EXECUTION PHASE
PROJECT PLAN
FOR
GEOSTATIONARY OPERATIONAL
ENVIRONMENTAL SATELLITES
(GOES-I/M)

April 7, 1999

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

EXECUTION PHASE PROJECT PLAN FOR THE
GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE
(GOES)-I/M PROJECT

Agreements:

_Original signed by Martin A. Davis on April 7, 1999
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1999_____
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1999_____
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
EXECUTION PHASE
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FORWARD

This Execution Phase Project Plan is the Goddard Space Flight Center (GSFC) Plan for the Geostationary Operational Environmental Satellites (GOES-I through M) Project. This Project Plan is issued in compliance with NASA Procedures and Guidelines (NPG)-7120.5.

It is the responsibility of the GSFC GOES Project Manager to keep this project plan up-to-date by timely revisions, as substantive changes occur.

ACRONYMS AND ABBREVIATIONS

ACE	Attitude Control Electronics
ADS	Angular Displacement Sensor
AEC	Able Engineering Company
ATN	Advanced Tiros-N
ATS	Applications Technology Satellite
BPDU	Bus Power Distribution System
BVC	Bus Voltage Controllers
CCD	Charge Coupled Device
CCR	Configuration Change Request
CDAS	Command and Data Acquisition Station
CFE	Contractor Furnished Equipment
COTS	Commercial Off-the-Shelf
CTCU	Central Telemetry and Command Unit
DCP	Data Collection Platform
DCPI	Data Collection Platform Interrogation
DCPR	Data Collection Platform Report
DOC	Department of Commerce
DPU	Data Processor Unit
DSN	Deep Space Network
ECRA	Electrical Contact Ring Assembly
ELT	Emergency Locator Transmitter
EMWIN	Emergency Managers Weather Information Network
EPS	Energetic Particle Sensor
EPEAD	Energetic Proton, Electron and Alpha Detector
ER	Eastern Range
ESD	Electrostatic Discharge
EUV	Extreme Ultra Violet Sensor
ETR	Eastern Test Range
eV	Electron Volts
E-W	East-West
FOV	Field of View
FRB	Failure Review Board
GFE	Government Furnished Equipment
GGSM	GOES Ground Systems Manager
GN	Ground Network
GOES	Geostationary Operational Environmental Satellite
GPD	Goddard Policy Directive
GPG	Goddard Procedures and Guidelines
GSFC	Goddard Space Flight Center

GIMTACS	GOES-I/M Telemetry and Command System
GTO	Geostationary Transfer Orbit
GVAR	GOES Variable Format
HASS	High Accuracy Sun Sensor
HEPAD	High Energy Proton and Alpha Detector
HIRU	Hemispherical Inertial Reference Unit
HPF	Hazardous Processing Facility
HSC	Hughes Space and Communications
Hz	Hertz (cycles per second)
IMC	Image Motion Compensation
INR	Image Navigation and Registration
IPC	Integrated Power Controller
IPDU	Instrument Power Distribution Unit
IR	Infrared
ISI	Integral Systems Inc.
ITO	Indium Tin Oxide
ITT/ACD	ITT/Aerospace Communications Division
JPL	Jet Propulsion Laboratory
K	Kelvin (degrees)
Kg	Kilograms
KBPS	Kilobits per second
KSC	Kennedy Space Center
LAM	Liquid Apogee Motor
LDS	Launch Display System
LM	Lightning Mapper
LMATC	Lockheed Martin Advanced Technology Center
LVC	Low Voltage Controller
MA	Mission Assurance
MAGED	Magnetospheric Electron Detector
MAGPD	Magnetospheric Proton Detector
MEPED	Medium Energy Proton and Electron Detector
MDL	Multi-use Data Link
MLI	Multi-Layer Insulation
MMH	Mono-Methyl-Hydrazine
MOM	Mission Operations Manager
MPS	MDL Processing System
MRB	Material Review Board
MSFC	Marshall Space Flight Center
N	Newton or North
N2O4	Formula for Nitrogen Tetroxide

NASA	National Aeronautics and Space Administration
NECT	Noise Equivalent Change to Temperature
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NOMSS	National Operational Meteorological Satellite System
NPG	NASA Procedures and Guidelines
NT	nanoTesla
NWS	National Weather Service
N-S	North-South
OATS	Orbit and Attitude Tracking System
OGE	Operational Ground Equipment
OMTPE	Office of Mission to Planet Earth
ORA	Office of Research and Applications (NESDIS)
OSD	Office of Systems Development (NESDIS)
OSDPD	Office of Satellite Data Processing and Distribution (NESDIS)
OSO	Office of Satellite Operations
PAF	Payload Attach Fairing
PCA	Program Commitment Agreement
PCC	Program Cost Commitment
PPF	Payload Processing Facility
PLT	Post Launch Test
PMD	Propellant Management Device
PMT	Photomultiplier Tube
RF	Radio Frequency
RTCU	Remote Telemetry and Command Unit
SARSAT	Search and Rescue Satellite Aided Tracking
SAIC	Science Applications International Corporation
SAM	Systems Assurance Manager
SAO	Systems Acquisition Office (NOAA)
SDU	Squib Driver Unit
SEC	Space Environment Center (NOAA)
SEM	Space Environment Monitor
S/N	Signal to Noise Ratio
SPS	Sensor Processing System
SSGS	Spacecraft Support Ground System
SXI	Solar X-Ray Imager
TBD	To Be Determined
T&C	Telemetry and Command
µrad	Microradian

WCDAS	Wallops Command and Data Acquisition Station
WEFAX	Weather Facsimile
XRCF	X-Ray Calibration Facility
XRP	X-Ray Positioner
XRS	X-Ray Sensor

EXECUTION PHASE
PROJECT PLAN
FOR
GEOSTATIONARY OPERATIONAL
ENVIRONMENTAL SATELLITES
(GOES-I/M)

1.0 INTRODUCTION

1.1 IDENTIFICATION

Geostationary Operational Environmental Satellites-I through-M (GOES-I/M) is the Project title designated by the National Oceanic and Atmospheric Administration (NOAA), the NASA Earth Sciences Enterprise (ESE) and the Goddard Space Flight Center (GSFC). This project requires the procurement and launch of 5 satellites which meet NOAA requirements. This effort is being funded under Unique Project Number (UPN) 616-3.

1.2 BACKGROUND

NASA and the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce (DOC) are involved in a joint effort, which allows for the continuation of the GOES System. The relationship between NASA and NOAA is defined in the Basic Ordering Agreement and the GOES specific Memorandum of Understanding (Appendix A).

Over the past 35 years, environmental service agencies have stated a need for near-continuous, timely, high-quality observations of the Earth and its environment. In 1961, an interagency plan for a National Operational Meteorological Satellite System (NOMSS) was submitted to the President. The plan recommended that a geostationary satellite be added to the operational system to meet these needs when technology and resources become available. The satellites being procured are logical extensions for the program that was started in 1974 with the launch of the Synchronous Meteorological Satellite (SMS-A).

The office within the DOC agency responsible for managing this program is NOAA. Within NOAA, responsibility for the program has been delegated to the Systems Acquisition Office (SAO). Consistent with the plan described above, NASA and NOAA are actively engaged in a cooperative program to continue the GOES system with the launch of the GOES-I/M satellites.

NASA’s GSFC is responsible for the procurement, development, and verification testing of the spacecraft, instruments, and unique ground equipment. GSFC is also responsible for the following:

- Activities at the launch site Payload Processing Facility (PPF), and satellite performance testing at the launch site, before and following the mating operations with the launch vehicle
- Arranging for the communications data lines and circuits during spacecraft launch simulations
- Providing engineering support to NOAA during the design and development of the ground telemetry and command system that was procured by the National Environmental Satellite Data and Information Service (NESDIS)

Following deployment of the spacecraft from the launch vehicle, GSFC is responsible for the mission phase leading to injection into geostationary orbit, and initial in—orbit satellite checkout and evaluation.

NOAA is responsible for the in-orbit operation of the system including determining the need for satellite replacement. NOAA and NASA are jointly involved in the design, development, installation, and integration of the ground system that is needed to acquire, handle, process, and disseminate the data from the sensors on the GOES-I/M satellites.

Responsibility for procurement of launch services was delegated to Lewis Research Center (LeRC). The Lockheed Martin Missile Systems (LMMS) has been competitively selected to provide the launch service using Atlas launch vehicles. The launch services include launch vehicle production and check-out, mission peculiar hardware, software, integration of the GOES spacecraft to the launch vehicle, and launch through injection into the geosynchronous transfer orbit. The LMMS will also arrange for the use of the PPF, Hazardous Processing Facility (HPF), transportation of the spacecraft between the PPF, HPF, and the launch site, communications between the PPF, HPF, and the Eastern Range (ER), and the use of ER facilities during the prelaunch/launch operations. A NASA reorganization transferred this responsibility to KSC for GOES-L/M.

1.3 PATHFINDER PROGRAM

The GOES Assessment Panel, formed by NOAA, concluded a thorough review of the program in August 1991. As a result of this review, the SN 02 Imager and Sounder instruments were defined to be Pathfinders, and were to be used to find and identify problems that are still lurking in the hardware. Fixes for the hardware problems should be implemented in the SN 03 instruments, and these instruments should then be flown on the GOES-I spacecraft.

1.4 SUMMARY

The GOES-I/M spacecraft series of satellites are a next generation system that is being developed to meet primary goals defined by NOAA. They will provide suitable platforms to support the environmental monitoring instruments to be used for

making measurements of the Earth’s atmosphere, its surface, cloudcover, and electromagnetic environment. The spacecraft will also support the communications requirements imposed by the Data Collection Systems (DCSs), Search and Rescue Satellite Aided Tracking (SARSAT) System, and the transmission of payload instrument data and meteorological analyses to the data user community.

2.0 OBJECTIVES

2.1 PROGRAM OBJECTIVES

The GOES-I/M Program objectives are as follows:

- Provide environmental data that will be used to produce routine meteorological analyses and forecasts
- Maintain continuity of service to the user agencies
- Provide environmental data that can be used to expand knowledge of mesoscale and synoptic scale storm development and provide data that may be used to help in forecasting these severe weather events
- Contribute to the development of a domestic and international in-situ environmental data collection network, which will provide timely observations from remote regions for use in environmental warning services and enhancements of basic environmental services
- Provide for the reception of early emergency distress signals to aid the SARSAT operation
- Improve the capability for forecasting and providing real-time warning of solar disturbances
- Provide for growth in the kind, quantity, and quality of environmental parameters measured
- Provide data that may be used to extend knowledge and understanding of the atmosphere and its processes (e.g., by viewing the evolution and motion of storms and other atmospheric phenomena) in order to improve short- and long-term weather forecasts

2.2 PROJECT OBJECTIVES

The general objectives of the GOES-I/M Project are to procure, develop, test, and launch five GOES satellites, meeting the NOAA-stated observational requirements. The changes that have been made to the NOAA requirements between 1983 and 1992 are described in the attachment to Appendix B, dated November 9, 1992.

To meet NOAA’s critical requirements for continuous and dependable operation of the element of its satellite system, a primary Project objective will be to support NOAA’s launch readiness requirements.

2.3 MISSION OBJECTIVES

The primary objectives of the GOES mission are to:

a) Maintain continuous service from a GOES system that meets the remote sensing requirements as specified by NOAA; that is, to provide for continuous observations of the Earth and its atmosphere from a geosynchronous orbit
b) Provide a satellite and Spacecraft Support Ground System (SSGS) designed to permit acquisition and dissemination of: 1) Imaging data, 2) Sounding data independent of the Imaging data and 3) Space Environment Monitor (SEM) data
c) Provide for reception and relay of data from ground based Data Collection Platforms (DCP) to the NOAA Command and Data Acquisition (CDA) ground station
d) Provide for continuous relay of weather facsimile (WEFAX) and other data to small users, independent of all other functions
e) Permit relay of distress signals from aircraft or marine vessels to the Search and Rescue ground stations of the SARSAT
f) Provide a spacecraft capability for permitting data transmission via the EMWIN.

2.4 LEVEL 1 PERFORMANCE REQUIREMENTS

2.4.1 Introduction

The Level 1 performance requirements for the GOES-I/M Program, which are traceable to the NOAA system requirements of Appendix B, are compiled below and are identified in other sections of this Project Plan. These requirements serve as the baseline for derivation of lower-level performance requirements. Any proposal by the GOES Project to change a Level 1 requirement, or any failure to meet Level 1 requirements, will be referred to the GOES Program Manager for appropriate action.

All Level 1 changes or failure to meet Level 1 requirements, must be approved by NOAA in accordance with the basic agreement and supplementary agreements as described in Appendix A.

2.4.2 Requirements

The GOES spacecraft will be placed in an orbit at 35,788 km (19,324 nmi) over the Equator. The nominal on-station locations are at 75 and 135 degrees West longitude.

2.4.2.1 Mission Lifetime

Each spacecraft has been designed to meet all in-orbit performance requirements for a minimum period of 5 years.

2.4.2.2 System Elements

The system elements consisting of the flight segment, launch ground segment, and the on-orbit ground segment are described below.

- Flight Segment — The flight segment will include the spacecraft bus, its support subsystems, the operational instruments, and the propulsion subsystem. The propulsion subsystem is required to transfer the satellite from the geostationary transfer orbit to its final station in geostationary orbit, and to maintain stationkeeping during the in-orbit lifetime of the satellite.

- Launch Ground Segment — The launch ground segment will include the Deep Space Network (DSN) operated by the Jet Propulsion Laboratory (JPL), Ground Network (GN) operated by GSFC, Air Force Satellite Control Network (AFSCN), and the NASA Communications Network (NASCOM). The NOAA Satellite Operations Control Center (SOCC) located at Suitland, Maryland and the Flight Dynamics Facility (FDF) at GSFC, will also be used.

- On-orbit Ground Segment — The on-orbit ground segment will consist primarily of the NOAA SOCC facility for satellite control, the NOAA Command and Data Acquisition (CDA) station for supporting spacecraft operations, the NOAA Central Data and Distribution Facility for data processing and dissemination, and the NOAA Space Environment Laboratory for processing and distribution of data from the Space Environment Monitoring (SEM) instruments.

2.4.2.3 Instrument Characteristics

The primary payload instruments consist of a multi-channel imaging radiometer for acquisition of high-resolution visible and infrared (IR) radiometry data and atmospheric sounder for obtaining data used to determine or infer temperature and moisture profiles of the atmosphere. SEM instruments are on each mission for measurement of: energetic particle flux, magnetic field intensity, and solar X-ray radiation. A Solar X-ray Imager (SXI) will be flown on one mission as a demonstration instrument. Specific characteristics for the instrument subsystems are contained in Section 6.

2.4.2.4 Communications User Services

The spacecraft communication user services consist of a capability that is used for relaying weather facsimile (WEFAX), SEM, and Imager/Sounder data products to data users, providing a data collection system to acquire and transmit data from remote Data Collection Platforms (DCPs), and providing satellite Search and Rescue (SAR) support services.

2.4.2.5 Data Products

NOAA is responsible for production of all operational data products required for satellite post-launch checkout and routine operations. All data products will be developed and disseminated by NOAA’s Central Data and Distribution Facility (CDDF) at the World Weather Building in Camp Springs, Maryland, and the Environmental Research Laboratory (ERL) in Boulder, Colorado.

3.0 CUSTOMER DEFINITION

The customer for the GOES Satellites and data products is the National Oceanic and Atmospheric Administration (NOAA) that is an organization within the Department of Commerce (DOC). Within NOAA, responsibility for the program has been delegated to the Systems Acquisition Office (SAO). The specific organizations within NOAA that share an interest in the GOES Program are indicated below.

- Systems Acquisition Office (SAO)
- National Environmental Satellite, Data, and Information Service (NESDIS):
  - Office of Satellite Operations (OSO)
  - Office of System Development (OSD)
  - Office of Research and Applications (ORA)
  - Office of Satellite Data Processing and Distribution (OSDPD)
- National Weather Service (NWS)
- Space Environment Center (SEC)

The following activities are performed in order to ensure customer coordination and involvement on the GOES Program.

a) A NOAA liaison office is co-located within the GOES Program Office. NOAA personnel have daily contact with key project personnel
b) Personnel from the SAO and NESDIS routinely attend the GOES Project Status Reviews with the spacecraft contractor and GFE instrument contractors. This forum is an opportunity for the customer to express their views on project status, issues, problems, or concerns
c) Monthly meetings are held between the GOES Program Office and key personnel from the SAO and NESDIS to discuss mutual concerns and/or issues

4.0 PROGRAM AUTHORITY

Lead Center - Goddard Space Flight Center
GPMC - NASA Headquarters Program Management Council
Program Manager - Mr. Martin Davis / GSFC

5.0 MANAGEMENT

5.1 ORGANIZATIONAL RESPONSIBILITIES

The NASA management responsibilities and procedures for the GOES-I/M Project are in accordance with NASA policy and guidance. The division of responsibilities between NASA and NOAA will be in accordance with NOAA-NASA Basic Agreement of 1998 and the GOES specific memorandum of agreement described in Appendix A.

5.2 PROJECT MANAGEMENT AND ORGANIZATION

NASA Headquarters has delegated program management responsibility to the Goddard Space Flight Center (GSFC). The NASA organization chart is included as figure 5-1. Within GSFC, the Flight Projects Directorate has responsibility for the GOES Program. The GSFC organization chart is shown in figure 5-2

The GOES Program has full responsibility for the successful implementation of two NOAA projects, GOES-I/M and GOES-NO/PQ. There is not a separate project manager for each project, rather, the Program manager and his deputies manage both projects. To the extent practicable, the technical and administrative staffs of the two projects are separate and distinct. The Program is responsible for the spacecraft, instruments, launch services and ground system. The organization chart for the GOES Program is given in figure 5-3

The Kennedy Space Center (KSC) is responsible for providing insight into the contractor provided launch services as described in Appendix C.

Figure 5.1, NASA Organizational Chart

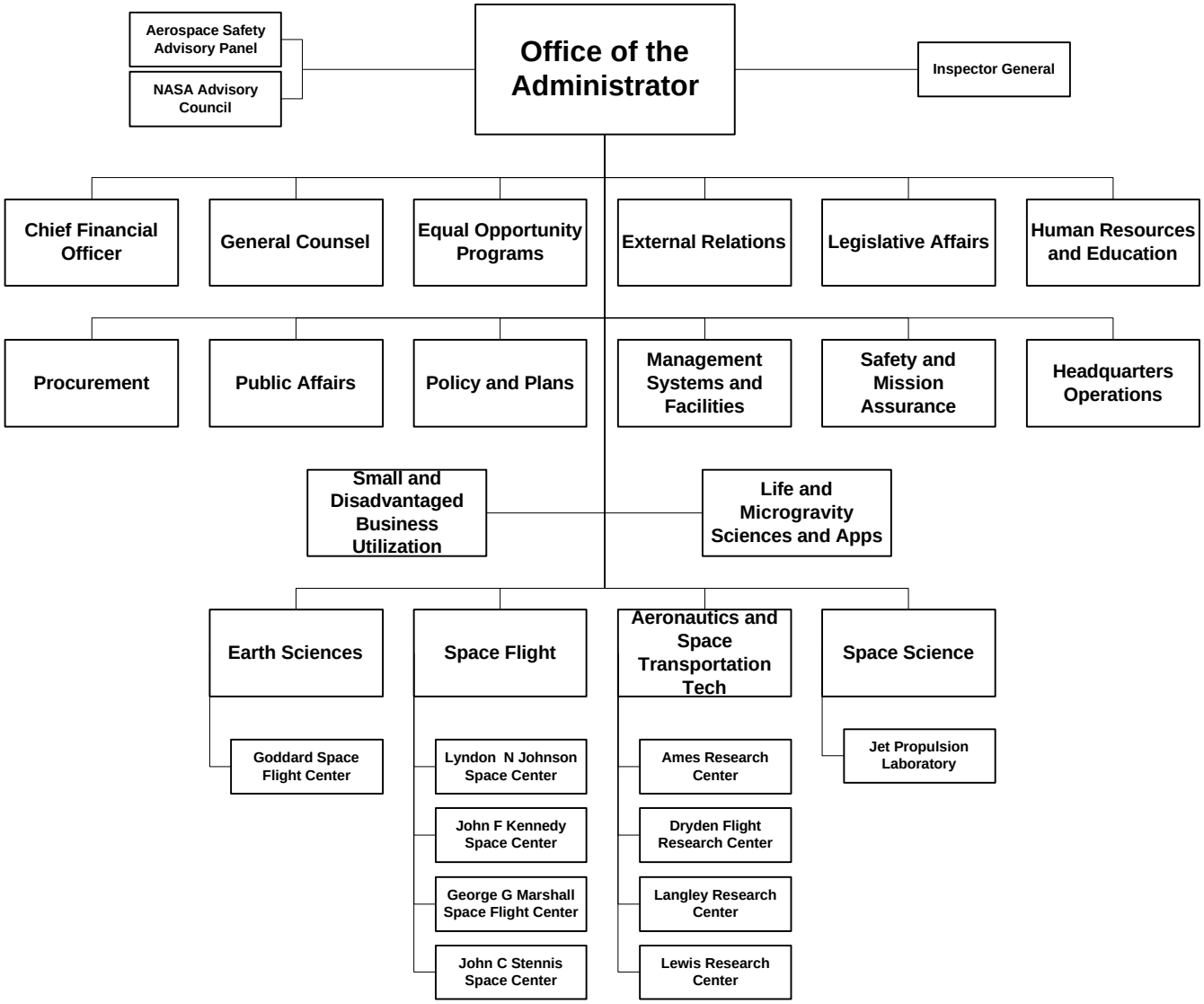


Figure 5.2, Goddard Space Flight Center Organizational Chart

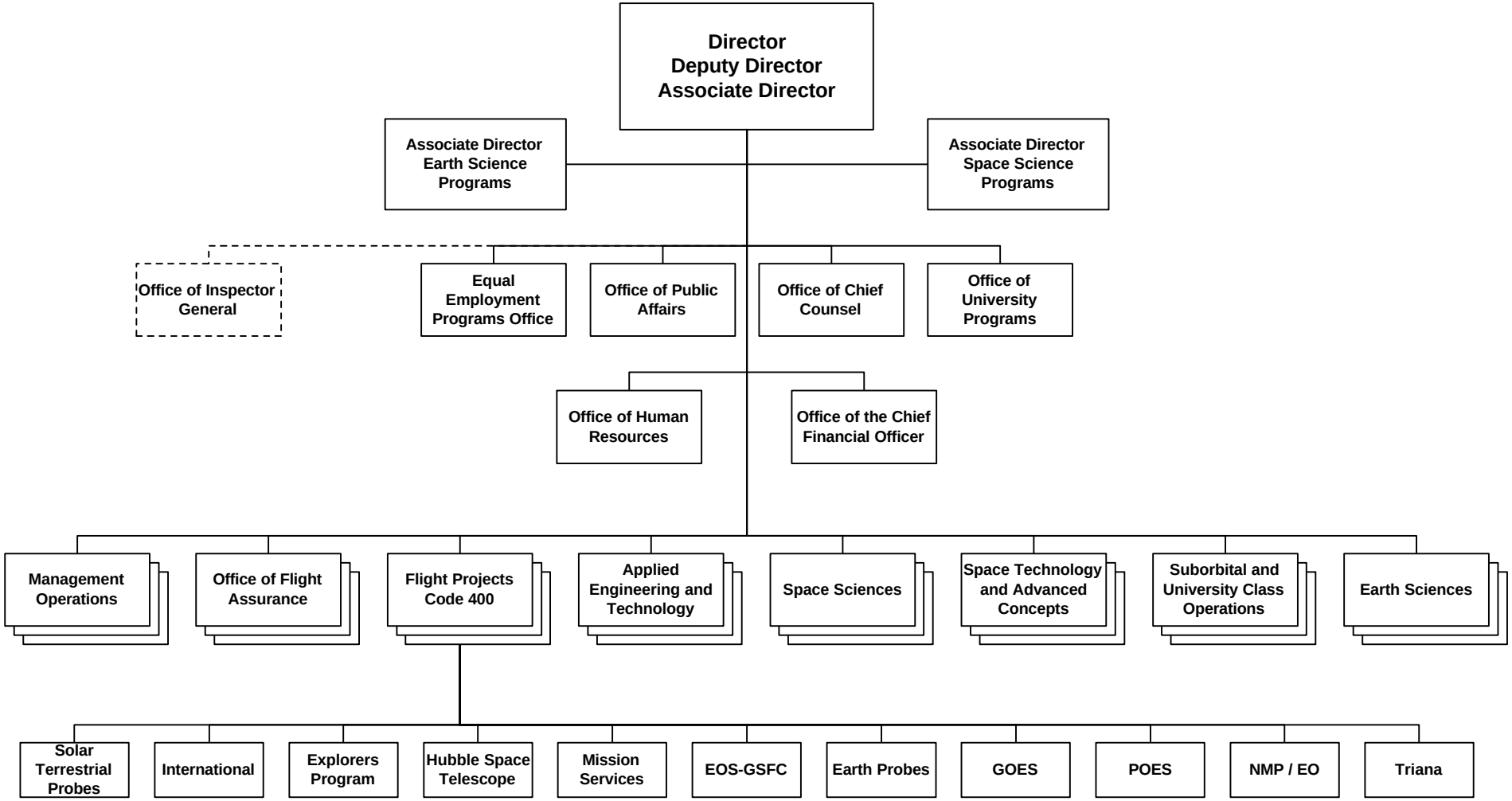
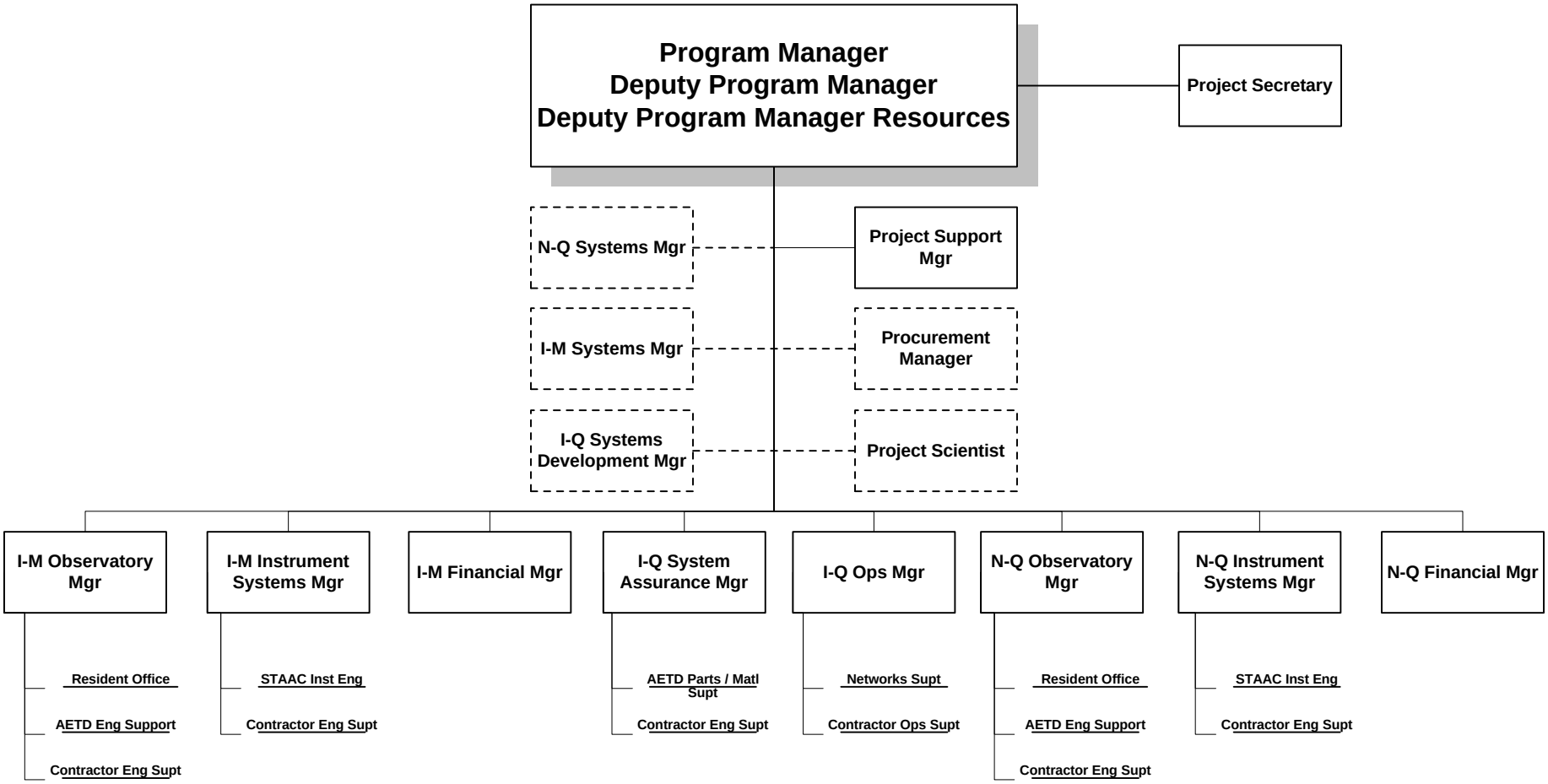


Figure 5.3, GOES Program Organizational Chart



5.2.1 Program Manager

The Program Manager is responsible for the performance of all necessary functions to ensure the total management of the Program. In particular, he/she is responsible for the planning and evaluation; systems safety; systems tests; configuration management; systems integration, tests, reliability, and quality assurance; spacecraft compatibility with the launch vehicle; integrity of the spacecraft to meet mission requirements; scheduling; health and safety; budgetary and financial planning; technical monitoring of contracts; life-cycle logistics cost, and project reporting. The Program Manager has full authority to carry out these functions, subject to limitations established by the GSFC Director. The Program Manager is also the Project Manager and discharges his/her responsibilities with the assistance and support of individuals and organizations assigned either administratively or functionally to the project management organization.

5.2.2 Deputy Program Manager

The Deputy Program Manager (DPM) is responsible to the Program Manager, and is an integral member of the management team. He/she supports the Program Manager in directing all phases of the Project, and has project-wide responsibility for personnel management and planning, and evaluating all Project activities on a day-to-day basis. He/she provides technical management to the team of technically skilled specialists and their supporting personnel in order to meet cost and schedule commitments. In the absence of the Program Manager, the DPM assumes full responsibility for Program management.

5.2.3 Deputy Program Manager/Resources

The Deputy Program Manager/Resources (DPM/R) is responsible to the Program Manager, and is an integral member of the management team. He/she contributes business management expertise to the establishment of technical program objectives and is responsible for the application of business, financial management, and performance measurement techniques to the accomplishment of those objectives. The DPM/R supervises a team of specialists in the areas of finance, budget, performance measurement, scheduling, pricing, configuration management, etc., and is responsible for the application of sound business techniques to the accomplishment of Project objectives. In the absence of the Program Manager and DPM, the DPM/R acts for the Program Manager.

5.2.4 Systems Manager

The Systems Manager is responsible for optimizing all systems aspects of the flight and ground segments. He/she is responsible for developing the systems design of the flight segment and for ensuring that it is compatible with the scientific instruments, launch vehicle, communications system, ground segment, reliability objectives, and end products. He/she establishes interface constraints and requirements for subsystems, resolves interface and system-level performance questions and problems, reviews and approves manufacture of the electrical/mechanical integration and test of the spacecraft. He/she reviews performance data and measurements throughout the project to ensure that flight and ground segments meet stated requirements and objectives. Specifically, the Systems Manager has review and sign-off responsibilities for all major system-level functional performance and design specifications; he/she performs risk assessments and evaluates design margins and adequacies; reviews all major test plans and procedures; compares predicted and actual performance of the system; reports routinely to the Program Manager on the status of system engineering activities; serves as chairperson for major failure review committees, and advises the Program Manager as to major (critical) aspects of his assignment. He/she is responsible for suggesting the use of new technical approaches to the project after having determined the risk involved.

5.2.5 Observatory Manager

The Observatory Manager directs the efforts of a team of Government, contractor and industry specialists to identify observatory requirements, in developing subsystems and systems capable of fully meeting those requirements, and in demonstrating that the spacecraft/observatory and its components meet its functional performance goals in the launch and space environments. He/she ensures that the facilities, tools, fixtures, test equipment and ADP hardware and software required in the fabrication, assembly, integration, and test of the subsystems and of the spacecraft/observatory are procured or developed and are available at the appropriate times and places. The Observatory Manager is responsible for planning and managing these tasks so that they are completed on schedule and within the available resources. He/she is the Contracting Officer’s Technical Representative (COTR) for the spacecraft contract.

The Observatory Manager also interfaces with the KSC lead person for insight into launch services.

5.2.6 Payload Manager/Instrument Systems Manager

The Payload Manager, or Instrument Systems Manager, is responsible for close liaison and monitoring of the instrument development or other types of payload hardware development being performed by other GSFC directorates or outside GSFC, such as universities and contractors. He/she must ensure, through coordination and technical review of the payload designs, that the instruments or payload hardware meet the technical performance, cost and schedule parameters for the basic mission requirements. He/she is responsible for coordinating the spacecraft bus/payload interfaces and for providing the related ground support equipment, and for assuring that scientific algorithm development, in conjunction with the Project Scientist, is completed in a timely manner.

5.2.7 Project Scientist

The Project Scientist provides scientific guidance to the Project and is the embodiment of the scientific objectives of the Project. He/she is responsible for assuring the satisfactory accomplishment of the scientific objectives of the mission. He/she is an integral part of the project management team, acting as a bridge between the project and the science community. As such he/she is consulted on all decisions and processes that in any way affect science objectives, including system trade decisions, budget decisions, schedule decisions, etc. He/she reviews the implementation of the project to ensure that the total system is consistent with the overall scientific objectives. He/she provides leadership in assuring that the scientific data are effectively used and the scientific results of the mission are produced expeditiously. The Project Scientist evaluates all scientific requirements placed on the project and provides scientific guidance to the Program Manager and others involved in the program. The Project Scientist is responsible for preparing the Project Science Plan that delineates the scientific portion to the project including instruments, data products, scientific investigation, and interface with the science community.

The Project Scientist further ensures that feedback is provided to the NASA Program Office through official channels of GSFC with as assessment of mission success as set forth in the Project Plan.

5.2.8 Project Support Manager

The Project Support Manager is a member of the business support team reporting to the DPM/R. He/she is responsible for scheduling, configuration management, manpower analysis, property management and control, and other general administrative and overall Project planning activities.

5.2.9 Project Financial Manager

The Project Financial Manager is a member of the business support team and reports to the DPM/R. He/she is responsible for the application of sound financial management principles in the areas of cost control, performance measurement, financial analysis, budget preparation and execution, and pricing.

5.2.10 Project Procurement Manager

The Project Procurement Manager, from the Management Operations Directorate, is responsible for all procurement functions of the Project, including planning, directing, coordinating, and evaluating all Project procurement activities in accordance with NASA authoritative guidelines, and for coordinating these activities with the DPM/R.

5.2.11 Systems Assurance Manager

The Systems Assurance Manager (SAM), from the Office of Systems Safety and Mission Assurance (OSSMA), is responsible for coordination of and follow-up on all the flight assurance disciplines for the project to ensure that the flight elements will meet intended performance objectives. These disciplines include reliability, design review, quality assurance, system safety, and testing.

5.3 RESIDENT OFFICES

Resident offices will be established at LORAL and ITT to assist in the management of these activities. Each resident office will consist of a manager, clerical support, engineering support, and a quality engineer.

5.4 NOAA LIAISON OFFICE ACTIVITY

The NOAA Technical Liaison Office at GSFC consists of a small resident staff that serve as the principle interface with the

GOES Project on a day-to-day basis. They report directly to the NOAA GOES Systems Acquisition Manager. The NOAA Acquisition Manager works closely with the NOAA GOES Program Manager on all technical and budget issues. The Acquisition Manager is the primary point of contact between NASA and NOAA and is the only individual authorized to provide direction to NASA.

5.5 CONFIGURATION CONTROL BOARD

A Configuration Management plan for the GOES-I/M project has been developed and in documented in S-415-CM-001. This plan requires that all changes be reviewed in a systematic manner to determine their validity and impact on performance, schedules and cost. It ensures that all affected parties are cognizant of the change and have a voice in the decision making process.

The Program Manager chairs the Configuration Control Board (CCB) and has authority to approve any change, which does not affect the Level 1 requirements or the interface to the NOAA operated ground system. Members of the NOAA System Acquisition Office, who are co-located within the Project, represent NOAA on the board. Changes that affect Program Level 1 requirements require approval from NOAA prior to implementation. The NOAA members of the board are responsible for coordinating the review of the proposed change within the NOAA management structure.

6.0 TECHNICAL SUMMARY

The GOES-I/M three-axis stabilization system will enable near-continuous monitoring of the earth's atmosphere by imaging and sounding radiometers located on the spacecraft. The spacecraft consists of a central body containing all the propulsion and electronic components and provides a platform on which the payload instruments are mounted. A single-wing, two-panel solar array mounted on the South panel of the spacecraft continuously rotates about the spacecraft pitch axis to track the sun. A mostly unobstructed view of cold space is provided for the Imager and Sounder passive radiation coolers. Only the North panel-mounted solar sail on top of a 58-foot (ft) (17-meter) boom partially obstructs the space view. The conical-shaped solar sail is used to balance the torque caused by solar radiation pressure on the solar array. A trim-tab panel at the end of the solar array provides the necessary fine balance control for the solar radiation pressure. All communications antennas, with the exception of the telemetry and command antenna, are hard mounted on the earth-facing panel for unobstructed earth coverage and maximum alignment stability. The telemetry and command antenna is mounted on a fixed 6.6 ft (2-meter) boom on the east panel of the spacecraft to provide near-omni directional coverage. Redundant three-axis magnetometers are mounted on a deployable 9.8-ft (3-meter) boom to minimize interference from the spacecraft. The spacecraft on-orbit configuration is shown in figure 6-1 and the deployed spacecraft outline dimensions are shown in figure 6-2. The payload instruments on the GOES spacecraft consist of the imaging and sounding instruments, X-Ray Sensor (XRS), magnetometer, Energetic Particle Sensor (EPS), and a High Energy Proton and Alpha Detector (HEPAD) sensor.

A Solar X-Ray Imager (SXI) will be a part of the SEM payload complement for GOES-M. The Memorandum of Understanding (MOU) between the Marshall Space Flight Center (MSFC) and the GSFC for the SXI is described in Appendix D.

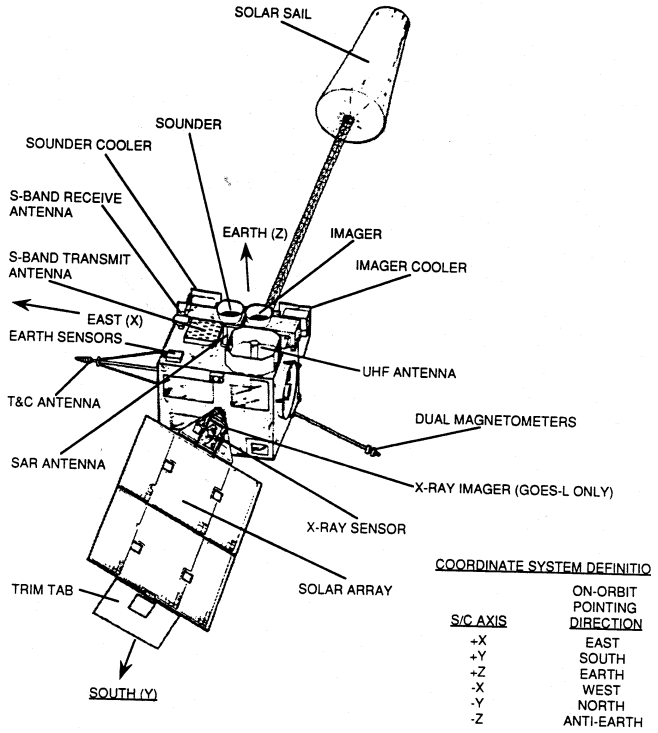


Figure 6-1 Spacecraft On-Orbit Configuration

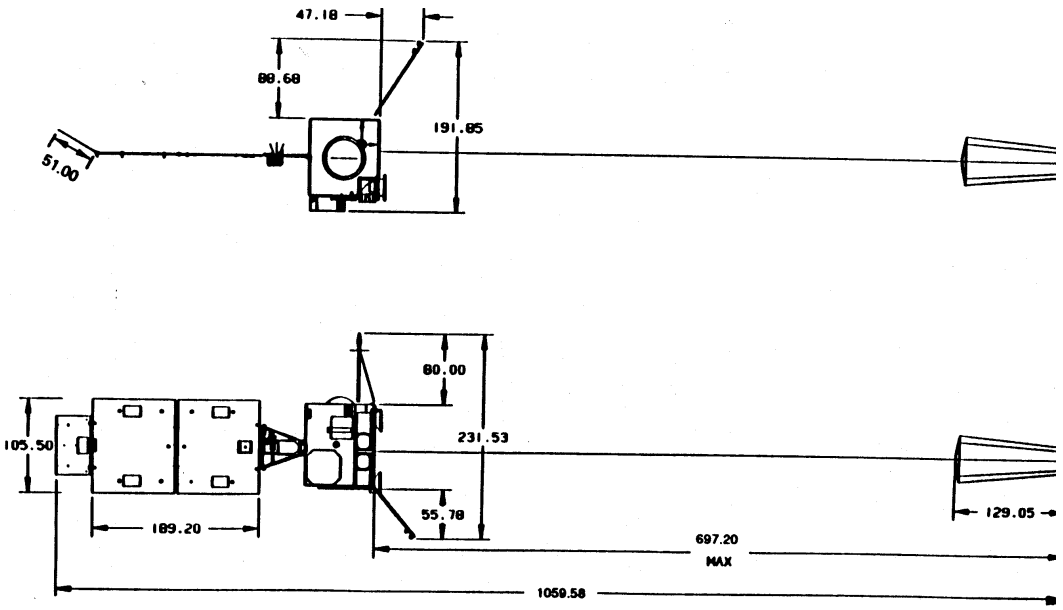
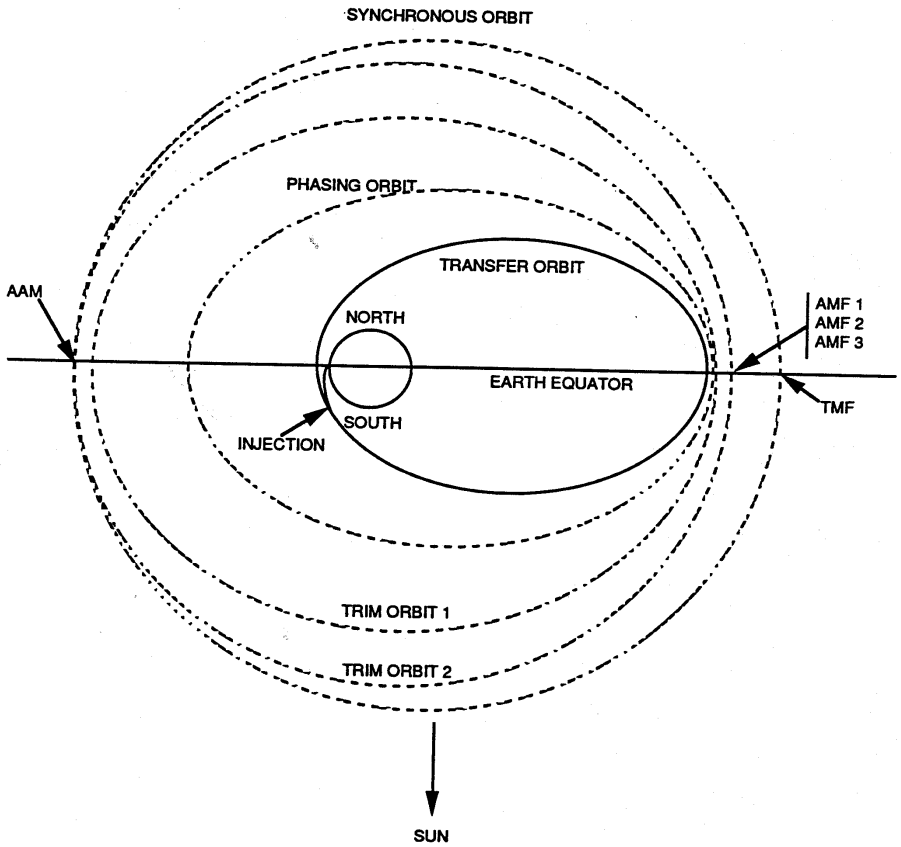


Figure 6-2 Deployed Spacecraft Outline Dimensions

The GOES spacecraft will be launched from the Eastern Space and Missile Center (ESMC) by the Atlas launch vehicle. The spacecraft orbit geometry, shown in figure 6-3, depicts the five phases of the mission to place the satellite in synchronous orbit.



NOTES
AMF Apogee Motor Fire
TMF Trim Motor Fire
AAM Apogee Adjust Maneuver

Figure 6-3 Spacecraft Orbit Geometry

The nominal orbit-raising scenario used to place the satellite into its final synchronous orbit from a nominal transfer orbit in chronological order consists of three Apogee Motor Fire (AMF) events, an Apogee Adjust Maneuver (AAM) at perigee, a Trim Motor Fire (TMF) maneuver at apogee, and additional TMFs as required. The five distinct phases of the mission are as follows:

a) Launch Phase: From Atlas lift-off to spacecraft separation in the Geostationary Transfer Orbit (GTO)

b) Transfer Orbit Phase: From spacecraft separation to the end of AMF 1
c) Phasing Orbit Phase: From the end of AMF 1 to the end of AMF 2
d) Trim Orbit Phase: From the end of AMF 2 to station acquisition
e) Synchronous Orbit Phase: From station acquisition to the end of the operational mission lifetime

After the satellite is placed into a geosynchronous orbit, its in-orbit performance will be tested and characterized by personnel from GSFC and NOAA. Following completion of the in-orbit test and evaluation period, the satellite will be handed over to NOAA for operational service. The GOES mission characteristics are summarized in table 6-1.

The nominal satellite locations will be in geostationary orbit at 75 and 135 degrees West longitude. The satellite will have an on-board fuel allocation for the capability to be moved at least three times during the planned 5-year operational life, if desired by NOAA.

Table 6-1 GOES Mission Characteristics

Item	Description
Mission Design life	**5 years minimum**
Nominal Orbit **Altitude** **Longitude** **Latitude**	**Geosynchronous** **35,768 km (19.324 nmi)** **75^0 and 135^0 West Long** **$\pm$ 0.5^0**
Launch Vehicle	**Atlas-I**
Launch Site	**ER Launch Complex 36B**
Spacecraft **Classification** **Nominal Launch Weight** **Main Body Dimensions** **Deployed Length**	 **A** **2061.6 kg (4545 pounds)** **2.0 x 21 x 2.3 meters** **(6.5 x 7 x 7.6 feet)** **26.9 meters (88.3 feet)**
Instruments	**Imager** **Sounder** **X-Ray Sensor** **Energetic Particle Sensor** **Magnetometer** **HEPAD** **SXI (GOES-M only)**

Propulsion **Fuel** **Oxidizer**	 **Monomethyl Hydrazine** **Nitrogen Tetroxide**
Attitude Control	**3-axis Body Stabilized**
Power	**Solar Array and Batteries**
Thermal Control	**Primarily by passive means, augmented with heaters**
Data Rates **Raw Imager Data** **Raw Sounder Data** **Processed Imager/Sounder Data Relay** **DCP Reports** **Telemetry** **Command** **MDL Dynamic interreaction Data** **MDI. SXI Data**	 **2.6 mbps** **40 kbps** **2.1 mbps** **100 bps** **2000 bps** **250 bps** **32 kbps** **100 kbps**
Ground System **Control Center** **Downlink Station**	 **SOCC** **CDA, Wallops Va.**

6.1 MISSION

The primary mission is to design, fabricate, integrate, test, and launch five operational spacecraft into geosynchronous orbit that will meet the objectives that are described in Section 2.

The GOES spacecraft will be launched from the ESMC using an Atlas launch vehicle. Each spacecraft mission is required to be non-interfering with the existing GOES system.

Reliability and continuous high performance are of prime importance, as each satellite will be turned over to NOAA for operation following completion of the postlaunch in-orbit test period. Each spacecraft will be designed to meet all in-orbit performance requirements for a minimum period of 5 years.

6.2 MISSION OPERATIONS CONCEPT

The GOES spacecraft will replace the in-orbit satellites to provide continuity to the operational system, which is managed and operated by NOAA. NASA’s role, in addition to that associated with satellite development, launch and checkout, includes procurement, development, test, installation, and checkout of the Operations Ground Equipment (OGE) at the CDA station and SOCC. Upon successful achievement of geostationary

orbit, NASA will conduct an engineering evaluation and checkout of each satellite. This will be accomplished by a NASA team in residence at NOAA's SOCC and CDA station. During the instrument turn-on and check-out period, which is expected to last 30 days, the NASA team will control the satellite and obtain and analyze engineering data necessary to indicate satellite performance.

An additional period of 90 to 120 days of extended testing to fully characterize instrument and Image Navigation and Registration (INR) system performance is also planned. Upon completion of the extended test period, the satellite will be turned over to NOAA for routine operational control. Once the satellite is turned over to NOAA, the NASA's responsibility will be limited to analysis of satellite in-orbit anomalies upon NOAA's request.

6.3 MISSION CONSTRAINTS

The mission constraints for the GOES Program are described below.

a) The satellite shall be visible to at least one Telemetry and Command (T&C) station within 45 minutes after injection into the transfer orbit. This constraint is imposed to allow timely solar array partial deployment to minimize the battery Depth of Discharge (DOD).
b) The satellite shall have mutual visibility with at least two T&C stations for a minimum of 3 hours before each AMF, and shall have a minimum elevation angle constraint of 5 degrees above the station horizon. This constraint will allow sufficient time for all required operations before AMF.
c) The satellite shall be separated from the launch vehicle Centaur stage with a transverse spin about its major moment of inertia axis, at approximately 7 degrees/second.

6.4 SPACE SEGMENT SYSTEMS AND SUPPORT

The GOES-I/M satellites will host environmental monitoring instruments that are used for making measurements of the earth's atmosphere, its surface, cloud cover and electromagnetic environment. Other spacecraft system functions include:

a) Providing a DCS capable of supporting a collection of data from terrestrial and oceanographic DCPs
b) Providing for transmission of WEFAX, imaging and sounding data products to various ground terminals

c) Provide a SAR system that will enable rapid detection of distress messages from Emergency Position Indicating Radio Beacons (EPIRBs) operating in the 406-megahertz (mHz) region

Figure 6-4 shows a top level illustration of the communications links that are used between the satellite and ground support systems that are used to support the GOES Mission requirements. The spacecraft weight breakdown data described in table 6-2 was summarized from the SS/L Mass Property Quarterly Report, dated July 1992.

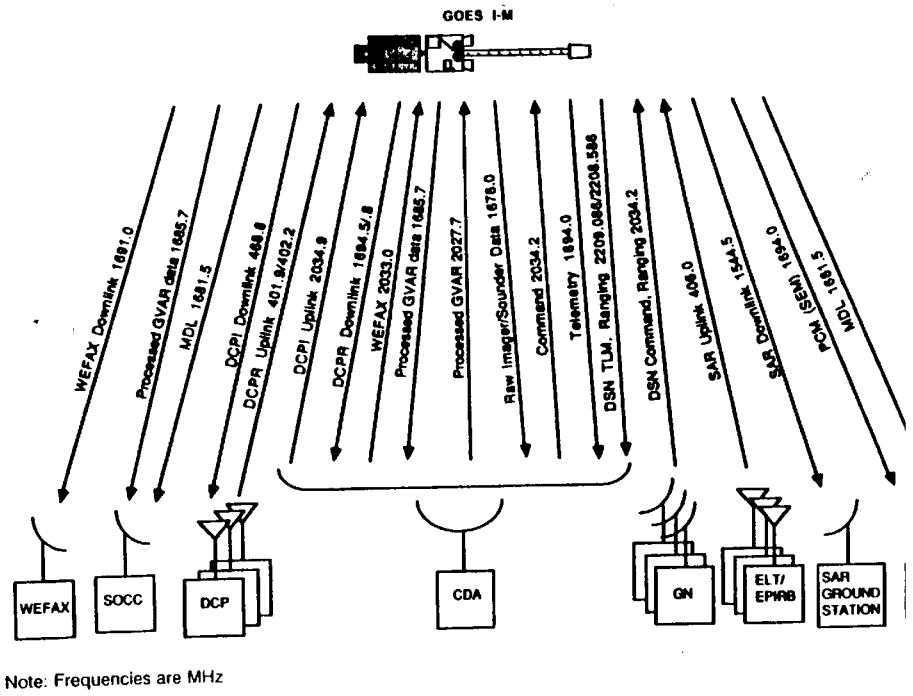


Figure 6-4 Spacecraft to Ground System Communication Links

Table 6-2 Typical Weight Summary

Description	Weight	
	Kilograms (kg)	Lbs
Spacecraft Bus		
Structure Subsystem	192.2	423.9
Electrical Power Subsystem	40.9	90.2
Cabling Harness	60.6	133.6
Attitude/Orbit Control Subsystem	82.2	181.2
Propulsion Subsystem (Dry)	88.3	194.7
Thermal Subsystem	68.2	150.3
Solar Array Subsystem	59.1	130.3
Communications Subsystem	44.0	97.0
Telemetry & Command Subsystem	31.4	69.2
Data Collection Subsystem	18.2	40.1
Search & Rescue Subsystem	8.5	18.7
Imaging/Sounding Subsystems		
Imager	121.2	267.2
Sounder	128.6	283.5
Space Environment Monitor System (1)		
Magnetometer	5.3	11.7
EPS/HEPAD	9.8	21.6
X-ray Sensor	18.3	40.3
Mass Margin	3.2	7.0
Total Spacecraft Dry Weight	980.0	2160.5
Propellant and Pressurant	1081.6	2384.5
Launch Weight	2061.6	4545.0

SXI Weight Summary (GOES-M)		
	Kilograms	Pounds
Telescope Assembly	13.0	28.7
Electronics Modules	17.2	37.9
MDL Transmitter	3.0	6.6
Harness/Integration	3.0	6.6
Total SXI	36.2	79.8

6.4.1 Spacecraft Structure

The principle function of the spacecraft structure is to support all other subsystems and to provide the launch vehicle interface with the spacecraft payload adapter. The primary structure consists of a central cylinder and equipment panels that are assembled to form the main body assembly of the satellite. The central cylinder is sized to accept the spherical propellant tanks, and to provide a structural interface for the launch vehicle payload adapter. The north, south, earth, anti-earth, east and west panels are used to mount the majority of the satellite electronics. The secondary structure consists of struts and brackets that are used to stabilize the equipment panels, and to support the thrusters, momentum and reaction wheels, pressurant tank, apogee thruster, and propellant components. All of the communications antennas, except the Tracking Telemetry and Command (TT&C) antenna are hard-mounted to the earth-facing panel for unobstructed earth coverage with maximum alignment stability.

6.4.2 Imaging Instrument Subsystem

The GOES Imager subsystem is a multi-channel instrument designed to sense radiant and solar reflected energy from sampled areas of the earth. A brief summary of characteristics for the five imaging channels is presented in table 6-3.

Table 6-3 Imager Channel Description

Channel Number	Nominal Wavelength micrometer (μrad)	Nominal IGFOV Resolution	S/N Ratio at 100% Albedo	Noise Equivalent Delta Temperatures (NEΔT)	Range of Measure-ment	End Use
1	0.55 to 0.75	28*	150	-	0-100 Albedo	Cloudcover
2	3.8 to 4.0	112	-	1.4K at 300K	4-320K	Night-Time Clouds
3	6.5 to 7.0	224	-	1.0K at 230K	4-320K	Water Vapor
4	10.2 to 11.2	112	-	0.35K at 300K	4-320K	Surface Temp
5	11.5 to 12.5	112	-	0.35K at 300K	4-320K	Sea-Surface Temp & Water Vapor

* 28μrad is equal to 1 km

The Imager’s multi-element spectral channels simultaneously sweep an 8-km North-South (N-S) path along an East-West (E-W) path by means of a two-axis gimballed mirror scan system. The

position and size of a selected area are controlled by command. The instrument is capable of producing full-earth disc images, sector images that contain the edges of the earth and various sizes of area scans completely enclosed within the earth scene. Area scan selection permits rapid continuous viewing of local areas for monitoring of mesoscale phenomena and accurate wind determination.

The Imager is also used in the GOES system to provide a star-sensing capability. The time and location of a star is predicted very accurately by the OGE, and translated into the satellite's orbital geometry and instrument field of view. From a set of this data, the OGE selects a location and time that is convenient within the image scenario. The Imager is then pointed to the selected space location (within its 21 degree N-S by 23 degrees E-W star sensing field of view) and the scan motion is stopped. As the star image passes through one or two of the eight elements of the visible channel detector array, it is sampled approximately 7500 times. An illustration of the image frame size formats and the time required for some typical Imager and Sounder frame formats are shown in figure 6-5 and table 6-4.

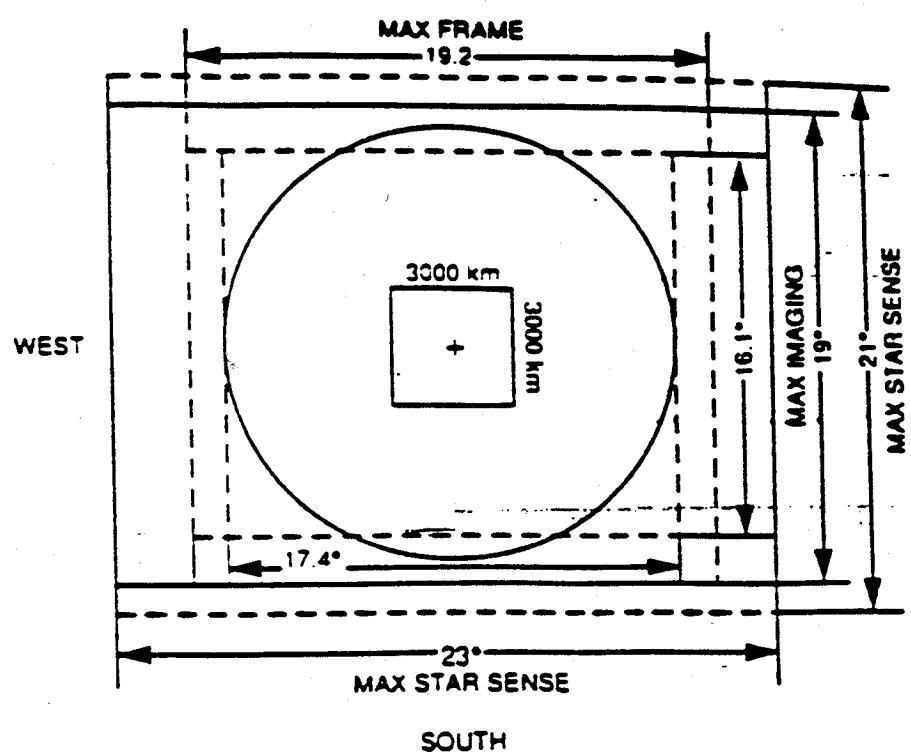


Figure 6-5 Imager and Sounder Frame Formats

Table 6-4 Nominal Imager and Sounder Frame Times

Image Size	Imager	Sounder (min)
Full Earth image 17.4 x 17.4 (Includes space clamp, star sense, and blackbody calibration events)	26.5 min	
Full Earth Sounding (18.1′ x 16.1′) (includes space clamp, star sense, and blackbody calibration events)		454
3000 km N-S by 3000 km E-W	3 min	42
1000 km N-S by 1000 km E-W	40 sec	5.3

The key features of the imaging instrument subsystem are summarized in Table 6—5.

Table 6-5 Key Features of the Imager Instrument

Optical Aperture	12.25 inches (311 cm)
Method of Scan	Two Axis, Line scan frame
Data Output	10-bit quantization
Data Rate	2.6208 megabits per sec
IR Detector Operating Temperature Options	94 K, 101 K, and 104 K
Calibration	Space and 290 K blackbody
IR Calibration Accuracy	1 K absolute (day), 2 K absolute (night), and 0.1 K relative (detector-detector, line-line, band-band)
Design Life	5 years, minimum
Spatial Resolution Visible Channel IR Channel 2,4, and 5 IR Channel 3	 28 µrad 112 µrad 224 µrad
Major Module Assembly Dimensions Sensor Module Electronics Module Power Supply Module	 16 x 16 x 42 inches (40.6 x 40.6 x 106.7 cm) 7 x 15 x 26 inches (17.8 x 38.1 x 66 cm) 6 x 8 x 1L4 inches (15.2 x 20.3 x 29 cm)

Peak Power Requirements	155 watts	
Module Assembly Weight	Pounds	Kilograms
Sensor Module	188.3	85.4
Electronics Module	66.6	30.2
Power Supply Module	12.3	5.6
Total	267.2	121.2

6.4.3 Sounding Instrument Subsystem

The GOES Sounder is designed to provide data from which atmospheric temperature and moisture profiles, surface and cloud-top temperature and ozone distribution can be deduced by mathematical analysis. The construction of the electronics and power supply modules are similar to the modules that are used in the imaging instrument subsystem.

The Sounder's multi—element detector array assemblies simultaneously sample four separate fields or atmospheric columns. The infrared channel spectral definition is provided by a rotating filter wheel, which brings selected filters into the optical path of the detector array. Spectral separation of the infrared channels is provided in each of three bands consisting of the longwave (12 to 14.7 μm), midwave (6.5 to 11 μm) and shortwave (3.7 to 4.6 μm). The Sounder detector channel allocation is shown in table 6—6.

The Sounder visible and star sensor detector arrays are illustrated in figure 6—6 and the Sounder filter wheel and IR channel separation concept is illustrated in figure 6—7. The rotation of the filter wheel is synchronized with the stepping motion of the scan mirror. An 1120—μrad swath is sampled by four IGFOVs of 262-μrad which are spaced on 280 microradian centers and step 280-μrad in each E-W or W-E motion. As commanded from the ground, the scan system will generate frames of any size or location by stepping W-E, followed by a N-S step of 1120 μrad, and then stepping in the E-W direction. This pattern is repeated until the desired frame is complete. The visible channel detectors are not part of the filter wheel, but are a separate set of uncooled detectors having the same field size and spacing as the IR detectors. These detectors are sampled at the same time as the IR channels in order to provide registration of all sounding data.

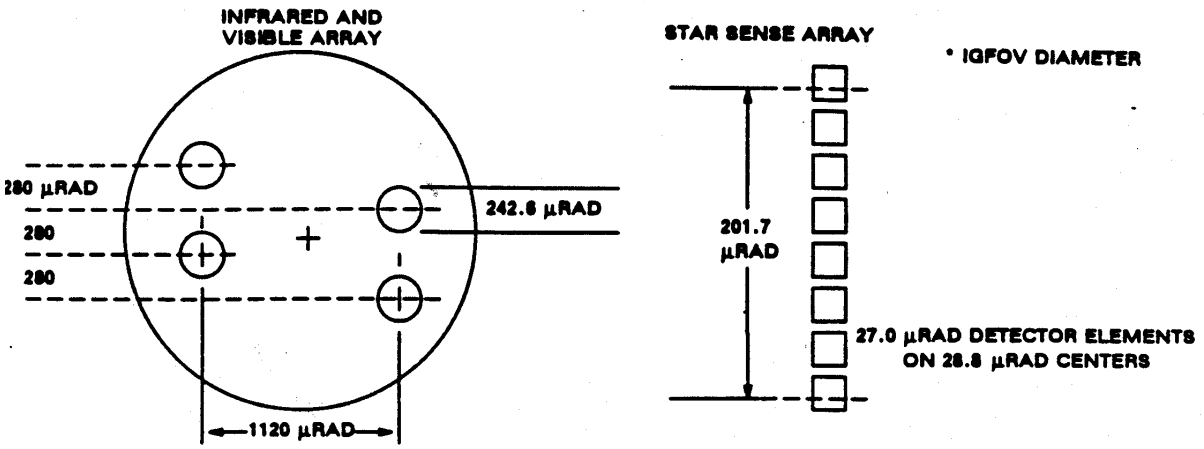


Figure 6-6 Sounder Visible and Star Sense Arrays

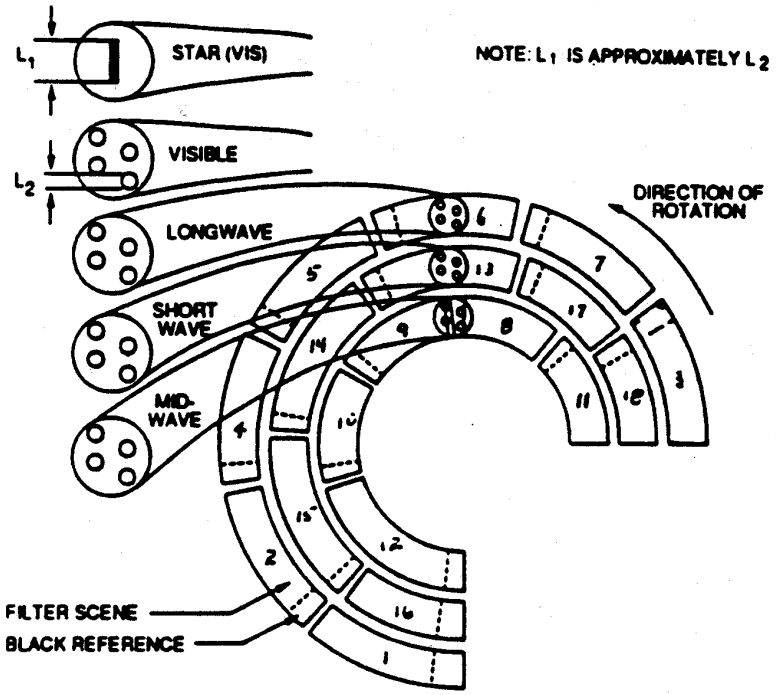


Figure 6-7 Sounder IR Channel and Filter Wheel Configuration

Table 6-6 Sounder Detector Channel Allocations

Detector	Channel Number	Central Wavelength (μm)	IGFOV (μrad)	Purpose
Longwave	1	14.71	242.6	Temperature Sounding
	2	14.37		"
	3	14.06		"
	4	]3.64		"
	5	13.37		"
	6	12.66		"
	7	12.02		Surface Temp
Midwave	8	11.03	242.6	Surface Temp
	9	9.71		Total Ozone Water Vapor
	10	7.43		"
	11	7.02		"
	12	6.51		"
Shortwave	13	4.57	242.6	Temperature Sounding
	14	4.52		"
	15	4.45		"
	16	4.13		"
	17	3.98		Surface Temperature
	18	3.75		"
Visible	19	0.67	242.6	Cloud

The Sounder used in the GOES system provides a star—sensing capability independent from the visible sounding channel detectors, to accurately determine instrument pointing parameters. Time and location of a star are predicted very accurately by the OGE. From a set of this data, the OGE selects a location and time that is convenient within the sounding scenario. The Sounder line-of—sight is pointed to a predetermined location within its 21-degree N-S by 23-degree E—W star—sensing view and the scan is stopped. As the star image passes through one or two detectors, the signal is sampled four times during each 0.1-second sounding interval. This signal is encoded to a 13-bit resolution and transmitted to the ground for extraction and use by the OGE at the ground station.

The spacecraft Attitude and Orbit Control Subsystem (AOCS) provides compensation control signals to the Imager and Sounder, which are used to counteract satellite attitude and orbit effects, and predictable structural—thermal effects within the satellite-instrument combination. A corrective control signal is provided by the AOCS to the Imager and Sounder to compensate for predicted image and mirror motion errors, resulting from momentum changes caused by transient events elsewhere on the satellite.

An illustration of the Sounder frame size formats and the time required for some typical sounding formats are indicated in figure 6-5 and table 6-4.

The key features of the Sounding Instrument Subsystem are summarized in table 6-7.

Table 6-7 Key Features of the Sounder Instrument

Optical Aperture	12.25 inches (31.1 cm)	
Method of Scan	Two Axis, discrete steps 280 µr (10 km) E-W 1120 µr (40 km) N-S	
Data Output -	13-bit quantization	
Data Rate	40 kbps	
IR Detector Operating Temperature Options	94K, 101K, and 104K	
Calibration	Space and 290K blackbody	
IR Calibration Accuracy	1 K absolute and 0.1 K relative (detector-detector, line-line, band-band)	
Design Life	5 years, minimum	
Spatial Resolution	242.6 µrad	
Major Module Assembly Dimensions Sensor Module Electronics Module Power Supply Module	 16 x 16 x 42 inches (40.6 x 40.6 x 106.6 cm) 7 x 15 x 26 inches (17.8 x 38.1 x 66 cm) 6 x 8 x 11.4 inches (15.2 x 20.3 x 29 cm)	
Peak-Power Requirements	176 watts	
Module Assembly Weight	Pounds	Kilograms
Sensor Module	211.8	96.1
Electronics Module	58.4	6.5
Power Supply Module	13.2	26.0
Total	283.4	128.6

6.4.4 Space Environment Monitoring (SEM) System

The SEM System consists of a set of instruments designed to provide real-time measurement of solar activity, charged particle environment, and the Earth's magnetic field at synchronous orbit. The SEM instrument complement includes a three-axis vector magnetometer, an EPS and associated HEPAD, and an XRS. The SXI will be included as part of the SEM system on the GOES-M spacecraft.

6.4.4.1 Vector Magnetometer

The triaxial fluxgate magnetometer measures three orthogonal components of the varying ambient magnetic field with an accuracy of ± 4 nanoTesla, correctable over temperature to ± 1 nanoTesla. There are two sensors located on a deployable boom, with the primary magnetometer sensor three meters away from the spacecraft. A second magnetometer, whose sensor is located 30 cm away (inboard) from the first, provides for complete instrument redundancy. Additional specifications include a range of ± 1000 nanoTesla with a resolution of 0.03 nanoTesla and a bandwidth of 0.5 Hz.

6.4.4.2 X-Ray Sensor (XRS)

The XRS performs real-time measurements of the solar x—ray emissions in two channels covering the spectral ranges of 0.5 to 3 Angstroms (shortwave) and 1 to 8 Angstroms (longwave). Detection of x—rays is accomplished by means of a dual ion chamber, one for each range. The XRS is mounted on a solar—pointing platform comprised of a N-S tracking X-Ray positioner (XRP) and an E-W tracking solar array yoke assembly, thereby ensuring that the solar disk is always contained fully in the field-of—view of the instrument.

The XRS is sensitive to x-ray flux as small as 5×10^{-9} watts/in^2 in the shortwave channel and 2×10^{-8} watts/m^2 in the longwave channel, with a dynamic range of 10^5 for both channels. The total dynamic range for each spectral band is accommodated by automatic range switching in the corresponding electronic channels, providing a resolution of better than 2 percent of readings for energy flux greater than 20 times threshold. Accuracy of the telemetered data is ± 20 percent.

6.4.4.3 EPS and HEPAD

The EPS provides multiple measurements characterizing the charged particle population for protons of energy greater than 0.8 Mega electron volts (MeV), alpha particles of energy greater than 4 MeV, and electrons greater than 0.6 MeV; the HEPAD instrument extends the coverage for protons to above 350 MeV and of alpha particles to above 2560 MeV.

The EPS/HEPAD includes three integral measurement channels of

electrons from 0.6 MeV to > 4 MeV, an eleven—channel differential analysis of protons from 0.8 MeV to >700 MeV, and an eight-channel differential analysis of alpha particles from 4 MeV to >3400 MeV. These primary data channels are supported by additional single channels located in the HEPAD to help determine reliability of the telemetered data. Data compression is used to accommodate the maximum expected accumulator count in a single telemetry word.

An in-flight calibration sequence will verify basic instrument operation, the accuracy of data channel energy thresholds, and intensity measurements.

6.4.4.4 Solar X-Ray Imager (SXI)

The SXI instrument will be developed and manufactured by the MSFC for flight on the GOES-M spacecraft. The SXI will monitor the overall solar radiation and major solar energetic events such as flares, loops, and coronal holes in the X—Ray region of the electromagnetic spectrum. The SXI and its associated test equipment, will be manufactured by the MSFC, and will be provided as Government Furnished Equipment (GFE) to the Space Systems/Loral (SS/L) Company for integration on the GOES-M spacecraft.

6.4.5 Search and Rescue Subsystem

The uplink SAR signals from the next generation of distress beacons are digitally phase modulated at 400 bits per second in the frequency band from 406 mHz to 406.100 mHz. The signals are received by the satellite UHF antenna, and are then amplified by a low-noise amplifier. The SAR subsystem can be operated in either a 20-kHz narrowband mode, or an 80-kHz wideband mode. The output from the SAR receiver is provided to the SAR transmitter, where the signal is used to phase modulate a carrier frequency. The signal is then up-converted, amplified to approximately 4 watts, and then transmitted by the satellite to the ground station where the alert signals are decoded and sent to the Mission Control Center. The SAR signals from the GOES satellite provide an instantaneous alerting capability, and are later combined with the data from the same beacons, which are obtained from the low-Earth orbiting satellite system containing the Doppler information that is needed to compute the location of the distress beacon. The combined data from the GOES synchronous orbit satellite and the low-Earth orbiting satellites, are used to perform efficient SAR procedures. The summarized technical data on the SAR transponder is described in table 6-8.

Table 6-8 SAR Subsystem Data Summary

Receive Frequency Narrowband Mode Bandwidth Wideband Mode Bandwidth SystemG/T G/T	 406.025 mHz 20 kHz 406.050 mHz 80 kHz 18.5 dB/K
Transmit Frequency Power Output Antenna Gain Earth Edge EIRP Bandwidth	1544.5 mHz 4 watts 12 dB 45 dBm 400 kHz

6.4.6 Weather Facsimile Service

The Wallops ground station re-transmits images and meteorological analysis to the user community through the WEFAX service. Data originates from the National Weather Service and NOAA image processing facilities and are provided for users appropriately configured with ground receiving stations.

6.4.7 Data Collection System

Over 8000 DCPs, in the form of buoys and remote environmental monitoring stations, provide near real—time acquisition and relay of environmental data for centralized distribution and processing. The information provides data that is used to develop analysis, warnings, and forecasts of environmental events such as tsunamis, tropical cyclones, floods, river stage, soil condition, and snow depth.

The satellite DCS receives the incoming signal (e.g., relative frequency, time of occurrence and environmental data) then retransmits these data to the ground for processing. Conversely, the DCS can relay an interrogation signal from the ground station to a special class of the DCPs to turn the platform on at specific times. However, most present-day platforms are self-timed.

6.4.8 Propulsion Subsystem

A single pressurant tank supplies helium through a normally closed pyrotechnic valve (EVl) to the pressure regulator. The regulator reduces the approximate 3300 pounds per square inch absolute (psia) helium to 230 psia for propellant tank pressurization during the apogee motor firing maneuvers. The liquid bipropellant system uses two spherical titanium propellant tanks pressurized with helium and containing nitrogen tetroxide (N_2O_4) and monomethyl-hydrazine (MMH). After

completion of the apogee firings, the tanks are operated in a blowdown mode for the remainder of the mission. One 490—N (110 lb) apogee thruster and twelve 22-N (5 lb) AOCS thrusters provide the required impulse to obtain final injection into geosynchronous orbit. These same thrusters provide a redundant capability for orbit and momentum control during routine operations. In addition, the AOC thrusters provide a capability for initial satellite station acquisition, apogee maneuver control, and satellite orientation control torques for satellite maneuvers required for stationkeeping and on-orbit control.

The propellant control module consists of the following:

a) Two NC pyro valves (EV2 and EV3) to isolate the propellant from the thrusters during ground handling and launch
b) Two propellant filters (F) to protect the downstream valve seats from any particles contained in the propellant. Two mechanically-linked, magnetically—latched, bipropellant latch valves (LV2 and LV3) to isolate each of the redundant AOC thruster branches A and B in the event of thruster valve leakage
c) Two Normally Open (NO) pyro valves (EV4 and EV5) to permanently isolate the apogee thruster upon completion of the AMF maneuvers
d) Two low-pressure (160 to 260 psia) transducers (PF2 and P02)in the propellant lines to monitor each of the propellant pressures after launch

The pressurant control module consists of the following:

a) One NC pyro valve (EVl) to isolate the high-pressure helium from the propellant tanks until the first apogee maneuver firing
b) One pneumatic-pressure regulator to reduce the pressure of the helium from the pressurant tank to the propellant tanks
c) Two dual—seat, series redundant, Check Valves (CVl and CV2) to prevent propellant vapor back flow and vapor mixing between propellant tanks through the pressurization circuit. On mechanically-linked, magnetically—latched, bipropellant latch valve LVl to provide primary isolation of the propellant tanks
d) One high—pressure (0 to 4000 psia) transducer (PHl) to monitor the helium tank pressure
e) Two low-pressure (0 to 500 psia) transducers (PFl and P01) to monitor each of the propellant tank pressures

Eight fill and drain valves (FD-l through FD—6, TPl and TP2) provide for loading and pressurization of fluids and act as test ports for proof, leak, and flow tests. Temperature sensors are located throughout the subsystem to provide telemetry for

monitoring the thermal control status.

A surface tension, Propellant Management Device (PMD), is included in each propellant tank to supply bubble-free propellant to the tank outlet during all phases of the mission.

6.4.9 Attitude and Orbit Control Subsystem

The AOCS is composed of four major categories of components consisting of sensors, actuators, electronics, and positioners.

6.4.9.1 Sensors

In general, sensors provide the attitude data in the form of position and rate for processing by the AOCS. There are two Earth sensors per spacecraft and a group of Sun sensors. The Sun sensor assemblies consists of Coarse Analog Sun Sensors (CASS), Digital Sun Sensors (DSS), and the Sun Analog Sensors (SAS). The CASS detects angular deviations in the roll/yaw and pitch directions. The DSS provides pitch and yaw position references during apogee thruster firing and calibration of the gyros in the Digital Integrating Rate Assembly (DIRA). The N—S SAS is used in the control loop of the XRP and the E-W SAS is used to verify the accuracy of the Solar Array Drive Assembly (SADA) operation. The earth sensor provides attitude reference in two axes (pitch and roll) for both transfer orbit and synchronous orbit operations. Complete redundancy is provided for all sensors.

The DIRA provides a measure of satellite rates and relative position changes about the roll, pitch, and yaw axes and is used during station acquisition and stationkeeping. The DIRA consists of a set of three rate integrating gyros.

6.4.9.2 Actuators

The AOCS actuators include two momentum wheels, canted slightly away from the pitch axis, one reaction wheel along the yaw axis; the valve coil driver assembly and two magnetic torquers.

During normal operation, the two skewed momentum wheels are simultaneously operated at approximately 5400 r/min (nominal) to provide a bias momentum vector of 120 Newton—meters (Nm) along the -Y axis. The earth sensor provides pitch and roll error signals. A pitch error signal causes a speed modulation of both momentum wheels to provide a correction torque about the pitch axis. A roll error signal causes a differential modulation of momentum wheel speed, thus producing an increment of momentum along the yaw axis and subsequent control about the roll axis. Yaw attitude is maintained by the inertial stability of the momentum bias and the kinematic roll-yaw coupling as well as the magnetic torquer. Thus, a continuous yaw reference is not

required in the on-orbit mode. The Valve Coil Driver (VCD) is the interface between the AOCE and the thruster valves. Redundant drivers whose outputs are summed are provided for each thruster valve, which consists of fuel and oxidizer valves electronically connected in parallel.

There are two orthogonally-mounted magnetic torquers. One is located on the anti—earth panel and the other on the East panel of the spacecraft. The magnetic torguer is a coil of wire located on the internal surface of the spacecraft panel assemblies. When current is driven through the coil, interaction with the earth's magnetic field produces torque on the spacecraft body to unload momentum. The anti—earth panel coil is used to unload roll momentum and the East panel coil is used to unload yaw momentum.

6.4.9.3 Attitude and Orbit Control Electronics

The primary function of the Attitude and Orbit Control Electronics (AOCE) is to generate the control signals for the thrusters, momentum wheels, and magnetic torquers by processing the output signals of the AOCS position and rate sensors. In addition, the AOCE generates the Image Motion Compensation (IMC) signals required by the Imager and Sounder instruments. The AOCE consists of a microprocessor based controller and an interface electronics unit. The microprocessor electronics incorporates all the circuitry needed to implement the following:

a) Initiation of each control mode, whether commanded or automatically selected (logic and timing).
a) Control-loop transfer functions.
b) Telemetry pertinent to each control mode. AOCS telemetry is available in six different formats.
c) Signals to the valve coil drivers.
d) Control signals for the momentum and reaction wheels.
e) Control signals for the magnetic torquers.
f) Mirror motion and image motion compensation signals for the Imager and Sounder instruments.

The Safe-Hold Mode Electronics (SHME) is a part of the AOCE Subsystem and is used to provide a benign spacecraft attitude for synchronous orbit contingencies. The spacecraft can be placed into the Safe-Hold Mode by using pre-determined procedures. The Safe—Hold Mode is used to control the satellite in a safe attitude until the appropriate engineering personnel can be made available to perform diagnostic and anomaly investigations.

6.4.9.4 Positioner Systems

The SADA provides for the structural support of the solar array, the positioning of the solar array about a single axis for Sun

orientation, and the transfer of power and control signals between the solar array and associated instruments, and the spacecraft main body. The Trim Tab assembly consists of the Trim Tab Positioning Mechanism (TTPM) and the Trim Tab Panel (TTP). The TTPM is used to position the TTP with respect to the solar array for attitude control of the spacecraft. The TTP is a honeycomb composite panel, one side of which is covered with an aluminized kapton layer, which acts as a reflective surface. The reflection of the sunlight on the TTP causes a torque to act upon the satellite. The torque is controlled by changing the angle of the TTP with respect to the sun.

6.4.10 Communications Subsystem

The separate Imager and Sounder data bit streams are multiplexed by a Quadraphase Shift Keying (QPSK) modulator in the 2—watt sensor data (SD) transmitter. As seen from the diagram, the SD, the Data Collection Platform Reports (DCPR), the Processed Data Relay (PDR) signal, and the WEFAX links are multiplexed in a five port output multiplexer and transmitted to the ground terminals through a common S—band transmit antenna. Solid state 11-watt amplifiers are used for the PDR and WEFAX transmitters.

The Multiuse Data Link (MDL) transmitter is a QPSK modulated transmitter that receives data from the Attitude Digital Multiplexer (ADM), which is used for transmitting diagnostic data relating to mechanical dynamic interactions. The MDL link capability will be provided on GOES I and at least one of the remaining GOES-I/M satellites. The SXI data will be transmitted directly through the other quadrate input of the QPSK modulator. The communications subsystem performance requirements summary is described in table 6-9.

6.4.10.1 Processed Data Relay

The processed data communications link is used exclusively for relaying processed imaging and sounding data. Once the raw imaging and sounding data have been earth located and calibrated by the NOAA OGE, they are uplinked to the GOES-I/M from the Wallops ground station and then relayed via the satellite to the data user community.

6.4.11 Tracking Telemetry, and Command Subsystem

6.4.11.1 Tracking System

The satellite has redundant DSN-compatible transponders for use in providing satellite tracking data, which include range and Doppler measurements. The data is provided by the DSN during the transfer orbit and the drift orbit for processing in the FDF during launch operations. During the satellite checkout period, the GSFC FDF will provide orbit determination.

Table 6-9 Communications Subsystem Performance Requirements Summary

Characteristics	Functions									
	Multiuse Data Link	Search & Rescue	Command	CDA Station Telemetry	STDN/DSN Ranging & Telemetry	DCPR Repeater	DCPI Repeater	WEFAX Repeater	Imaging & Sounding Sensor Data	Processed Data Relay
Satellite Transmit										
Minimum EIRP (d8m)	44.0	45.0	—	27.0	24.0	33.0	45.0	54.4	45.0	54.4
Antenna Coverage	Earth Coverage	Earth Coverage	—	Omni	Omni	Earth Coverage	Earth Coverage	Earth Coverage	Earth Coverage	Earth Coverage
Polarization	Linear	Right Hand Circular (RHC)	—	RHC	RHC	Linear	RHC	Linear	Linear	Linear
Center Freq. (mHz)	1661.48	1544 500		1694.000	2209.066 2206.586	1694.500 1694.800	488.825 468.8375	1891.000	1676.00	1885.700
Satellite Receive										
Minimum G/T (dB/K)	_	-16.5	-40.6	—	-40.6	-22.0	-25.0	25.0	—	-25.0
Dynamic Range (dBm)	—	Noise to -125	-113 to -50	—	-50 to -95	Noise to -100	Noise to –90	-100 to -89	—	-92 to -86
Antenna Coverage	_	Earth Coverage	Omni	—	Omni	Earth Coverage	Earth Coverage	Earth Coverage	—	Earth Coverage
Polarization	—	RHC	RHC	—	RHC	RHC	Linear	Linear	—	Linear
Center Freq. (mHz)	—	406.050 406.025	2034.200	—	2034.200	401.900 402.200	2034.900 2039.9125	2033.000	—	2027.700
Earth Terminal Transmitters										
Nominal EIRP (dBm)	—	36.0	CDA 85.7 DSN: 101.2	—	101 .2(3)	45.0	85.7	96.7	—	102.7
Polarization	—	Linear	CDA: Linear DSN:RHC	—	RHC	RHC	Linear	Linear	—	Linear
Earth Terminal Receivers										
G/T (db/K)	15.2	6.0	—	26.0	32.0	26.0	-21.6	-0.3	26.0	-
Polarization	Linear	RHC	—	Linear	RHC	Linear	RHC	Linear	Linear	Linear

During normal on-orbit operations, the OGE at the CDA ground station will determine the range of the satellite by transmitting and receiving a known bit pattern through the satellite using the processed data link. The satellite orbit will be determined by combining these data with computations made from data within the images obtained from the Imager and Sounder instruments.

6.4.11.2 Telemetry and Command Subsystem

The T&C subsystem provides the necessary telemetry and command links between the satellite and the ground stations through connections to various components of the communications subsystem.

The telemetry subsystem accepts, conditions, samples, and digitizes satellite analog and digital data. Normal and dwell telemetry data bit streams are provided to both the CDA and DSN transmitters.

The command subsystem receives and demodulates the command baseband signals and executes the commands. It is capable of encrypted and clear—mode command processing. The use of encrypted commands are planned after satellite hand—over to NOAA. The encrypted command mode provides protection from unauthorized attempts to command the satellite by requiring commands to be processed by the use of a National Security Agency endorsed decryptor chip set, housed in the command decoder units.

The key features of the T&C subsystem are summarized in tables 6-10 and 6-11, respectively.

Table 6-10 Key Features of the Telemetry Subsystem

Mainframe Rate	0512 sec/frame
Bit Rate	2000 bps
Minor Frame Length	128 words
Word Length	8 bits
Output Format	Biphase - level
Error Code	16-bit polynomial code

Table 6-11 Key Features of the Command Subsystem

Modes	Clear and Secure
Message Length	Clear .. 8-bit Barker + 48-bit command Secure ... 8-bit Barker + 63-bit command
Command Verification Types	Ground verify and satellite auto verify
Modulation	Biphase NRZ-L

Subcarrier	16 kHz
Bit Rate	250 bps
Bit Error Rate	16^{-5} @ 15dB
Error Code	7-bit polynomial code

6.4.12 Thermal Subsystem

Thermal control of the spacecraft is achieved primarily by passive means augmented by heaters. Ground—commanded, as well as thermostatically controlled heaters, are used on various components including propulsion tanks, lines, and valves. Proportionally controlled heaters are used on the Earth sensors, batteries, and the Imager and Sounder instruments. In addition, the Imager and Sounder use thermal control louvers to control peak temperatures. Spacecraft thermal control is achieved by mounting most of the high heat dissipating components on the North-or-South radiating panels of the spacecraft, which experience low solar inputs during the life of the mission. The other four sides of the spacecraft are covered by Multilayer Insulation (MLI) blankets to keep daily temperature variations, due to direct solar energy, to a minimum.

6.4.13 Power Subsystem

The spacecraft primary power is provided by a two—panel solar array that is attached to a continuously rotating SADA by the mechanical yoke structure. The power bus is regulated at 42 ±0.5 volts in sunlight and 30 volts minimum during battery/eclipse operations by the sequential shunt unit, which is mounted on the backside of the in-board solar array. The GOES-I spacecraft power budget and power margin at the end of the spacecraft 5—year mission design life is listed in table 6-12. The power budget for the GOES-J/M satellites is expected to be similar to the GOES-I power budget

Table 6-12 GOES-I Power Budget and Power Margin

Equipment	Synchronous Orbit (Watts)	
	Summer Solstice	Eclipse
Imager	154.8	7.7
Sounder	175.9	23.7
SEM	31.4	18.8
Communications	234.7	84.2
T&C	33.7	25.5

Equipment	Synchronous Orbit (Watts)	
Power	19.1	14.6
AOCS	173.5	121.5
Propulsion	4.7	4.7
Thermal	167.1	72.4
Harness	9.9	3.7
Total	1004.8	376.8
Battery Charging	10.4	N/A
Required Power	1015.2	376.8
Array Capability	1057.0	N/A
Array Margin	41.8	N/A
Battery DOD (%)	N/A	56.8

The spacecraft has two 12 ampere-hour nickel-cadmium batteries that are used to provide power during the launch and ascent phase of the mission, and during synchronous orbit eclipse periods. An automatic eclipse load disconnect/reconnect control and battery under-voltage disconnect capability are also provided with manual command override features. The Power Control Unit (PCU) provides the battery charge and discharge control circuits, battery temperature control, T&C functions for the power subsystem, solar eclipse load control circuits, and the circuits for the Electro-Explosive Device (EED) functions.

The key features of the power subsystem are listed in table 6-13.

Table 6-13 Key Features of the Power Subsystem

Solar Array	Single Axis Sun Tracking
Number of Panels	2
Panel Size	105.5 x 93 inches
Batteries	2
Type	Nickel-Cadmium
Number of Cells	28
Capacity	12 ampere-hours
Depth of Discharge	56.8% at maximum eclipse
Eclipse Load Supported	376.8 w (72 minutes)
Bus	Single bus system
Voltage (sun)	42.0v ±0.5 vdc

6.4.14 Image Navigation/Registration System

The purpose of the Image Navigation/Registration (INR) System is to provide information necessary to precisely co-register and earth-locate Imager and Sounder radiometric products in real time. These data products will enable users to accurately monitor severe storms, determine winds from cloud motion, and when combined with data obtained from conventional meteorological sensors, produce improved short-term weather forecasts. The major components of the INR System are the Imager and Sounder instruments, the satellite AOCS, and the OGE.

The requirement for GOES-I/M requires the INR system to remove the apparent image-to-image motion resulting from orbital motion, satellite attitude deviations, and satellite thermal distortions. This is achieved by continuously steering the instrument scan mirrors to compensate for this motion. Compensation signals are generated in the AOCS based on predicted orbit and attitude parameters, that are uplinked to the satellite at least once per day from the OGE. These parameters are generated in the OGE using image landmarks, star views, and range data collected throughout the day. The INR system performance requirements are listed in table 6-14.

Table 6-14 INR System Performance Requirements (3 Sigma)

Imager		
Earth Location Accuracy (1)	Noon ±8 hours	Midnight ±4 hours
	4 km	6 km
Registration (2) Within image (25 minutes) Between Images	42 µrad	2 µrad
15 minutes	42 µrad	70 µrad
90 minutes	84 µrad	105 µrad
24 hours	168 µrad	168 µrad
2 days	210 µrad	210 µrad
Coregistration (3)	28 µrad	28 µrad

Sounder		
Earth Location Accuracy (1)	Noon ± 8 hours	Midnight ± 4 hours
	10 km	10 km
Registration (2) Within same Sounder area (120 minutes)	84 µrad	112 µrad
Between repeated soundings (24 hours)	280 µrad	280 µrad
Coregistration (3)	22 µrad	22 µrad

NOTES

1. Earth Location Accuracy is the process of determining absolute latitude/longitude location of individual picture elements (pixels). This process is often referred to as image navigation, since a knowledge of the satellite orbit and attitude during the time of recording the image or sounding is essential.
2. Registration is the relative alignment and stability of the individual pixels that make up a scene. It is the process of maintaining the latitude/longitude coordinates of each picture element, independent of time.
3. Coregistration defines the allowable variation between channels, relative to the scene, and the ability to

register successive images, one to the next. The nominal MDL data rate of the dynamic interaction measurement data is 32 kbps.

6.4.15 Dynamic Interaction Measurements

Special purpose non-redundant hardware will be flown on GOES-I and one additional spacecraft to permit the measurement of dynamic interaction between moving mechanisms on the spacecraft and the data output from the Imaging and Sounding instruments. The hardware consists of Angular Displacement Sensors (ADSs), MDL transmitter, and the ADM. The data from the DIRAs that are part of the AOCS subsystem are also used to make diagnostic measurements of the dynamic interaction of the spacecraft.

The DIRA and ADS roll, pitch, and yaw data will be encoded by the ADM. Also included in the ADS data stream will be Imager/Sounder E—W and N—S servo error data, and event flags for the Imager/Sounder mirror scan/no-scan status and solar array drive assembly slew steps. The nominal MDL data rate of the dynamic interaction measurement data is 32 kbps.

6.4.16 OGE

The OGE consists of four major systems plus data simulation equipment located at the NOAA CDA Station at Wallops, Virginia and at the SOCC in Suitland, Maryland. The OGE, developed by SS/L and Integral Systems Inc., provides initial ground-based processing and products for the GOES-I/M spacecraft. The OGE Data Acquisition and Patching Systems (ODAPS) provides signal conditioning and routing of the primary satellite data streams in and out of the OGE at the CDA station. From the ODAPS, raw instrument data are input to the Sensor Processing System (SPS) at the CDA station. The SPS is responsible for the real—time processing of GOES sensor data and the generation of the GOES-Variable (GVAR) formatted output data stream. The SPS calibrates instrument IR data, normalizes instrument visible data, provides Imager data gridding and earth location, and Sounder data earth location. After SPS processing, the GVAR data stream is routed through ODAPS for retransmission to the GOES satellite. The Product Monitor (PM) System at SOCC and at the CDA station provides graphics, text display, and plotting capabilities to monitor and assess GVAR data quality and to support sensor calibration and normalization analysis. In addition, the PM is used to generate landmark measurements from satellite images for use by the Orbit and Attitude Tracking System (OATS). The OATS equipment is located at S0CC, with backup equipment at the CDA station, provides computational support for orbit and attitude determination, image navigation and registration support, satellite maneuver planning, and satellite dynamic interaction diagnostic capabilities. The OATS also provides orbital event information and other command related data to the NOAA GOES-I/M T&C Subsystem (GIMTACS). The

GIMTACS equipment is another element of the GOES-I/M Ground Support System independent from the OGE, which is responsible for GOES—I/M commanding and satellite health and safety telemetry monitoring. The OGE data simulation equipment consists of the OGE Input Simulator (0IS) at the CDA station, that provides simulated Imager and Sounder data streams and the GVAR simulator which provides a simulated GVAR data stream output. The OGE shall also provide IR calibration data processing and data analysis capabilities to diagnose and compensate for effects of instrument clamp noise, 1/f noise, gradients, and nonlinearities.

6.5 LAUNCH OPERATIONS

The director of GSFC has arranged for the John F. Kennedy Space Center (KSC) to provide launch operations support for all launch vehicles at the Air Force’s Eastern Space and Missile Center (ESMC).

6.6 LAUNCH SERVICES

The GOES-I/M spacecraft will be launched on a commercially available Atlas/Centaur launch vehicle. GOES I/J/K were launched on an Atlas-I vehicle. GOES L/M will be launch on an Atlas-II. KSC is responsible for providing the launch services for GOES-L/M. LeRC provided the launch services for GOES-I/J/K.

6.7 ATLAS EXPENDABLE LAUNCH VEHICLE

6.7.1 Atlas Major Characteristics

The Atlas vehicle is a constant 10-foot (3.05 m) diameter with a total length of 72.7 feet (22.2 m). The propellant tanks are of thin-wall, fully-monocoque, corrosion-resistant stainless steel construction. The fuel tank, which contains RP-l, and the oxidizer tank, which contains liquid oxygen, are separated by an ellipsoidal intermediate bulkhead. Structural integrity of the tanks is maintained in flight by the pressurization system and on the ground by either internal tank pressure or by the application of mechanical stretch.

Atlas propulsion is provided by the Rocketdyne MA-S engine system, which includes the sustainer, two vernier, and two booster engines. All engines are ignited before lift-off and they develop a total sea- level rated thrust of 439,338 pounds (1,953 kN). The section containing the booster engines is jettisoned approximately 155 seconds after launch.

6.7.2 Centaur Major Characteristics

The Centaur vehicle is 10 feet (3.05 m) in diameter and 30 feet (9.1 m) long. The Centaur employs high-energy liquid hydrogen and liquid oxygen propellants separated by a double-wall, vacuum insulated intermediate bulkhead. The propellant tanks, like those of Atlas, are constructed of thin-wall, fully-monocoque corrosion—resistant stainless steel. Tank stabilization is maintained at all times by either internal pressurization or the application of mechanical stretch.

The Centaur propulsion system uses two RLlOA-3-3A engines manufactured by Pratt & Whitney. These engines are regeneratively cooled and turbo—pumped, with a rated thrust of 16,500 pounds (73.4 kN) each.

6.7.3 Launch Mode and Separation

The GOES spacecraft will be launched from the ESMC aboard an Atlas expendable launch vehicle. The Atlas booster and the first burn of the Centaur upper stage will insert the Centaur stage and the spacecraft into a low-altitude parking orbit. At the first Equator crossing after launch (descending node), the Centaur will burn for a second time to place the spacecraft in a geostationary transfer orbit.

The separation system provided with the spacecraft adapter consists of a clamp—band assembly and four separation spring assemblies. The clamp-band assembly is a Marman—type clamp band that consists of two strap assemblies and two pyrotechnic bolt assemblies. Each strap assembly has twelve V—block shoes to provide the necessary clamping force between the spacecraft adapter and spacecraft. The four spring assemblies are mounted inside of the payload adapter and provide the necessary separation velocity to the spacecraft.

The separation sequence is initiated by a command from the Centaur guidance system. Power for this is supplied from the main vehicle battery. Separation indicators are installed at the spacecraft/launch vehicle (SC/LV) interface to verify the separation event and to provide spacecraft separation telemetry data.

6.8 FLIGHT DYNAMICS

The GSFC FDF will provide mission analysis, orbit determination, and satellite computations for the GOES Program, as described below.

6.8.1 Mission Analysis

Prior to launch, the Mission Operations and Data Systems

Directorate (MO&DSD) will work with the Mission Design Integration Working Group to conduct studies to assist the Project Office in the selection of the proper mission parameters to meet the mission objectives. These studies include the determination of launch window, mission orbit design, fuel budget, mission timeline, orbit lifetime, the adequacy of spacecraft orbit and attitude control sensors, and propulsion systems for satellite control.

6.8.2 Orbit Determination

Predictive and definitive orbit determination using DSN and GN tracking data will be required, as necessary, for the GOES-I/M Program Mission planning and DSN and GN scheduling. Real-time orbit determination will be required during satellite maneuvers.

6.8.3 Attitude Computations

The computation of both predicted and observed GOES satellite attitude will make maximum use of existing general—purpose computer programs with modifications for unique satellite sensors and characteristics, as required.

6.8.4 Orbit and Attitude Maneuvers

All spacecraft orbit and attitude maneuvers necessary to attain the mission objectives will be calculated and a maneuver plan will be provided to the project flight operations team in the SOCC during the launch and checkout phase of the mission. A Launch Display System (LDS) will contain orbit and attitude data generated in the FDF. These discrete data sets will be sent via a NASCOM data line from the FDF to SOCC following all orbit and attitude changes.

6.9 POST LAUNCH CHECKOUT AND FINAL HAND-OVER

The procedures and guidelines for Post-Launch Testing (PLT) and the hand-over process are contained in 415-PG-5330.1.1. This procedure establishes the process and responsibilities for PLT definition, spacecraft verification, and final PLT hand-over.

7.0 SCHEDULES

As an operational weather satellite system, GOES is an important asset in safeguarding life and property. As such, continuity of service is of prime importance to our customer and the nation.

GOES satellites are designed for 5 year missions. However, NOAA determines the actual satellite replacement schedule based upon the performance of the on-orbit spacecraft. NOAA's assessment of the schedule is conveyed to NASA twice per year as part of the Budget guidelines. They establish requirements for Launch Readiness Dates (LRD) and Planning Launch Dates (PLD). The LRD is the date on which both the spacecraft and launch vehicle must be available to support a launch. The PLD is the most likely date on which NOAA will want the launch to occur. NASA based on these requirements revises the contractor's schedule requirements.

Master schedules which integrate all project activities by mission are maintained in the GOES Program Office. Intermediate and detailed schedules are maintained by the various contractors for their respective activities. These schedules are reported to the GOES Program Office in accordance with the contract CDRL requirement.

The master phasing schedules for the GOES-I/M Satellite are included in Appendix E.

8.0 RESOURCES

NOAA requests budget preparation twice per year due in March and August. NOAA provides program guidance on launch dates (Readiness and Planning), program scope and funding available by fiscal year.

NASA develops funding requirements in response to NOAA's guidance. Funding requirements are reviewed by the Director of Flight Projects and the GSFC Center Director before submission to NOAA. The Program Commitment Agreement, Program Cost Commitment, Program Plan and this Project plan are updated accordingly.

Appendix F contains the budget direction from NOAA, the formal transmission letter from GSFC to NOAA and the budget package reviewed by the GSFC Center Director. This appendix shall be kept up to date with the current requirements. The GSFC Center Directors approval (signature of the transmittal letter) and their formal transmission to NOAA shall constitute authority to replace Appendix E with the current requirements

Once per year, a comprehensive manpower plan is developed. This plan includes both civil service manpower and support service contractors.

9.0 CONTROLS

GOES is a reimbursable program being managed by NASA for NOAA. As such, any change in program scope, performance, funding or schedule must be approved by NOAA. Typically, as part of the semi-annual budget process, NOAA directs changes in the program scope, funding or launch date requirements (both readiness and planning). NASA responds to this direction in the form of a new POP which is reviewed and approved by the Director of GSFC. Following approval of the POP, the Program Plan, PCA and PCC are updated accordingly.

Changes in system performance are controlled by the Project Configuration Management Plan. All changes that affect a Level 1 performance criteria including waivers are systematically reviewed by NASA and NOAA technical personnel. NOAA concurrence with the change is required prior to implementation.

10.0 IMPLEMENTATION APPROACH

The GSFC has been assigned lead center responsibility for the GOES Program. The system is being procured from various major aerospace contractors. The SXI instrument is developed in-house at the MSFC.

Funding for the GOES-I/M project originates from three sources:

- NOAA funds the operational hardware, launch and GSFC support.
- NASA funds the MSFC manpower for SXI development.
- The Air Force funds the SXI hardware.

11.0 ACQUISITION SUMMARY

Table 11.1 summarizes the procurement efforts on GOES I-M:

Table 11.1, Procurement Summary

Element	Type of Procurement	Type of Contract	Source	Procurement / Monitoring Org
Spacecraft, OGE and GSE - Design Fabricate, Integrate, Test and Mission Support	Competitive	CPAF	Space Systems Loral	GSFC
ELV Launch Services	Competitive	FP	Lockheed Martin	KSC
Solar X-ray Imager	In-house development	N/A	MSFC	GSFC
GOES-I/M Telemetry and Command System	Competitive	CPAF	Space Systems Loral	NOAA
Project Technical Support	Competitive	CPAF	Boeing	GSFC

11.1 SPACECRAFT

The spacecraft procurement was awarded to Space Systems Loral (SS/L) in 1985 for the development of the spacecraft bus, ground system and instruments. The procurement is for 5 satellites with their full instrument compliment. SS/L is responsible for the mission through delivery to the launch site. The Government is responsible for the in orbit activation and test with support from SS/L. Anomaly support is provided to NOAA through the GSFC Mission Operations Support Team (MOST) and task order assignments to SS/L.

11.2 IMAGER AND SOUNDER INSTRUMENTS

The Imager and Sounder instruments are developed by ITT under subcontract to SS/L. The contract required 5 sets of flight instruments. Due to development problems, the first 2 sets of instruments were down graded to engineering model status and are referred to as the “Pathfinder Program.”

11.3 SOLAR X-RAY IMAGER

The SXI instrument will be developed by MSFC. The basic instrument development was funded by the Air Force. NASA has funded the MSFC civil service labor required for the development.

11.4 PROJECT TECHNICAL SUPPORT

The GOES Program office will use support contractors to provide support as needed during the planning, pre-procurement, and development phases of the program. This support will be provided on the basis of one or more Task Order support contracts, depending of the limitations of the GSFC civil service manpower available to the project.

12.0 PROJECT DEPENDENCIES

12.1 SUMMARY

The GOES Program requires the use of a combination of major facilities listed below. The facilities will be used during prelaunch preparations, launch operations, in-orbit checkout and routine operations activity following satellite hand-over to NOAA.

Table 12-1 Major Facility Requirements

Function	Facility	Location	Organization
S/C Processing	PPF	Titusville, FL	Astrotech
S/C Launch	Launch complex 36	Cape Canaveral	USAF
Tracking Network	GN, DSN	MILA Madrid Canberra Goldstone	NASA/SOMO JPL/DSN
Operations	SOCC	Suitland, MD.	NOAA
Data Acquisition	WCDAS	Wallops, Va.	NOAA
Data Acquisition Backup	CDAS	GSFC	NASA/GSFC
SEM/SXI Data Acquisition	SEC	Boulder, Co.	NOAA

Payload Processing Facility (PPF): The Payload Processing Facility at Astrotech is required to test the spacecraft after shipment and prepare the payload for launch. This includes fueling the spacecraft in the Hazardous Processing Facility (HPF).

12.2 GROUND NETWORK

Table 12-1 Ground Segment Systems and Support

Ground Segment System	Launch Support of Spacecraft to On-Station	Spacecraft Checkout and Evaluation	Spacecraft On-Orbit Operations
NASA Support			
- Flight Dynamics Facility	X	X	
- Goddard Space and Tracking Data Network (GSTDN)	X		
- NASA Communications Network (NASCOM)	X	X	
- Wallops/NASA	X	X (1)	X (2)
JPL DSN Network			
- Madrid	X		
– Canberra	X		
- Goldstone	X	X(1)	X(2)
NOAA Support			
- Satellite Operations and Control Center (S0CC)	X	X	X
- Command & Data Acquisition Station at Wallops, VA	X	X	X
- Central Data Facility at Camp Springs, MD			X
- Space Environment Laboratory at Boulder, Colorado			X
- Satellite Field Service Stations			X
Air Force Support	X		
- Air Force Satellite Control Network (AFSCN)			
– DGS	X		

Notes:

1. Ranging Support only
2. Goldstone provides backup command, telemetry, and ranging functions. The Wallops/NASA station provides backup ranging only.

12.2.1 Goddard Space and Tracking Data Network

The Goddard Space and Tracking Data Network (GSTDN) stations, located at Merritt Island, Florida (MILA) will be used to

support GOES launch operations.

During the ascent phase of the mission, the MILA ground stations will provide satellite telemetry data to SOCC at Suitland. The satellite will not be commanded during the ascent phase. The ground stations at Wallops, Virginia and at MILA will provide support only during the launch phase of the mission.

12.2.1.1 NASA Communications Network

The NASA Communications Network (NASCOM) will be used to provide voice and communications data circuits during pre—launch, launch, and post-launch activity.

12.2.2 JPL Deep Space Network (DSN)

The JPL DSN will maintain and operate the DSN tracking network during the launch and checkout phases of the mission. Following hand-over of the satellite to NOAA, JPL will provide emergency backup tracking support when requested by NOAA. JPL will also support spacecraft compatibility testing and network simulations.

12.2.3 NOAA Support Facilities

12.2.3.1 Satellite Operations Control Center (SOCC)

The SOCC at NOAA will be used as the focal point during the GOES-I/M launch phase operations, which are expected to last 10 to 14 days. The necessary software and procedures will be developed to control the satellite until it has reached its designated orbit location and operational configuration. The SOCC will be responsible for obtaining the satellite housekeeping data in real time; processing data for display and analysis by satellite analysts; satellite command operations; and mission scheduling. The OGE IR calibration diagnostic and trending capabilities will be utilized to maximize GOES in-flight calibration accuracy through techniques identified both pre-launch and during NASA post-launch testing.

Satellite instrument turn—on and checkout is expected to require approximately 30 days. For GOES-I, extended testing of the instruments and INR system will require an additional 90 to 120 days. This activity will be completed in parallel with the NOAA preparations for operating GOES-I in support of user requirements.

12.2.3.2 Command and Data Acquisition Station (CDA)

The NOAA CDA station is located at Wallops, Virginia. The CDA station performs satellite telemetry acquisition, and transmits commands to the satellite.

Backup CDA Station: The NOAA backup command and data acquisition station will be located in Building #25 at GSFC.

12.2.3.3 Central Data and Distribution Facility (CDDF)

The Central Data and Distribution Facility (CDDF) at Camp Springs, Maryland performs sectorization of the GOES image data by providing sectors of interest to weather forecasters, according to a predetermined schedule. The image data sectors are formatted into a proper facsimile (FAX) format for transmission via dedicated telephone lines to the appropriate Satellite Field Service Stations (SFSS).

12.2.3.4 Space Environment Laboratory (SEM)

The SEM data are received and processed by the NOAA Space Environment Laboratory, of NOAA’s Environmental Research Laboratories in Boulder, Colorado. Data collected from the SEM instruments include measurements of the variability of the geomagnetic field at the satellite, the emission of x-rays from the sun, and the strength and concentration of charged particles from the sun. The SEM data are used for prediction and monitoring of solar activity and its effects on the earth’s environment.

12.2.3.5 Satellite Field Service Stations

The SFSSs are located in Miami, Kansas City, Anchorage, Hawaii, Washington, D.C., San Francisco, and Redwood, California. The GOES data are distributed from the SFSSs to forecast offices of the World Weather Service (WWS) and other users such as military, private industry, and educational institutions.

12.2.4 Air Force Support

12.2.4.1 Launch Complex

Launch Complex: The GOES-I/M missions will be a commercial launch on a Government provided Atlas launch vehicle. It is the responsibility of KSC to provide insight into the launch vehicle production and processing.

12.2.4.2 Air Force Satellite Central Network (AFSCN)

The AFSCN station in Sunnyvale, California will be used to support the GOES launch and post launch operations. The AFSCN will be responsible for acquiring the GOES telemetry data during launch operations, and providing the data to the GSFC NASCOM network. The AFSCN will also provide the necessary communications data lines so that voice communications data lines so that voice communications with Air Force DGS personnel can be maintained during spacecraft launch operations.

13.0 AGREEMENTS

13.1 GENERAL

The agreements that are necessary for project success, and their projected dates of approval are described below.

13.2 AGREEMENT BETWEEN NASA AND NOAA

The Basic Agreement Between the National Aeronautics and Space Administration and the U.S. Department of Commerce Concerning Collaborative Programs is included in Appendix A. The Memorandum of Agreement Between the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce for Cooperation in the Geostationary Operational Environmental Satellite (GOES) Program is included.

13.3 LAUNCH SERVICES

An agreement between GSFC and LERC defines the launch services support provided by LeRC for the GOES I,J,K missions. It originally covered the entire GOES-I/M project. A NASA reorganization transferred responsibility for GOES L/M to KSC. There is no formal agreement between GSFC and KSC for this support. KSC does have an approved program plan which defines the support provided to all ELV launches including GOES L/M.

The LeRC agreement and the KSC Program Plan are included as Appendix C

13.4 MOU BETWEEN MSFC AND GSFC FOR SXI-M

This MOU is the agreement between GSFC and MSFC governing the development of the SXI instrument for the GOES-M mission. It is included in Appendix D.

14.0 MISSION ASSURANCE

14.1 GENERAL

The Performance Assurance Program for GOES-I/M is based on the Performance Assurance Requirements for the Geostationary Operational Environmental Satellite System GOES-I. -J. and -K. S-480-18; implementing the intent of the following:

- Reliability Program Requirements for Aeronautical and Space System Contractors, NHB 5300.4 (1A—l)
- Quality Program Provisions for Aeronautical and Space Systems Contractors, NHB 5300.4 (Rev. B)
- Classification of GSFC Orbital Flight Projects and Determination of Commensurated Performance Assurance Requirements, GMI 8010.2q

The Performance Assurance Program for GOES-I/M addresses both the flight and ground segments including spacecraft, instrument payload, airborne and ground support equipment and systems, and their interfaces for the life-cycle of the Project, including design, fabrication, integration, test, launch, deployment and checkout, and subsequent orbital anomalies. The contractors[1] are required to formulate definitive reliability, quality assurance, parts, materials, processes, contamination control, software assurance, electrostatic discharge, performance verification and test, and systems safety implementation plans for Project approval to govern the execution phase.

14.2 RELIABILITY

The reliability program requirements will be directed toward ensuring that the GOES spacecraft design is compatible with the requirements of the mission. The reliability requirements will follow the Reliability Program tasks delineated in Reliability Program Requirements of Aeronautical and Space System Contractors, NHB 5300.4 (lA), as tailored to the needs of the GOES Project and Mission and Section 7 of S-480-18 Performance Assurance Requirements for Geostationary Operational Environmental Satellite System. GOES-I. -J. and -K, (Rev. B), dated August 18, 1985.

Emphasis will be placed on conducting (at the spacecraft/ subsystem, subsystem/component, and the spacecraft/instrument interfaces) Failure Modes Effects Criticality Analyses (FMECAs), parts and materials applications reviews, worst—case analyses (emphasizing mission—critical stresses and design degradation),

This data will be subject to detailed review by the GSFC Project and Flight Assurance personnel to assure identification and elimination (where possible) of single point failures, adequacy of cross—strapping of redundant

units, automatic switching to redundant units where appropriate, and that component/unit stress levels are consistent with GSFC approved derating standards and spacecraft life requirements.

14.3 QUALITY ASSURANCE

The Quality Assurance Program requirements for the GOES-I/M Project will follow the quality tasks delineated in Quality Provisions for Aeronautical and Space System Contractors, NHB 5300.4 (lB), tailored to Project and Mission requirements and Section 8 of S—480—18 Performance Assurance Requirements for Geostationary Operational Environmental Satellite Systems. GOES— I. -J. and -K, (Rev. B), dated August 18, 1985. Letters of delegation will be maintained at both the prime contractor and the Imager/Sounder subcontractor Defense Contracting Administrative Service (DCAS) organizations to implement these requirements.

14.4 PARTS

Parts whose performance and reliability have been proven or that have demonstrated acceptance for the application are required for the GOES-I/M Project. Electrical, electronic, and electromechanical (EEE) parts are standard and acceptable if they are selected and procured in accordance with the Grade 1 category of the NASA Standard Electrical. Electronics. and Electromechanical Parts List, Military Standards (MIL-STD) 975 or with the GSFC Preferred Parts List (PPL). Any part not included in the listing of the MIL-STD-975 or the GSFC PPL is considered nonstandard. The use of nonstandard parts is limited to only those applications for which a standard part does not fulfill the design requirement. The rationale for selection and the supporting data attesting to the acceptability of the nonstandard part for the application (both performance and reliability) must be documented by the contractor and submitted for approval to the GOES Project on the GSFC form for Non-Standard Parts Approval Request (NSPAR).

14.5 MATERIALS AND PROCESSES CONTROL

Materials and processes whose performance and reliability have been proven or demonstrated to be acceptable for the intended application must be used for the GOES-I/M Project. Materials selected from Spacecraft Materials Guide, NASA Special

Publications (SP) 3094; Compilation of VCM Data of Nonmetallic Materials, JSC 08962; An Outgassing Data Compilation of Spacecraft Materials, NASA RP-1061; An Evaluation of Liquid and Grease Lubricant for Spacecraft Applications, GSFC Materials Technology Report (MTR) TM 82276, and Design Criteria for Controlling Stress Corrosion, MSFC Spec. 522A, are considered suitable for the application. Materials must be:

- Noncombustible or self—extinguishing nontoxic vapors as determined by tests described in Flammability. Odor and Offgassing Requirements. and Test Procedures for Materials in Environments that Support Combustion, NHB 8060.1
- Highly resistant to stress-corrosion cracking in accordance with MSFC Specification 522
- Reviewed from a fracture mechanics aspect if they are to be used in high strength fracture critical application such as fasteners, pressure vessels, and the like
- Have outgassing characteristics with a total mass loss (TML) less than or equal to 1.00 percent and a collected volatile condensable material (CVCM) less than or equal to 0.10 percent when tested in accordance with American Society of Testing Materials (ASTM) Specification E595-77

Any material for which there is a lack of aerospace experience shall be considered a nonconventional application. In that case, the material shall be verified for the desired application on the basis of similarity, analysis, test, inspection, existing data, or a combination of these methods, and approved for use by GSFC.

14.6 PERFORMANCE VERIFICATION

14.6.1 Test and Analytical Program

A formal GOES Test and Analytical Program will be conducted to provide assurance that the hardware is capable of surviving and performing its mission within specifications under the various environments to which it will be subject. This program will demonstrate the validity of design, the positive margins, the quality of workmanship and materials, and the satisfactory performance under the various mission environments with appropriate factors of safety. It will also screen the hardware for latent malfunctions. The program will include functional tests at the black-box and system levels. These tests will be conducted under ambient and simulated mission conditions, including factors of safety as applicable. Verification activities will demonstrate compliance with the system safety requirements as appropriate.

14.6.2 End-to-End Compatibility Tests and Simulations

End-to-end tests will be conducted on all GOES-I/M payloads and will include all portions of the operational system, such as flight hardware, operational software and ground systems, communications links, and data processing facilities. These tests will demonstrate that the entire system performs and that data flow paths and actual data are verified as required for the mission. Following these tests, mission simulation exercises are conducted to validate nominal and contingency mission—operating procedures and to provide for operator

familiarization training. The launch network readiness checkout is described in greater detail in the Network Support Plan, the Mission Operations Support Plan, and the Network Test Plan 531-NTP-GOES.

14.7 REVIEW PROGRAM

The contractor has conducted a series of packaging and design reviews for most designs within the components, subsystems, and at the payload level of assembly of both the flight and ground segments. In addition to the normal function reviews for all technical disciplines, these review processes also stressed packaging and manufacturing techniques and processes. Summaries of discussions, as well as decisions reached at these reviews, were provided to the GOES Project Office. The Project Office and Flight Assurance Office participated in these reviews.

14.8 CONTAMINATION ALLOWANCE AND CONTROL

A Contamination Control Plan has been developed that meets the needs of the GOES-I/M Project. The plan includes contamination allowances, methods and criteria for control, and analyses showing how the controls will keep contamination within allowable limits. The limits are based on an assessment of the sensitivity of the payload to contamination.

Consideration has been given to the effects of incidental materials and equipment, such as those used for cleaning, handling, and packaging. Solar arrays, major wiring harnesses, and thermal blankets will be baked out unless it can be shown to be unnecessary. Anticipated and potential transportation and launch systems contamination possibilities have been evaluated for inadvertent spacecraft contamination from these sources.

15.0 RISK MANAGEMENT

The major risks to the GOES Program are the uncertainty in the spacecraft launch dates and possible failure(s) during the environmental qualification test programs at ITT and SS/L. The presently known specific risk areas are described in table 15-1.

Table 15-1 Risk Assessment Chart

Risk Area	Risk	Description	Risk Offset
Imager Visible Channel Radiometric Performance	Moderate	Performance will be degraded by mirror thermal distortion during the period of ± 4 hours around satellite midnight.	Evaluate triangular core scan mirror design Evaluate alternate nickel plating treatments
Imager Navigation/Registration a. Imager visible-to-IR channel co-registration b. Sounder IR channel coregistration c. Imager/Sounder within frame registration	Moderate-to-High	Some present requirements cannot be met due to combination of instrument and satellite performance.	Recommend that specifications be relaxed or waived
Imager and Sounder Longwave IR Channel Radiometric Performance	Moderate-to-High	Longwave channel performance specifications are not being achieved	Lower the IR detector operating temperature if possible
Imager/Sounder IR Calibration	Moderate	The 1K absolute and 0.1K relative calibration accuracy will be difficult to meet. Limiting factors are low frequency detector noise and electronic drift.	OGE will be modified to partially compensate for low frequency noise effects on calibration A specification change or waiver may be required
Momentum Wheel Performance	Moderate	Momentum Wheel current fluctuations experienced on lnsat-1 D and Superbird which have momentum wheels similar to the design used on GOES	Continue Investigation of on-orbit anomaly Analyze bearing retainer lubrication process

16.0 ENVIRONMENTAL IMPACT

16.1 EXPENDABLE LAUNCH VEHICLE

Pursuant to the NASA/Lockheed Martin GOES launch service contract, General Dynamics is responsible for compliance with any/all federal laws, regulations, etc. associated with the Atlas launch vehicle. Further, compliance with the National Environmental Policy Act with regards to Atlas launches from the Cape Canaveral Air Force Station (CCAFS) have been addressed by the February 1989 United States Air Force (USAF) Environmental Assessment for the Medium Launch Vehicle II (MLV II) Program.

16.2 PAYLOAD

There is no environmental impact anticipated due to the payload or its reentry

17.0 SAFETY

17.1 INDUSTRIAL SAFETY

The safety procedures and requirements to be followed in implementing the GOES-I/M Project are in response to, and in accordance with, the policies and guidelines set forth in the Health and Safety Program, GMI 1700.2B; Basic Safety Manual, NHB 1700.1 (VI); and with the overall GSFC policy of avoiding injury to people, as well as property loss, to the maximum extent practical. To this end, the following measures will be implemented. It is GSFC policy to inform affected personnel of any hazards resulting from involvement in this Project, and to provide all requested hazardous material information.

- Inclusion of the Safety and Health Clause contained in the NASA Procurement Regulation 1.5204 in all resulting GOES contracts
- Submission of industrial safety plans by contractors for review, comment, and approval by the GOES Project with assistance given by the GSFC Health, Safety, and Security Office
- Compliance with applicable chapters of the Code of Federal Regulations and the National Environmental Protection Agency codes when using, handling, storing, or transporting dangerous materials
- Compliance with Range Safety Manual, Air Force Eastern Space and Missile Center/Air Force Western Space and Missile Center (AFESMC/AFWSMC) document 127.1 and KSC Safety Program, Kennedy Management Instruction (KMI) 1710.1; and any applicable launch vehicle restraints manuals
- Accomplishment of final review of all aspects of Mission safety in accordance with the GSFC Design Review Program and in compliance with the Systems Safety Plan

17.2 RANGE SAFETY

Range safety shall be in compliance with EWR-127-1.

17.3 SYSTEM SAFETY

The GOES-I/M Project will establish a comprehensive Safety Program for the entire Mission in accordance with System Safety for Flight Programs, GMI 1700.3. Project and ground support personnel, test and integration personnel and facilities, hardware and software, and Mission operations will be covered. The end-to-end system approach is described in NHB 1700.0 (VI—A), and System Safety, NHB 1700.1 (V3).

18.0 TECHNOLOGY ASSESSMENT

The hardware required for the GOES-I/M spacecraft is well within the state of the art. The Imager and Sounder instruments are now complete. The launch services will be commercially procured from Lockheed Martin.

19.0 COMMERCIALIZATION

There are no known commercial applications or products associated with GOES data. NOAA freely disseminates the data.

20.0 REVIEWS

20.1 FLIGHT HARDWARE TECHNICAL REVIEWS

The flight hardware technical reviews are detailed in the Program Mission Assurance Plan. In general, the following reviews will be held for all hardware.

Table 20-1 Flight Hardware Reviews

System Concept Review(SCR)
Preliminary Design Review(PDR)
Critical Design Review(CDR)
Mission Operations Review(MOR)
Pre-Environmental Review(PER)
Pre-Shipment Review(PSR)
Flight Operations Review(FOR)

Table 20-2 Launch Services Reviews

Mission Integration Program Kickoff Review
Requirements Review
Component/System Design Review
Mission Peculiar/Mission Unique PDR
Mission Peculiar/Mission Unique CDR
Pre-Installation Review
Final Loads Verification Review
Pre-Shipment Review
Pre-Payload Mate Review

Table 20-3 GOES Mission Level Reviews

Senior NASA Management Mission Readiness Review
Launch Readiness Review

20.2 EXTERNAL INDEPENDENT READINESS REVIEW

An External Independent Readiness Review (EIRR) will be held at the spacecraft contractor’s facility prior to the launch of each satellite. The purpose of the review is to have an independent panel of experts review the launch readiness of each satellite and launch vehicle.

20.3 INDEPENDENT ANNUAL REVIEW

The program will be reviewed annually by an independent team appointed by NASA Headquarters. The purpose of the review is to

assess progress toward meeting the commitments contained in the PCA. This independent team reports its findings to the NASA PMC.

21.0 TAILORING

NOAA controls program objectives, requirements, schedule and funding for the GOES Program. NOAA provides formal direction to NASA at least twice per year on a special schedule to accommodate the NOAA/DoC budget schedule. Schedules and funding remain somewhat flexible to respond to the on-orbit performance needs of the operational satellite program. To ensure compliance with NPG-7120.5 and consistency between the PCA, Program Plan, and Project Plan, while meeting our customer's requirements in a timely manner, the schedule and cost commitments contained in the PCA, PCC, Program Plan and Project Plan will be updated at least twice per year

Schedule and cost commitment changes will be recorded in the activity logs of each of the documents and shall not require notification of the approving official. The Lead Center Director's signature on the formal transmittal letter to NOAA shall constitute authority to update these documents with the new cost and schedule commitments. Any changes other than those directed by NOAA shall require the signature of the appropriate approving official.

22.0 CHANGE LOG

Change	Date	Description

23.0 APPENDIX A, NASA-NOAA BASIC AGREEMENT

BASIC AGREEMENT BETWEEN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE U.S. DEPARTMENT OF COMMERCE CONCERNING COLLABORATIVE PROGRAMS

MEMORANDUM OF AGREEMENT (MOA) BETWEEN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) AND THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)OF THE U.S. DEPARTMENT OF COMMERCE FOR COOPERATION IN THE GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE PROGRAM (GOES)

24.0 APPENDIX B, NOAA REQUIREMENTS FOR GOES-I/M

U.S. DOC NOAA NESDIS MCELROY LETTER AND NOAA REQUIREMENTS FOR GOES-NEXT SATELLITE SERIES

25.0 APPENDIX C LAUNCH SERVICES AGREEMENT

KENNEDY SPACE CENTER (KSC)
EXPENDABLE LAUNCH SERVICE PROGRAM PLAN

The Role of Lewis Research in Providing Launch Services for the
GOES-I/M Program

26.0 APPENDIX D, SOLAR X-RAY IMAGER (SXI) AGREEMENT

MEMORANDUM OF UNDERSTANDING (MOU) BETWEEN MARSHALL SPACE FLIGHT CENTER (MSFC) AND GODDARD SPACE FLIGHT CENTER (MSFC)

27.0 APPENDIX E, CURRENT MASTER SCHEDULES FOR GOES-I/M

28.0 APPENDIX F: BUDGET DIRECTION FROM NOAA AND CURRENT BUDGET PACKAGE