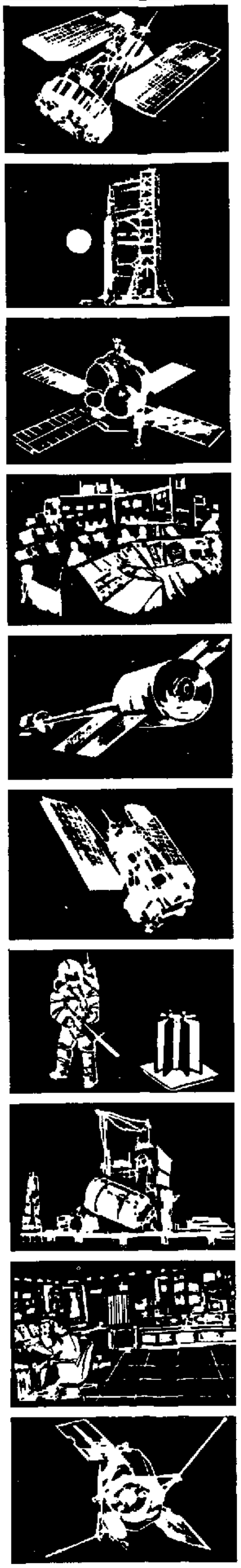
SPACE DIVISION

NASA CR-143653

Document No. 74SD4249
16 September 1974



EARTH OBSERVATORY SATELLITE SYSTEM DEFINITION STUDY

Report No. 5
SYSTEM DESIGN AND SPECIFICATIONS

Volume 2
EOS-A SYSTEM SPECIFICATION

Prepared for:
GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771

Under
Contract No. NAS 5-20518

GENERAL ELECTRIC
SPACE DIVISION
Valley Forge Space Center
P. O. Box 8555 • Philadelphia, Penna. 19101

GENERAL ELECTRIC

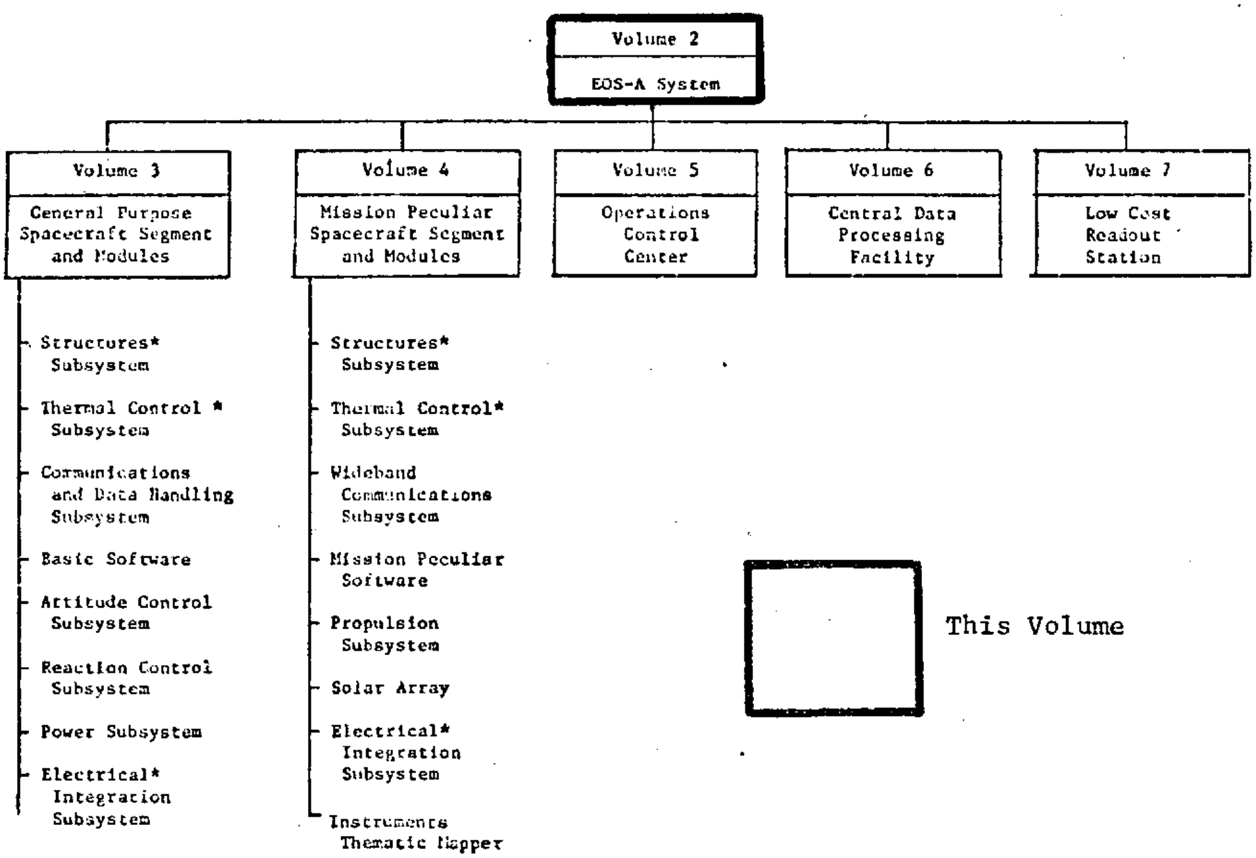
PREFACE

This report, "Baseline System Design & Specifications", has been prepared for NASA/GSFC under contract NAS 5-20518 EOS System Definition Study. It describes the system design that has evolved through a series of design/cost tradeoffs to satisfy a spectrum of mission/system requirements. The basic spacecraft design is compatible with many missions. The EOS-A mission, the potential first mission, is used to define the mission peculiar elements of the system.

For convenience this report is bound in separate volumes as follows:

- Volume 1 Baseline System Description
- Volume 2 EOS-A System Specification
- Volume 3 General Purpose Spacecraft Segment and Module Specifications
- Volume 4 Mission Peculiar Spacecraft Segment Specification
- Volume 5 Operations Control Center Specification
- Volume 6 Central Data Processing Facility Specification
- Volume 7 Low Cost Ground Station Specification

Volume 1 "Baseline System Description" presents the overall EOS-A system design, a description of each subsystem for the spacecraft, and the major ground system elements. Volumes 2 through 7 present the specifications for the various elements of the EOS system and are organized according to the specification tree as follows:



* These specifications are written as integral specifications for the GPSS and MPSS and appear in Volume 3 only.

SPECIFICATION #SVS-XXXX
16 SEPTEMBER 1974

VOLUME 2

EOS-A SYSTEM SPECIFICATION

TABLE OF CONTENTS

1.0 SCOPE 1

2.0 APPLICABLE DOCUMENTS 1

3.0 REQUIREMENTS 2

3.1 General 2

3.1.1 Mission Objectives 2
3.1.2 Mission Requirements 4
3.1.2.1 Global Coverage 4
3.1.2.2 Repeating Coverage 4
3.1.2.3 Illumination 4
3.1.2.4 Payload 4
3.1.2.5 System Resolution 5
3.1.2.6 System Radiometric Accuracy 5
3.1.2.7 System Geometric Accuracy 5
3.1.2.8 Number of Spacecraft 5
3.1.2.9 Launch Date 5
3.1.2.10 Launch Vehicle 5
3.1.2.11 Spacecraft Retrieval 6
3.1.3 System Requirements 6
3.1.3.1 Payload Characteristics 8
3.1.3.2 Central Data Processing Facility Design 9
3.1.3.3 Output Products 9
3.1.3.4 Output Product Quality 10
3.1.3.5 Output Product Quantities 13
3.1.3.6 Orbit 13
3.1.3.7 Launch Vehicle Injection Errors 14
3.1.3.8 Ground Stations 14
3.1.3.9 Tracking and Data Relay Satellite System (TDRSS) 14
3.1.3.10 Data Delivery Time 14
3.1.3.11 Payload Data Processing 14
3.1.3.12 System Performance Requirements Allocation 15
3.1.3.12.1 Attitude Control System 15
3.1.3.12.2 Ephemeris 15
3.1.3.12.3 Instruments 17
3.1.3.12.4 Structure 19
3.1.3.12.5 Spacecraft Clock 19
3.1.3.12.6 Central Data Processing 20

3.2 Observatory Requirements 20

3.2.1 General Purpose Spacecraft Segment 20
3.2.1.1 Attitude Control Module (ACS) 20
3.2.1.2 Power Module 20
3.2.1.3 Command and Data Handing (C&DH) Module 23

3.2.1.4 Propulsion Module 23
3.2.1.5 Solar Array and Drive 23
3.2.1.6 Launch Vehicle Adapter 24
3.2.2 Mission Peculiar Segment 24
3.2.2.1 Instruments 24
3.2.2.2 Wideband System 24
3.2.2.2.1 Downlinks 24
3.2.2.2.2 RF Spectrum 25
3.2.2.2.3 Operation 26
3.2.2.2.4 Data Formats 26
3.2.2.2.5 Link Performance 26
3.2.2.2.6 LCRS Compacted Data 26
3.2.2.2.7 On-Board Correction 27
3.2.3 Spacecraft Segment Interface 28
3.2.3.1 Mechanical 28
3.2.3.2 Electrical 28
3.2.3.3 Launch Configuration 28

3.3 Ground System Requirements 29

3.3.1 Operations Control Center 33
3.3.1.1 PCM Data Processing 34
3.3.1.2 Command Generation 34
3.3.1.3 Communications and Data Distribution 35
3.3.1.4 Status Control and Display 35
3.3.1.5 OCC Software 35
3.3.1.6 OCC Computing Services 36
3.3.2 Central Data Processing Facility 36
3.3.2.1 Image Processing Element 38
3.3.2.2 Data Management Element 41
3.3.3 Low Cost Readout Station 43
3.3.3.1 Subsystems and Functions 43
3.3.3.2 Coverage Area 44
3.3.3.3 Input Data Rate 46
3.3.3.4 Input Data Type 46
3.3.3.5 LCRS Interfaces 46
3.3.3.5.1 EOS Project Office 46
3.3.3.5.2 OCC 46
3.3.3.5.3 Spacecraft 46

3.4 System Interface Requirements 47

3.4.1 Launch Vehicle 47
3.4.2 Launch Support and Test Facilities 47
3.4.3 Space Transportation System 47
3.4.4 NASCOM/Remote Sites 48
3.4.5 National Oceanographic and Atmospheric Administration 48
3.4.6 GSFC Orbit Determination Group 48
3.4.7 Data Users 48

4.0 QUALITY ASSURANCE PROVISIONS 49

6.0 NOTES 50

1.0 SCOPE

This specification establishes the requirements for performance, design, qualification and acceptance testing of the Earth Observation Satellite A (EOS-A) System. EOS is the next generation system for both research and development and operational applications missions in low Earth orbit.

2.0 APPLICABLE DOCUMENTS

General Purpose Spacecraft Segment Spec.

EOS-A Mission Peculiar Spacecraft Segment Spec.

Operations Control Center Segment Spec.

Central Data Processing Facility Segment Spec.

Low Cost Readout Station Segment Spec.

* Ground Data Handling System Facility Requirements

* Quality/Reliability Specification

Tracking and Data Relay Satellite System Description

* Multispectral Scanner Interface Control Document

* Thematic Mapper Interface Control Document

Space Shuttle System Payload Accommodations JSC 07700 Volume XIV

* Telecommunications Interface Control Document

* Data Format Control Book

* Launch Vehicle Interface Control Document

* Launch Support and Test Facilities Interface Control Document

* Space Transportation System Interface Control Document

* NASCOM/Remote Sites Interface Control Document

* National Oceanographic and Atmospheric Administration Interface Control Document

* Orbit Determination Group Interface Control Document

* EOS-A Data Users Interface Control Document

---

* To be prepared as part of the Phase C/D Program

3.0 REQUIREMENTS

3.1 GENERAL

3.1.1 MISSION OBJECTIVES

The overall objective of the EOS program is to provide an economical, multipurpose, modular, spacecraft system to support observations missions through the 1980's in the areas of:

- Earth & Ocean Survey
- Pollution Detection and Monitoring
- Weather and Climate Predictions

The initial mission in the EOS series is Land Resource Management. This mission combines the continuation of the gathering of Earth Resources data on an operational basis with the research and development of a new Thematic Mapper instrument providing broader spectral coverage and improved spatial resolution. The operational capability provides the same spectral and spatial coverage as the precursor ERTS series of spacecraft but with temporal coverage improved later in the mission from 18 to 7-9 days.

The broad objectives of the EOS-A mission are:

- Provide a continuing source of Multispectral Scanner (MSS) data for operational utilization.
- Develop sensor and other spacecraft systems to acquire spectral measurements and images suitable for generating thematic maps of the earth's surface.
- Operate these systems to generate a data base from which land use information such as crop or timber acreages or volumes, courses and amounts of

actual or potential water run-off and the nature and extent of stresses on the environment will be extracted.

- Demonstrate the application of this extracted information to the management of resources such as food and water, the assessment and prediction of hazards such as floods, and the planning and regulation of land use such as strip mining and urbanization.

To accomplish these broad objectives the EOS-A program will

- Develop space-borne sensors for the measurement of parameters, as required by earth observations discipline objectives, with increased performance and in new spectral regions not achievable by present sensors.
- Evolve spacecraft systems and subsystems which will permit earth observations with greater accuracy, coverage, spatial resolution and continuity than existing systems by avoiding spacecraft constraints on sensor performance.
- Develop improved information processing, extraction, display and distribution systems so that the applicability of the observations may be enhanced.
- Achieve these objectives with sufficient economy and flexibility to permit the operational use of any hardware or other system components with little or no redevelopment.
- Use the space transportation system's resupply and retrieval capability to sustain and refresh this remote sensing capability through the 1980's, thereby providing an efficient means for demonstrating the vaiability of improvements prior to committing to operational use.

3.1.2 MISSION REQUIREMENTS

To achieve its broad objectives the following mission requirements have been established:

3.1.2.1 Global Coverage

The system shall be capable of acquiring and processing image data anywhere on the surface of the Earth, constrained only by the latitude limit imposed by the sun synchronous orbit. The bulk of the data to be acquired shall be over land masses and near coastal waters.

3.1.2.2 Repeating Coverage

Repeating coverage of the surface of the Earth shall be provided initially at an interval of not greater than 18 days. A goal of the program shall be to reduce this repeat cycle time to 7 to 9 days. As a program guideline, the reduction of the repeat cycle shall be achieved by use of multiple satellites.

3.1.2.3 Illumination

Nearly constant illumination conditions shall be provided as typified by a sun synchronous orbit. Descending node time shall be selected in the range of 1000-1200 hours in order that maximum illumination be provided to the instruments.

3.1.2.4 Payload

The EOS-A mission shall carry two imaging instruments and a Data Collection System (DCS). The instruments are:

- 5-Band Multispectral Scanner (MSS)-to continue the operational acquisition of Earth Resources data.
- 6-Band Thematic Mapper (TM)--to permit R&D effort both in the advanced instrument area and in the ground processing of high data rate, high

resolution data. The instruments shall both view the same 185 Km ground swath at nadir from mission altitude.

3.1.2.5 System Resolution

- o Output products produced from MSS data shall be equivalent to the resolution produced from the ERTS program (approximately 80 meters).
- o Output products produced from TM data shall have resolution in the range of 30 to 40 meters.

3.1.2.6 System Radiometric Accuracy

The system shall provide the best achievable radiometric accuracy consistant with instrument state-of-the-art.

3.1.2.7 System Geometric Accuracy

The geometric accuracy of film and digital output products shall be a function of available auxillary processing data and shall be limited by the instrument and ground control point inaccuracies.

3.1.2.8 Number of Spacecraft

Two identical spacecraft shall perform the EOS-A mission. The launch of the second spacecraft shall provide the opportunity to decrease the repeat cycle to 7-9 days.

3.1.2.9 Launch Date

EOS-A: 1979

EOS-A': 1980

3.1.2.10 Launch Vehicle

The launch vehicle for the EOS-A program shall be the Delta 2910, using the standard 8 ft. fairing.

3.1.2.11 Spacecraft Retrieval

The spacecraft shall contain provisions for retrieval by the space shuttle and ultimate reuse of elements via refurbishment on the ground.

3.1.3 SYSTEM REQUIREMENTS

The EOS-A mission shall be implemented by a system consisting of five major system segments:

- General Purpose Spacecraft Segment
- Mission Peculiar Spacecraft Segment
- Operations Control Center Segment
- Central Data Processing Facility Segment
- Low Cost Readout Station Segment

This system configuration is defined in Figure 3-1.

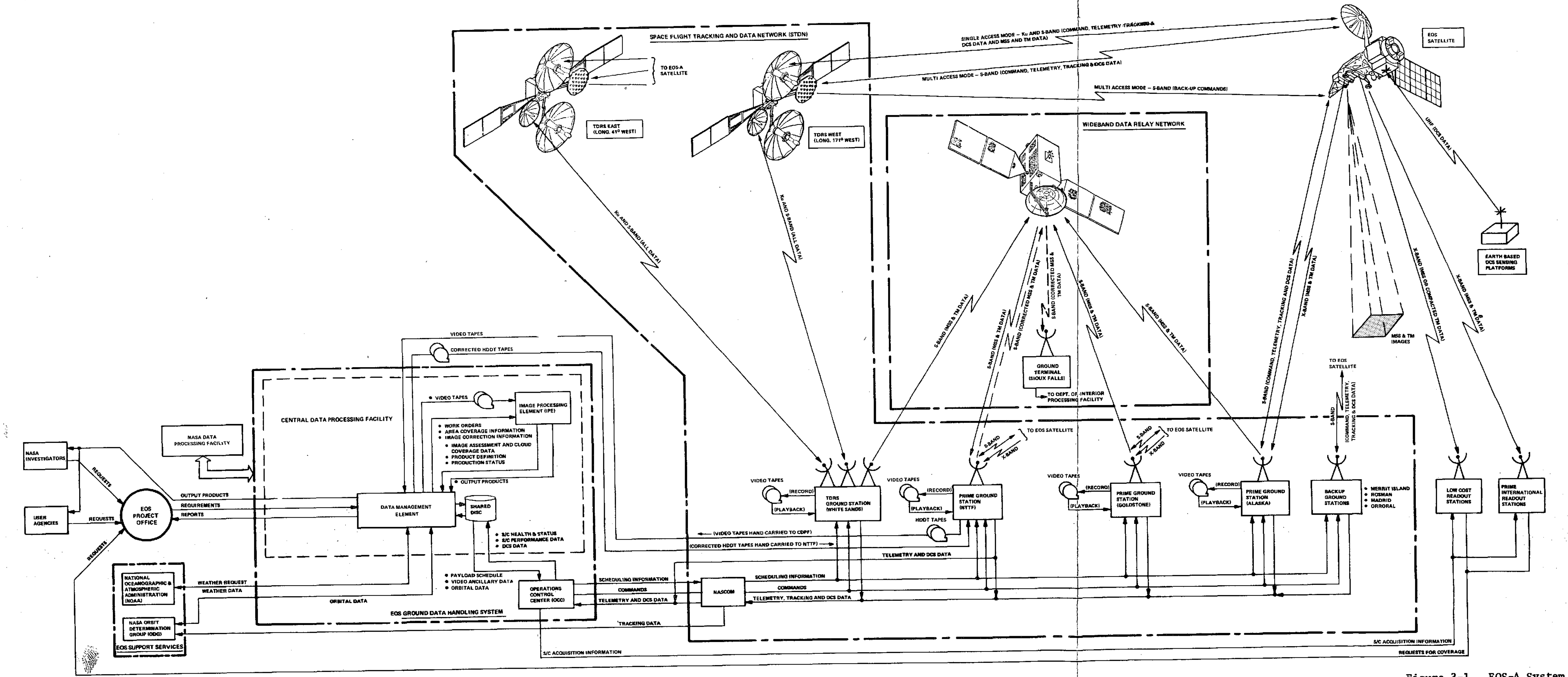


Figure 3-1. EOS-A System

3.1.3.1 Payload Characteristics

o Thematic Mapper

Band	Spectral Range (Microns)	Nominal Ground Resolution (meters)	Minimum Radiance* (mw/cm^2 ster)	Maximum Radiance** (mw/cm^2 ster)	S/N at Minimum Radiance***
1	.45 - .52	30	.22	2.24	TBD
2	.52 - .60		.20	2.34	
3	.63 - .69		.09	1.38	
4	.8 - .95		.12	1.79	
5	1.55 - 1.75		.12	1.00	
6	10.4 - 12.6	120	.77 (243°K)	2.62 (320°K)	NE T = .5°K @ 300°K

* Based on bare soil at 47°N in December with ground visibility of 10 Km
** Scaled from ERTS-1 values
*** Requires additional user definition

63.7 Mbps	- Output data rate
.80	- Scan efficiency
17.06 sweeps/sec	- Scan frequency
13.45°	- Field of view
1.0	- Samples per picture element (crosstrack)
7	- Bits per sample
330 lbs	- Weight of scanner & electronics
55 watts	- Power
100	- Commands required

o Multispectral Scanner

Band	Spectral Range (Microns)	Nominal Ground Resolution (meters)	Minimum Radiance (mw/cm^2 ster)	Maximum Radiance (mw/cm^2 ster)	S/N at Minimum Radiance
1	.5 - .6	79	.22	3.20	27
2	.6 - .7		.16	2.92	17
3	.7 - .8		.09	2.30	8
4	.8 - 1.1		.14	3.58	4
5	01.4 - 12.6	237	5.7 (223°K)	36.0 (330°K)	N/A

15.06 Mbps	- Output data rate
.46	- Scan efficiency
14.03 scans/sec	- Scan frequency
13.45°	- Field of view
1.4	- Scamples per picture element (crosstrack)
6	- Bits per sample
142 lbs.	- Weight of scanner & mux
65 watts	- Average power
73	- Commands required

- Data Collection System

Electronics		
	Volume	12,000 cc
	Weight	20 kg
	Power	40 watts
Antenna		
	Volume	42,000 cc
	Weight	4 kg
Commands		
	Power	4 (2 on/off)
	Impulse	10
Telemetry		
	Analog	12
	Bilevel	10
Data Rate		TBD

3.1.3.2 Central Data Processing Facility Design

The Central Data Processing Facility shall be initially sized to accommodate all processing required for the EOS-B mission. The EOS-B mission consists of the EOS-A Thematic Mapper plus a High Resolution Pointable Imager (HRPI). The CDPF shall not process MSS data; MSS data shall continue to be processed in the ERTS developed NASA Data Processing Facility.

3.1.3.3 Output Products

The Land Resources Management (LRM) mission is to be a prototype for operational flight systems. The ground processing system is likewise to characterize the prototype features required for an operational system. The outputs from such a system are defined as standard products and custom products. All products, standard and custom, shall be radiometrically corrected. The standard products and requirements are shown in the following matrix:

	Geometrically Uncorrected	Geometrically Corrected	Reduced Data Options
B/W Film	X	X	X
Color Film	X	X	X
High Density Digital Tape (HDDT)	X	X	
Computer Compatible Tape (CCT)	X	X	X

Custom output products from the system shall include film products geometrically corrected with custom gamma capability and sub-area enlargement capability to specific map scales. Additional custom film products are those of specific false color mix.

Custom digital products relate to CCT output. These include sub-area or swath width reduction, band sequential or band interleaved, specific bands, and reduced resolution.

3.1.3.4 Output Product Quality

The following digital output product quality requirements apply only to TM and HRPI data. MSS product quality shall be consistant with that produced by the ERTS NDPF in the 1979 time frame. All values are 1σ.

o <u>Geometric Mapping - Central Data Processing Facility Products</u>

	Uncorrected			Corrected		
	T M	H R P I		T M	H R P I	
		In TM FOV	Outside*** TM FOV		In TM FOV	Outside*** TM FOV
Position Accuracy						
Without Ground Control	450 m	450 m	800	170 m	170 m	650 m
With Ground Control	--	---	---	15 m	15 m	30 m
Internal Distortion**						
Along Track (per 185 Km)	0.4 IFOV	1.2 IFOV	1.2 IFOV	0.2 IFOV	0.2 IFOV	.4 IFOV
Across Track	0.2 IFOV	0.2 IFOV	.4 IFOV	0.2 IFOV	0.2 IFOV	.4 IFOV
Registration						
Band-to-Band	0.1 IFOV	0.3 IFOV	.3 IFOV	0.1 IFOV	0.3 IFOV	.3 IFOV
Sensor-to-Sensor	--	---	---	0.3 IFOV	0.9 IFOV	---

** With respect to specified output format projection
*** Acchievable values vary with off-axis pointing angle

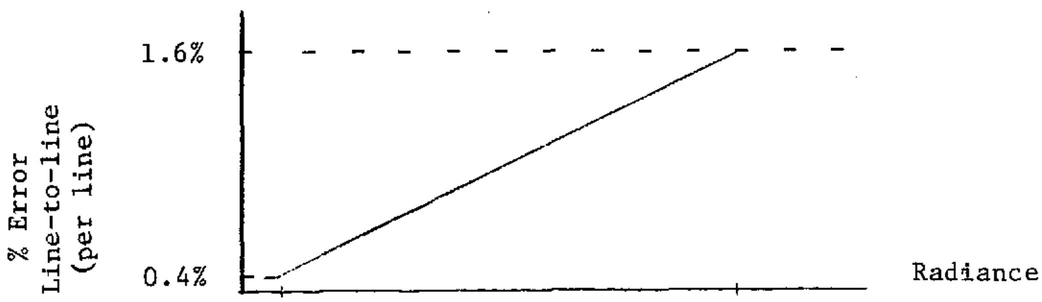
o <u>Geometric Mapping - Low Cost User Station Digital Data</u>

	Uncorrected*		Corrected**	
	TM	HRPI	TM	HRPI
Position Accuracy				
Without Ground Control	700	800	---	---
With Ground Control	---	---	30 m	30 m
Internal Distortion**				
Along Track (per 185 Km)	0.4 IFOV	1.2 IFOV	0.2 IFOV	0.2 IFOV
Across Track	0.2 IFOV	0.2 IFOV	0.2 IFOV	0.2 IFOV
Registration				
Band-to-Band	0.1 IFOV	0.3 IFOV	0.3 IFOV	0.3 IFOV
Sensor-to-Sensor	---	---	---	4.2 IFOV

* Correction only; no GCP's
** Using 1 GCP per image area and without resampling in y direction
*** Up to 10° off-axis pointing

o Radiometric Accuracy (CDFF & LCRS Products)

- Banding



Minimum Radiance Value

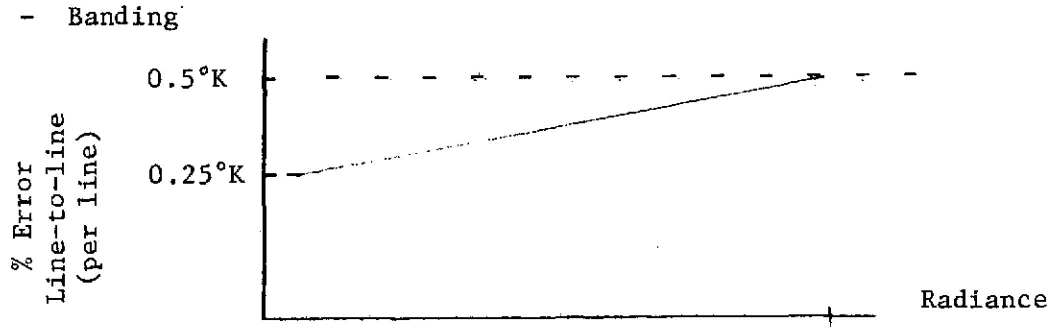
Full Scale Radiance Value

- Temporal Stability
  - o Per day - 0.8%
  - o Per mission - 1.6%

- Relative Accuracy ~ 5%
  - o Sensor-to-sensor - 2.4%
  - o Band-to-band - 1.6%
  - o Across scan - 0.8%

o TM Band 6

- Banding



Minimum Radiance

Full Scale Radiance

- Absolute Accuracy 1°K

3.1.3.5 Output Product Quantities

The system shall be capable of delivering the following quantities of output products:

Product	Data Volume	Number of Data Users	Number of Formats
HDDT (uncorrected)	10^{12} bits/day	10	---
HDDT (corrected)	3×10^{11} bits	10	---
CCT	2.5×10^{11} bits/day	100	1 - 5
Black & White Pos/Neg (1)	80 scenes/day	50	1 - 3 (3)
Black & White Prints		10	1 - 3 (3)
Color Pos/Neg (2)	50 scenes/day	20	1 - 3 (3)
Color Prints		10	1 - 3 (3)

(1) First generation product - 241 mm (9.5 in.)
(2) Second generation product - 241 mm (9.5 in.)
(3) Enlargement to standard map scales

3.1.3.6 Orbit

Altitude	775 Km (418 nm)
Inclination	99° sun synchronous
Eccentricity	≤ .002 following injection error removal
Descending Node Time	
EOS-A	1115 hours (nominal)
EOS-A'	~50 minutes prior to EOS-A
Launch Window	
EOS-A	+15 minutes, - 0 minutes
EOS-A'	Consistent with descending node requirement
Interlace Factor	6
Repeat Cycle	17 days

3.1.3.7 Launch Vehicle Injection Errors

Altitude ± 14 nm maximum

Inclination ± 0.04 degree maximum

3.1.3.8 Ground Stations

Three primary STDN ground stations shall be utilized for recovery of all EOS-A data whenever the spacecraft is in view of one of the stations. The stations are:

- Network Test and Training Facility, GSFC, Greenbelt, Md.
- Goldstone, California
- Fairbanks, Alaska

Additional STDN stations may be used for command and narrowband telemetry communications as required.

3.1.3.9 Tracking and Data Relay Satellite System (TDRSS)

The system shall incorporate the provision for use of the TDRSS for recovery of data whenever the spacecraft is not in view of one of the primary ground stations. Data shall be returned to GSFC from the TDRSS ground station at White Sands, N.M. via a Domsat as the primary link. Recording of payload data at White Sands with return to GSFC by mail shall serve as the secondary means of data return.

3.1.3.10 Data Delivery Time

Data Products shall be available to investigators within (TBD) days of acquisition by the spacecraft.

3.1.3.11 Payload Data Processing

Processing of all payload data shall be performed at GSFC.

3.1.3.12 System Performance Requirements Allocation

To achieve the product qualities specified in Section 3.1.3.4, the following subsystem performance requirements (15) must be achieved:

3.1.3.12.1 Attitude Control System

Pitch, roll, and yaw measurement accuracy requirements (knowledge with respect to inertial reference) shall be as shown in Figure 3-2. Error bounds are specified in the mid frequency range corresponding to the need for 2 and 10 ground control points (GCP's) to achieve the geometric accuracies specified in section 3.1.3.4 over a 20 minute data swath. The 2 gcp case shall be a goal of the program consistent with the capability to achieve corresponding ephemeris accuracies as specified in Section 3.1.3.12.2. Pitch, roll and yaw control accuracy requirements (control with respect to spacecraft nadir line) shall be as shown in Figure 3-3.

3.1.3.12.2 Ephemeris

Best fit ephemeris accuracy shall be as specified on Figure 3-4. Error bounds are specified in the mid frequency range corresponding to the need for 2 and 10 GCP's to achieve the geometric accuracies specified in Section 3.1.3.4 over a 20 minute data swath. The 2 gcp case shall be a goal of the program; the 10 gcp case is a requirement.

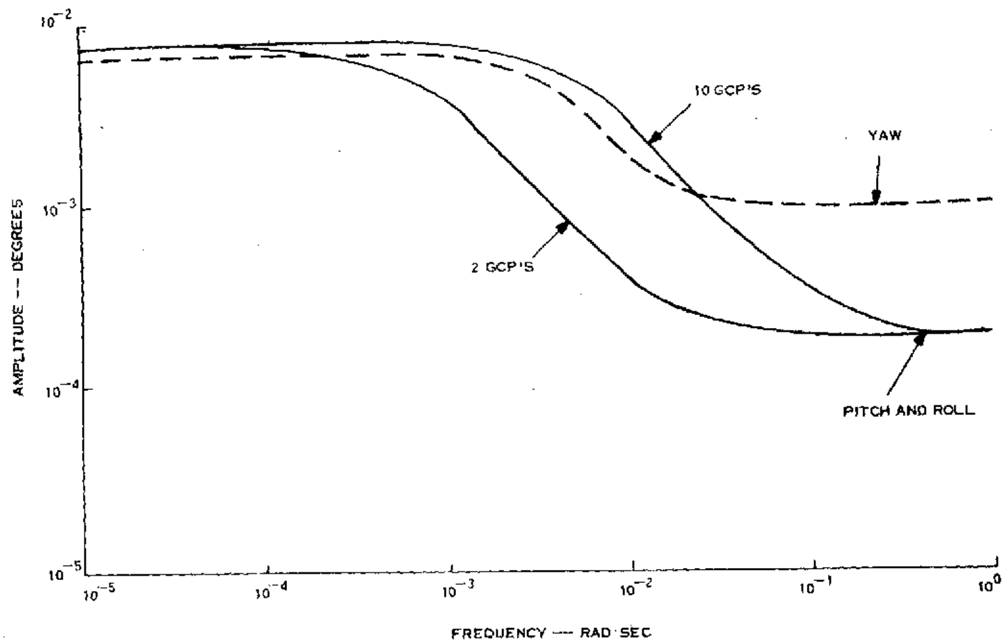


Figure 3-2. Spacecraft Altitude Requirements (with Respect to Inertial Reference)

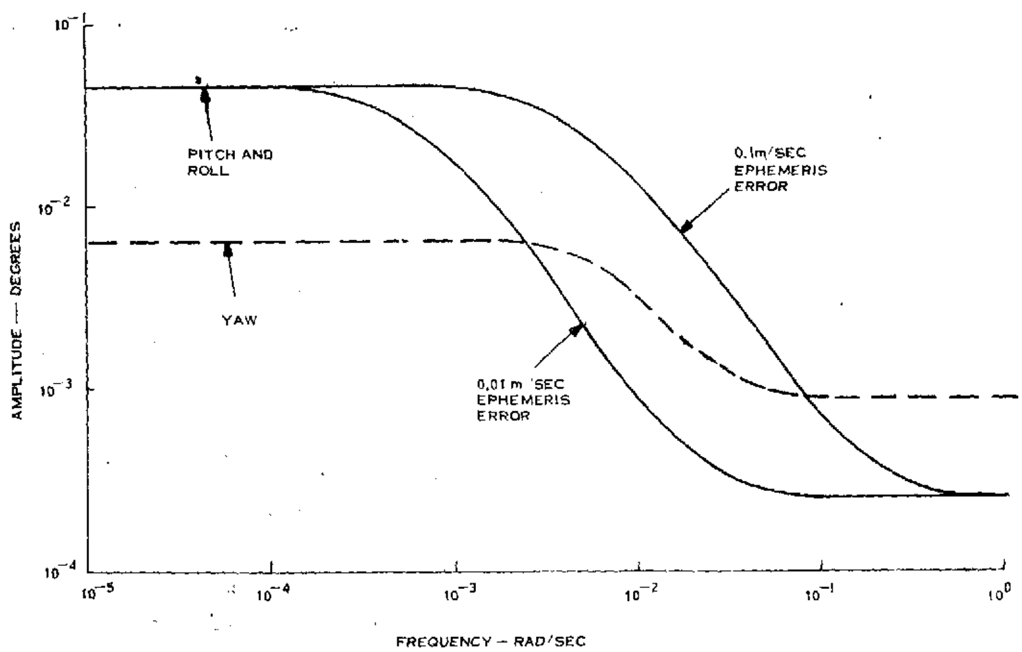


Figure 3-3. Spacecraft Attitude Control Requirement (with Respect to Nadir)

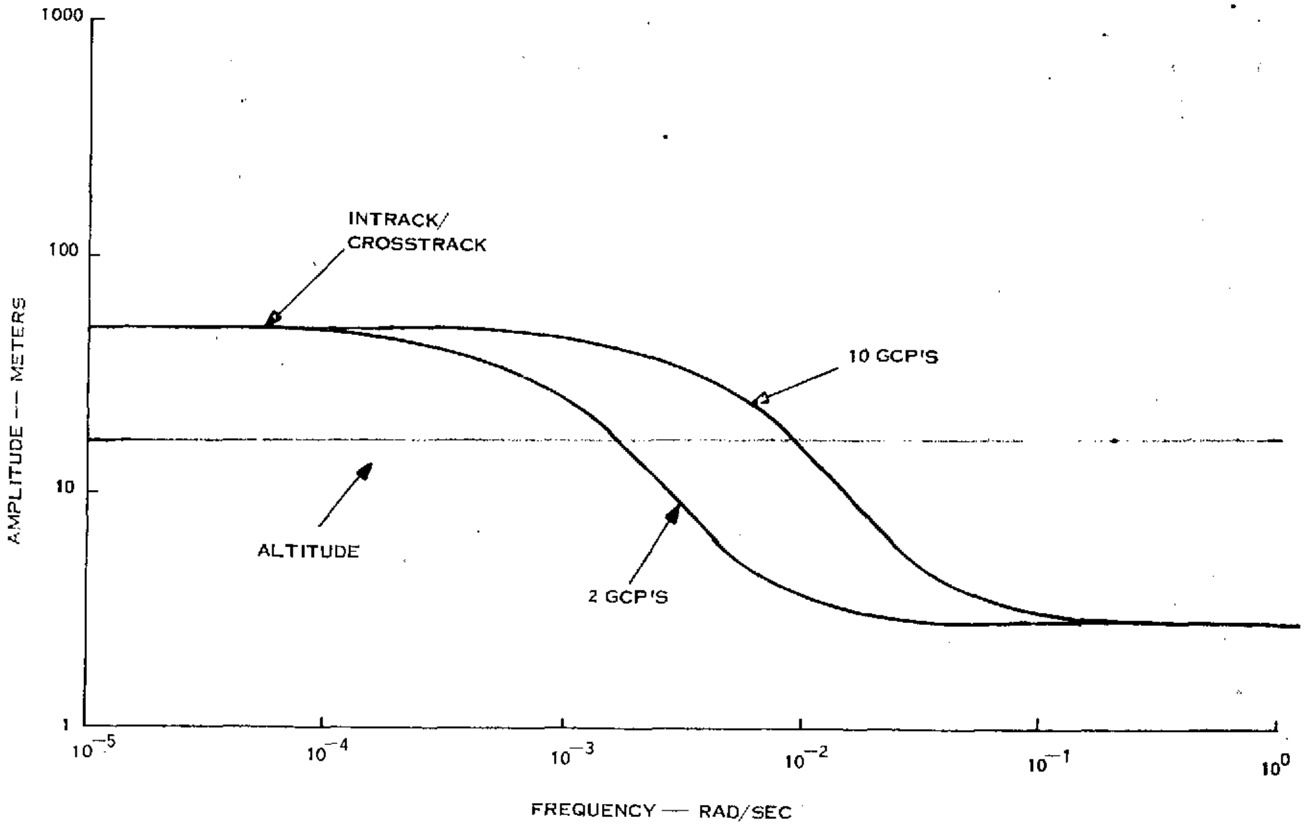


Figure 3-4. Best Fit Ephemeris Accuracy Requirements

3.1.3.12.3 Instruments

Geometric Accuracy

Line Scanner	TM	HRPI
Start of Scan Stability	3 μ rad	2 μ rad
*Along Scan Positional Accuracy (repeatability along entire scan including optical distortions)	4 μ rad	1.3 μ rad
Across Scan Non-linearity (⊥ to scan line)	4 μ rad	4 μ rad
Detector Position		
Placement (to a specific location)	.1 IFOV	.1 IFOV
Knowledge	0.05 IFOV	0.05 IFOV
Detectors in Bands 1 - 5	16	N/A
Detectors in Band 6	4	N/A

* Variations from this accuracy which are linear, are acceptable.

Pushbroom HRPI - Relative Geometry

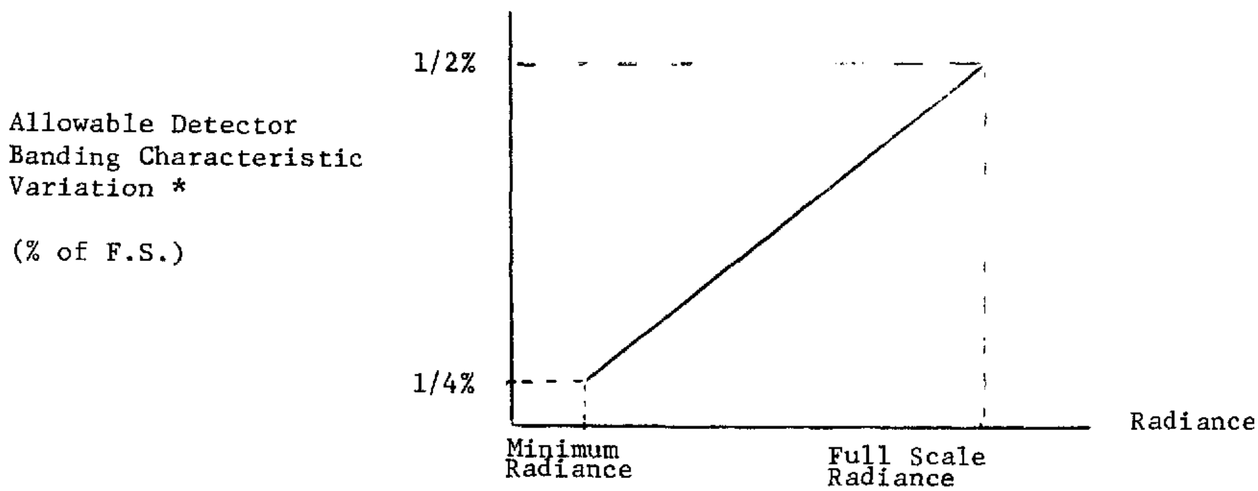
Detector Position - two dimenstional	
Placement	0.1 IFOV
Knowledge	0.05 IFOV
Sampling Time Error	100 μ rad
Optical Distortions of LOS over Array	
Control (band to band)	1.3 μ rad
Knowledge	2 μ rad

HRPI Offset Pointing (Array and Scanner)

Increment Steps & Repeatability	1° ±.05
Stability Once Locked	4 μ rad
Slew Rate - Nominal	1°/sec

Radiometric Accuracy

a. Stripping requirement (between updates)



* Due to temperature, shape, gain, and offset variations

b. Cal. lamp temporal stability
- Low radiance - 0.25%
- High radiance - 0.5%

c. Instrument-to-instrument relative accuracy - 2.4% of received radiance

d. Band-to-band accuracy = 1.6% of received radiance

e. Across scan = 0.8% of received radiance

Dynamic Response

(TBD)

3.1.3.12.4 Structure

Vehicle structural stability shall be as follows:

	Bias	Temporal Stability: 20 Min. Pass	Temporal Stability: Per 1 Day Cycle
Sensor-Sensor			
Pitch	1 m rad	4 μrad	200 μrad
Roll	1 m rad	4 μrad	200 μrad
Yaw	260 μrad	20 μrad	100 μrad
TM to A/C			
Pitch	700 μrad	8 μrad	60 μrad
Roll	700 μrad	8 μrad	60 μrad
Yaw	160 μrad	40 μrad	10 μrad
MSS to A/C			
Pitch	700 μrad	20 μrad	160 μrad
Roll	700 μrad	20 μrad	160 μrad
Yaw	160 μrad	100 μrad	30 μrad

The short term (20 minutes) stability requirement defines the deviation from a linear misalignment with respect to time of any structural deformation of the spacecraft. The long term (per day) stability requirement defines the magnitude of the error in predicting the misalignment due to structural bending.

3.1.3.12.5 Spacecraft Clock

Absolute accuracy	1×10^{-3} seconds
Pre-mirror sweep	0.5×10^{-6} seconds
Short Term Stability (per 20 minute swath)	0.8×10^{-6}

3.1.3.12.6 Central Data Processing

The combined effects of ground system computational accuracy and modeling techniques shall not introduce more than 3 meters error into the data. This is the residual error that would be found in a digital array processed through the ground system with perfect input data.

3.2 OBSERVATORY REQUIREMENTS

The EOS-A observatory is defined to be the mated configuration of the General Purpose Spacecraft Segment and the EOS-A Mission Peculiar Spacecraft Segment. The orbital configuration of the observatory is shown in Figure 3-5 and an exploded view in Figure 3.6.

3.2.1 GENERAL PURPOSE SPACECRAFT SEGMENT

The EOS-A system shall utilize the general purpose modular spacecraft consisting of spacecraft structure, Attitude Control Module, Power Module, Command and Data Handling Module, Propulsion Module and standard electrical integration subsystem. The standard module size shall be 16 x 40 x 48-inches and arranged in the configuration shown in Figures 3-5 and 3-6. The general purpose spacecraft segment is defined in Specification Number (TBD).

3.2.1.1 Attitude Control Module (ACS)

EOS-A shall utilize the standard ACS module defined for the general purpose spacecraft. No modifications to the ACS module are required.

3.2.1.2 Power Module

EOS-A shall utilize the standard Power Module. Three batteries and three regulators are required to support the EOS-A mission.

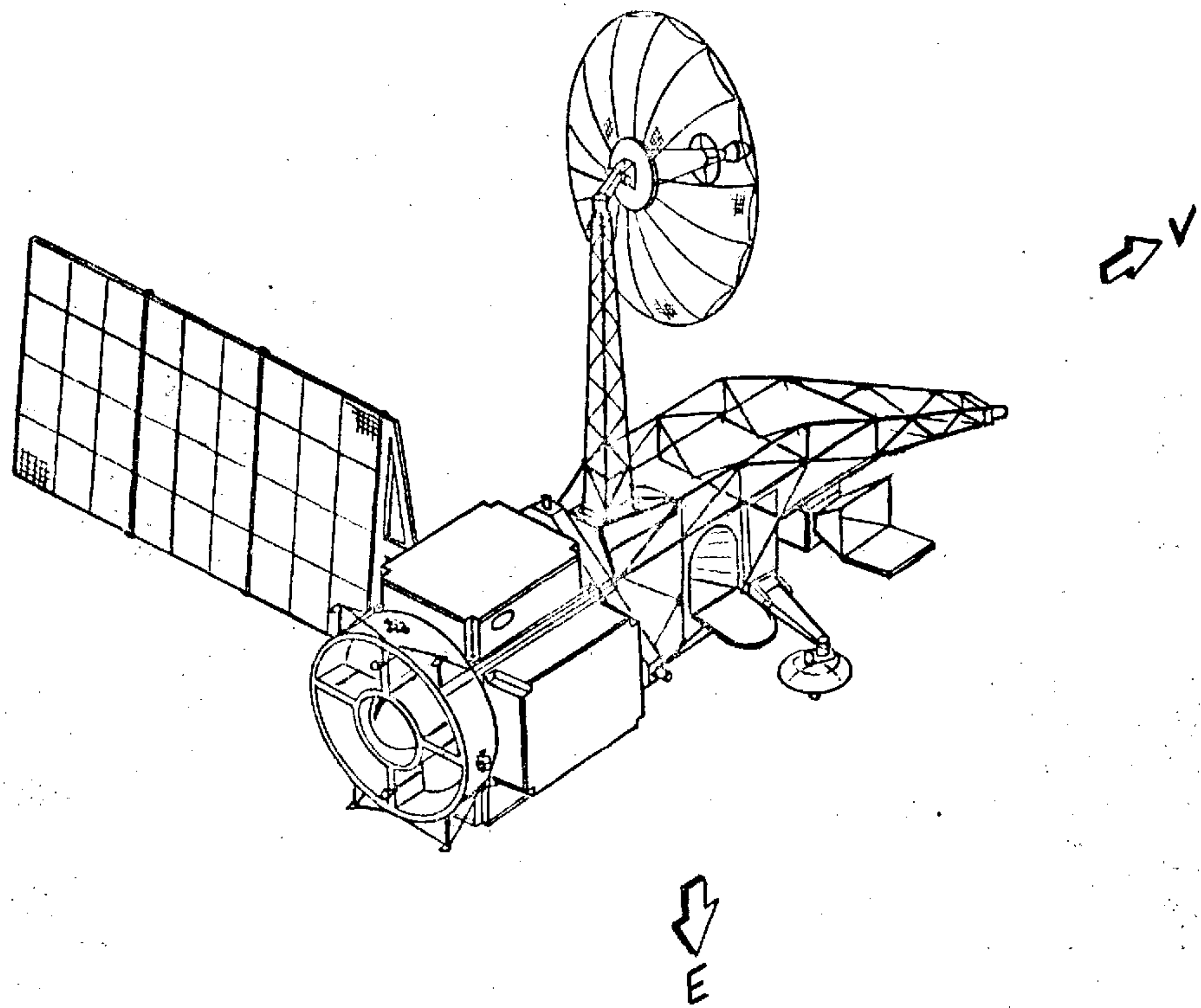


Figure 3-5. EOS-A Observatory Orbital Configuration

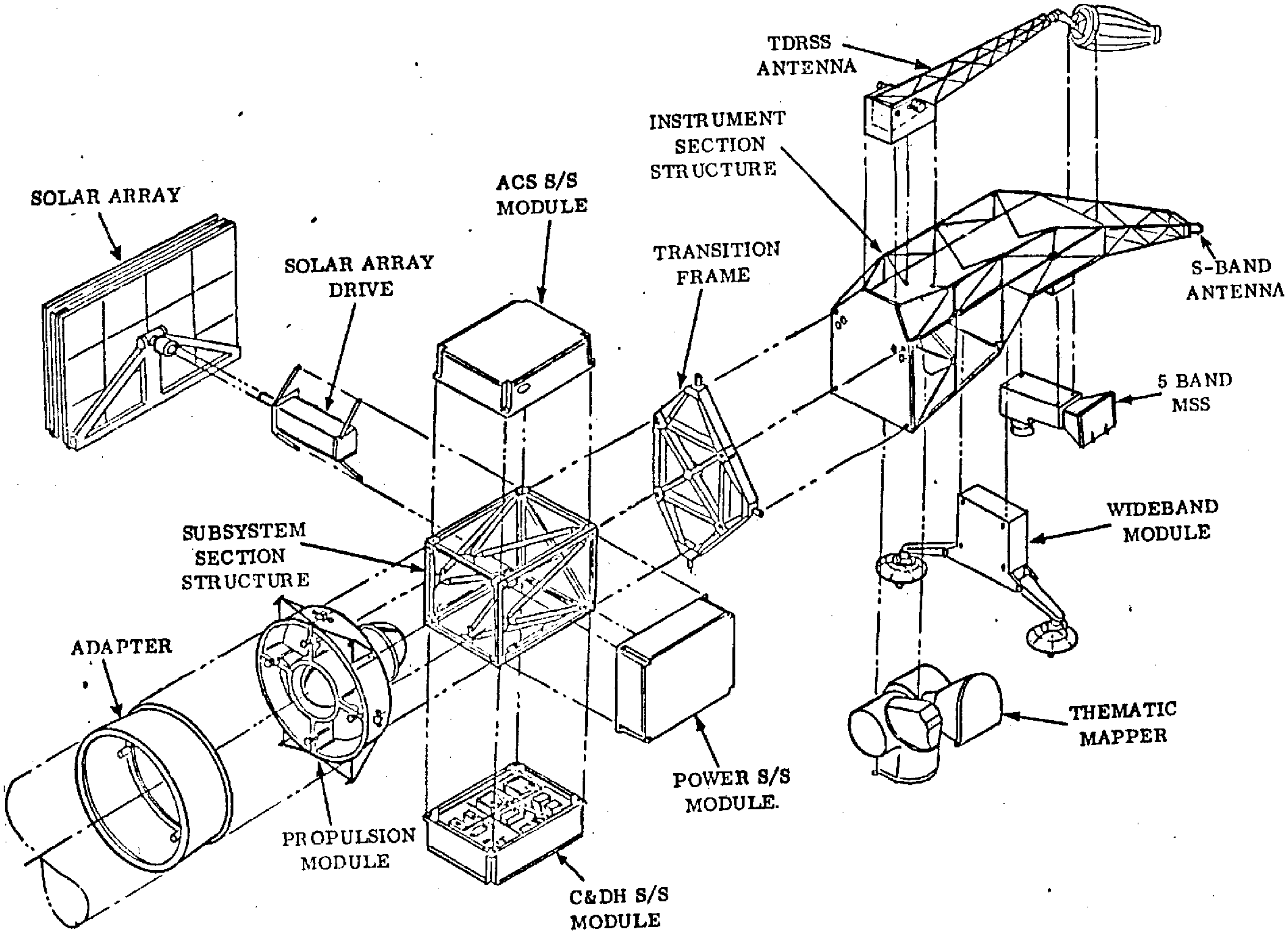


Figure 3-6. EOS-A Spacecraft Exploded View

3.2.1.3 Command and Data Handling (C&DH) Module

The standard C&DH module shall be utilized on the EOS-A mission. Specific options to be selected in the module to support the mission are:

a. Narrowband telemetry rate: 4 Kbps

b. Number of computer central processors: 2
(redundant configuration)

c. Incorporate Data Collection System

d. 11 Remote Decoder/Mux's

e. Incorporate narrowband tape recorder with a capacity of 10^9 bits

f. Clock - frequency: 1.6 MHz
- stability: 1 part in 10^8 per year

g. Time code resolution: 1 Msec

Formats for all spacecraft/ground communication links shall be as defined in the Data Format Control Book, Document ___TBD___ . Link performance shall be defined in the Telecommunications Interface Control Document, Document Number ___TBD___ .

3.2.1.4 Propulsion Module

The standard propulsion module shall be used on EOS-A. Provision for orbit transfer and orbit adjust shall be included in the module capability. The propulsion system shall carry sufficient fuel to support 3 spacecraft reacquisitions, orbit maintenance for a 3-year life and return of the spacecraft to a 330 nm Shuttle retrieval altitude.

3.2.1.5 Solar Array and Drive

The standard single axis, redundant drive, solar array shall be utilized with three solar paddle sections.

3.2.1.6 Launch Vehicle Adapter

A conventional aft adapter shall be used for mating to the launch vehicle.

3.2.2 MISSION PECULIAR SEGMENT

All equipment not designated as standard, yet required to support the EOS-A mission shall form the Mission Peculiar Segment of the spacecraft.

This equipment includes the following:

- Instruments
- Wideband System
- Mission Peculiar (Instrument) Structure

The mission peculiar spacecraft segment is defined in Specification Number (TBD).

3.2.2.1 Instruments

Instrument characteristics shall be as defined in sections 3.1.3.1 and 3.1.3.12.3. Detailed definition of the instruments are included in the following Interface Control Documents:

Multispectral Scanner	-	Document Number (TBD)
Thematic Mapper	-	Document Number (TBD)

3.2.2.2 Wideband System

The Wideband System shall sample, format, analog to digital convert and transmit the TM data. It shall also modulate and transmit the MSS data. In addition, the wideband system shall compact and selectively correct portions of the TM data for use by Low Cost Readout Stations (LCRS).

3.2.2.2.1 Downlinks

The wideband system shall have four separate downlinks:

- o TDRSS Link - one 2-axis steerable antenna for Ku-band communication via the Tracking and Data Relay Satellite System to the TDRS ground station in White Sands, N.M.

- o STDN Links - two 2-axis steerable antennas for direct X-band communication to the primary EOS STDN ground stations at Alaska, Goldstone, and GSFC plus international ground stations around the world.

- o LCRS Link - one fixed shaped beam antenna for direct X-band communication to Low Cost Readout Stations at arbitrary but known locations around the world.

3.2.2.2.2 RF Spectrum

The RF spectrum and bandwidth allocations shall be as shown on Figure 3-7.

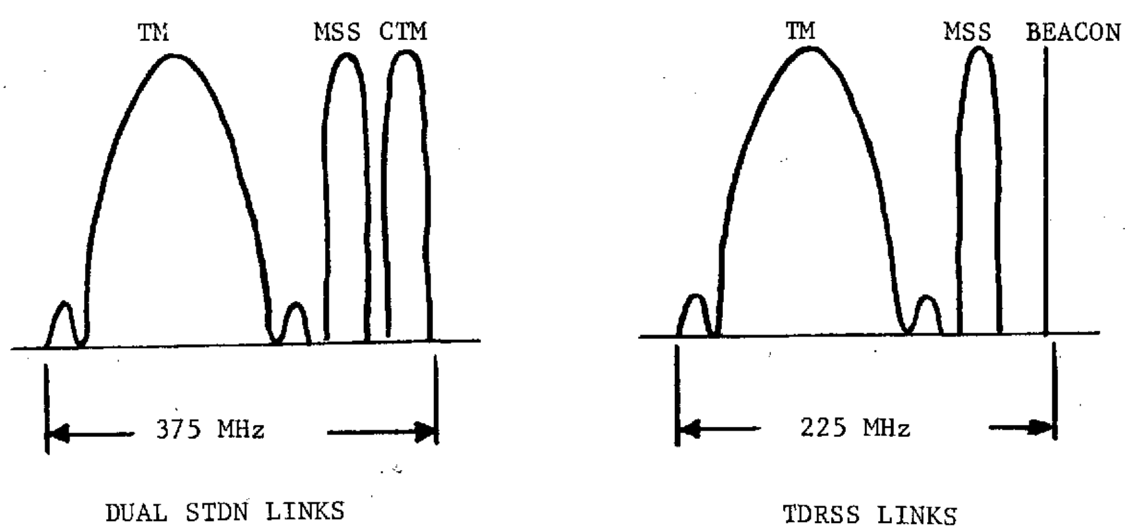


Figure 3-7. Wideband System Spectrum Allocations

3.2.2.2.3 Operation

The wideband system shall be capable of simultaneous operation of all four links with data transmission as follows:

a. TDRS Link - TM and/or MSS data with tracking beacon with the option to substitute LCRS data for MSS.

b. STDN Links - TM and/or MSS on either or both links simultaneously with the option to substitute LCRS data for MSS.

c. LCRS Link - LCRS data or MSS data only .

3.2.2.2.4 Data Formats

Formats for all spacecraft/ground communication links shall be as defined in the Data Format Control Book, Document Number TBD .

3.2.2.2.5 Link Performance

Performance for all spacecraft/ground communications links shall be as defined in the Telecommunications Interface Control Document, Document Number TBD .

3.2.2.2.6 LCRS Compacted Data

The wideband system shall include a compaction function to provide reduced rate TM data to the LCRS. Compaction modes shall be selectable by command with a different mode potentially utilized for each different LCRS. Modes shall be as follows.

Mode	Ground Resolution Meters	Spectral Bands Used	Swath Width
Reduced Resolution	60 x 60	6	full
Reduced Swath, 3 Bands	30 x 30	any 3 of first 5 + Band 6	1/2
Reduced Swath, All Bands	30 x 30	6	1/4
Reduced Bands	30 x 30	any 1 of 5 + Band 6	full

3.2.2.2.7 On-Board Correction

LCRS Data

The wideband system shall perform on-board geometric corrections sufficient to provide data quality as specified in Section 3.1.3.4 without further processing at the LCRS. Corrections shall include linearity, band-to-band registration and image annotation. Correction computations shall be performed in the on-board computer in the C&DH subsystem and supplied to the wideband module via the command data buss.

In addition, the wideband system shall insert all necessary information into the LCRS data stream to permit full radiometric data corrections at the LCRS without inputs from any other source.

CDPF Data

The wideband module shall insert into the TM data stream all necessary auxillary data (except best fit ephemeris) to permit full radiometric and geometric correction of the video.

This auxillary data includes:

- o scan nonlinearity profiles
- o detector offsets
- o line linearity
- o sampling nonlinearities
- o attitude position and rate
- o internal calibration lamp data
- o predicted ephemeris
- o earth rotation effect
- o earth curvature effects
- o boresight alignments
- o time
- o sun calibration updates
- o failed detector annotation

3.2.3 SPACECRAFT SEGMENT INTERFACE

3.2.3.1 Mechanical

The mission peculiar spacecraft segment shall mechanically mate to the general purpose spacecraft segment at the transition frame which is part of the general purpose spacecraft structure. Mating shall be via the transition frame standard four point carry-through arrangement.

3.2.3.2 Electrical

Electrical mating of the mission peculiar and general purpose spacecraft segments shall be via connectors mounted to a panel on the transition frame. Signals to be carried across this interface include:

a. command data bus
b. telemetry data bus
c. clock signals
d. time code
e. spacecraft power
f. narrowband rf

3.2.3.3 Launch Configuration

Launch of the observatory by the Delta 2910 requires that the TDRS antenna be nondeployed and the boom structure stowed. In addition the STDN dishes and the solar array must also be non-deployed. The launch configuration shall be as shown in Figure 3-8.

3.3 GROUND SYSTEM REQUIREMENTS

The EOS-A ground system shall consist of the following three major segments

a. Operations Control Center (OCC)

b. Central Data Processing Facility (CDPF)

c. Low Cost Readout Stations (LCRS)

In addition a System Integration and Test Equipment (Site) Computer and Software system plus the normal aerospace ground equipment used during spacecraft development, test and launch shall be provided as part of the EOS system.

The OCC and CDPF shall be co-located in Building (TBD) at Goddard Space Flight Center and shall provide operational control and data processing functions for the EOS-A system. These functions include operations planning, spacecraft command generation, reduction and analysis of telemetry data, sensor data processing, user product generation and product distribution. The OCC and CDPF are tied together via a common data base provided as part of the CDPF. The OCC and CDPF along with their interfaces are defined in Figures 3-9 and 3-10. Together the OCC and CDPF form the ground data handling system and this system is defined to include the facilities, all contractor supplied and government furnished equipment, personnel and procedures necessary to perform the functions specified in subsequent paragraphs.

The third major ground segment of the system is the Low Cost Readout Station. These stations are essentially independent of the CDPF and have the capability to receive, record and process limited amounts of EOS-A instrument data. While the number of LCRS to become operative during the EOS-A program is currently unknown, the system shall be designed to support 20 such stations at arbitrary locations around the world with growth capability.

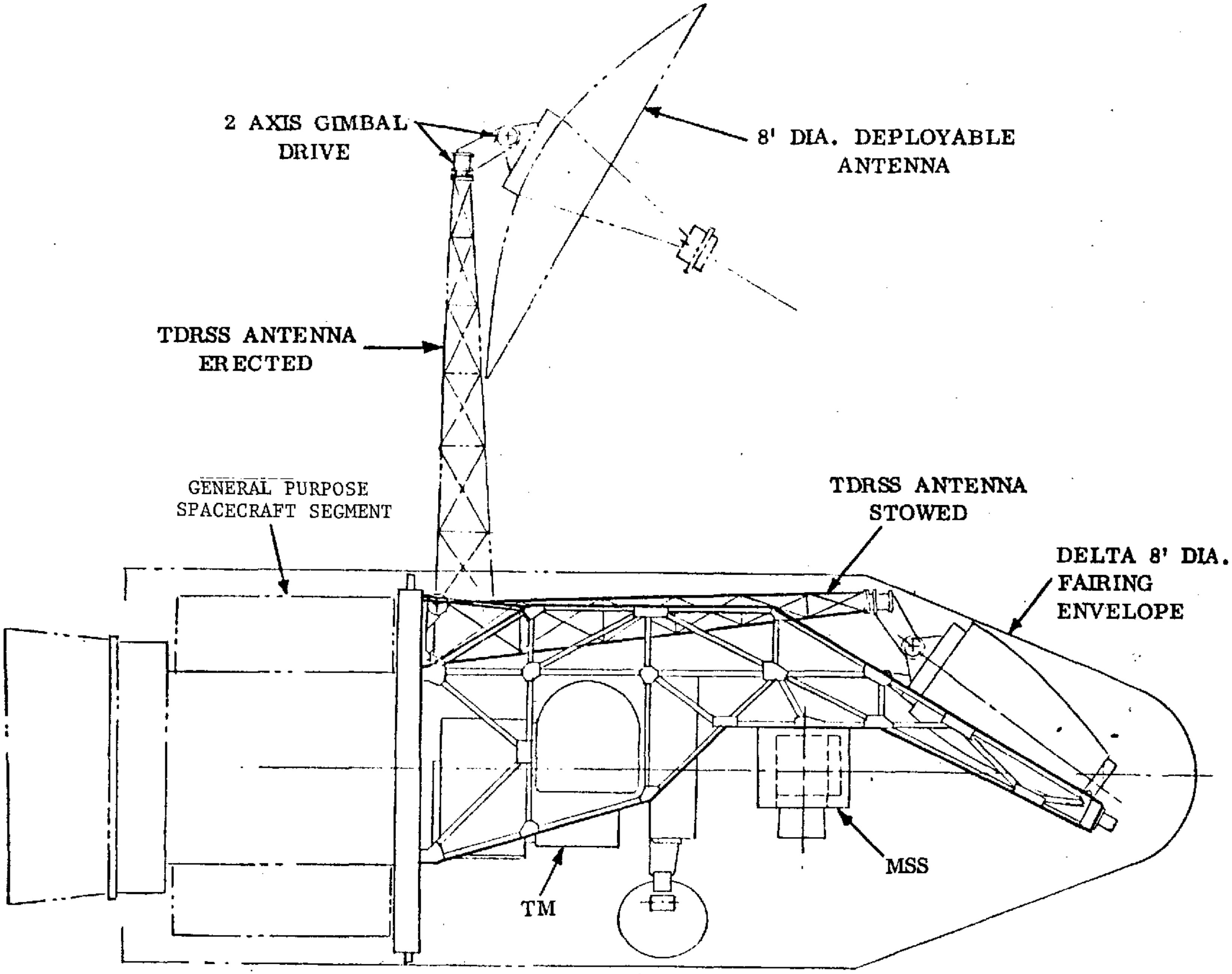


Figure 3-8. Observatory Launch Configuration

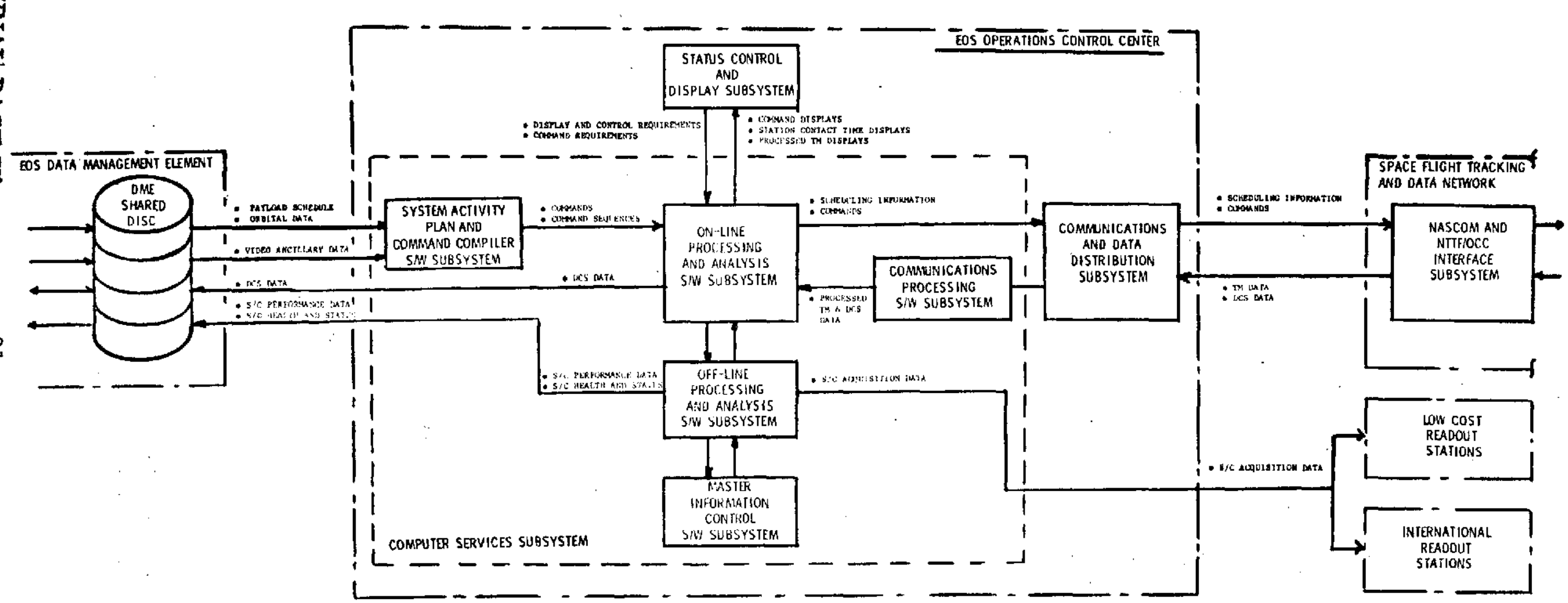


Figure 3-9. Operations Control Center

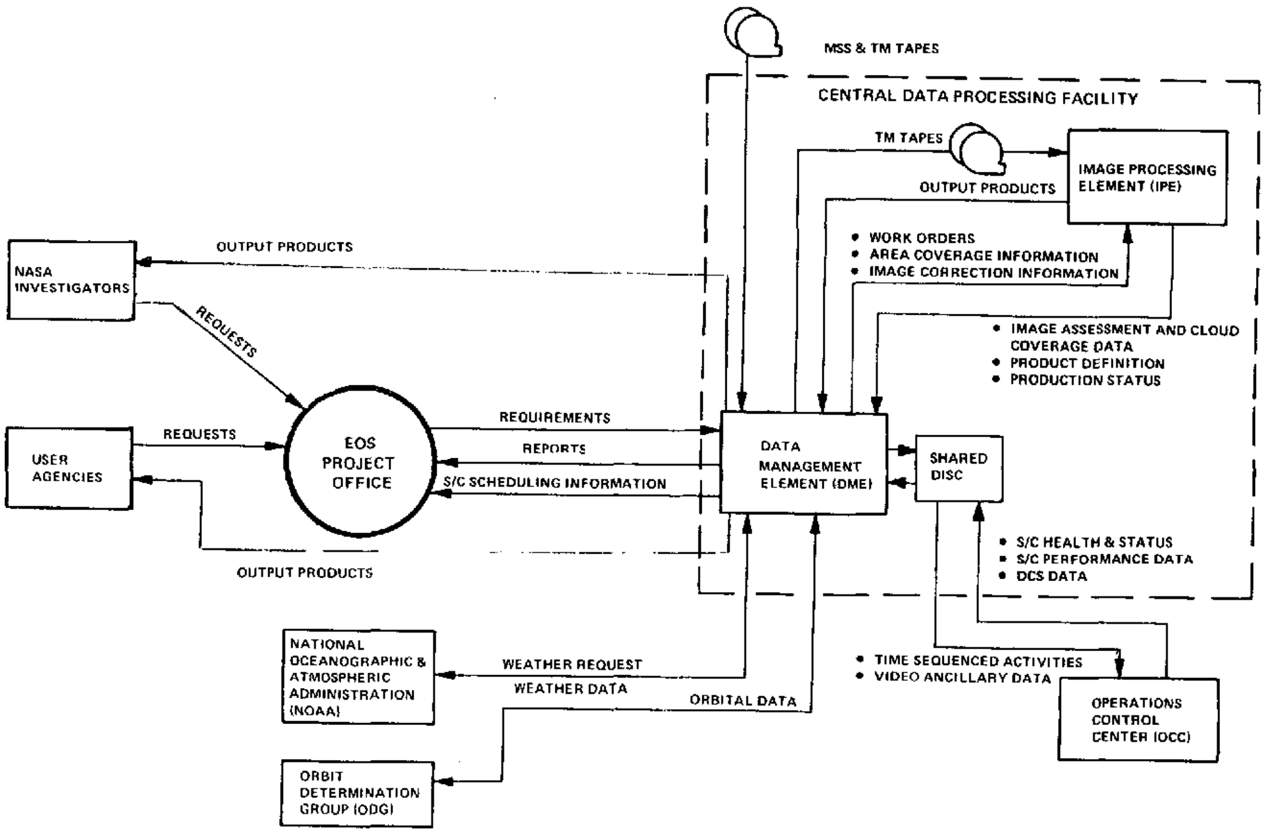


Figure 3-10. Central Data Processing Facility

Detailed design requirements for the three major segments of the EOS-A ground system are defined in:

OCC Segment Specification, Document Number (TBD)

CDPF Segment Specification, Document Number (TBD)

LCRS Segment Specification, Document Number (TBD)

3.3.1 OPERATIONS CONTROL CENTER

The OCC shall perform the following functions:

(1) Serve as the focal point for project unique mission operations.

(2) Originate the spacecraft activity plan and coordinate schedules with NASA combined networks and other supporting facilities.

(3) Generate, display, and verify spacecraft commands for:

a. spacecraft status (configuration and performance)

b. orbit maintenance

c. payload operation

(4) Direct and/or monitor all EOS spacecraft operations support.

(5) Transmit commands to NASA stations for transmission to the Observatory.

(6) Receive, process, display, distribute, and store spacecraft housekeeping telemetry data.

(7) Analyze and evaluate data to determine spacecraft configuration, health and performance.

(8) Analyze and evaluate data to determine sensor configuration, health and performance.

(9) Compile and maintain operational records and data.

(10) Provide facilities for sensor and spacecraft displays and controls that may be required.

(11) Provide OCC input data simulation capability for real time/dump PCM in serial and burst form.

These OCC functions shall be organized into and performed by the following subsystems:

3.3.1.1 PCM Data Processing

The OCC shall provide capability to receive and process realtime and playback narrowband PCM telemetry, and to convert the data to the various calibrated formats necessary for subsequent display.

In addition, the OCC shall provide software for processing and display of real-time data for on-line (quick-look) display and evaluation of spacecraft performance and of playback data for off-line (in-depth) analysis of spacecraft performance.

The OCC shall also provide the capability to receive all DCS data from remote stations and store the data in the common data base of the Data Management Element.

3.3.1.2 Command Generation

The OCC shall provide capability to compile, format, transmit and verify spacecraft realtime and stored commands. Commands shall be compiled prior to each spacecraft contact based on inputs received from the system scheduling function specified in Section 3.3.2.2.

The OCC shall provide switching and signal conditioning equipment for output of commands through NASCOM terminals for automatic routing to the remote sites for subsequent transmission to the spacecraft.

The command generation functions shall be capable of being operated in conjunction with PCM data processing and status data control and display functions to afford capability for near realtime display, transmission and verification during periods of realtime spacecraft acquisition. Backup and command transmission provisions shall include use of Voice, TWX and TTY Tape communications with remote stations. These communications shall also provide backup transmission in the event of OCC computer or high speed transmission failure.

3.3.1.3 Communications and Data Distribution

The OCC shall provide a centralized interface for data flow between the OCC and remote site network(s), including all equipment required for signal conditioning and switching, time correlation, and tape recording of narrowband data. In addition, capability shall be provided for generating analog PCM simulation data tapes with OCC simulation software.

The equipment used in fulfilling these requirements shall be capable of being controlled by a Maintenance and Operation console comprising part of the system. This console shall provide the console operator with capability to select OCC equipment configuration and to control routing of data throughout the OCC by switch actuations.

3.3.1.4 Status Control and Display

The OCC shall contain hardware and software necessary to present, maintain and update all status data and control information necessary to conduct realtime space-operations. OCC Operations Consoles and strip-chart recorders shall be designed and developed to perform these tasks. The consoles shall contain those alphanumeric keyboards, fixed function keypanels, CRT's and other display devices necessary for control and presentation of data from command generation and data processing software programs.

3.3.1.5 OCC Software

The OCC shall have a software system which is organized to efficiently support the OCC processing, command generation, command verification, communications and data distribution activities during all on-line and off-line operations. The software shall provide for interfaces with the networks and all other portions of the ground data handling system operational software subsystems. The OCC software also shall be capable of supporting development, integration and test of all OCC subsystems and shall include routines for checkout, system testing, network compatibility and configuration testing.

3.3.1.6 OCC Computing Services

General purpose digital computers, mass storage, printer and tape units, shall be provided having the capability to perform the basic communications, processing and computation functions necessary to OCC operations. The computer operating system and associated general utility software shall also be provided. The resulting computer configuration shall be compatible with the SITE system located at the spacecraft integration contractors facility.

3.3.2 CENTRAL DATA PROCESSING FACILITY

The CDPF shall perform the following functions:

(1) Perform radiometric and geometric correction plus annotation of all TM and HRPI instrument data

(2) Produce and distribute output products including:

- High density digital tapes
- Computer compatible magnetic tapes
- Film transparencies and prints in color and black and white
- Computer printouts

(3) Process and dessiminate DCS data

(4) Maintain centralized image data base

(5) Provide the external interface for the ground data handling system.

Inputs to the CDPF shall include:

- o Payload data tapes from NASCOM/NETWORKS
- o Coverage and data requirements from EOS users and investigators
- o Weather data from the National Oceanographic and Atmospheric Administration (NOAA)
- o Ephemeris data from the GSFC Orbit Determination Group

Outputs shall include:

- o Products to users and investigators
- o Management and accounting reports to EOS Project Office and users
- o Data base information to users upon request

(6) Schedule instrument coverage requirements

(7) Provide accounting and reporting support for EOS project management

(8) Maintain the interface with the OCC via a shared data base. Inputs from the OCC shall include:

- o Selected telemetry data
- o DCS data

Outputs to the OCC shall include:

- o Payload scheduling requirements
- o Auxiliary data for eventual insertion into the video data stream

These functions shall be performed by the following elements:

3.3.2.1 Image Processing Element

All processing and correction of the data shall be accomplished in the digital domain to achieve the desired output product accuracy requirements and to satisfy the needs of a user community that performs digital extractive processing to derive information from the data. The allocations defined in Section 3.1.3.2 specify the characteristics of the input data while the system performance requirements defined in Sections 3.1.3.4 and 3.1.3.5 specify the quality and quantity of the output products. These sets of requirements provide the specifications for the performance of the Image Processing Element (IPE).

Quality Assessment. An assessment of the received data shall be performed to identify regions of valid data and to determine characteristics used for data cataloging and the scheduling of subsequent processing. Parameters to be determined include data quality (i.e., bit error rate), cloud cover and failed detectors as a function of position on the input tapes.

Reformatting. A reformatting function shall be performed to compensate for the multiplexing strategies and various sensor configurations which produce serial data streams that have non-optimum pixel arrangements. The output format shall be band-to-band registered, spectrally interlevered, and linearized (all pixels along a straight line in sequence).

Radiometric Correction. All data, regardless of the geometric accuracy, will be corrected to the same radiometric accuracy as specified in Section 3.1.3.4. All information necessary to calculate this correction shall be included in the data stream. The data shall be calculated on the ground and uplinked to the spacecraft via the OCC.

This data is:

- o Internal calibration lamp data utilized to remove detector banding and short term instability
  - Thematic Mapper
    - o Gain and offset correction
    - o Calibration table for each detector
  - HRPI
    - o Gain and offset correction
    - o 256 calibration tables for 19,200 detectors
- o Sun calibration data to remove long term instabilities
- o Failed detector compensation
- o Video histogram analysis applied if necessary

Geometric Correction. All output data shall have a geometric accuracy falling into one of the following categories:

- o Uncorrected data - 450 meter accuracy
  - Utilize predicted ephemeris
  - Perform X correction of each scan line (line length, earth rotation, scanning/sampling/array non-linearities, earth curvature and best fit planar projection)
  - All data linearized to straight lines
- o Uncorrected data - 170 meter accuracy
  - Utilize best fit ephemeris
  - Performs X correction of each scan line (same as uncorrected data - 450 meter accuracy)
  - All data linearized to straight lines
- o Corrected data - 15 meter accuracy
  - Utilize best fit or predicted ephemeris
  - Performs X, Y correction of all error sources
  - Uses Ground Control Points (GCP's) to model errors
  - Data presented in specified map projection
  - Data grided with respect to the earth

Due to the uncertainty in the user community as to the desirability of one resampling technique as opposed to another, the Image Processing Element shall have the resampling capabilities for nearest neighbor, bilinear and $\frac{\sin x}{x}$ (cubic approximation). The baseline system shall be designed for 100% data throughput with the cubic approximation to $\frac{\sin x}{x}$.

HDDT Generation. The Digital Image Correction Subsystem shall produce both resampled and non-resampled HDDT's of the data received. The resampled HDDT shall be copied and shipped to major data users as well as utilized for archiving. The non-resampled HDDT shall be archived along with the derived correction information data and utilized in custom processing functions.

Computer Compatible Tape Generation. This function shall produce computer compatible tapes from HDDT's or film and perform custom processing of the data. An illustrative list of the custom processing to be provided is as follows:

- Digital Enlargement
- MTF
- Resolution Reduction
- Area Reduction
- Custom Projection
- Pixel Reformatting

Film Image Generation and Processing. The system shall have the capability to produce first generation B&W products and second generation color products. The options available for custom processing shall be the same as those listed for CCT generation with the addition of the following:

- Photographic Gamma Change
- False Color Mixes
- Photo Copying
- Photo Enlargement

The system shall also have the capability to produce for cataloging purposes, of a selected channel from each sensor of the data contained on the resampled HDDT's provided to the major data users. The film strip shall be copied and included with the shipment of the HDDT's, then used for archiving.

Browse Access. The system shall provide a capability for investigators to access and view the archived data. Since the primary shortage medium is the HDDT, a video display capability shall be provided along with the capability of viewing the catalog film identified above.

Extractive Processing. An extractive processing option shall be provided which is capable of converting corrected EOS multispectral image data into user-oriented parametric information such as the identification and classification of agricultural crops, urban areas, etc. The implementation system shall be interactive and have the capability of performing the following functions:

- o Feature Selection/Extraction: obtaining the features or characteristics of the scene which can be used to identify points or objects in the scene.
- o Feature Reduction: a linear transformation of the features obtained above to gain a minimum optimal set of features which will be sufficient to identify objects or points in a scene.
- o Feature Classification/Estimation: the conversion of feature measurements into user oriented parameters (i.e., corn yield, soil moisture, etc.).

3.3.2.2 Data Management Element

The Data Management Element (DME) shall serve as the single centralized control element of the ground system. The DME shall interface with the OCC and IPE as well as with the user community and the GSFC EOS project management office. It shall consist of a single integrated hardware/software system to perform all of the following functions:

Direct IPE On and Off-Line Activities. The DME shall direct all phases of imagery and product processing from Video Tape Assessment to output product processing. Where the particular activity is highly automated the activity shall be directed by direct computer to computer data transfer with hard copy reports of activity progress. Provisions for over-ride shall be included at any point to allow non-standard processing. Where the activity involves human interface and/or manual operations, the DME shall control the activity by the production of work-orders.

Management Reports and Accounting. The DME shall provide periodic and special reports to facility management regarding the status and performance of the DME and the other associated functional elements. These reports may be keyed to periodic intervals, specific DME activities or in response to facility management requests.

Data Base Maintenance. The DME shall create, maintain and assure the integrity of an integrated product/image data base. This data base shall consist of a hierarchy of storage media: on-line random access storage for most recent data; on-line sequential access for older data; off-line sequential access for all archival data. The DME shall also provide reports describing the statistical aspects of data base utilization to aid in providing insight into alternate, more efficient data structures as the DME matures toward an operational capability.

The data base shall be structured to provide information storage and retrieval to the level of individual images and/or work orders via any of the following chains:

- o Work Orders
  - Work Order Number
  - Generating User Request
  - Production Status
  - Referencing Image
  - Product Type
  - Work Station
- o Images
  - Scene
  - HDDT
  - Catalog Film Roll
  - Pending Request

User Community Interface. The DME shall control the interface between the various elements of the user community and the EOS system. The DME shall accept and reply to queries concerning the data base contents. These queries may be from interactive terminals in the Browse Processing area or input by punched cards from mail and telephone requests. The DME shall also accept and respond to requests for various products relating to EOS imagery. The images may be already available or my be an implicit request for production of the image via spacecraft and sensor scheduling.

Direct Spacecraft and Sensor Scheduling. When valid requests for EOS imagery are received, but for which the required imagery is not available, the DME will provide information to the OCC to command the spacecraft and sensors to provide such imagery. The information to the OCC shall consist of a feasible time-scheduling of the spacecraft and sensors. It shall include ground control point data as well as other correction data (e.g., sun calibration information, alignment biases, timing updates, etc.) which will be relayed to the spacecraft. This data will be stored and retransmitted by the spacecraft with the imagery video data stream. The spacecraft and sensor scheduling by the DME shall take into account the priority of the users who requested imagery, the predicted weather, predicted ephemeris, and spacecraft operational constraints and shall be continually coordinated with the EOS project office.

3.3.3 LOW COST READOUT STATION

3.3.3.1 Subsystems and Functions

The LCRS shall consist of the following three subsystems as shown in Figure 3-11.

a. Data Acquisition Subsystem

Function - The data acquisition subsystem shall acquire and receive the 8 GHz LCRS link signal from the spacecraft, demodulate and record the video data. Reduced speed capability shall be provided for playback of the data into the data processing and correction subsystem.

Equipment - The subsystem shall consist of antenna plus drive, preamplifier, receiver, bit synchronizer and high density digital tape recorder.

b. Data Processing and Correction Subsystem

Function - The subsystem shall digitally correct the data contained on the high density digital tape at the rate of one spectral band per tape pass, and record the corrected data on a magnetic tape unit. Radiometric correction capability shall be provided in the LCRS for both compacted TM and MSS data . Geometric corrections will be performed on board the spacecraft for compacted TM data.

Equipment - The subsystem shall consist of a mini-computer with keyboard and printer, and input/output unit for interface with the high density digital tape recorder, an output magnetic tape unit, a tape unit buffer/controller and all control and correction software.

c. Display and Extractive Processing Subsystem

Function - The display and extractive processing subsystem shall be a station unique set of equipment for purposes of image reproduction, display and analysis. This subsystem shall not be supplied as part of the basic LCRS but its function must be considered in the design of the basic LCRS.

Equipment - The subsystem will typically consist of CRT displays, image reproduction devices providing hard copy output, image viewers, and extractive processing devices plus computer algorithms.

3.3.3.2 Coverage Area

The LCRS shall be capable of receiving and processing all data acquired within a 500 km radius of the station.

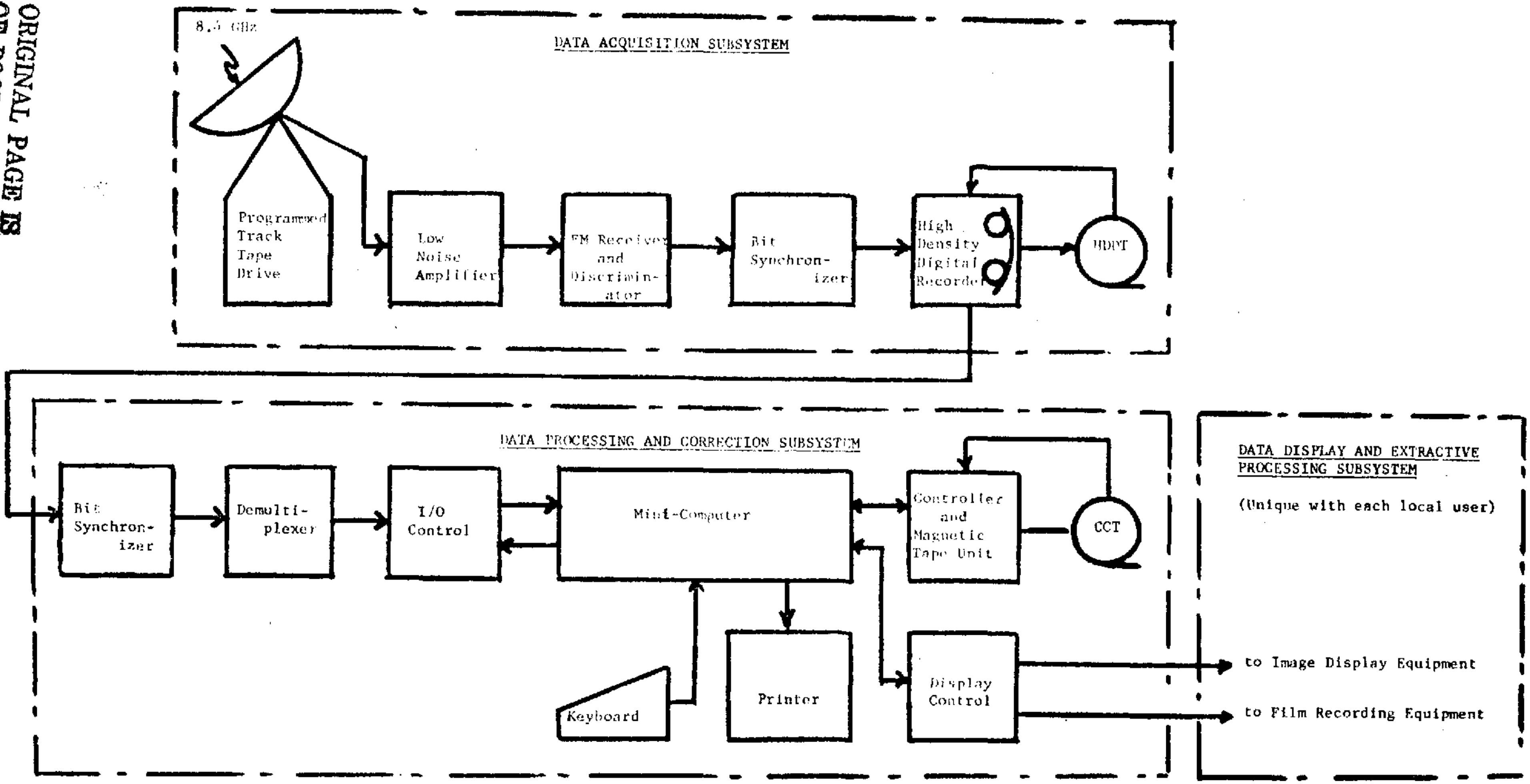


Figure 3-11. Block Diagram - Low Cost Readout Station

3.3.3.3 Input Data Rate

15 Mbps.

3.3.3.4 Input Data Type

Compacted Thematic Mapper (with modes as defined in Section 3.2.3.6) or MSS.

3.3.3.5 LCRS Interfaces

3.3.3.5.1 EOS Project Office

To obtain instrument and downlink operation over a LCRS and to identify the desired modes of operation, the LCRS shall be required to request coverage with the EOS Project Office at GSFC.

3.3.3.5.2 OCC

Predicted spacecraft orbit and station contact times shall be supplied to the LCRS from the OCC.

3.3.3.5.3 Spacecraft

LCRS downlink characteristics shall be as defined in the Data Format Control Book, Document Number TBD and the Telecommunications Interface Control Document, Document Number TBD.

3.4 SYSTEM INTERFACE REQUIREMENTS

The EOS System has major external interfaces in the following areas:

- Launch Vehicle
- Launch Support and Test Facilities
- Space Transportation System (Shuttle)
- NASCOM/Remote Sites
- National Oceanographic and Atmospheric Administration (NOAA)
- Data Users

Each external interface shall be defined via an Interface Control Document (ICD) which shall specify all data flow across the interface including the interface media, format, quantities, timeliness of delivery and the responsibilities of the parties to the interface. Specific areas to be considered in the external internal Interface Control Documents are defined in subsequent paragraphs.

3.4.1 LAUNCH VEHICLE

EOS-A will mate to the launch vehicle via a conventional adapter. ICD TBD shall define the electrical and mechanical adapter interface plus the sequence of events during the prelaunch and launch phase.

3.4.2 LAUNCH SUPPORT AND TEST FACILITIES

ICD TBD shall specify the facility requirements and test support services supplied by the launch site at the Western Test Range.

3.4.3 SPACE TRANSPORTATION SYSTEM

EOS-A will be designed to be retrievable by the space shuttle. ICD TBD shall define all electrical and mechanical interfaces with the shuttle, the time line of events and the procedures to be utilized during the retrieval operation.

3.4.4 NASCOM/REMOTE SITES

ICD TBD shall define the interface between the EOS-A system and all portions of the NASCOM/Remote Site network. This shall include the three primary EOS-A ground stations, backup STDN command and telemetry stations, the TDRSS system and the Domsat links for both return of payload and telemetry data and the transmission of commands.

3.4.5 NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION

ICD TBD shall specify the weather information to be supplied by NOAA on a regular basis for use in the scheduling of payload operations.

3.4.6 GSFC ORBIT DETERMINATION GROUP

ICD TBD shall define the orbit determination services to be provided to the EOS-A program by the GSFC Orbit Determination Group. These services shall include predicted and best bit ephemeris definition, forecast ground station contact times, definition and the verification of all orbit adjust maneuvers.

3.4.7 DATA USERS

EOS-A data users include government agencies and GSFC investigators. Support is also required to both low cost readout and international ground stations. ICD TBD shall specify the EOS-A interface with these users defining output products and product formats, GSFC supplied services and methods to request products and services.

SECTION 4.0

QUALITY ASSURANCE PROVISIONS

Quality Assurance and Configuration Management Programs shall be implemented for all segments of the EOS-A systems. Specific programs are identified in the corresponding Specification for each major segment in the EOS-A system.

SECTION 6.0

NOTES

6.1 ABBREVIATIONS AND ACRONYMS

B&W	Black and White
CDPF	Central Data Processing Facility
DCS	Data Collection System
DME	Data Management Element
GSFC	Goddard Space Flight Center
HDDT	High Density Digital Tape Recorder
HRPI	High Resolution Pointable Imager
ICD	Interface Control Document
IPE	Image Processing Element
LCRS	Low Cost Readout Station
MSS	Multispectral Scanner
NASA	National Aeronautics and Space Administration
NDPF	NASA Data Processing Facility
OCC	Operations Control Center
SITE	System Integration and Test Equipment
TBD	To Be Defined
TM	Thematic Mapper