSFC Television Support. The KSC USB Ground Station will monitor and record the prelaunch TV transmissions originating in the CM and LM. The TV systems are inactive during the launch phase.

4.2.3.3 KSC Television Support

4.2.3.3.1 Abort System Television Coverage. Six cameras will view the vehicle to provide abort advisory information: Two located on the LUT, two in the pad area, and one remote long-range camera (ETR supplied) adjacent to the Range Safety Flightline TV camera. The IGOR at PAFB provides long-range coverage.

4.2.3.3.2 Operational Television (OTV) Support. Sixty TV cameras as listed will support the launch:

- 12 - Mobile Service Structure (MSS)
- 27 - Launch Umbilical Tower
- 18 - Pad Area
- 2 - Firing Room
- 1 - VIB

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 Table 3.2.

a. Airborne TLM coverage - Four 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 - Station 91 (Antigua) - This station will route certain data in real time for range safety purposes.

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

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

S-Band

KSC
Bermuda
Vanguard
(Insertion Ship)

VHF

KSC
Bermuda
Vanguard

The KSC USB site will transmit 51.2 kbs PCM to CIF for processing and relay to MCC-H via the ALDS equipment.

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. These data 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 data are routed to Data-Core for local CIF recording, display, and retransmission to MSC, MSFC, LC-39, and MSOB.

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

d. MSOB ACE Station - Acceptance Checkout Equipment located in the MSOB will receive spacecraft 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 SC and launch vehicle data.

4.4 FREQUENCY CONTROL AND ANALYSIS

4.4.1 ETR FC & A SUPPORT

4.4.1.1 C-Band Beacon Checkout. IU C-band Beacon 1 and 2 are checked out prior to launch by SP-104 EMC vans and in conjunction with Radar 1.16.

4.4.2 KSC FC & A SUPPORT

4.4.2.1 Spurious Emission Search. The KSC EMC Van will provide RFI search and record coverage from 100 MHz to 10 GHz.

4.4.2.2 Command and Astronaut Voice Link Record. The KSC Van will record UHF command and Astronaut Voice link signal strength while vehicle RF is radiating open loop. In addition, the UHF command link will be recorded from the roof of the VAB.

4.4.2.3 Power Line Transient Record. Equipment will monitor CIF power line transients.

4.5 SURFACE INSTRUMENTATION SUMMARY

Location of the data acquisition systems planned to support this mission are shown in Figure 4-1 through 4-4. Elevation angles from the major land-based tracking stations for the launch phase are shown in Figures 4-5, 4-6, and 4-7. The expected flight time coverage for metric trajectory coverage is given in Figure 4-25. The estimated accuracies of the C-band radars are given in Figure 4-8 through 4-24. The elevation angles and estimated accuracies are for AS-508. The AS-509 parameters are expected to be very similar.

LAUNCH PAD 39A

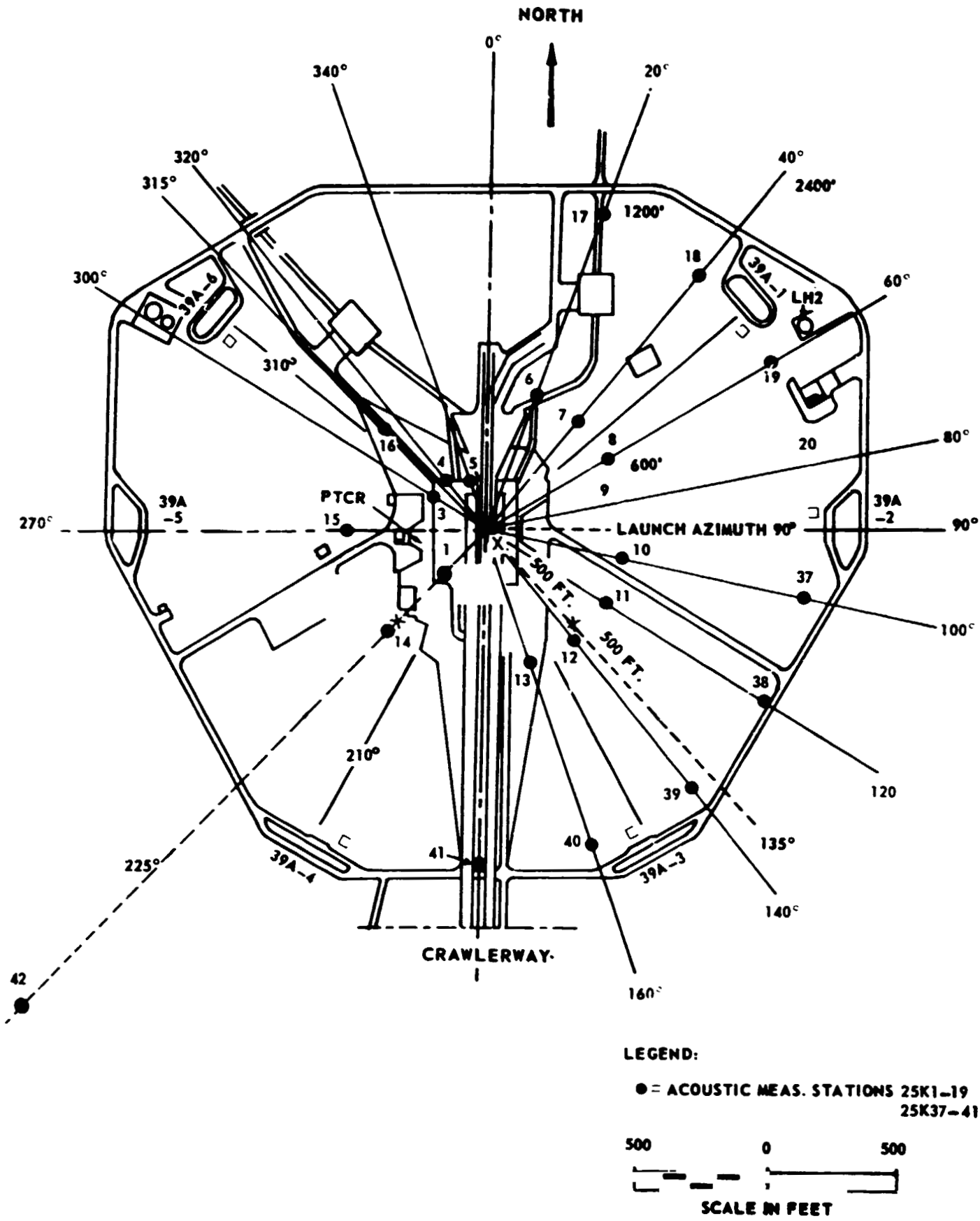


Figure 4-1. Close-In Instrumentation

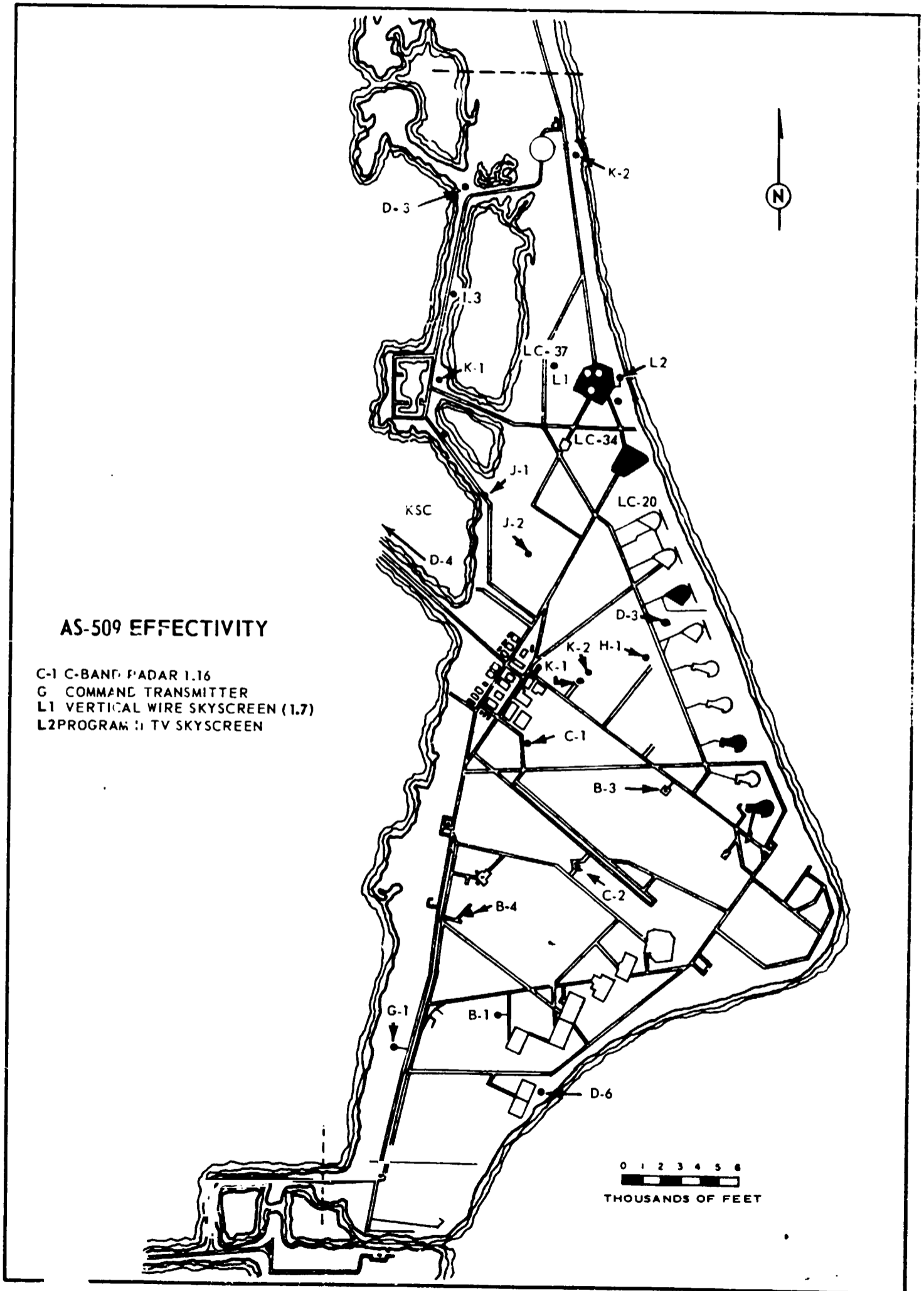


FIGURE 4-2 CAPE INSTRUMENTATION

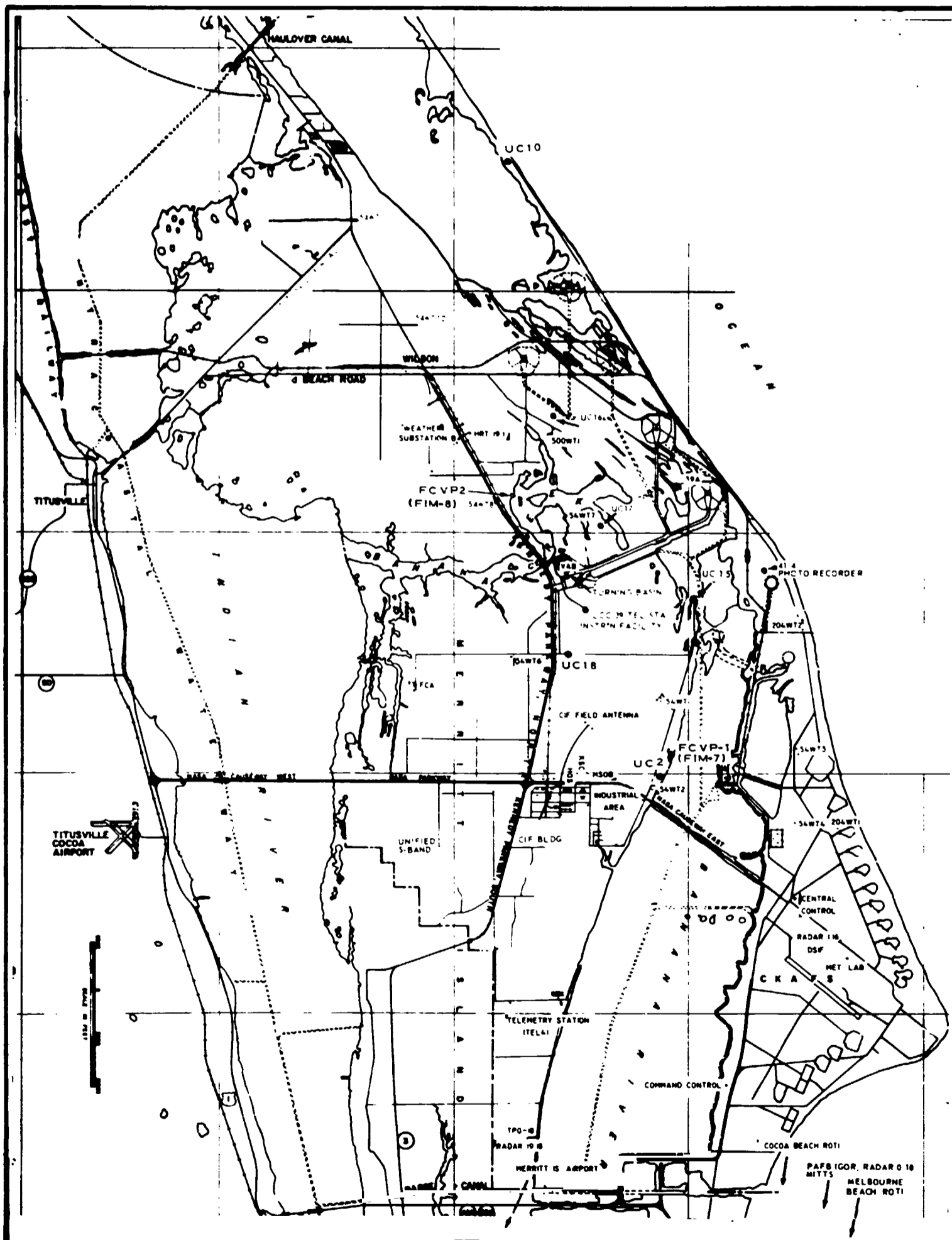
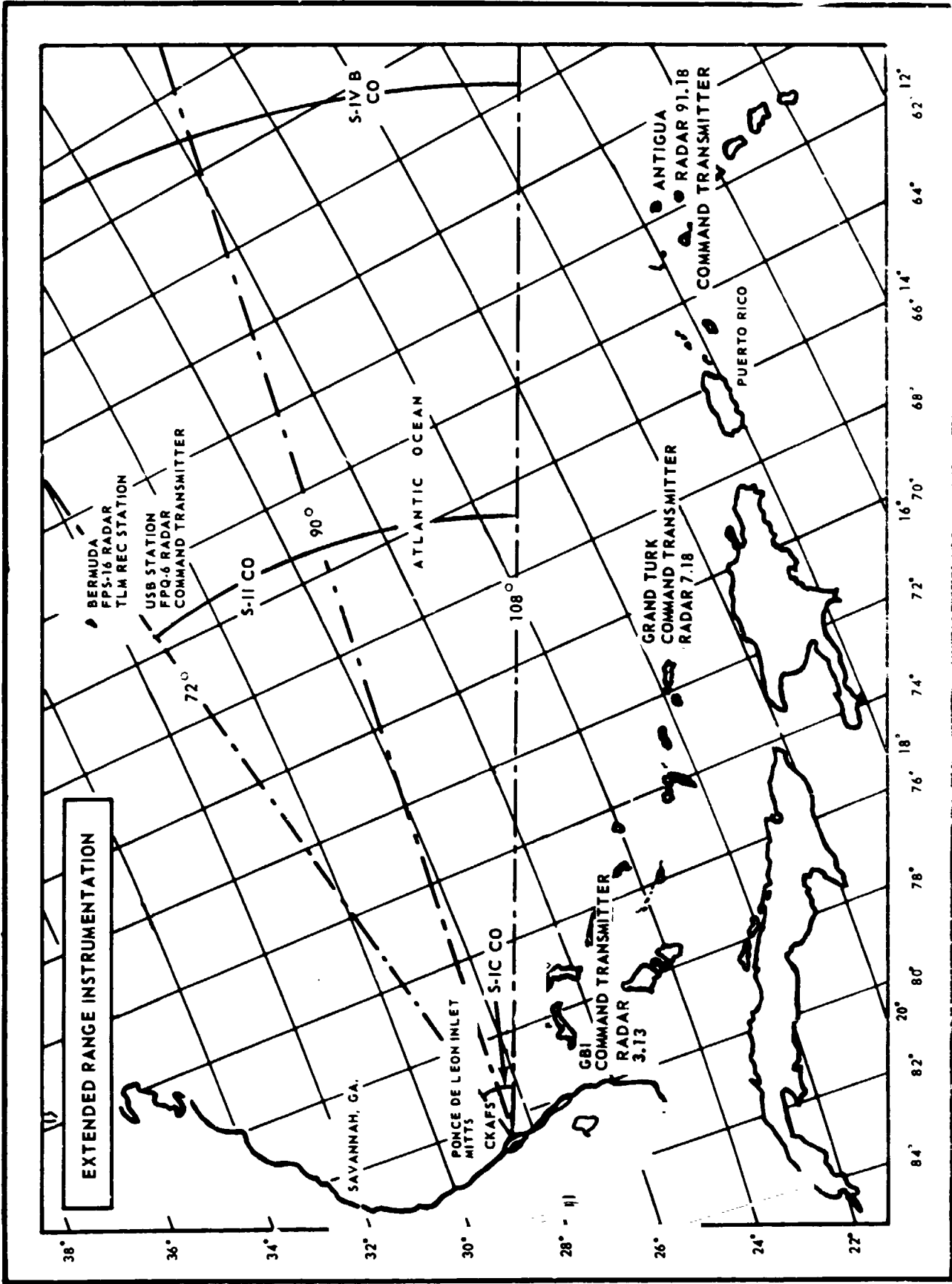


Figure 4-3. Uprange Instrumentation



AS-500 Fl. Az. Limits 72° -

Figure 4-

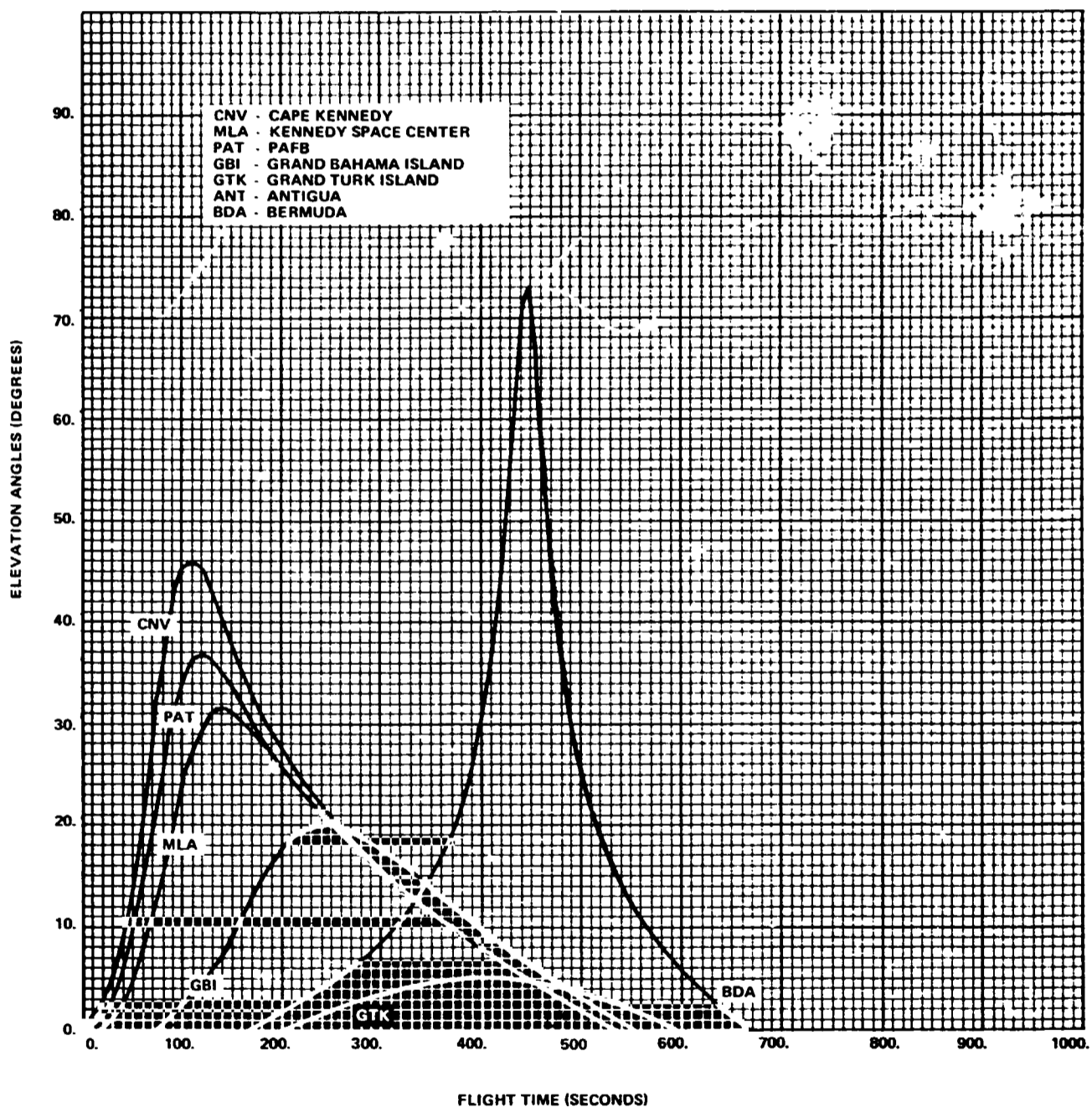


FIGURE 4-5. ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, AS-508 (F.A. 72°)

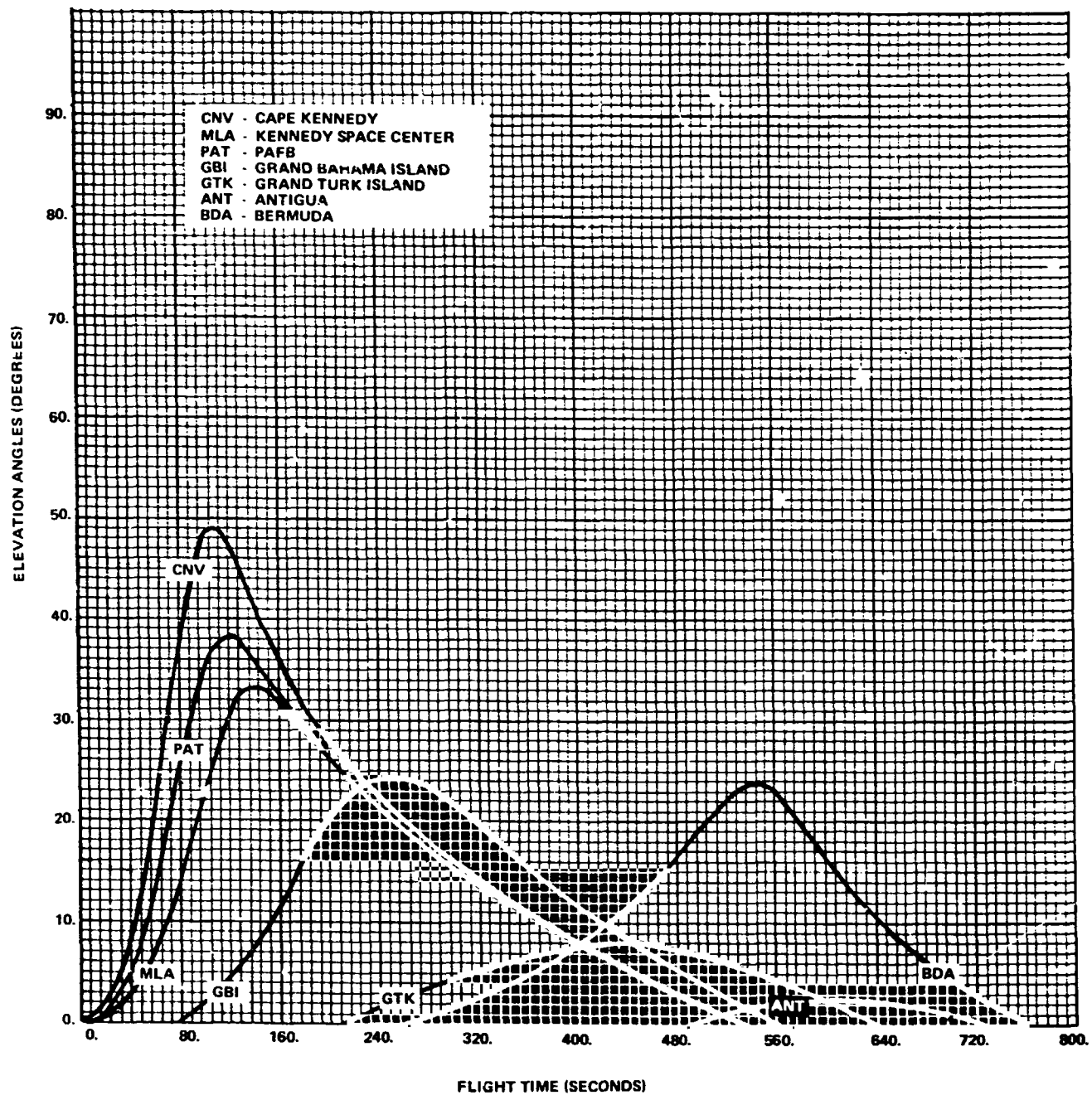


FIGURE 4-6. ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, AS-508 (F.A. 84°)

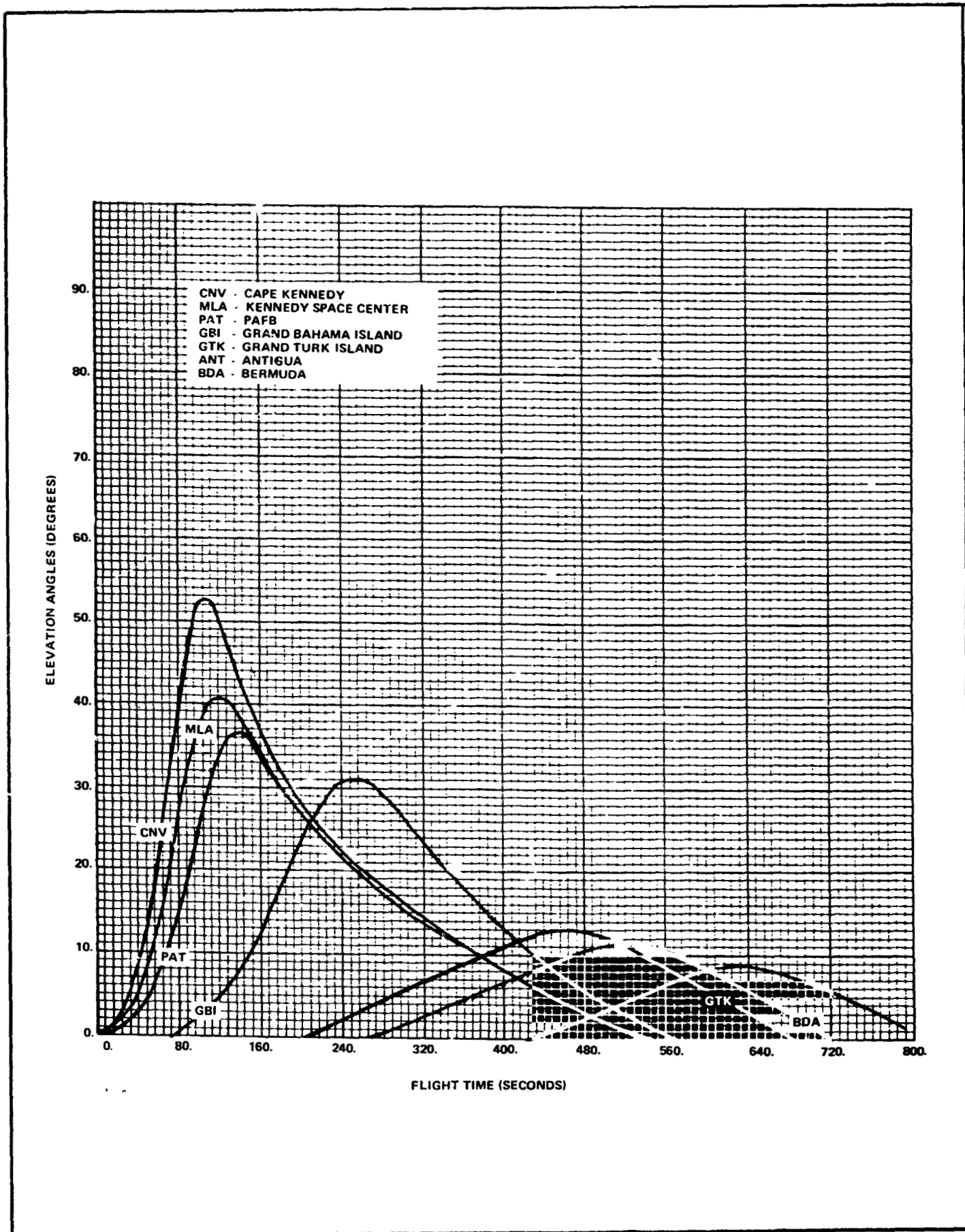


FIGURE 4-7. ELEVATION ANGLES FROM MAJOR LAND-BASED TRACKING STATIONS, AS-508 (F.A. 96°)

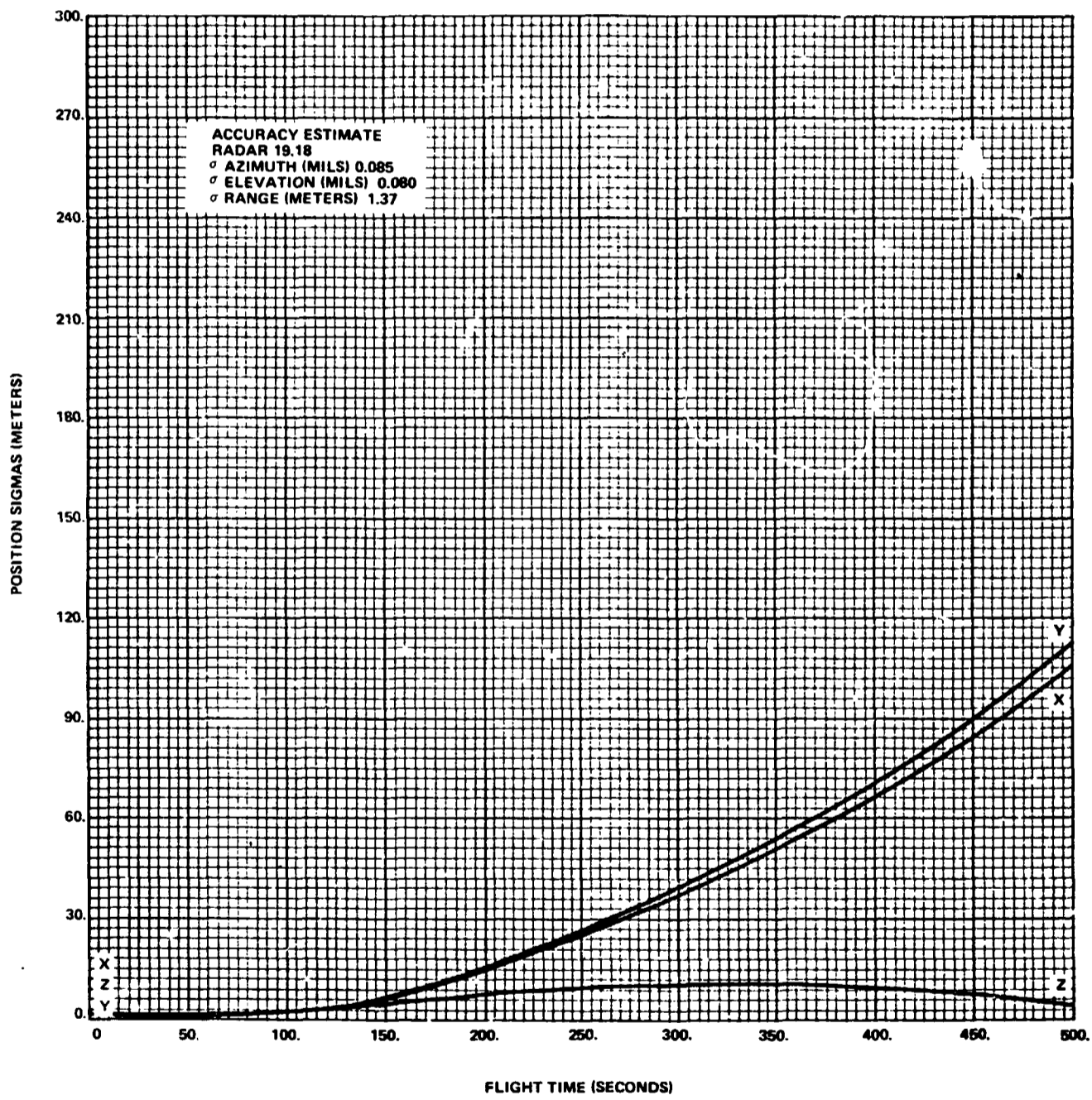


FIGURE 4-8. ESTIMATES OF KSC C-BAND RADAR 19.18 POSITION ACCURACIES, AS-508 (F.A. 729)

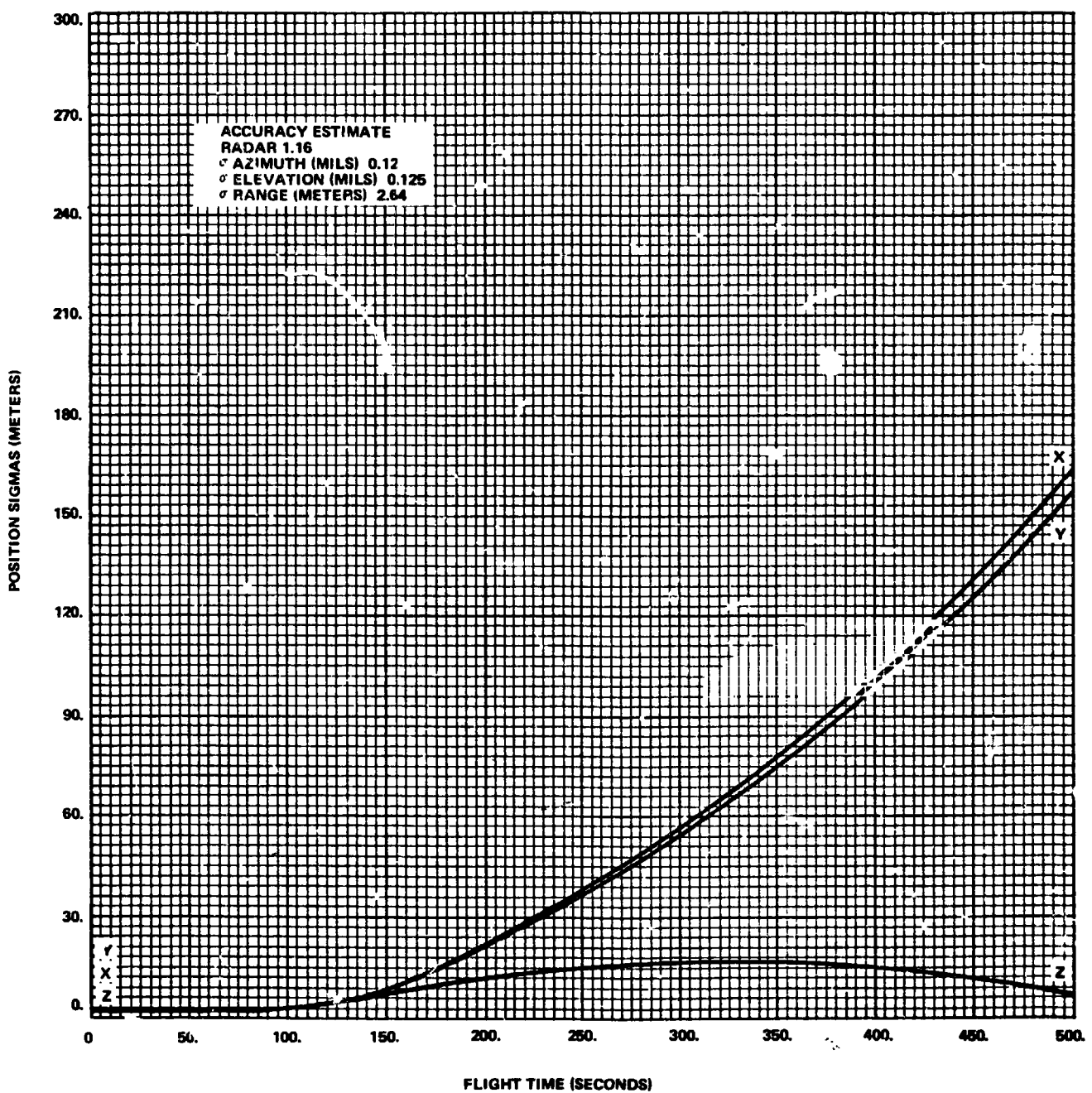


FIGURE 4-3. ESTIMATES OF CAPE KENNEDY C-BAND RADAR 1.16 POSITION ACCURACIES, AS-508 (F.A. 72°)

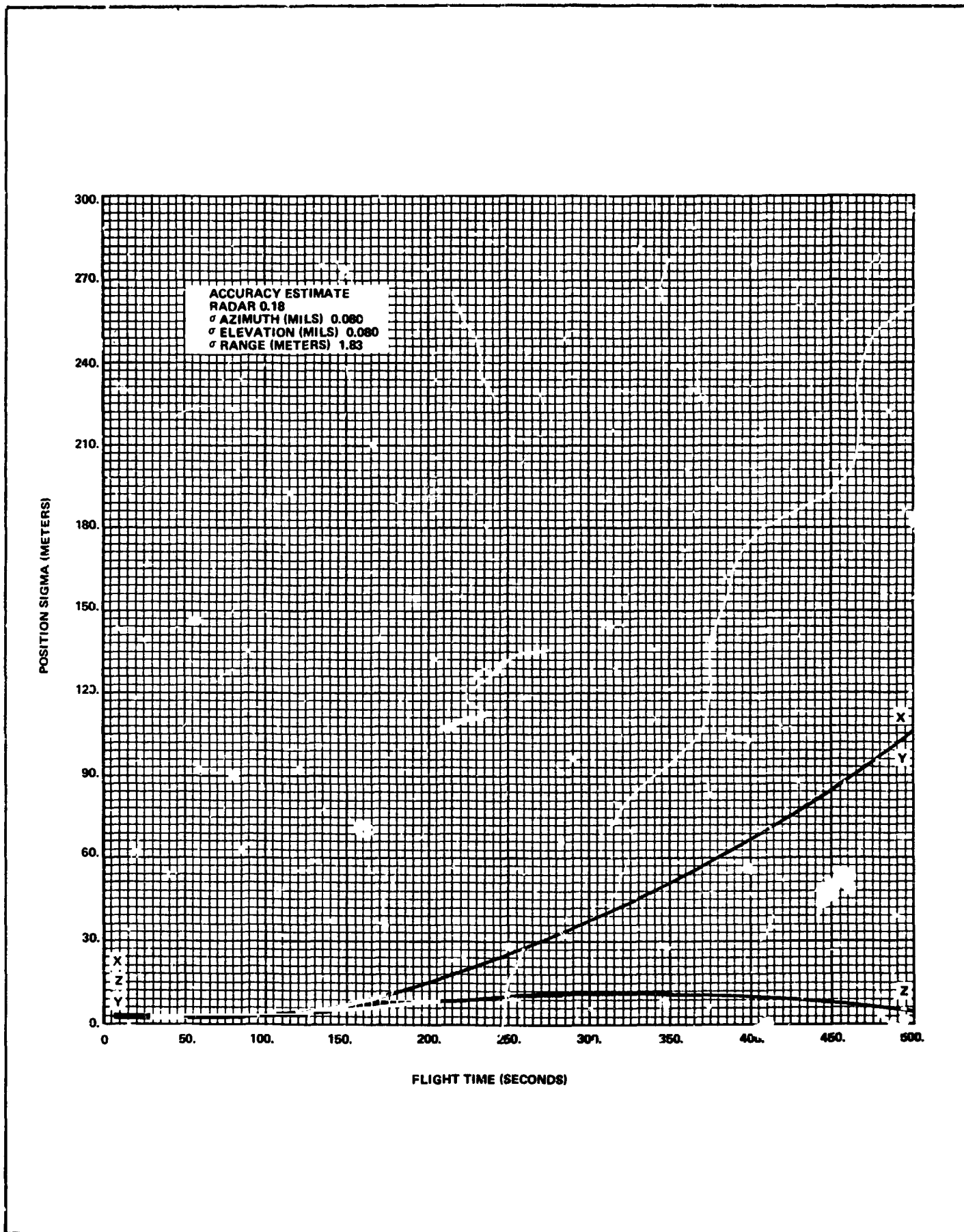


FIGURE 4-10. ESTIMATES OF PAFB C-1 AND RADAR 0.16 POSITION ACCURACIES, AS-508 (F.A. 72°)

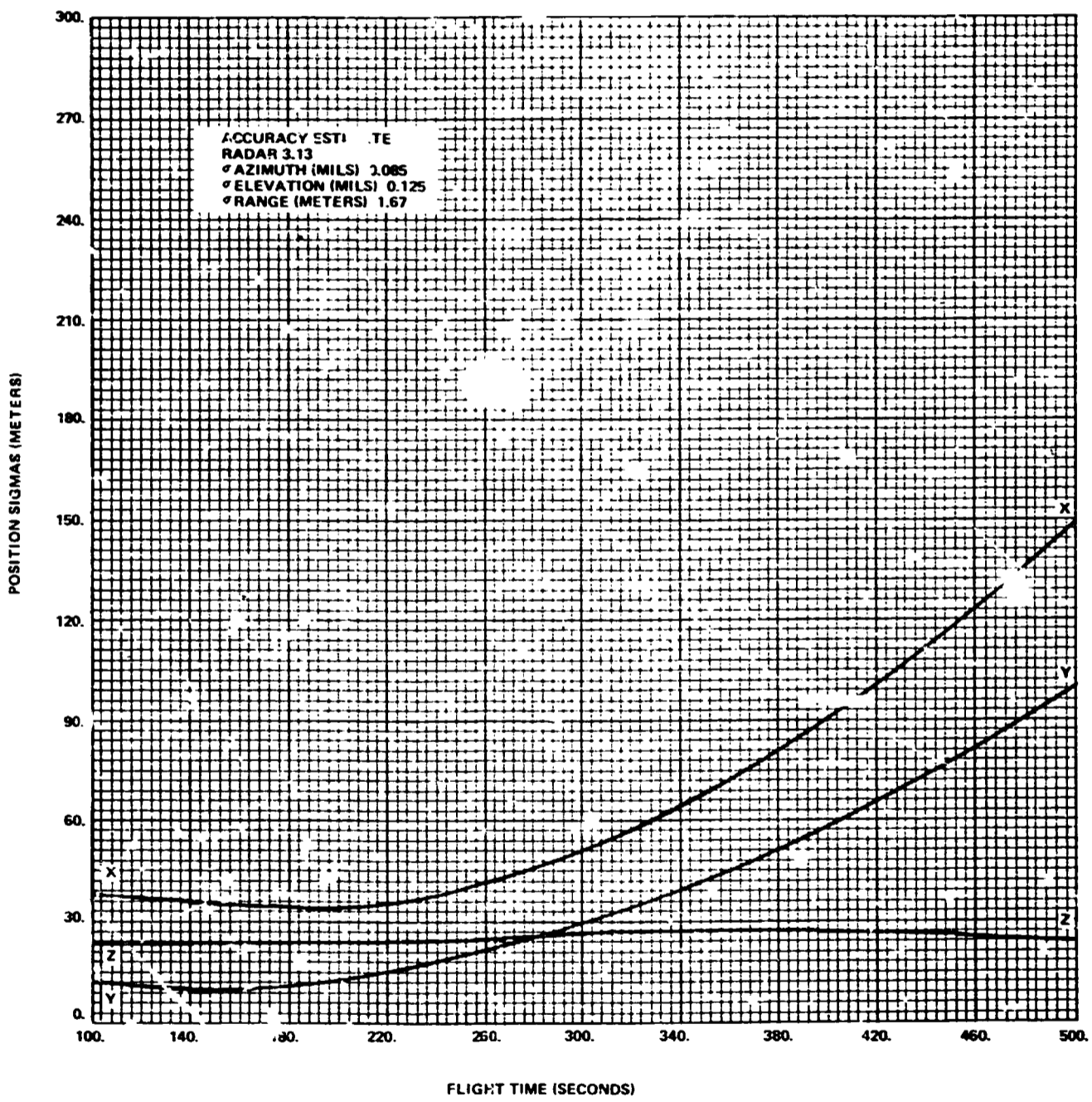


FIGURE 4-11. ESTIMATES OF GB I C-BAND RADAR 3.13 POSITION ACCURACIES, AS-508 (F.A. 72°)

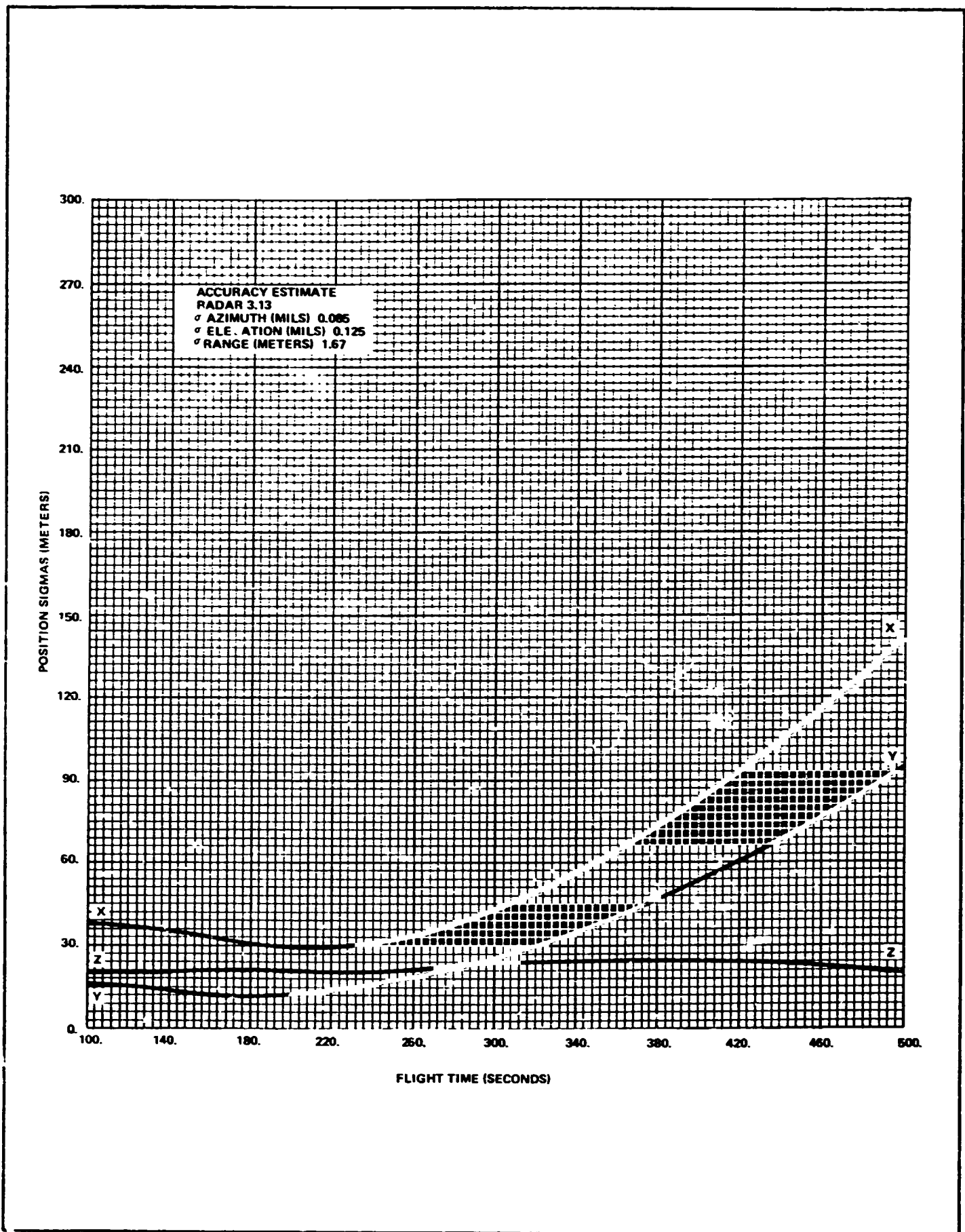


FIGURE 4-12. ESTIMATES OF GBI C-BAND RADAR 3.13 POSITION ACCURACIES, AS-508 (F.A. 84°)

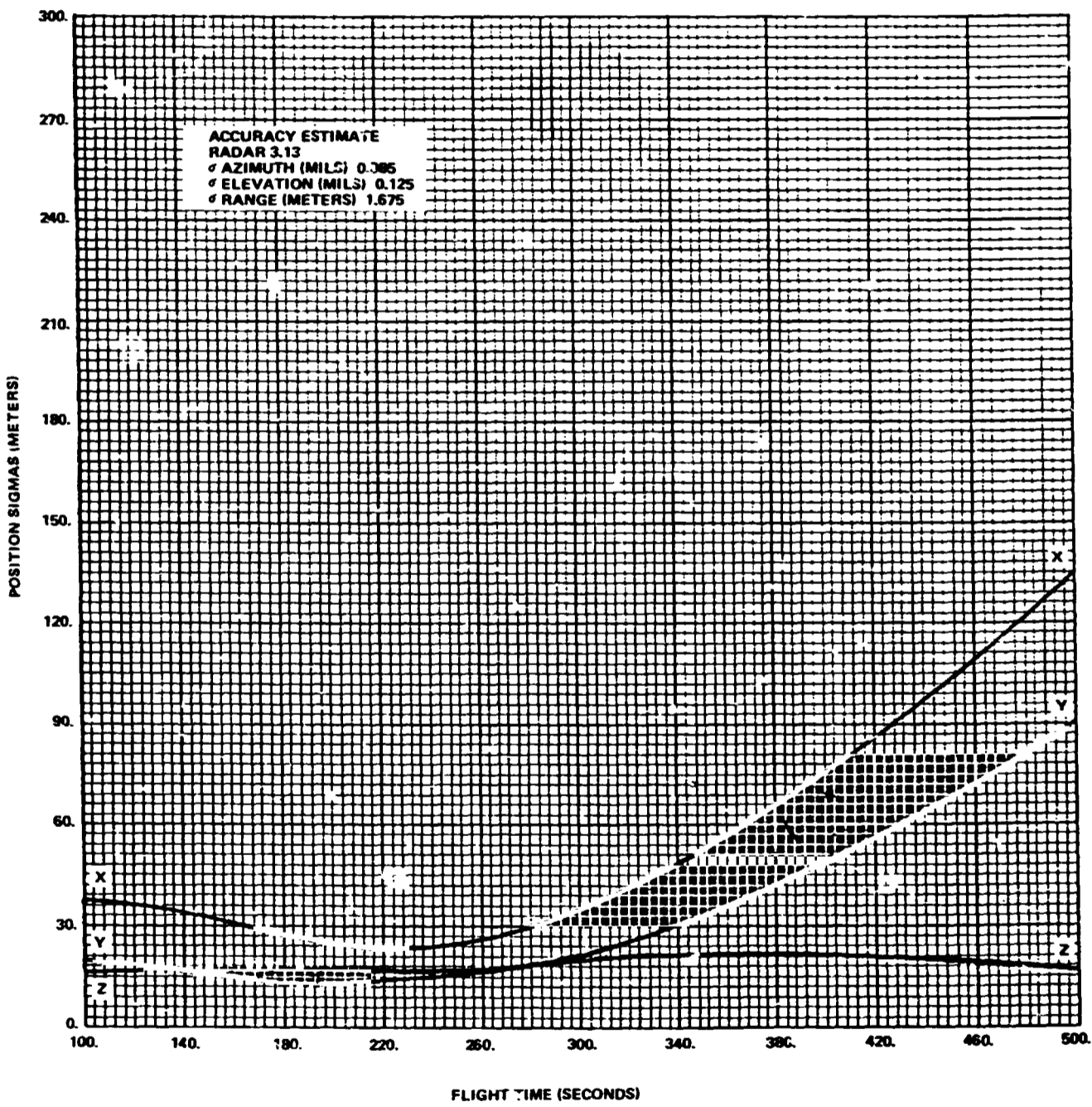


FIGURE 4-13. ESTIMATES OF GBI C-BAND RADAR 3.13 POSITION ACCURACIES, AS-508 (F.A. 96°)

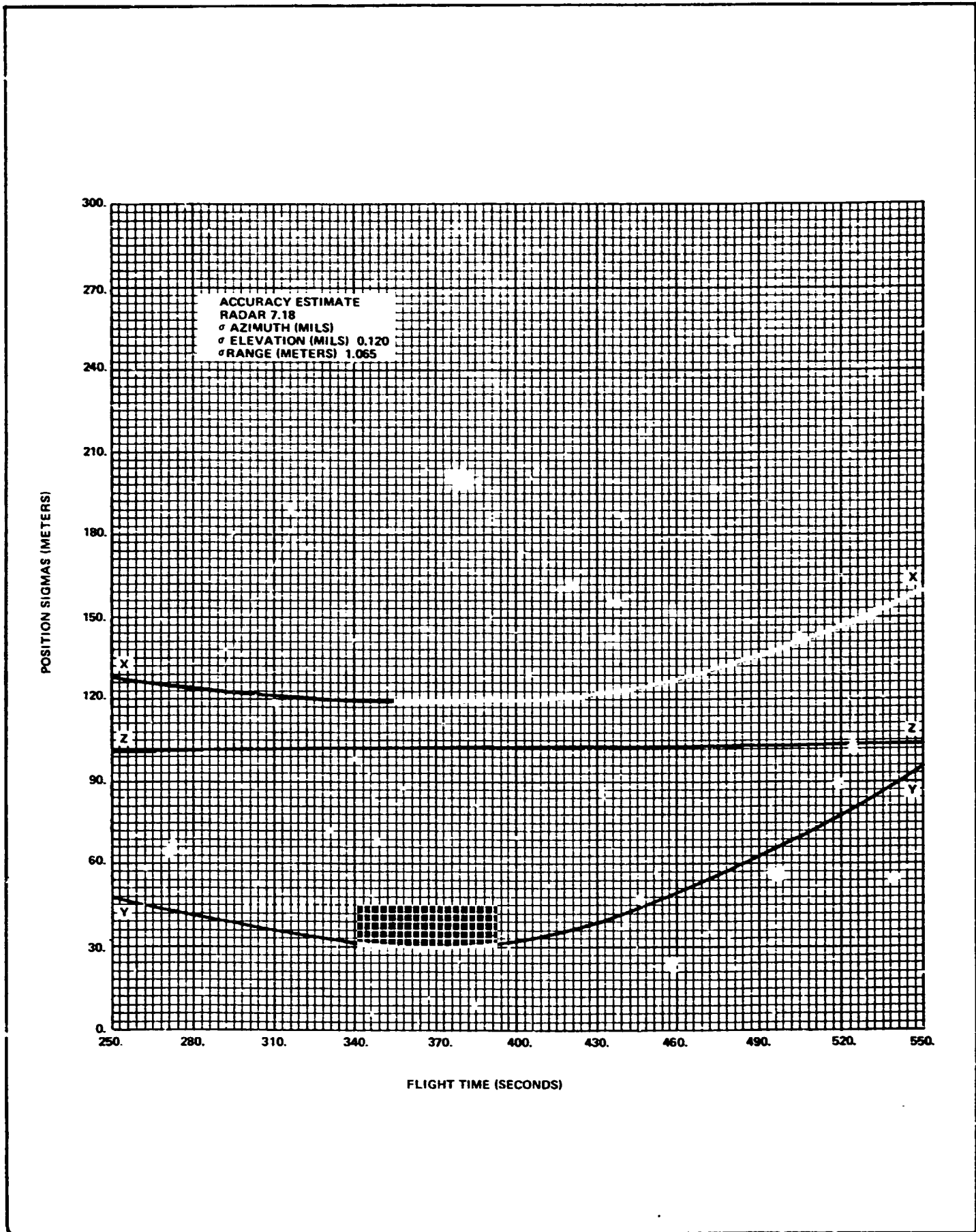


FIGURE 4-14. ESTIMATES OF GRANL TURK ISLAND C-BAND RADAR
 7.18 POSITION ACCURACIES, AS-508 (F.A. 72°)

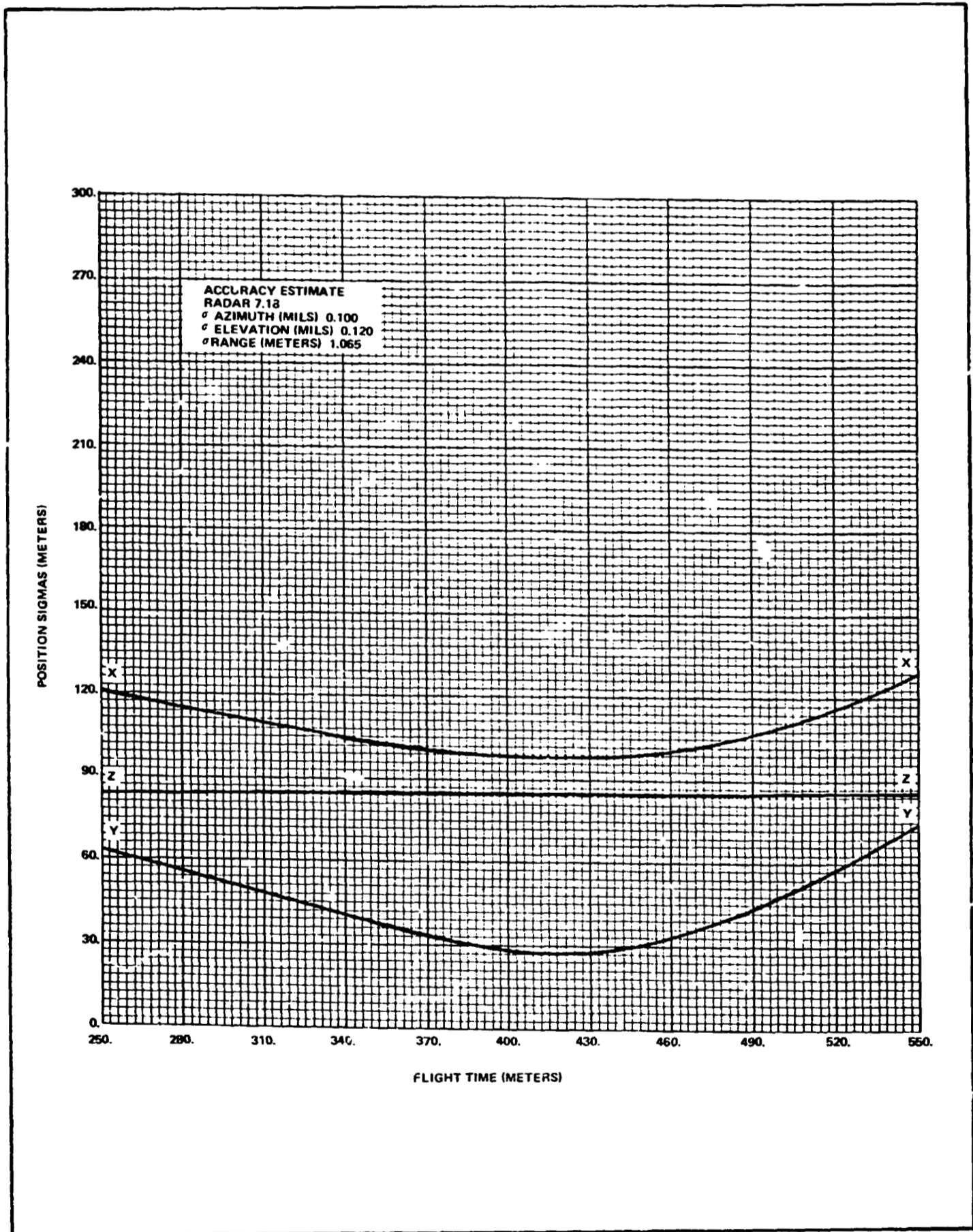


FIGURE 4-15. ESTIMATES OF GRAND TURK ISLAND C-BAND RADAR 7.18 POSITION ACCURACIES, AS-508 (F.A. 84°)

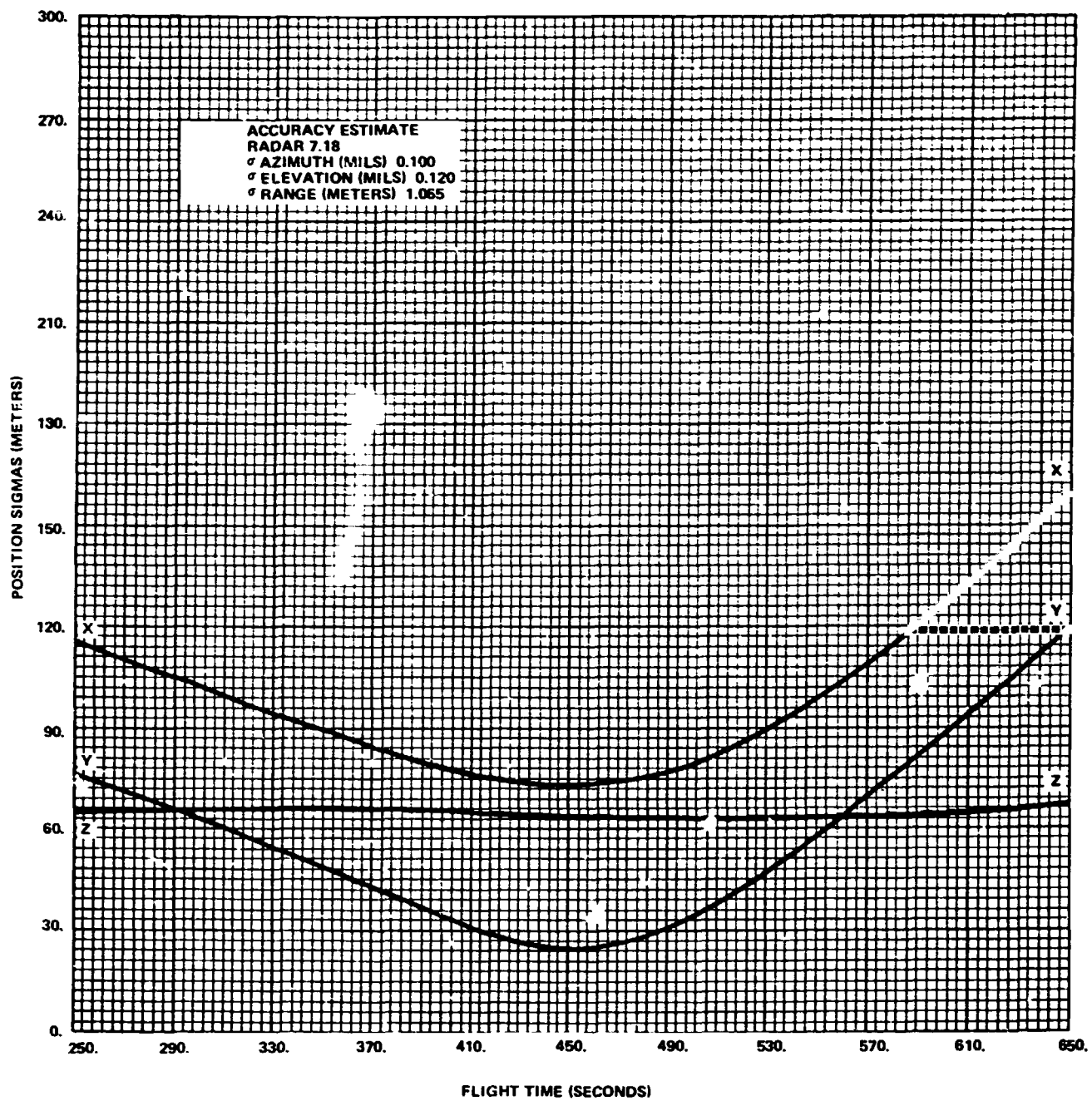


FIGURE 4-16. ESTIMATES OF GRAND TURK ISLAND C-BAND RADAR
 7.18 POSITION ACCURACIES, AS-508 (F.A. 96°)

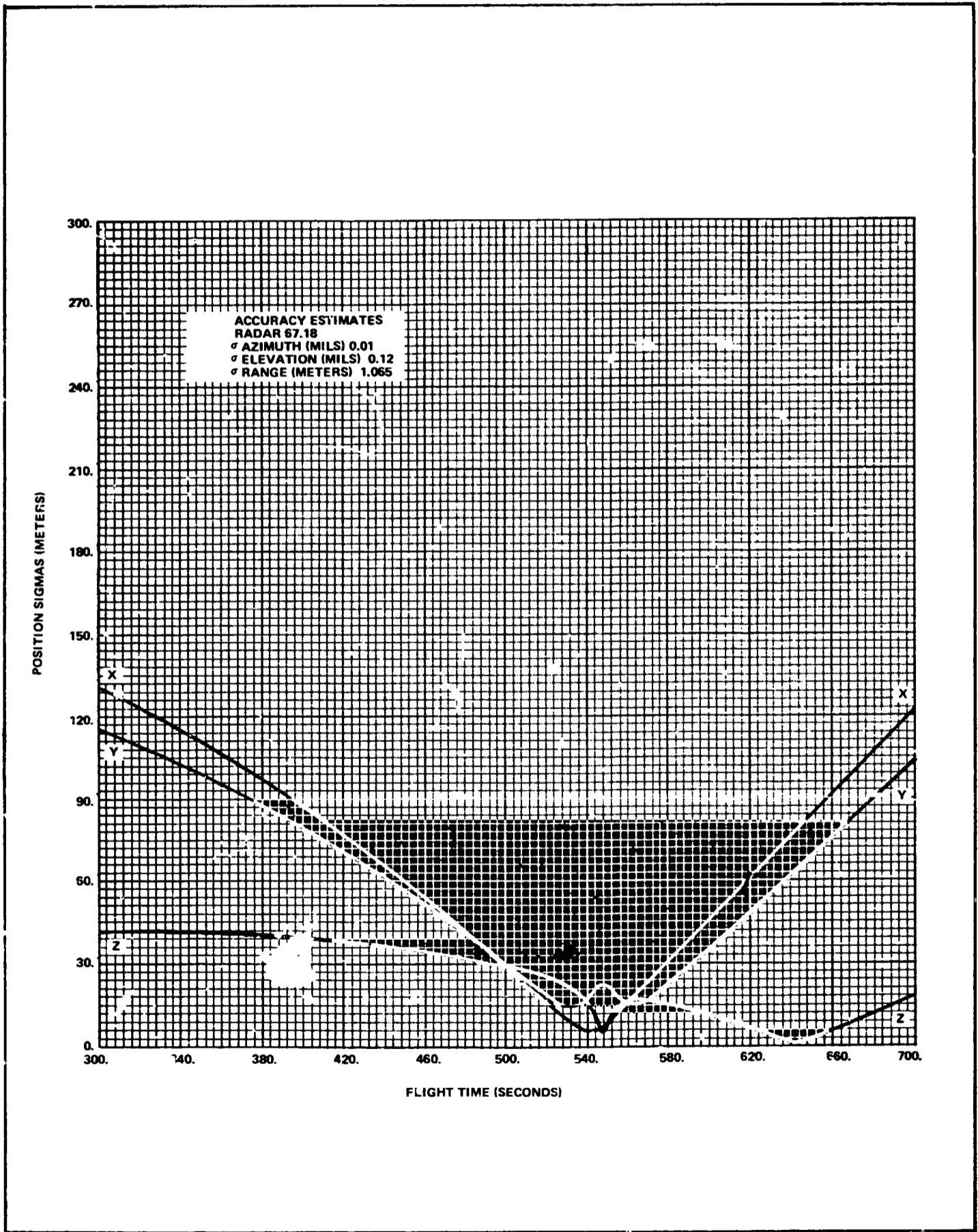


FIGURE 4-17. ESTIMATES OF BERMUDA C-BAND RADAR 67.18 POSITION ACCURACIES, AS-508 (F.A. 72°)

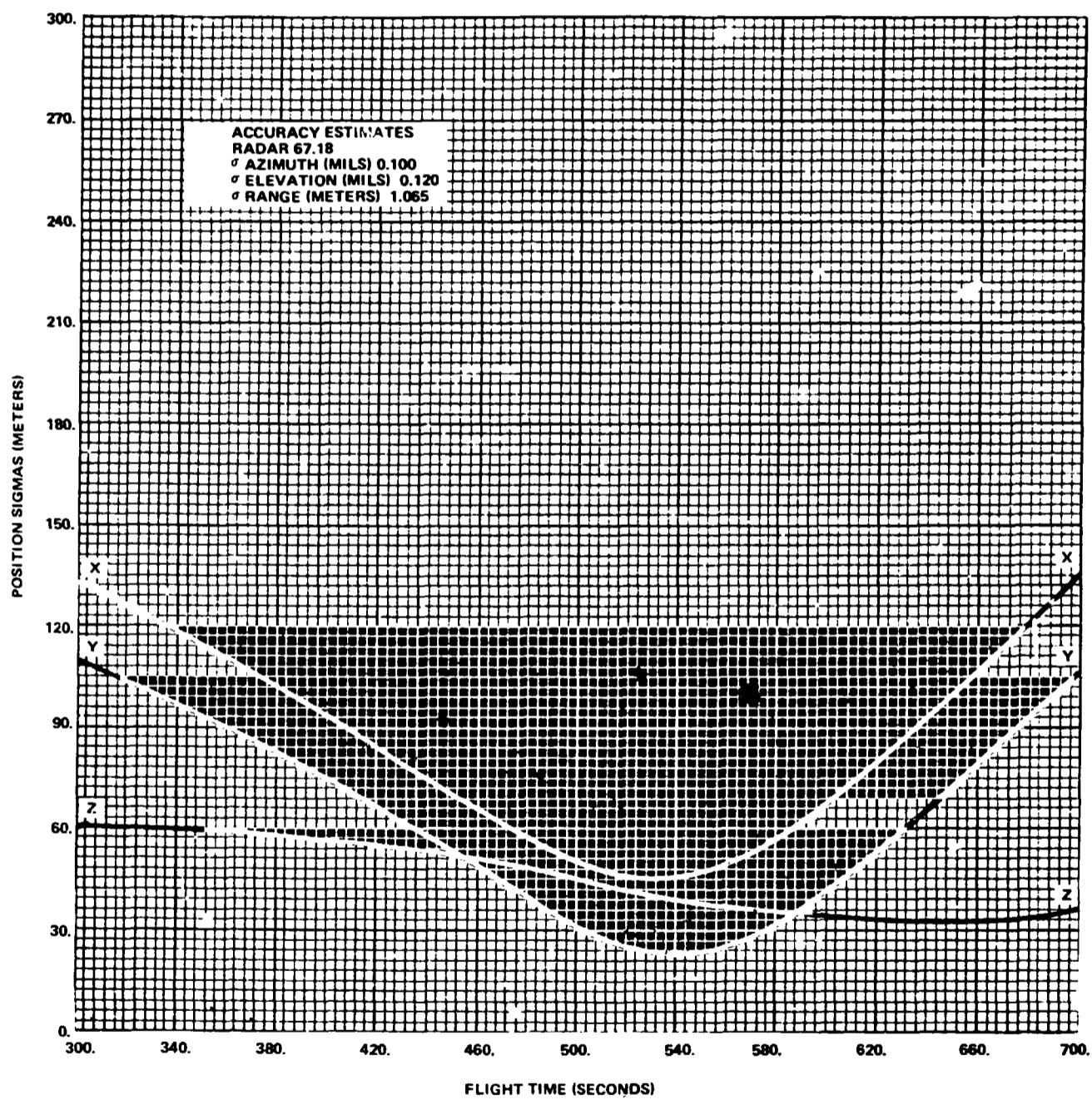


FIGURE 4-18. ESTIMATES OF BERMUDA C-BAND RADAR 67.18
 POSITION ACCURACIES, AS-508 (F.A. 84°)

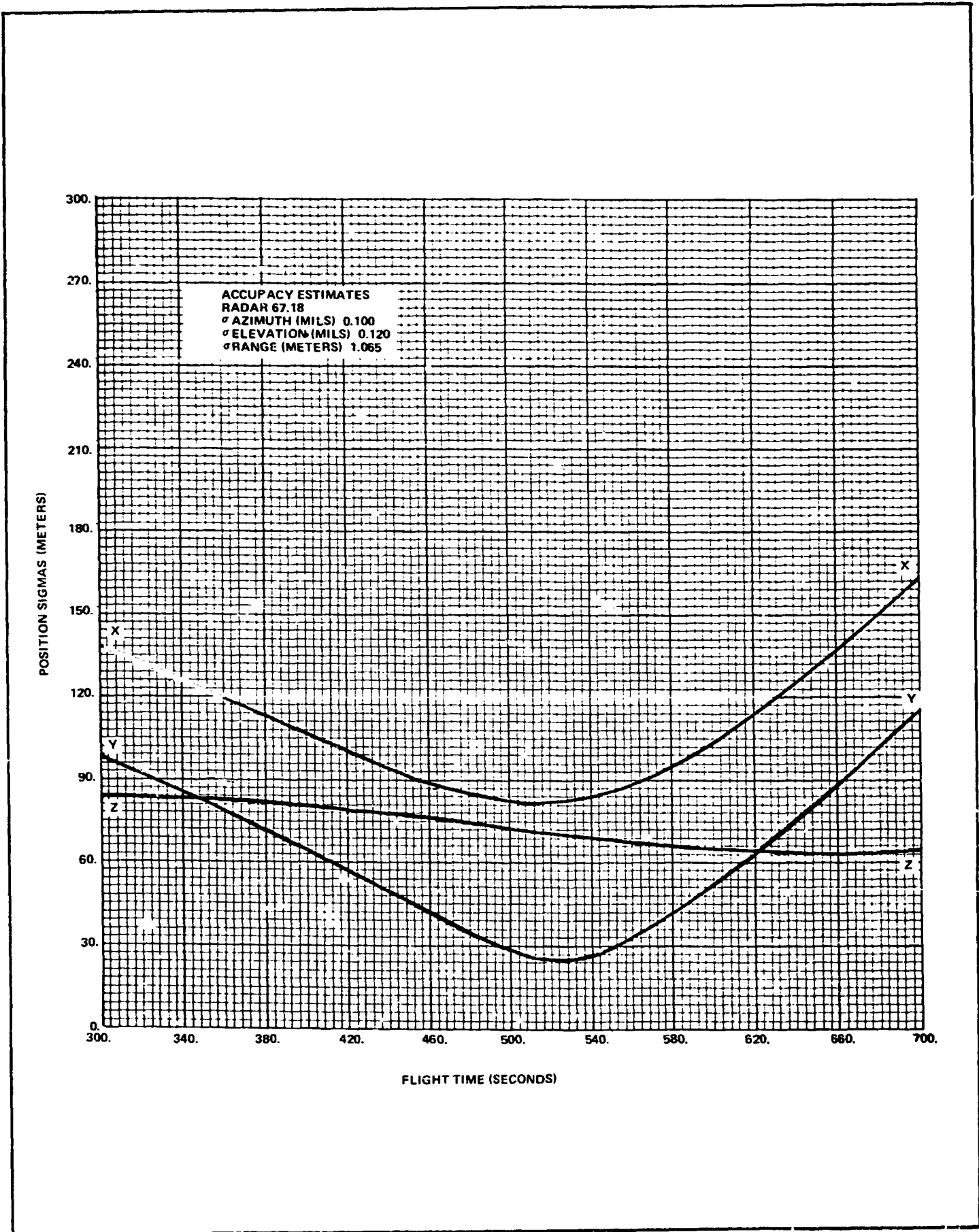


FIGURE 4-19. ESTIMATES OF BERMUDA C-BAND RADAR 67.18 POSITION ACCURACIES, AS-508 (F.A. 96^o)

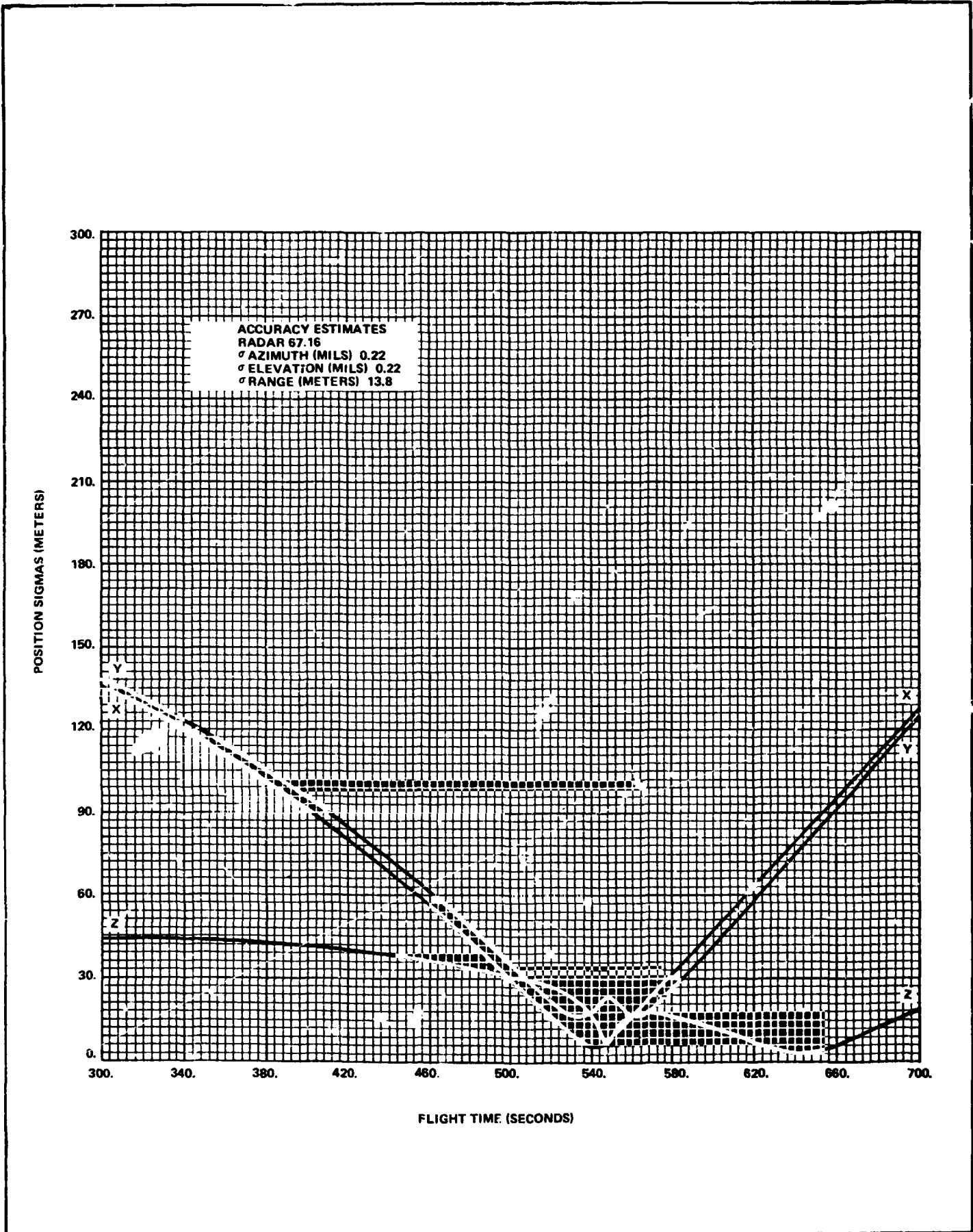


FIGURE 4-20. ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES, AS-508 (F.A. 72°)

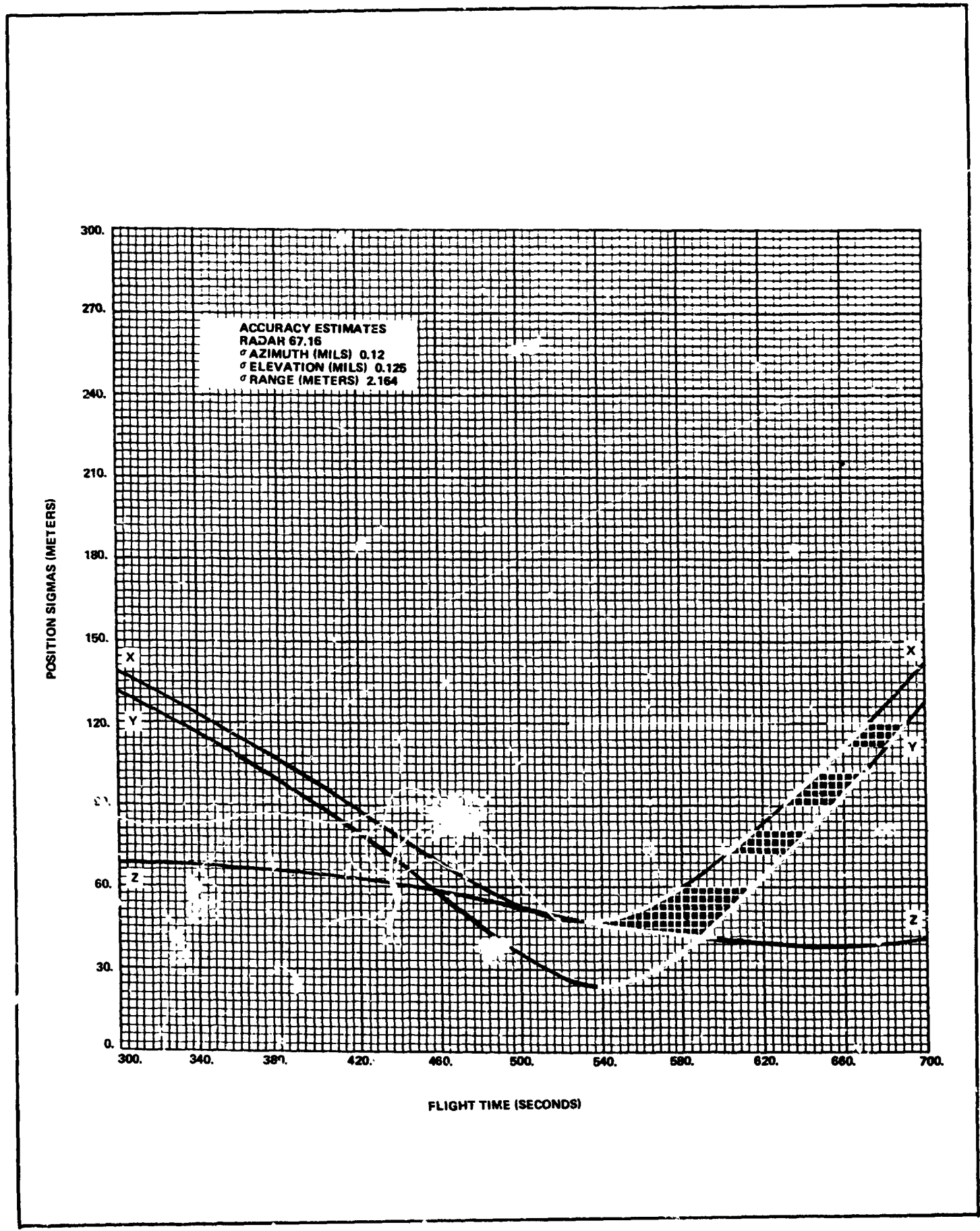


FIGURE 4-21. ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES, AS-508 (F.A. 84°)

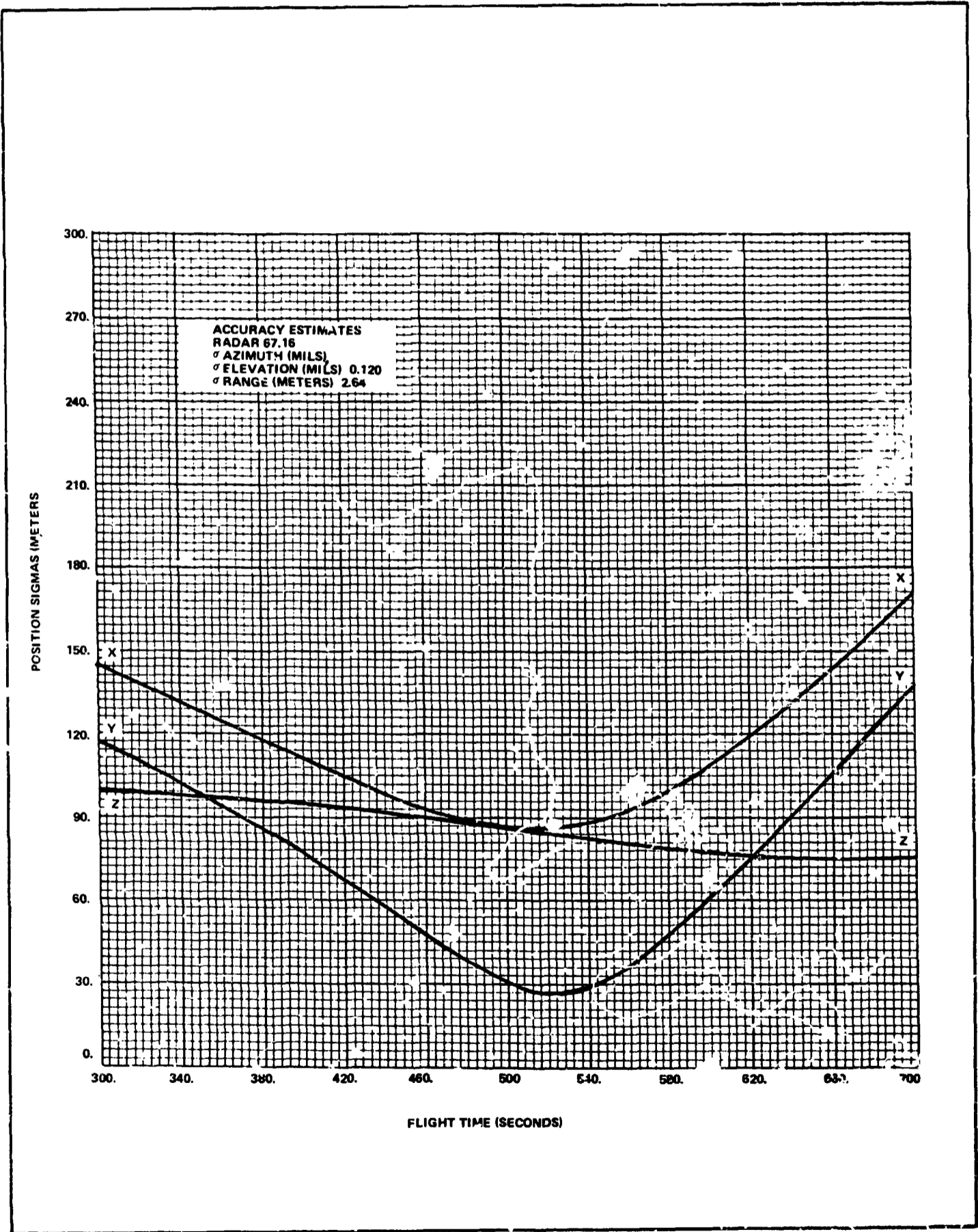


FIGURE 4-22. ESTIMATES OF BERMUDA C-BAND RADAR 67.16 POSITION ACCURACIES, AS-503 (F.A. 96°)

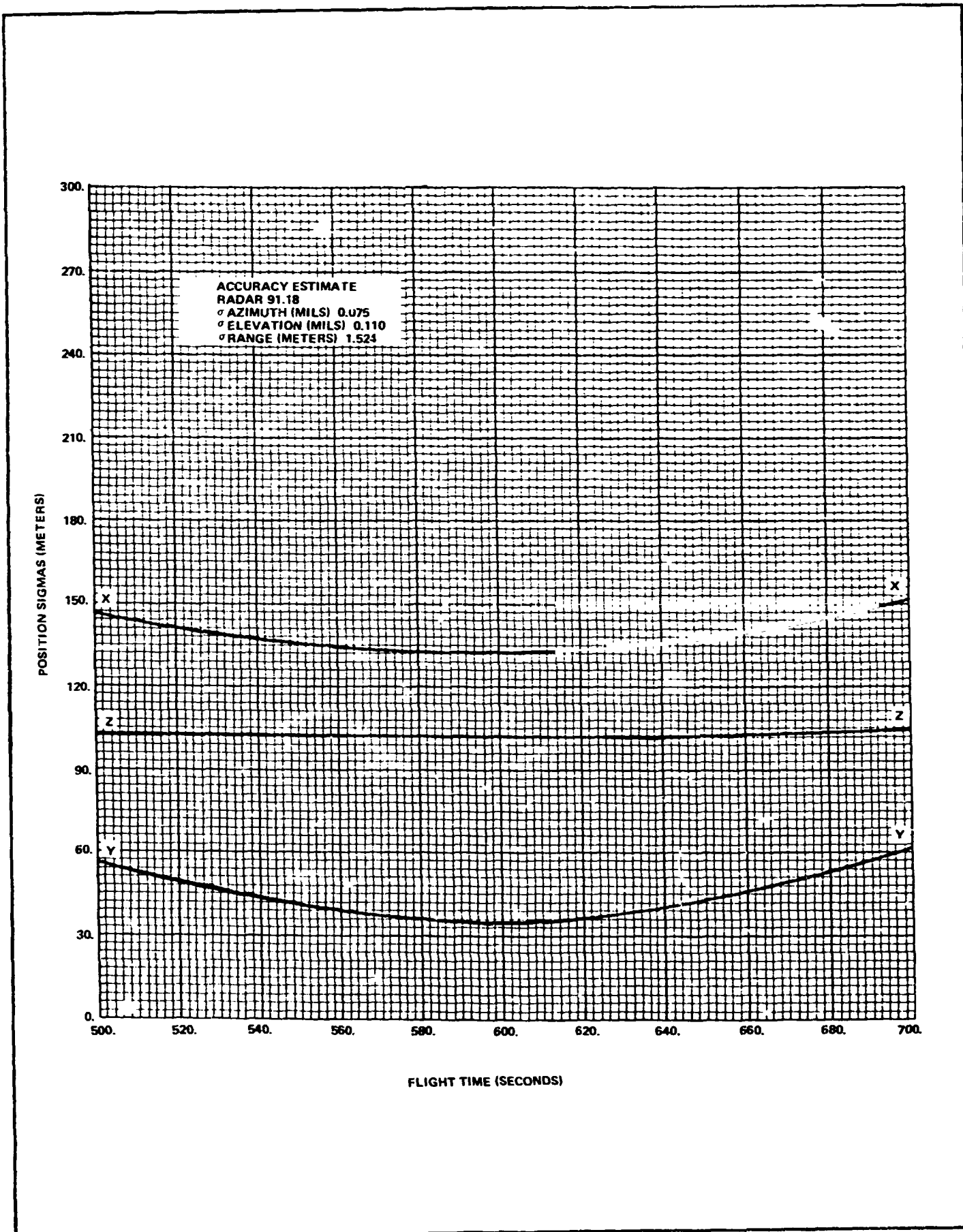


FIGURE 4-23. ESTIMATES OF ANTIGUA C-BAND RADAR 91.18 POSITION ACCURACIES, AS-508 (F.A. 84°)

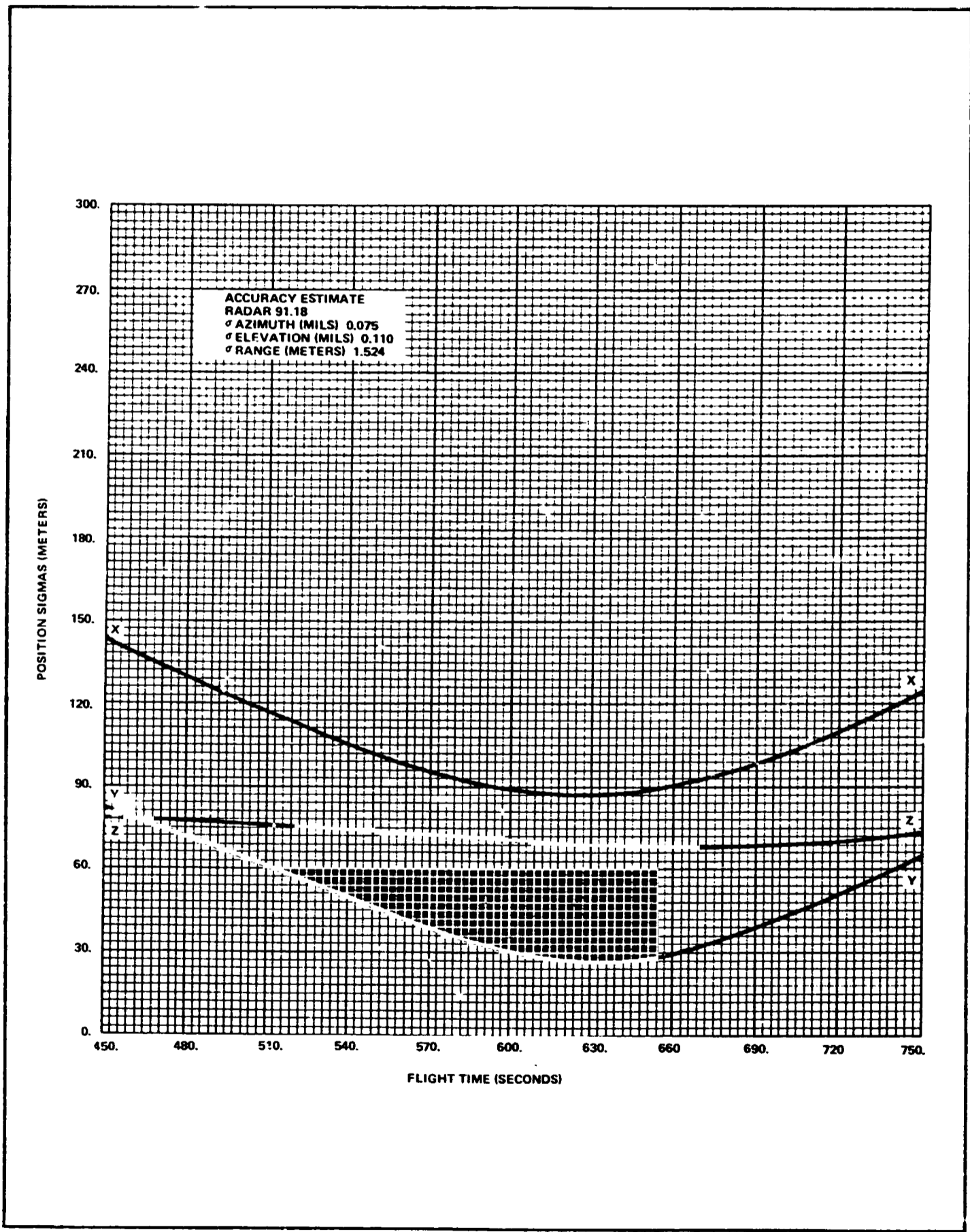


FIGURE 4-24. ESTIMATES OF ANTIGUA C-BAND RADAR 91.18 POSITION ACCURACIES, AS-508 (F.A. 96°)

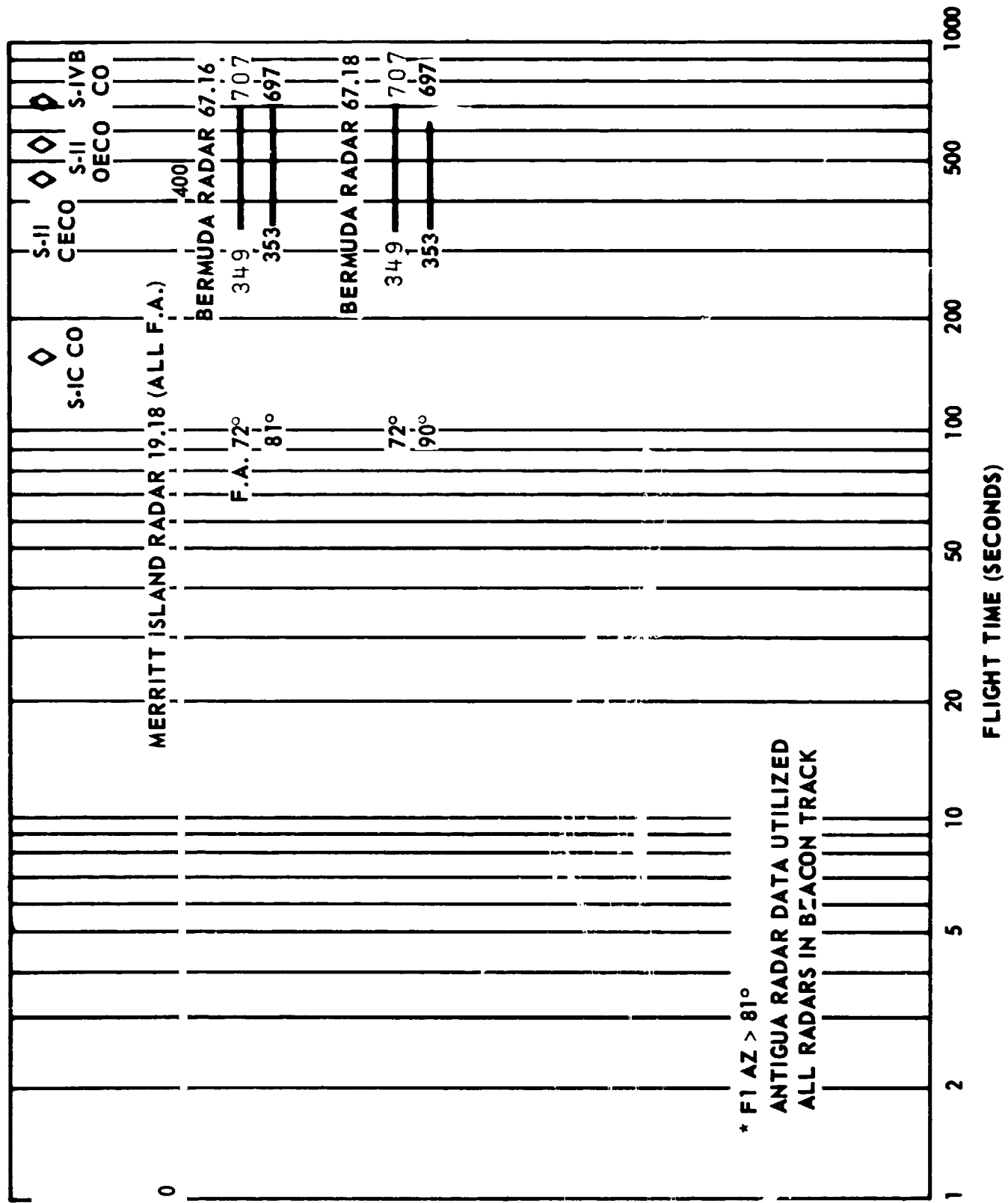


Figure 4-25 Metric Data Instrumentation Coverage for AS-508

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 30 knots are forecast or when 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 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 CPS-9 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 Space-flight Meteorology Group (SMG) and WE. Forecasts valid from F-3 days or longer 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 AFETR Meteorological Observations. Automatic remote meteorological sensors are used for surface measurements. 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 Packard-Bell 250 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.

5.2.1.2 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 the launch pad. 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 MSOB and to MSFC via LIEF.

5.2.1.2.2 NASA 150-Meter Meteorological Tower. The facility provides wind speed and direction to the Air Force WINDS at the Cape and to the MPC at the MSOB. Starting at L-30 hours, the tower is continuously manned for verbal readout to MSFC and others as required. The facility provides a comprehensive data collection capability for essential lower-altitude atmospheric studies.

5.2.1.2.3 Lightning Warning System. The lightning warning net consists of 8 remote sites. Each site is equipped with potential gradient and corona current measuring instrumentation. The measurements will be displayed in the MPC. Two sferics sites (one at HRT site 19.1 and one at the MSOB) 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 Lightning Detection Systems. The instrumentation on the umbilical tower includes: Stroke counter, stroke current amplitude (2), and corona current measuring instrumentation. The data display of the above instrumentation is in the LCC.

5.2.1.3 KSC Environmental Measurements

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 - Thirty-one measurements will be made on the umbilical tower. Figure 4-1 gives additional measurements in pad area.

b. Far-Field Measurements - Portable equipment will be used to measure and record data at approximately 10 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 area. The data will be reduced only in case of an explosion.

5.2.1.3.3 Facilities and Environmental Measurements. Approximately 533 measurements 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 6.2.2 and 6.2.3.5). 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 the RS system, sonde equipment launched by rockets, and by WS equipment.

5.2.3 WEATHER AIRCRAFT. An ETR aircraft carrying an observer will provide launch area reconnaissance from approximately T-2 hours through launch.

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 entered in the automatic data select program to determine the best data source which is then used to compute present position and velocity, instantaneous impact point, and acquisition data. 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 and GSFC.
- 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 ADASP source.

Data from radars 0.18, 19.18, 67.16, 67.18, 7.18, and 91.18 will be reformatted into the standard 38-character TTY format by AN/UYK computers at each site and transmitted to the RTCS. At the RTCS, these data will be patched through to GSFC in real/near-real time; however, no 3.13 data will be transmitted off range.

IU guidance data from the CIF TLM station, and SC guidance data from the KSC USB site will be transmitted to the RTCS via ALDS for Range Safety and/or launch recovery application. The ETR TLM station TEL IV will provide analogue 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, Apollo simulators, LTDS, CCATS (selected TLM parameters from Houston), DLAS, and the MILA USB Station (S-band and VHF).

The Data-Core provides data to the following points: ALDS, LIEF, Central Computer Facility, CIF Operational Support Center, CIF Ground Station (selected parameters for display), MSOB ACE Station (Spacecraft 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 in the alternate Firing Room (LCC) at ten monitor positions. Out-of-tolerance data as detected by the Central Computer are displayed in a "blink" mode on one of the two adjacent CRT's at the monitoring position.

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 1-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 3000 measurements) and tracking data from the Data-Core. It converts the TLM data to engineering units for display or storage. The system records raw TLM (up to 5000 measurements) and tracking data for off-line launch analysis.

6.2.4.1 Data Distribution. The real-time data are displayed on CRT's, Eidophor screens, recorders, or printed out locally in the CIF, in the Firing Rooms, and other operational rooms of LC-39. However, no printout is accomplished at the LCC.

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.

6.2.5 CIF OPERATIONAL SUPPORT CENTER. The CIF Operational Support Center, room 307 in the CIF Building, provides space vehicle facility engineers with real-time data. The room contains fifteen CRT data display units, twenty-one 8-channel Brush recorders, eight 20-pen event recorders, eight TV monitors, four Eidophor projectors, one Vugraph projector, and one slide projector.

6.2.5.1 CRT Display. The CRT data display units display data in either graphic or alphameric form. Any one measurement contained in 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 monitor the display from any of the other panels, or observe any television video programmed into the system.

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 (see Section 6.2.4).

6.2.5.2 Brush Recorder Display. Eighteen of the 8-channel Brush recorders are equipped with a call-up capability which allows the operator to display any measurement contained in Data-Core (see Section 6.2.1) on any one of the 8-channels. The other three Brush recorders display fixed measurements hardlined from the ground station through a patch panel contained in the room.

6.2.5.3 Event Recorder Display. Each of the eight 20-pen event recorders have a sixteen-measurement call-up capability. The operator may call up any of the measurements in Data-Core and record any one of the ten data bits in each measurement. The remaining 4 unused channels of each recorder accept fixed measurements as "hard-lined" from the CIF TLM Ground Station or timing signals as required.

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

6.2.6 APOLLO LAUNCH DATA SYSTEMS. The ALDS receives TLM data from the Data-Core and transmits selected TLM parameters to MCC-H at the rate of 40.8 kbs and to GSFC and the RTCS at the rate of 2.4 kbs. (See Section 6.2.1)

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

a. A 40.8 kbs data circuit and a 2.4 kbs data request circuit. MSFC is supplied selected real-time telemetry and/or tracking data via the 40.8 kbs circuit. Parameter selection is controlled by MSFC via the 2.4 kbs data circuit (See Section 6.2.1)

b. One OTV Circuit. Any one of the OTV cameras (see Section 4.2.3.3.1) may be monitored at MSFC. Camera selection is controlled by MSFC by verbal request.

c. One Countdown Clock Circuit.

d. One Tape-to-Tape Circuit.

e. 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 Mission 509 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 room 2296 and 2299 of the MSOB. Launch vehicle data will be displayed in rooms 2R7 and 2R9 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 3.5.1) are listed below:

<u>Station No.</u>	<u>Station Name</u>	<u>Transmitter</u>
-	CKAFS	Low Power
1	CKAFS	High Power
3	CEI	High Power
7	Grand Turk	High Power
67	Bermuda	High Power
91	Antigua	High Power

Setup 1: Stations 1 and 67 primary and 3, 7, and 91 partial backup when the flight azimuth is 72° to 90°.

Setup 2: Stations 1, 7, and 91 primary with 3 and 67 partial backup when the flight azimuth is 90° to 96°.

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. One Flightline and two Program systems are provided.

7.1.3.2 Wire Skyscreen. Wire skyscreen 1.7 will be used to provide program deviation.

7.1.4 SELECTED TLM PARAMETERS. Selected TLM parameters from the IU and SC guidance systems are used for computation of instantaneous impact points. ETR Stations 19 (TEL IV) and 91 (Antigua) provide Launch Vehicle parameters for range safety decision (see Section 6.1.1.d).

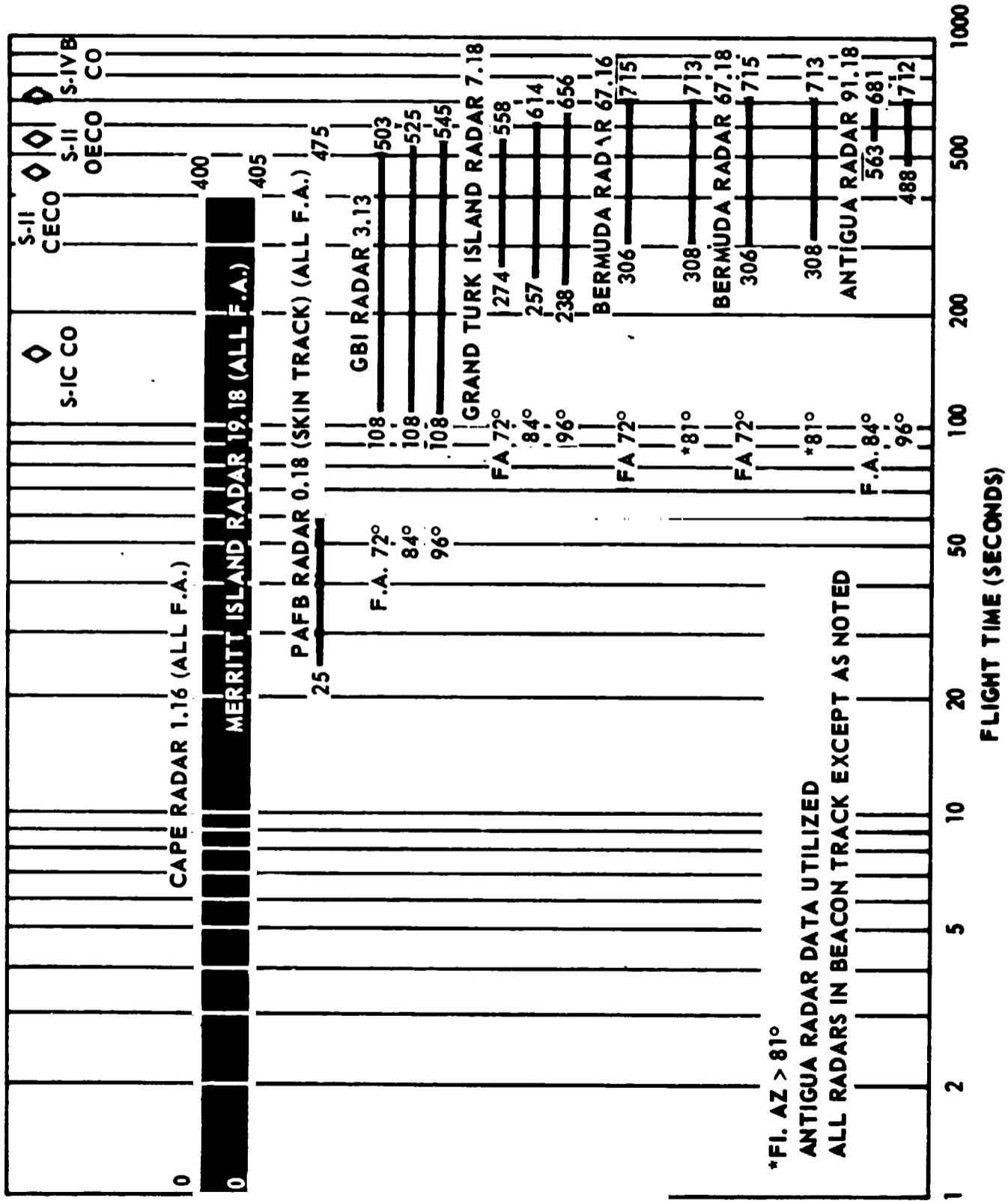


Figure 7-1. Range Safety Instrumentation Coverage for AS-508

7.1.5 SURVEILLANCE RADARS

7.1.5.1 Range Surveillance Radars. MOD II Radar 1.5 and 1.35, located at Central Control, will provide sea surveillance. The SPS-35 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 Figure 7-1. The coverage times are for AS-508. The AS-509 coverage is estimated to be very similar.

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 H₂.

7.2.1.1.2 Portable Systems. Each detector consists of a probe connected to an instrument box by a 6-foot cable. 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 H₂ 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 (aerazine 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.