November 12, 1997

TO: All Rapid Spacecraft IDIQ Contractors

FROM: RSDO Contracting Officer/210

SUBJECT: Laser Altimetry Mission (LAM) Request For Offer (RFO)

The Rapid Spacecraft Development Office (RSDO) and the LAM Office are releasing this RFO to solicit offers to implement the LAM spacecraft. Offers shall be deposited to the RSDO web site by December 16, 1997, 2:00 PM EST.

A summary of the top level spacecraft requirements, the RFO schedule and identification of some key areas of design that require further study have already been posted to the RSDO web site (http://rsdo.gsfc.nasa.gov)

Any Offers submitted in response to the RFO shall include a firm fixed price for the LAM effort.. Please be advised that the potential areas of further study have been identified for your information, and should not be included or priced in your response to this RFO. An Offeror may only propose one core system for the LAM implementation and any additional core-systems proposed by a single offeror will not be considered.

Offerors are required to submit only the changed and/or new portions of the contractor's respective Core System Performance Specification and Mission Implementation Specification as attached to your Rapid Spacecraft Contract. Following selection and prior to placement of the LAM delivery order, the selected Offeror shall be required to formally complete the LAM spacecraft performance specification and mission implementation specification.

If you have any questions with regard to the LAM RFO please contact me at (301) 286-0421 or by e-mail at scollign@pop200.gsfc.nasa.gov.

Sharon Collignon
Contracting Officer

Changes From Draft LAM RFO

General - Removed icon symbols; standardized paragraph numbering

Attachment B, CDRL

1 Mission Performance Verification Plan may be submitted as Preliminary or Final
6 Spacecraft and Observatory I&T Plan may be submitted as Preliminary or Final

Attachment D, SPS

Table 3-1, 3-2 Changed Mean Anomaly to 0 (TBR); allowed parking orbit
3.2.3 Offeror asked to state the solar flux levels assumed.
3.2.3.1 Clarified orbits: a) initial (3 days max), b) calibration (90 days), c) mission (~5 years)
3.2.3.5 Clarified re-entry demonstration is an analytical exercise
3.2.4.4.a. Clarified that slewing is by "trigonometric algorithm or look-up table"
3.2.4.4.e Clarified that limits to yaw slewing are only for solar array positioning; settling time is (TBR)
3.2.4.6 Specified radial orbit knowledge at 1 sigma.
3.2.4.8.c Spacecraft backloading of GLAS thermal radiator made "(TBR)"
3.2.6.2.a Science & GPS solutions are "Real-time and playback"; modulation is SQPSK; 25 Mb rate is minimum
3.2.6.2.b Clarified D/L rate as "up to" 16 kbps; noted GPS solutions are "real-time"; modulation is BPSK
3.2.6.2.c Noted that all downlink data is real-time and playback; modulation is BPSK
3.2.6.3 Added "algorithms" to uplink content; modulation is BPSK
3.2.7 Noted that GLAS is thermally isolated from the Spacecraft.
Table 4-1 Changed to "typical" rather than specific part identification
4.1.9 Added section on ground support equipment
5.2.1.1 "Power Bus" changed to "Power Feed" throughout this section
5.2.1.1.b Laser can only be powered-on during ground contact.
5.2.1.2 Keep-alive power reduced to 50 W (TBR); noted temperature criticality for GLAS lasers
5.2.2.1.b.1 Clarified storage to previous ten (TBR) orbit's data
5.2.2.1.b.2 Changed from transmit "any previously transmitted data" to transmit "specific time-tagged data blocks"
5.2.2.1.b.4 Clarified the downlink combinations required simultaneously
5.2.2.1.c Clarified science and housekeeping channels; star camera and IRU data is available for spacecraft use
5.2.2.2.b GLAS commanding is via the MIL-STD-1553 data bus

Attachment E, MIS

2 and 8.1 Deleted reference to GLAS-S/C Integration Plan (not written yet)
3.1 Clarified Special Studies as Non-Standard Services under the contract.
3.1 Added possible study: "Accomplishing programmed track slew in pitch and roll axes"
3.10 Changed MDR date to "9 to 11 months ARO (TBR)"; added S/C-Ground Data Simulator
3.10 Added "GLAS-S/C Working Group" to match master schedule in Attachment F
4.2 Clarified the S/C-GLAS Data Simulator definition; added S/C-Ground Data Simulator
7.0 Added S/C-GLAS Data Simulator
8.1.1.1 Added the spacecraft safety officer's role in determining health and safety
8.1.3 Added Offeror's joint responsibility to develop GLAS mechanical integration procedures
8.1.5.h (deleted) Deleted Instrument CPT at the launch site
8.1.6 Added OK for Offeror to use Instrumenter's GSE to cool the GLAS radiator.
8.2 Asked Offeror to tailor EMI/EMC testing to meet intent of detailed requirements.
8.4 (deleted and renumbered) Deleted Magnetic Survey

Attachment H, Evaluation Criteria

REPP Added "particularly with regard to recent flight history and environmental qualification".

Rapid Spacecraft
Request For Offer (RFO) # 3

Title: Laser Altimetry Mission **Date of RFO:** 11/12/97

Type: Mission Specific **Date Responses are Due:** 12/16/97

Ordering Clause: G.2 **Required Delivery/Completion Date:** August 1, 2001
Acceptance On-Orbit

Mission Summary: The Laser Altimetry Mission is to make long term measurements of the ice sheet height, to determine the global ice mass balance, using the Geoscience Laser Altimeter System (GLAS) instrument. The three key mission areas are:
- Polar ice sheets, which affect predictions of global sea level;
- Clouds and the Earth's radiation balance, which strongly influence the magnitude of climate change;
- Conduct topographic measurements of land surface to provide control points and detect topographic change.

List of Attachments:
A. Changes to RSA contract SOW; None
B. Clarification to RSA CDRL
C. Modification of RSA Major Payment Events; None
D. Spacecraft Performance Requirements
E. Mission Implementation Requirements
F. Master Schedule
G. Offer Format and Instructions
H. Evaluation Factors and Relative Importance
I. GFE GPS Information (Hard Copy Only, Available on request from RSDO)
J. GLAS Instrument Definition Document (reference only), LAM Mission Operations Concept, and GPS TurboStar data package.

Non-Government Evaluation Personnel List:
Dr. Bob Schutz/University of Texas, Austin - Laser Altimetry Science Team Leader
Mr. Ron Follas/SSAI - Code 924 GLAS Instrument Manager

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT A
Changes to RSA contract SOW

None

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT B
Clarification to RSA CDRL

LASER ALTIMETRY MISSION
CONTRACT DATA REQUIREMENTS LIST

REQUIREMENT: The Offeror shall reply to the contract data requirements list as contained in the Rapid Spacecraft contract. Note: the "A/I" column in the CDRL indicates Government "Approval" vs. "Information"; "Draft" means initial information, annotations, or rough format; "Date Specific" means the submittal date is to be determined jointly after selection.

CHANGE:
CDRL 1, Mission Performance Verification Plan, and CDRL 6, Spacecraft and Observatory I&T Plan, may each be submitted as Preliminary or in Final version, at the Offeror's discretion.

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT C

Modification of RSA Major Payment Events

None

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT D

Performance Requirements

RAPID SPACECRAFT PROCUREMENT REQUEST FOR OFFER

EOS/LASER ALTIMETRY MISSION SPACECRAFT PERFORMANCE REQUIREMENTS DOCUMENT

11/12/97

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PERFORMANCE REQUIREMENTS DOCUMENT

The offeror shall generate a mission-specific LAM Performance Specification compliant with this format, augmenting the text given here with performance specifications for the proposed core system and integrated options, as directed below. The Offeror may interpret and tailor LAM requirements marked "TBR" (To Be Reviewed) to best fit their spacecraft and still meet the mission performance requirements. ***Offeror shall delete all italicized text****.*

1. SCOPE

This document defines the performance requirements for the Laser Altimetry Mission (LAM) spacecraft. The requirements are presented in the following categories:

- Spacecraft Performance Characteristics
- Spacecraft and Subsystem Descriptions
- Mission-Specific Spacecraft Modifications
- Options

The intent of this document is to present the top-level system performance separately from the detailed component and subsystem descriptions. In other words, ***what*** *the spacecraft bus does is captured in Section 3,* ***how*** *it gets it done is in Section 4. Section 5, Payload Accommodation, is the top-level first cut at the spacecraft-GLAS interface control document.*

NASA's implementation of this three-year EOS Laser Altimetry Mission has no implied nor expressed connection with any projected follow-on altimetry mission under EOS, nor does it imply a commitment to future contributions to the desired fifteen-year altimetry data set.

2. REFERENCE DOCUMENTS

The following Government and commercial documents support the requirements described in this document.

Government Documents

GLAS Instrument Description Document, dated October 24, 1997
GLAS Functional Requirements Document, dated TBD
LAM Mission Operations Concept, dated TBD
TAURUS Launch Vehicle Payload User's Guide, dated March 29, 1996
ATHENA-2 Launch Vehicle Payload User's Guide, dated TBD
TurboRogue Space Receiver Instrument Interface Description, dated 17 September, 1997
MIL-STD-461, Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility, dated 11 January 1993

MIL-STD-1246C, Product Cleanliness Levels and Contamination Control Program

CCSDS 100.0-G-1: Telemetry Summary of Concept and Rationale. Green Book. Issue 1. December 1987

(Offeror to add documents as needed, but valid references only, no boilerplate)

Commercial Documents

(Offeror to add documents as needed, but valid references only, no boilerplate)

3.

SPACECRAFT PERFORMANCE CHARACTERISTICS

In this section, the Offeror shall first identify the proposed core system including any proposed options as originally offered under the RSD; the RSA "core system" as an integrated whole with any RSA "options" constitute the LAM spacecraft offered for the LAM implementation. No options (i.e. additional performance choices) to the LAM implementation are to be proposed in Section 6 of this specification as separate selectable offers – all such enhancements should be included in the proposed spacecraft by the Offeror.

The following sections on Observatory Level Performance and Spacecraft Performance are the minimum set of performance characteristics required for the LAM Spacecraft performance specification. The Offeror is ***strongly*** *encouraged to provide any additional performance characteristics which will provide understanding of the proposed spacecraft, beyond those characteristics outlined here. The Offeror shall add additional text wherever needed to completely define the spacecraft performance.*

The LAM spacecraft performance characteristics are given in the following sections in terms of Observatory performance, and spacecraft performance.

3.1. OBSERVATORY PERFORMANCE

The Observatory performance requirements include:

- Launch Vehicle Compatibility
- Orbit Compatibility/Constraints
- Cleanliness Levels Achieved
- Design Lifetime.

Each is expanded upon in the following sections.

3.1.1. Launch Vehicle Compatibility

The Observatory shall be compatible with either or both of the following:

a. Launching LAM on a TAURUS XL procured by the Government. The Offeror shall show Observatory compatibility with the TAURUS XL launch environment, the 2,337 mm (92 inch) fairing, and the Model 3881 payload attach fitting.

b. Launching LAM on an LMLV- 2 (Athena-2) procured by the Government. The Offeror shall show Observatory compatibility with the LMLV-2 launch environment, 92 inch fairing, and payload attach fitting.

Link the text in this Section with CDRL 4, Launch Vehicle Documentation.

3.1.2. Orbit Compatibility/Constraints

The Offeror shall show the proposed Observatory is compatible with the LAM orbit element mean values shown in Table 3-1. The Offeror may recommend using a parking orbit, and fully define the mission affects. Following trim maneuvers to correct the initial injection orbit, the first 90 (TBR) days of the mission will be spent in the calibration orbit shown in Table 3-1, having exact ground repeats every eight days. At the completion of the calibration period, the spacecraft shall maneuver to the final mission orbit which has an exact ground track repeat every 2,723 revolutions (183 days). The perigee is at the northernmost latitude (a "frozen" orbit). The coordinate system is True-of-Date, Earth equator and equinox.

Table 0-1
LAM ORBIT ELEMENTS

ELEMENT	CAL. ORBIT MEAN VALUES	MISS. ORBIT MEAN VALUE
Semi-major axis	6971.5 km	6970.0 km
Eccentricity	0.0013	0.0013
Inclination	94°	94°
Right Ascension of the Ascending Node	66.381° (TBR)	66.381° (TBR)
Argument of Perigee	90°	90°
Mean Anomaly	0° (TBR)	0° (TBR)

The ground tracks of both the calibration and mission orbits shall be maintained to an accuracy of ✂800 m (E and W) of a reference track (no drag repeat cycle), as defined in Paragraph 3.2.3.3.

3.1.3. Cleanliness Levels Required

If CDRL 17, Contamination/Cleanliness Control Plan completely defines the Offeror's approach, enter no text in Section 3.1.3 except for a reference to the CDRL.

The Offeror shall present how the following cleanliness requirements of assembly, integration and test environment, handling, particulate control, molecular control, CVCMs, and NVRs will be met, including a description of facilities available, contamination control techniques, monitoring techniques (witness plates, wipes, analysis techniques, etc.), validation, and cleaning.

The spacecraft shall conform to the following requirements for:

- Assembly, integration and test environment
- Handling
- Particulate and molecular control: surface and material cleanliness.

The requirements for each of these are detailed in the following paragraphs.

3.1.3.1. Assembly, Integration and Test Environment

After GLAS is integrated with the spacecraft, the Observatory environment shall be held to Class 10,000 cleanliness levels at all times. If testing of the Observatory outside of cleanroom environments is unavoidable, the Observatory shall be completely bagged, tented, and purged at all times while outside of the cleanroom.

3.1.3.2. Handling

The LAM instrument shall be handled to Class 1,000 cleanliness levels (gowns, masks, gloves, air flow, etc.) at all times, including when integrated with the spacecraft.

3.1.3.3. Particulate and Molecular Control

The particulate and molecular processes and controls during assembly and integration shall be maintained to assure the GLAS external surfaces, maintained by the Instrumenter at level 500A, will not be compromised by the spacecraft. Specifically, the Offer shall ensure:

a. Materials used do not exceed 1% Total Mass Loss, with no absorption bands at 1064 and 532 nm

b. Materials used do not exceed 0.1% Collected Volatile Condensable Materials, with no absorption bands at 1064 and 532 nm

c. Any surfaces with line-of-sight to critical surfaces do not result in molecular or particulate redistribution to the critical surfaces.

d. The cleanliness of subassemblies, MLI, solar arrays, structures, and harnessing will be assured by controls such as:

1. Vacuum bakeout to 150 Hz/hr on a 15 MHz TQCM
2. Particulate cleanliness level 750 maintained per MIL-STD-1246B
3. Molecular cleanliness level A maintained per MIL-STD-1246B

e. On-orbit spacecraft venting is controlled to avoid contaminating critical surfaces.

These processes and controls are described in Section 5 of the LAM Mission Implementation Specification.

3.1.4. Design Lifetime

The Offeror shall show that the spacecraft design lifetime is compatible with the GLAS three year mission requirement and five year goal.

The Offeror shall add text wherever needed in this section to completely define the spacecraft design lifetime.

3.1.4.1. Three Year Design Lifetime

The minimum spacecraft Probability of Success (P_s) for a three year mission lifetime shall be 0.85.

3.1.4.2. Five Year Design Goal

The spacecraft expendable materials (fuel, battery, EOL solar array performance, MLI blankets with respect to atomic oxygen and radiation, etc.) shall support the five year mission lifetime goal.

3.2.

SPACECRAFT PERFORMANCE

The Spacecraft Performance characteristics include:

- Mass Characteristics
- Electrical Payload Power
- Propulsion Performance
- Attitude Control Performance
- Command and Data Handling Performance
- Communications Performance
- Thermal Control
- Electrical
- Radiation Tolerance.

Each performance characteristic is discussed in a following section.

3.2.1. Mass Characteristics

The Offeror shall describe here the mass characteristics of the Observatory showing how they meet the static, dynamic, and field of view needs of the instrument (as defined in paragraph 5.1.1) and spacecraft, through the launch and mission environments.

3.2.2. Electrical Payload Power

The Offeror shall describe here the characteristics of the electrical payload power proposed to support the instrument (as defined in paragraph 5.2.1) and the spacecraft throughout the mission life.

3.2.3. Propulsion Performance

The spacecraft propulsion shall provide for injection error correction and attaining the calibration orbit, attain mission orbit, ground track maintenance, minimal platform disturbance, and re-entry according to the following paragraphs. Thruster plumes shall not impinge on the GLAS optics.

The Offeror shall add text wherever needed in this section to completely define the spacecraft propulsion performance. State the solar flux levels assumed.

3.2.3.1. Injection Error Correction and Attaining Calibration Orbit

The spacecraft shall correct for the three-sigma dispersion errors of the launch vehicle as defined by the launch vehicle prime contractor, to correct the initial injection orbit and achieve the calibration orbit defined in Table 3-1 within three days of launch.

Note that the GLAS star camera and inertial reference unit will not be powered-on during initial orbit acquisition.

3.2.3.2. Attain Mission Orbit

The spacecraft shall attain the mission orbit defined in Table 3-1 within 7 (TBR) days after the 90-day calibration and verification period in the calibration orbit is completed.

3.2.3.3. Ground Track Maintenance

The spacecraft shall assure that the Observatory ground track at the equator be kept within ✂800 m (East and West) of the ideal reference track (no-drag repeat cycle), for all equatorial crossings once the calibration orbit of Table 3-1 is achieved, for the entire remaining five-year life of the mission.

3.2.3.4. Platform Disturbance

Platform disturbances during critical science-gathering shall be avoided. Orbit adjustments (maneuvers) shall not occur:

a. More than twice per week
b. Over Antarctica
c. Above 60☜ latitude on a track which will descend over Greenland.

This requirement will be waived for critical ground contacts any time in the mission when real-time contact with the Observatory is required during maneuvering for safety.

3.2.3.5. Re-Entry

The Offeror shall show how the laser altimetry mission is expected to re-enter the atmosphere within 25 years after the completion of the five-year mission performance goal.

3.2.4. Attitude Control Performance

The spacecraft shall provide safe-hold operation and real-time attitude control and knowledge in accordance with the GLAS requirements in the following paragraphs. The axes shall be as defined in the GLAS Instrument Description Document.

The Offeror shall add text wherever needed in this section to completely define the spacecraft attitude control performance.

3.2.4.1. Safe-Hold Operation

The spacecraft shall autonomously enter safe-hold operation upon detecting a mission-threatening fault. *A stable Observatory attitude during safe-hold operation would be characterized by the ability to ensure the following are maintained indefinitely:*

a. Battery temperatures are maintained within operating limits
b. The spacecraft acquires and holds solar array sun pointing
c. Keep-alive power is provided to GLAS (as defined in Section 5.2.1.2)
d. All essential spacecraft loads are maintained
e. The spacecraft is configured to receive and process ground commands
f. The S Band transmitter is enabled and ready to transmit to the ground
g. The GLAS thermal radiator does not conduct heat to the instrument.

Note that the GLAS star camera and inertial reference unit will not be powered-on during safe-hold operation.

3.2.4.2. Attitude Control

The spacecraft attitude control during science operations shall meet the following requirements:

a. The spacecraft shall provide attitude control in the roll and pitch axes to ✂100 ☞r (1 ☞) accuracy of the commanded pointing, which shall be local geodetic nadir (i.e. perpendicular to the ellipsoid) or any other commanded position within ✂5 degrees of local geodetic nadir.

b. The spacecraft shall provide attitude control in the yaw axis to better than ✂17 mr (1☞) to maintain thermal and power control.

Note that the GLAS star camera and inertial reference unit will not be powered-on during initial orbit acquisition.

3.2.4.3. Attitude Knowledge

The spacecraft shall provide real-time attitude knowledge of better than ✂50 ☞r (1☞) precision in all axes during science operations.

Note that the GLAS star camera and inertial reference unit will not be powered-on during initial orbit acquisition.

3.2.4.4. Observatory Slew Rate

As an exception to maintaining pointing at nadir, the Observatory shall be capable of off-nadir pointing by slewing in accordance with the following paragraphs:

a. The spacecraft shall be capable of slewing the Observatory at not less than ✂ 10 degrees per minute about the roll and pitch axes by stored command and on-board programmed track (trigonometric algorithm or look-up table), to a maximum of 5 degrees off-nadir pointing.

b. Roll and pitch slews shall be performed one axis at a time, returning to local geodetic nadir pointing before the next slew

c. The spacecraft shall achieve the control and knowledge requirements of Paragraphs 3.2.4.2 and 3.2.4.3 within 10 (TBR) seconds after completion of an Observatory slew.

d. The spacecraft shall have a back-up stored command to return to local geodetic nadir pointing from off-pointing, in the event no return-to-nadir command is executed within 90 TBR minutes of a slew.

e. The spacecraft shall slew about the yaw axis no more than once every seven days for solar array positioning. To minimize platform disturbances during critical science-gathering, yaw slewing shall not be performed between 60☜ and 90☜ latitude (North and South).

3.2.4.5. Center of Gravity Knowledge

The Offeror shall provide the models, parameters, and telemetry points to support ground calculations of the Observatory center of gravity location migration with respect to the Observatory coordinates, with near real-time knowledge resolution of ✂5 mm, throughout the mission life.

3.2.4.6. Orbital Position Knowledge

The spacecraft shall provide real-time orbital position knowledge with ✂50 m (1☞) radial accuracy consistent with the real-time GPS solutions.

3.2.4.7. Sun Exclusion

The spacecraft shall exclude the Sun from ✂30 degrees of the GLAS receiver telescope optical axis, from the time of fairing release to completion of the mission, including throughout all safe-hold operations (as defined in Section 5.2.1.2).

3.2.4.8. Maintaining Thermal Field-Of-View

The GLAS thermal radiator panel normal to the Observatory nadir requires a constant view of cold space as defined in Paragraph 5.1.1.5.c at all times during mission operations including back-loading effects from spacecraft structures. The backloading requirements are:

a. Incident Earth infrared energy shall be less than 66 W/m^2

b. Reflected solar energy, Earth infrared and albedo energy shall be less than 5 W

c. No direct thermal radiation or reflected environmental energy shall be provided by the spacecraft into the radiator (TBR).

3.2.5. Command and Data Handling Performance

The Offeror shall describe the command and data handling performance of the spacecraft which supports the GLAS command and data handling requirements (as defined in Section 5.2.2). Link this Section to CDRL 9, Telemetry and Command Requirements Document.

3.2.6. Communications Performance

The LAM Observatory shall be capable of communicating with the EOSDIS polar ground stations in compliance with the CCSDS format, at least four times per day as defined in the LAM Mission Operations Concept, given the orbit elements specified in Paragraph 3.1.2. The ground station characteristics are shown in Table 3-3. General communications performance, downlink, and uplink characterizations are in the following sections. *The Offeror shall add text wherever needed in this section to completely define the spacecraft communications performance. Link this Section with CDRL 5, Ground System Interface Control Document.*

Table 3-3
GROUND STATION CHARACTERISTICS

CHARACTERISTIC	Wallops WPSA	EPGS Plataberget Flat PLAT	EPGS Poker PKFT
Latitude	39.9270 deg	78.1300 deg	65.1170 deg
Longitude	284.525 deg	14.400 deg	212.5380 deg
Altitude	5 m	430 m	420 m
No. of Antenna	One	Two	One
Antenna Diameter	11.3 m	11.3 m	11.3 m
Autotrack through Zenith	Yes	Yes	Yes
Station Mask	5 deg	5 deg	5 deg
X Band G/T	None	35 dB/K	35 dB/K
S Band EIRP	96 dBW	96 dBW	96 dBW
S Band G/T	23 dB/K	23 dB/K	23 dB/K
P_s	0.99	0.99	0.99

3.2.6.1. General Communications Performance

For general communications performance, the spacecraft shall:

a. Incorporate zenith and nadir omni antenna coverage for S Band communication, to assure command and telemetry integrity with the ground when the Observatory is tumbling.

b. Be capable of simultaneously transmitting and receiving any combination of S Band downlink, X Band downlink, and S Band uplink signals.

c. Be capable of communicating with the ground when the spacecraft is maneuvering and when it is not.

3.2.6.2. Downlink

The spacecraft shall support the following downlink characteristics:

a. X Band (Science) Downlink:

Transmit rate: no less than 25 Mbps
Modulation: SQPSK
Format: CCSDS
Frequency band: X
EIRP: TBD W
Content:
- Playback and Real-time science data
- Playback and Real-time GPS solutions
- Playback and Real-time Spacecraft housekeeping
- Playback and Real-time GLAS housekeeping

Link Quality: $1x10^{-7}$ BER or better
Planned contacts:
- Time: four times per day (minimum)
- Duration: ten minutes, average
- Max Time Between Downlink Contacts: 10 TBR orbits

b. S Band (Real-Time Housekeeping) Downlink:

Transmit rate: up to 16 kbps (TBR)
Modulation: BPSK
Format: CCSDS
Frequency band: S
EIRP: TBD W

Content:
- Real-time GPS solutions

Real-time Spacecraft housekeeping
Real-time GLAS housekeeping
Link Quality: $1x10^{-7}$ BER or better
Planned contacts
Time: four times per day (minimum), nominally simultaneous with playback science
Duration: ten minutes, average

c. S Band (Housekeeping) Downlink:

Transmit rate: 512 kbps (TBR)
Modulation: BPSK
Format: CCSDS
Frequency band: S
EIRP: TBD W
Content:
Playback and Real-time GPS solutions
Playback and Real-time Spacecraft housekeeping
Playback and Real-time GLAS housekeeping
Link Quality: $1x10^{-7}$ BER or better
Planned contacts
Time: four times per day (minimum), nominally simultaneous with playback science
Duration: ten minutes, average

3.2.6.3. Uplink

The spacecraft shall support the following uplink characteristics:

Transmit rate: 2 Kbps (TBR)
Modulation: BPSK
Format: CCSDS
Frequency band: S
Content:
GLAS commands
Spacecraft commands
Flight software uploads including off-nadir programmed track tables and algorithms
GLAS processor uploads
Link Quality: $1x10^{-7}$ BER or better
Planned contacts:
Simultaneous with Primary and Contingency Downlink

3.2.7. Thermal Control

The spacecraft shall continuously monitor the GLAS temperature at twelve locations during safe-hold operations, whenever keep-alive power is applied (as defined in Section 5.2.1.2). The GLAS instrument is thermally isolated from the Spacecraft.

The Offeror shall add additional text wherever needed in this section to completely define the spacecraft thermal performance.

3.2.8. Electrical

The spacecraft electrical requirements are given in terms of EMI/EMC and ESD in the following sections.

The Offeror shall add additional text wherever needed in this section to completely define the spacecraft electrical performance.

3.2.8.1. EMI and EMC

The spacecraft shall comply with EMI and EMC performance stated in MIL-STD-461 for the following requirements:

a. CE01 (TBR)
b. CE02 (TBR)
c. RE01 (TBR)
d. RE02 (TBR)
e. CS01* (TBR)
f. CS02* (TBR)
g. CS03* (TBR)
h. RS01 (TBR)
i. RS02 (TBR)

* *In particular, the Offer shall show that the spacecraft power distribution bus is not susceptible to the reflected ripple from the pulsing of the GLAS laser. The Offeror may recommend and justify a different program of EMI/EMC testing.*

3.2.8.2. ESD

The GLAS instrument is ESD sensitive and shall be handled with due regard to avoiding electrostatic buildup by properly grounding connecting cables, work surfaces, equipment, and personnel.

The Offeror shall present the overall grounding scheme particularly addressing spacecraft structures and MLI.

3.2.9. Radiation Tolerance

The GLAS instrument is radiation tolerant to 40 Krad total dose, at the end of the five year mission.

The Offeror shall add additional text wherever needed in this section to completely define the spacecraft radiation tolerance.

4.

SUBSYSTEM CHARACTERISTICS

The offeror shall describe the spacecraft make-up to the component level. The description shall provide the basis for performance claims made in Section 3.0 and confirm the design margins. This section shall contain the equipment list or table originally submitted under the RSDO itemizing all core system components down to the subsystem "component level" (that is, core system structure, solar array, battery vessel and cell type and number, wire harness, star tracker etc., high-density boards and electronics should be itemized at the box level). For each component show as a minimum the typical manufacturer and model, mass, nominal power, and heritage.

The offeror is ***strongly*** *encouraged to provide any additional component characteristics which will help the Government understand the spacecraft offered, beyond those components outlined here.*

TABLE 4-1
Example Spacecraft Component Characterization Table

Component	*Typical Manufacturer, Model*	*Mass*	*Nominal Power*	*Heritage*

4.1. OVERALL SPACECRAFT ARCHITECTURE

The Offeror shall define the spacecraft architecture including dimensioned launch and on-orbit configurations in the following suggested subsystems. Link this Section to CDRL 7, As-Built Configured Item List.

Top-level features of the spacecraft include:

- Structural/Mechanical Subsystem
- Power Subsystem
- Propulsion Subsystem
- Attitude Control Subsystem
- C&DH Subsystem
- Communications Subsystem
- Thermal Control Subsystem
- Spacecraft Flight Software
- Spacecraft GSE
- *Not Applicable (formerly Optics)*
- *Not Applicable (formerly Cryogenics).*

Each of these is defined fully in the following sections.

4.1.1. Structural/Mechanical Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft structural/mechanical subsystem.

4.1.2. Power Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft power subsystem.

4.1.3. Propulsion Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft propulsion subsystem.

4.1.4. Attitude Control Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft attitude control subsystem.

The Offeror shall include incorporation of the Government-provided two flight GPS units, one engineering unit, two antennae, and two cables.

4.1.5. C&DH Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft C&DH subsystem.

4.1.6. Communications Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft communications subsystem.

4.1.7. Thermal Control Subsystem

The Offeror shall add text wherever needed in this section to completely define the spacecraft thermal control subsystem.

4.1.8. Spacecraft Flight Software

The Offeror shall add text wherever needed in this section to completely define the spacecraft flight software, including implementation of the attitude control off-nadir programmed track.

4.1.9. Spacecraft Ground Support Equipment

The Offeror shall add text wherever needed in this section to completely define the spacecraft ground support equipment.

5.

PAYLOAD ACCOMMODATIONS

This section shall describe how the Spacecraft accommodates, interfaces with, and operates the GLAS payload. The Offeror shall define the payload interface with enough detail to be used as a preliminary interface design document. Link this Section with CDRL 3, Instrument Interface Control Document.

Payload accommodation includes:

- Physical Requirements
- Electrical Power and Signals/Data Interface
- Software Applications
- Payload Environmental Requirements
- Safety
- Ground Support Equipment
- Operational Factors.

Each is more fully defined in a following section.

5.1. PHYSICAL REQUIREMENTS

5.1.1. Mass Characteristics

The Spacecraft shall be compatible with the maximum limits of the GLAS mass and physical characteristics defined in the following paragraphs, with the frame of reference as shown in the GLAS Instrument Description Document.

5.1.1.1. Maximum Mass

The spacecraft shall support a GLAS mass that does not exceed 300 kg, which includes the mass of the GLAS mounting structure.

5.1.1.2. CG Location

The location of the GLAS center of gravity will not exceed the following envelope (with respect to the GLAS coordinate system, see the GLAS Instrument Description Document):

$$X = -130 \pm 70 \text{ mm}$$
$$Y = 107 \pm 70 \text{ mm}$$
$$Z = 288 \pm 70 \text{ mm}$$

5.1.1.3.

MOI Envelope

The mass moments of inertia for the GLAS instrument will not exceed the following maximum values measured about the GLAS center of mass:

$$I_{XX} = 38272 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$
$$I_{YY} = 29954 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$
$$I_{ZZ} = 28114 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$
$$I_{XY} = -888 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$
$$I_{YZ} = 2863 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$
$$I_{XZ} = -8400 \text{ kg} \cdot \text{mm}^2 \pm 10\%$$

5.1.1.4. Footprint and Mounting

The suggested footprint and mounting structure for the GLAS instrument are shown in the Instrument Description Document.

5.1.1.5. Fields Of View

The GLAS nadir, zenith, and thermal field of view requirements are given in the following paragraphs.

a. Nadir Fields Of View

The spacecraft shall provide:

1. An unobstructed optical field of view of 0.4 mr about nadir for the GLAS receiver telescope

2. An unobstructed optical field of view of ± 60 degrees about nadir for the GLAS satellite laser reflector.

b. Zenith Fields Of View

The spacecraft shall provide:

1. An unobstructed glint-free optical field of view of 8 degrees about zenith for the GLAS stellar reference system.

2. An unobstructed RF field of view of 2π sr about zenith for the GPS antenna.

c. Thermal Field Of View

The spacecraft shall provide an unobstructed 2π sr view of cold space normal to the Observatory nadir for the GLAS thermal radiator.

5.1.1.6. Spacecraft Dynamics

The spacecraft contributions to platform stability for structural modes and jitter spectrum are given in the following paragraphs.

a. Structural Modes and Design Loads

The GLAS instrument has a minimum first fundamental frequency of 75 Hz when mounted to a rigid interface via flexures. The net CG quasi-static flight level loads are ± 12 g in each of three orthogonal axes acting independently. The spacecraft shall not couple loads that exceed the net CG quasi-static flight level loads.

b. Jitter Spectrum

The maximum allowable jitter spectrum at the spacecraft interface with GLAS shall not exceed either the thrust (X) direction acceleration requirement shown in Table 5-1, or the lateral (Y and Z) direction acceleration requirements shown in Table 5-2. *The Offeror shall address the jitter affects of such contributors as thermal snap, solar array drives, and momentum wheel zero crossings.*

Table 0-1
Allowable Trust Direction Jitter at GLAS Interface

Frequency (Hz)	Input (m g)
0.0	30.0
10.0	30.0
50.0	1.5
300.0	1.5

Table 0-2
Allowable Lateral Direction Jitter at GLAS Interface

Frequency (Hz)	Input (m g)
0.0	20.0
20.0	20.0
70.0	0.8
150.0	0.8
200.0	1.5
300.0	1.5

5.2. ELECTRICAL POWER, DATA AND COMMAND INTERFACE

The spacecraft shall interface with the GLAS instrument for power and signals in accordance with the following sections.

5.2.1. Electrical Payload Power

The Spacecraft shall supply GLAS primary and keep-alive power, for both orbit characteristics defined in Paragraph 3.1.2, for the five-year mission goal.

5.2.1.1. Primary Payload Power

The spacecraft shall provide primary payload power on six separate individually switched (TBR) and unfused feeds, with the following characteristics:

a. One power feed for each of the three GLAS lasers, at 100 Watts each, (energizing any of these three feeds by the spacecraft shall be the indication of "Laser On"). Each laser has a turn-on inrush current of 5 Amps for 5 TBR milliseconds. Each laser also has a thermal control circuit with a 5 TBR W start-up load for 30 TBR seconds.

b. The spacecraft shall power only one laser at a time, based on commands from the ground, and only during a ground contact.

c. One power feed for the GLAS star camera at 15 TBR Watts.

d. One power feed for the GLAS inertial reference unit at 50 TBR Watts.

e. One power feed for the GLAS electronics subsystem at 135 TBR Watts.

f. Provide 300 Watts total for all six feeds, continuous orbit power to the GLAS payload, at 28 V ±6 V.

g. Provide peak power of TBD Watts total primary power (heater increment) for all six feeds.

h. To preserve the ultimate mission integrity, the spacecraft shall be able to shed the entire primary GLAS power autonomously, without prior coordination with GLAS nor with the EOSDIS and LAM ground operations. GLAS primary power shall be shed for all six feeds at once, not by individual power distributions.

The GLAS instrument provides its own power conditioning.

5.2.1.2. Keep-Alive Power Feed (Safe-Hold Operation)

At all times whenever primary GLAS power is not provided, the spacecraft shall provide not more than 50 (TBR) Watts at 28 V ± 6 V keep-alive power, provided on a separate switched power feed from the primary power feeds, to protect GLAS. GLAS keep-alive power is not required prior to spacecraft initialization (that is, through launch and orbit injection). Note that the GLAS laser crystals suffer hard and irrevocable failure when cooled below their minimum non-operating temperature limit.

5.2.2. Command and Data Handling Performance

The spacecraft command and data handling shall support the requirements in the following paragraphs. *Link this Section with CDRL 5, Ground System Interface Control Document, CDRL 9, Telemetry and Command Requirements Document, and CDRL 10, Flight Operations Support Plan.*

5.2.2.1. Data Handling Performance

The spacecraft data handling shall be in accordance with the following requirements. Synchronization of data transfer from GLAS to the spacecraft shall be referenced to the 1 Hz (TBR) GPS toc pulse.

a. Dedicated GPS Channels

The spacecraft shall provide:

1. A dedicated data channel in the downlink containing the spacecraft GPS solutions, to support ground station range and target calculations.

2. A dedicated data channel to GLAS containing the spacecraft GPS solutions

3. A dedicated conditioned signal line to GLAS containing the 1 Hz (TBR) GPS toc signal.

b. Data Handling Integrity

The spacecraft shall be capable of:

1. Storing without error or data loss, all GLAS science and housekeeping data generated over the previous ten (TBR) orbits.

2. Playing back and transmitting downlink at a scheduled contact, recorded GLAS science and housekeeping data for any given interval over the preceding ten (TBR) orbit's time (for example, playback data over particular latitudes, data for a particular orbit portion, specific time-tagged data blocks).

3. Storing and playing back data simultaneously without data loss.

4. Transmitting downlink any one of the following combinations:

    a. Playback and real-time science and housekeeping data
    b. Playback and real-time housekeeping data
    c. Real-time housekeeping data.

c. GLAS Data Generation

The spacecraft shall ingest the total GLAS science and housekeeping described in the following paragraphs.

1. Three RS-422 data lines at a continuous rate of TBD kbps (science).

2. One MIL-STD-1553 data bus at 300 kbps (housekeeping).

The GLAS star camera and inertial reference unit data is available on one of the RS-422 lines for spacecraft use.

5.2.2.2. Command Performance

Synchronization of the signals from the spacecraft to GLAS shall be referenced to the 1 Hz (TBR) GPS toc pulse. The commands for GLAS from the spacecraft shall be in accordance with the following requirements:

a. The spacecraft shall provide primary power to the GLAS instrument only by real-time or stored ground command.

b. The spacecraft shall support the command rates, format, and content defined in the GLAS Functional Requirements Document, over the MIL-STD-1553 data bus.

c. Certain ground commands and command sequences for the GLAS instrument shall be stored on the spacecraft.

5.3. SOFTWARE APPLICATIONS

The Offeror shall describe how the spacecraft software accommodates and supports payload commanding, science and housekeeping data, and other operational functions for the mission lifetime (for example, attitude control off-nadir programmed track tables, stored command processing and executing, data compression, downlink packetizing, safe-hold monitoring, etc.).

5.4. PAYLOAD ENVIRONMENTAL REQUIREMENTS

The GLAS instrument shall remain bagged and purged at all times prior to spacecraft integration to assure a Class 1,000 environment. During and after integration, the spacecraft and instrument shall be maintained in a Class 10,000 clean environment, while all handling and personnel requirements will in accordance with Class 1,000. The GLAS instrument shall be kept in a climate-controlled environment maintained between 18° C and 24° C, at 40% to 60% relative humidity.

Link this Section with CDRL 17, Contamination/Cleanliness Control Plan.

5.5. SAFETY

The GLAS requirements for orbital debris mitigation and ground operations of the laser are described in the following sections. GLAS and its GSE contain no hazardous materials.

5.5.1. Orbital Debris Mitigation

The Offeror shall show the approach toward mitigating orbital debris from launch vehicle release through operations, to the end of the mission and re-entry.

5.5.2. Ground Laser Operation

The Offeror shall show safety plans for spacecraft operations during MSI&T with regard to eye safety and laser operation (including hardware interlocks on the GSE, multiple switches, use of eyesafe bays, etc.), for the situations described in the GLAS-Spacecraft Integration Plan.

THE GLAS LASER WILL BE OPERATED AT FULL TRANSMIT POWER AT SPECIFIC TIMES DURING OBSERVATORY I&T, INCLUDING THERMAL/VACUUM TESTING

The spacecraft shall immediately detect, and convey to the ground station via telemetry at the current contact (or the next contact if not currently in contact), the hazardous condition "**Laser On**" based on any one of the following three situations:

a. Power On commanded to any one of the laser busses
b. Voltage detected on any one of the laser busses
c. Current detected on any one of the laser busses

5.6. GROUND SUPPORT EQUIPMENT

Specific elements of the GLAS GSE requires the same cleanliness handling as the instrument as specified in Section 3.1.3.

5.7. OPERATIONAL FACTORS

If CDRL 10, Flight Operations Support Plan, completely defines the Offeror's approach, enter no text in Section 5.7 except for a reference to the CDRL.

The Offeror shall define the Observatory operational factors, including:

- *Test Scenarios*
- *Mission Simulations: Commanding & Telemetry recovery*
- *End-To-End Testing*
- *Operational duty cycle and availability*
- *Compatibility Testing with the EOS Ground System and the Test Van*
- *Testing with the EOS Ground System at the Launch Site*
- *Offeror support at the EOS Operations Center during Launch and early orbit*
- *Flight Software Maintenance*
- *Mission Operations Training*
- *Ground Calibration.*

The Offeror shall link any text in this Section to CDRL 8, Spacecraft Operations Description Manual, CDRL 11, Observatory Launch Site and Operations Test Plan, and CDRL 12, Observatory Launch Site Operations and Test Procedures.

6. OPTIONS

The Government will select between the TAURUS XL and LMLV-2 vehicle no later than three months After Receipt of Order (ARO).

7.

MISCELLANEOUS

The following table maps the paragraphs in the Spacecraft Performance Specification to the CDRL items they reference.

SPECIFICATION/CDRL MATRIX

PERFORMANCE SPECIFICATION	CDRL
3.1.1 Launch Vehicle Compatibility	4 Launch Vehicle Documentation
3.1.3 Cleanliness Levels Required	17 Contamination/Cleanliness Control Plan
3.2.5 Command and Data Handling Performance	9 Telemetry and Command Req Document
3.2.6 Communications Performance	5 Ground System ICD
4.1 Overall Spacecraft Architecture	7 As Built Configuration Item List
5 Payload Accommodations	3 Instrument Interface Control Document
5.2.2 Command and Data Handling Performance	5 Ground System ICD 9 Telemetry and Command Req Document 10 Flight Operations Support Plan
5.4 Payload Environmental Requirements	17 Contamination/Cleanliness Control Plan
5.7 Operational Factors	8 S/C Operations Description Manual 10 Flight Operations Support Plan 11 Observatory Launch Site Ops & Test Plans 12 Observatory Launch Site Ops & Test Procs

The following table maps the CDRL items to the Spacecraft Performance Specification paragraphs where they are referenced.

CDRL/SPECIFICATION MATRIX

CDRL	PERFORMANCE SPECIFICATION
3 Instrument Interface Control Document	5 Payload Accommodations
4 Launch Vehicle Documentation	3.1.1 Launch Vehicle Compatibility
5 Ground System ICD	3.2.6 Communications Performance 5.2.2 Command and Data Handling Performance
7 As Built Configuration Item List	4.1 Overall Spacecraft Architecture
8 S/C Operations Description Manual	5.7 Operational Factors
9 Telemetry and Command Req Document	3.2.5 Command and Data Handling Performance 5.2.2 Command and Data Handling Performance
10 Flight Operations Support Plan	5.2.2 Command and Data Handling Performance 5.7 Operational Factors
11 Observatory Launch Site Ops & Test Plans	5.7 Operational Factors
12 Observatory Launch Site Ops & Test Procs	5.7 Operational Factors
17 Contamination/Cleanliness Control Plan	3.1.3 Cleanliness Levels Required 5.4 Payload Environmental Requirements

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT E

MISSION IMPLEMENTATION REQUIREMENTS

RAPID SPACECRAFT PROCUREMENT REQUEST FOR OFFER

EOS LASER ALTIMETRY MISSION MISSION IMPLEMENTATION REQUIREMENTS

11/12/97

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EOS LASER ALTIMETRY MISSION
MISSION IMPLEMENTATION REQUIREMENTS

The offeror shall generate a mission-specific LAM Implementation Specification compliant with this format, augmenting the text given here with implementation specifications for the proposed core system and integrated options, as directed below. The Offeror may interpret and tailor LAM requirements marked "TBR" to best fit their spacecraft and still meet the mission performance requirements. ***The Offeror shall delete all italicized text****.*

1. SCOPE

This document defines the implementation requirements for the Laser Altimetry Mission (LAM) spacecraft. The requirements are presented in the following categories:

- Program Management
- System Engineering
- Contamination Control
- Mission Performance Verification
- Core System Integration and Test
- Observatory Integration and Test
- Storage, Transportation and Handling
- Observatory Launch Site and Operations
- Operational Flight Software Maintenance
- Operations Support and Transition
- Miscellaneous.

The Offeror is ***strongly*** *encouraged to provide any additional mission implementation characteristics which will help the Government understand the mission-specific implementation offered, beyond those outlined here.*

2. REFERENCE DOCUMENTS

The following Government and Commercial documents support parameters or processes defined in this specification.

Government Documents

(Offeror to add documents as needed, but valid references only, no boilerplate)

Commercial Documents

(Offeror to add documents as needed, but valid references only, no boilerplate)

3.

PROGRAM MANAGEMENT

Complete the following program management activities in enough detail to provide an understanding of how the implementation effort specific to the Laser Altimetry Mission will be monitored, resources assigned and managed, and progress determined and reported. The Offer SHALL NOT include photographs or maps of facilities – simple descriptions are sufficient.

The program management activities are:

- Mission Specific Delivery Order Management (Special Studies)
- Scheduling and Program Control
- Quality Management
- Documentation Systems
- Reviews and Audits
- Government Insight
- Subcontract Management
- Risk Management
- Resource Management (Staffing, Facilities, etc.)
- Implementation Schedule.

Each activity is described in the following paragraphs.

3.1. Mission Specific Delivery Order Management (Special Studies)

The Government will, from time to time, identify special study topics for the offer to price as additional tasks under contract line item 4, Non-Standard Services. Studies approved by the Government will be performed during the first year of the delivery order. Study topics may include but are not limited to:

- *Suggested GLAS Footprint and Mounting*
- *GPS Multipath Affects*
- *Coupled Loads*
- *Observatory POD Factors*
- *S Band TDRS Link*
- *GLAS Data Generation and Interface*
- *Accomplishing programmed track slew in pitch and roll axes*
- *Additional Studies; Offeror Recommendations.*

The Offeror shall add new text wherever needed in this section to completely define the special study approach for LAM.

3.2. Scheduling and Program Control

The Offeror shall add new text wherever needed in this section to completely define the original RSA scheduling and program control approach for LAM.

3.3. Quality Management

The Offeror shall add new text wherever needed in this section to completely define the original RSA quality management approach for LAM. If the LAM approach is the same as the Offeror's Quality Manual previously submitted for the RSA core system, state that here and add no text.

3.4. Documentation Systems

The Offeror shall add new text wherever needed in this section to completely define the original RSA documentation systems for LAM.

3.5. Reviews and Audits

The Offeror shall add new text wherever needed in this section to completely define the original RSA reviews and audits for LAM.

3.6. Government Insight

The Offeror shall add new text wherever needed in this section to completely define the original RSA Government insight for LAM.

3.7. Subcontract Management

The Offeror shall add new text wherever needed in this section to completely define the original RSA subcontract management approach for LAM.

3.8. Risk Management

The Offeror shall add new text wherever needed in this section to completely define the original RSA risk management approach for LAM.

3.9. Resource Management *(Staffing, Facilities, etc.)*

The Offeror shall add new text wherever needed in this section to completely define the original RSA resource management approach for LAM.

3.10.

Implementation Schedule

The following milestones requiring Offeror support shall be reflected in the Offeror's LAM implementation schedule. The Offeror may wish to attend italicized events marked *(info only)*:

MILESTONE	DATE CONSTRAINT	SITE
Launch Vehicle Selection	Within 3 months ARO	GSFC
MTPE Confirmation Review	*April - May 1998*	*GSFC (info only)*
S/C-GLAS Data Simulator .	4 months ARO (TBR)	FOB Offeror's Site
GLAS-S/C Work Group	4 to 6 months ARO	GSFC or Offeror
MDR	Within 9 to 11 months ARO (TBR)	Offeror's Site
GPS Engr Model Avail.	November 1998 (TBR)	Offeror's Site
GPS Flight Model Avail.	January 1999 (TBR)	Offeror's Site
GLAS CDR	*February 1999*	*GSFC (info only)*
MTPE IAR	*April 1999 (TBR)*	*GSFC (info only)*
GF GLAS Data Simulator	May 30, 1999 (TBR)	FOB GSFC
S/C Drill Template Avail.	Mid 1999 (TBR)	FOB Offeror's Site
GF GLAS Mass Model	Mid 1999 (TBR)	FOB GSFC
S/C-to-Ground Simulator	July, 1999 (TBR)	FOB Offeror's Site
MOR	Approx L -18 months (~12/99)	GSFC
MTPE IAR	*April 2000 (TBR)*	*GSFC (info only)*
GLAS PER	*July 2000*	*GSFC (info only)*
S/C IIRR	2 to 4 weeks before GLAS Delivery	Offeror's Site
GLAS PSR	September 2000	GSFC
GLAS Delivery	October 30, 2000 (TBR)	FOB GSFC
Observatory PER	2 to 4 weeks before Qualification Testing	Offeror's Site
FOR	Approx L - 3 months (~3/01)	GSFC
MTPE IAR	*April 2001 (TBR)*	*GSFC (info only)*
PSR	No later than L - 2 months (~5/01)	Offeror's Site
Launch Readiness	July 1, 2001	WTR
SYSTEM ACCEPTANCE	L + 30 days	GSFC

Acronyms & Abbreviations

Avail.	Available	*Info*	Information
ARO	After Receipt of Order	L	Launch
CDR	Critical Design Review	MDR	Mission Design Review
FOB	Free On Board	MOR	Mission Operations Review
FOR	Flight Operations Review	MTPE	Mission To Planet Earth
GF	Government Furnished	PER	Pre-Environmental Review
GLAS	Geoscience Laser Altimetry System	PSR	Pre-Ship Review
GPS	Global Positioning System	S/C	Spacecraft
GSFC	Goddard Space Flight Center	TBR	To Be Reviewed
IAR	Independent Annual Review	WTR	Western Test Range
IIRR	Instrument Integration Readiness Review		

4. SYSTEMS ENGINEERING

The Offeror shall add new text to the original RSA proposal as necessary to define how the following systems engineering activities are accomplished, with enough detail to provide an understanding of how the requirements will be defined and allocated, and the interfaces defined and maintained, as well as the approach toward specialty areas such as reliability, safety, and configuration management.

The systems engineering activities are:.

- Requirements Analysis
- Interface Definition and Maintenance
- Reliability Analysis
- Safety
- Configuration Management
- Instrument and Mission Accommodations
- Mission Design and Analysis
- Failure Modes and Effects Analysis.

Each is discussed in a following section.

4.1. Requirements Analysis

The Offeror shall add new text wherever needed in this section to completely define the original RSA requirements analysis approach for LAM.

4.2. Interface Definition and Maintenance

The Offeror shall add new text wherever needed in this section to completely define the original RSA interface definition and management approach for LAM. Link this section to CDRL 2, External Interfaces, Models and Analysis.

The Offeror shall provide a certified high-fidelity drill template for the GLAS mounting bracket which defines the size and location of the mounting bolts, as well as the instrument alignment.

The Offeror shall provide a Spacecraft-to-GLAS Data Simulator which duplicates the GLAS electrical interface with the spacecraft in terms of primary and keep-alive power, primary power feeds, data protocols and clocking. The simulator will be used to verify the interface electrical performance with the Spacecraft prior to instrument delivery.

The Offeror shall provide a Spacecraft-to-Ground Data Simulator which duplicates the uplink and downlink content with the ground segment in terms of telemetry framing, GPS solutions channel, CCSDS protocol and formats, housekeeping data, etc. The simulator will be used to verify the data interface performance with the EOSDIS.

The Government will provide a GLAS Data Simulator which duplicates the electrical interface with the spacecraft in terms of GLAS primary and keep-alive power loads, data generation, and command ingest. The simulator will be used to verify the spacecraft interface electrical performance prior to instrument delivery.

The Government will provide a certified high-fidelity GLAS mass model which the Offeror shall use during spacecraft vibration testing to confirm the magnitude of spacecraft coupled loads to the GLAS instrument. The mass simulator will not, except for its mounting baseplate, be a form and fit model of the GLAS instrument.

4.3. Reliability Analysis

The Offeror shall add new text wherever needed in this section to completely define the original RSA reliability analysis approach for LAM.

4.4. Safety

The Offeror shall add new text wherever needed in this section to completely define the original RSA safety approach for LAM, consistent with the performance given in the Spacecraft Performance specification, paragraph 5.5.

4.5. Configuration Management

The Offeror shall add new text wherever needed in this section to completely define the original RSA configuration management approach for LAM. Link this section to CDRL 15, Engineering Change Proposals (ECPs), Deviations and Waivers.

4.6. Instrument and Mission Accommodations

The Offeror shall add new text wherever needed in this section to completely define the original RSA instrument and mission accommodations approach for LAM.

4.7. Mission Design and Analysis

The Offeror shall add new text wherever needed in this section to completely define the original RSA mission design and analysis approach for LAM.

4.8. Failure Modes and Effects Analysis

The Offeror shall add new text wherever needed in this section to completely define the original RSA failure modes and effects analysis approach for LAM. Link this section to CDRL 16, Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL).

5.

CONTAMINATION CONTROL

The Offeror shall describe the contamination control processes used to assure the levels defined in the Spacecraft Performance Requirements Document. If CDRL 17, Contamination/Cleanliness Control Plan, completely addresses the Offeror's approach enter no text in Section 5 and reference the CDRL.

6. MISSION PERFORMANCE VERIFICATION

The Offeror shall describe the mission performance verification approach, showing how appropriate spacecraft performance requirements will be verified and validated, before and after launch. If CDRL 1, Mission Performance Verification Plan, completely defines the Offeror's approach, enter no text in Section 6 except for a reference to the CDRL.

6.1. Core System Integration and Test, Observatory Integration and Test

The Offeror shall provide any new matrix or outline narrative beyond the RSD, if appropriate, showing the requirements traceability, as well as how and where each appropriate performance requirement of the spacecraft will be verified in the I&T flow. Identify the technique that accomplishes the verification (i.e. by analysis, test, inspection, or demonstration).

6.2. On-Orbit Verification

The Offeror shall provide a matrix or outline narrative showing where and how each appropriate performance requirement of the spacecraft will be verified after launch. Identify the technique that accomplishes each verification.

7. SPACECRAFT INTEGRATION AND TEST

The Offeror shall identify any change from the RSA text in the scope, purpose, sequence (test flow), and success criteria for the final spacecraft integration and test which leads to a completed core system ready for Instrument Integration. Include a definition of the test facilities, staffing and expendable supplies needed for the effort. If CDRL 6, Spacecraft and Observatory Integration and Test Plan, completely addresses the Offeror's approach, enter no text in Section 7 except for a reference to the CDRL.

As defined in Paragraph 4.2, the Government will provide a certified high-fidelity GLAS mass model which the Offeror shall use during spacecraft vibration testing to confirm the magnitude of spacecraft coupled loads to the GLAS instrument. The mass simulator will not, except for its mounting baseplate, be a form and fit model of the GLAS instrument.

As defined in Paragraph 4.2, the Government will provide a GLAS Data Simulator which duplicates the electrical interface with the spacecraft in terms of GLAS primary and keep-alive power loads, data generation, and command ingest. The simulator will be used to verify the spacecraft-to-GLAS interface electrical performance prior to instrument delivery.

As defined in Paragraph 4.2, the Offeror shall provide a Spacecraft to Ground data simulator to verify the data-level protocols and formats between the EOS Ground Segment and the Spacecraft.

8. OBSERVATORY INTEGRATION AND TEST

The Offeror shall describe any change from the proposed Observatory integration and test program in sufficient detail to present the scope, purpose, sequence (test flow), and success criteria, for each of the activities listed here (as appropriate, identify any of the listed test activities not offered with this implementation). Show where repeat activities (e.g. Spacecraft Full Functional Test, Observatory Full Functional Test) occur in the test flow to re-baseline system performance.

As a minimum, the Observatory level integration and test activities shall include:

- *Instrument Integration*
- *EMI/EMC/ESD Test*
- *Optical and Mechanical Alignments*
- *Magnetic Survey*
- *Attitude Control Subsystem Phasing*
- *Solar Array Integration (required only if integrated at the Observatory level)*
- *Flight Payload Attach Fitting Integration*
- *Mass Properties Measurements*
- *Vibration Test*
- *Acoustics Test*
- *Shock Test*
- *Solar Array Deployment*
- *Thermal Vacuum Test*
- *Thermal Balance Test*
- *Cleanliness, Control and Monitoring*
- *End-to-End Functional Test.*

If CDRL 6, Spacecraft and Observatory Integration and Test, completely addresses the Offeror's approach including use of the Government's Compatibility Test Van, enter no text in Section 8 except for a reference to the CDRL.

The following paragraphs expand on each test activity.

8.1. Instrument Integration

For the following activities, include also how the contractor's plans and procedures for GLAS integration will be coordinated with the Instrument representative.

The GLAS instrument shall be bagged and purged for contamination control during specific integration and test activities. Instrument integration requirements include:

- Responsibilities and Safety
- GLAS Delivery and Bench Check-Out
- Mechanical Integration
- Electrical Integration
- Instrument Comprehensive Test
- Controlling the GLAS radiator temperature.

Each is detailed in the following paragraphs.

8.1.1. Responsibilities and Safety

The GLAS instrument contains lasers which can cause blindness if safety precautions are not followed. The Offeror shall ensure that:

a. All personnel working near the instrument when the lasers **could** be powered shall wear approved eye protection.

b. The laser is leak checked at both the bench check-out area and the Observatory I&T area. Each area shall be optically sealed such that light from the lasers, should the lasers leak, will not leave the area.

Any additional constraints to be followed throughout Observatory I&T will be identified by the LAM Project before GLAS is delivered. The Instrumenter and Offeror responsibilities for integration and test are defined in the following paragraphs.

8.1.1.1. Instrumenter Responsibilities

The GLAS Instrumenter will be responsible for providing all instrument GSE, the setup and operation of all GSE, and to provide their own tools and equipment. The Instrumenter is responsible for the GLAS instrument until the instrument is mechanically integrated with the spacecraft. The Instrumenter is the only authority for GLAS operation and, with the spacecraft safety officer, for determining the instrument health and safety.

8.1.1.2. Offeror Responsibilities

The Offeror shall provide secure work and storage areas, communications, electrical power, thermal radiator cooling, clean (99.9999% pure) GN2, and cleaning materials for the GLAS Instrumenter to checkout and operate the instrument during bench checkout, and throughout the Observatory integration and test. The Offeror shall certify GLAS GSE for operation with the spacecraft GSE. The Offeror shall certify certain GLAS GSE for use with the Observatory. The Offeror shall assume physical responsibility for GLAS after it is integrated with the spacecraft. Other responsibilities include:

a. Clean Room Services. The Offeror shall provide clean room services, including but not limited to:

- Gloves, masks, booties, and suits
- Tape for sealing gloves
- Air shower for entering 10k cleanroom areas
- Sticky mats
- Test equipment cleaning support
- Clean room monitoring.

b. Work Areas – The Offeror shall provide the following work areas for the delivery and unpacking of the GLAS instrument (Area 1), storage of the shipping containers and other MGSE (Area 2), initial check-out and acceptance testing of the GLAS instrument (Areas 3 and 4) and integration of the GLAS instrument onto the observatory and observatory I&T (Areas 5 and 6). The GLAS instrument can be located in the same area as the GLAS bench test equipment for both initial check-out/acceptance and integration, that is, Areas 3 and 5 can be the same and areas 4 and 6 can be the same. The definitions and requirements for each area are detailed in the following paragraphs.

Area 1 For delivery of the GLAS instrument and unloading from the shipping container.

Area 2 Shipping container and mechanical GSE storage area; 10'x20'x10' high, sheltered from the elements, with crane or forklift access.

Area 3 Instrument Check-out Clean room (Can be same as area 5). Requirements:

Physical:

20'x20', Class 10,000 clean room
Climate controlled from 18° C to 24° C, 40% to 60% relative humidity
Capability to optically seal room as a laser safety requirement
Within 200' of Area 4, activity visible (line-of-sight) from Area 4

Power:

Two 240 Volt 30 Amp single phase circuits (for coolers)
Six 120 Volt 20 Amp single phase circuits
Quiet Earth ground for grounding instrument, separate from facility ground.

Communication:

One phone line with long distance capability
3 Headsets for communication with Area 4

Mechanical

Lifting crane, 1000 pound lift certified, with microinch step capability or a qualified hydroset
Forklift, 1500 pound moving GLAS in its shipping container.

GN2: Clean GN2 (99.9999 % pure) for instrument purge

Area 4 Instrument Check-out GLAS BTE Area (Can be same as Area 6). Requirements:

Physical:

15'x20'
Climate controlled for standard computer equipment
Within 200' of Area 4; activity in Area 3 visible (line-of-sight) from Area 4

Power:

Six 120 Volt 20 Amp single phase circuits

Communication:

Two phone lines with long distance capability
Three 10 base T internet hookups with internet access
3 Headsets for communication with Area 3

Area 5: Observatory I&T Clean room (Can be same as Area 3). Requirements:

Physical:

Large enough to support installation of the GLAS Instrument onto the spacecraft
Class 10,000 clean room
Climate controlled from 18C° to 24° C, 40% to 60% relative humidity
Capability to optically seal room as a laser safety requirement
Within 200' of Area 6, activity visible (line-of-sight) from Area 6

Power:

Two 240 Volt 30 Amp single phase circuits (for coolers)
Two 120 Volt 20 Amp single phase circuits
Quiet Earth ground for grounding instrument, separate from facility ground.

Communication:

One phone line with long distance capability
3 Headsets for communication with Area 6

Mechanical:

Lifting crane, 1000 pound lift certified, with microinch step capability or a qualified hydroset

GN2:

Clean GN2 (99.9999 % pure) for instrument purge

Area 6 Observatory I&T GLAS BTE Area (Can be same as area 4). Requirements:

Physical:

15'x20'; climate controlled for standard computer equipment
Within 200' of Area 5, activity in Area 5 visible (line-of-sight) from Area 6

Power:

Six 120 Volt 20 Amp single phase circuits

Communication:

Two phone lines with long distance capability
Three 10 base T internet hookups with internet access
3 Headsets for communication with Area 5

8.1.2. GLAS Delivery and Bench Check-out

The GLAS instrument will be delivered as Government-furnished flight hardware for secure storage by the Offeror. Bench checkout will consist of a visual inspection, cleaning, and electrical performance verification by the Instrumenter, monitored by the Offeror. Following successful bench check-out, the Offeror will accept GLAS delivery. The Offeror shall assist in removing hardware from shipping containers, moving GLAS to the check-out area, storing all GLAS GSE, and storing shipping and packing material for eventual reshipment.

8.1.3. Mechanical Integration

Following the acceptance of GLAS by the Offeror, the Offeror shall be responsible for moving GLAS from the check-out area to the Observatory I&T area. The GLAS chassis shall be connected to earth ground at all times during this move.

The vendor shall mechanically integrate the GLAS Instrument onto the Observatory in accordance with the GLAS Mechanical Integration Procedure developed jointly by the Instrumenter and Offeror. GLAS mechanical integration requires a certified crane; the crane must have microinch step capability or a qualified hydroset .

The vendor shall also place the GLAS radiator GSE near the GLAS instrument, and shall support the cabling from the radiator GSE to the GLAS instrument with scaffolding or other suitable mechanical support.

8.1.4. Electrical Integration

The Offeror shall electrically integrate the GLAS instrument onto the LAM Observatory in accordance with the GLAS Electrical Integration Procedure provided by the GLAS Instrumenter. The Offeror shall provide qualified electrical technicians and spacecraft test conductors to perform Safe-To-Mate, Initial Power Turn-On and Functional Testing of the GLAS Instrument under the engineering supervision of the GLAS Instrument team. The Offeror shall provide

Break-out-boxes, DVMs, oscilloscopes, current probes, and other general electrical test equipment. Specialized equipment such as laser power measurement equipment and lasers, will be provided by the GLAS Instrument team as part of their BTE.

8.1.5. Instrument Comprehensive Performance Test

The Instrument Comprehensive Performance Test shall be performed:

a. After integration is complete but before the environmental test program
b. Before Mechanical testing (Vibration, acoustics, pyro shock)
c. Between Mechanical testing and Thermal Vacuum/ Thermal Balance
d. During Thermal Vacuum Testing - Hot
e. During Thermal Vacuum Testing – Cold
f. During Thermal Balance Testing
g. After environmental testing is complete and before shipping to the launch site.

The GLAS Instrument Team will provide all specialized test equipment that is required to perform the GLAS CPT as part of their bench test equipment. The Offeror shall provide general test equipment, such as DVMs and oscilloscopes. Comprehensive performance testing will require use of nadir and zenith targets installed on GLAS.

8.1.6. GLAS Radiator Temperature Control

The GLAS radiator conducts hundreds of Watts of heat from the GLAS components. During bench testing, the GLAS GSE includes a cooler to maintain the radiator efficiency. During Observatory testing, the Offeror shall, with the Instrumenter's coordination, provide temperature control for the radiator. The Offeror may use the Instrument's radiator cooling GSE.

8.2. EMI/EMC Test

The Offeror may recommend and justify a different program of EMI/EMC testing that satisfies the intent of the following testing.

Electromagnetic compatibility testing shall be performed to demonstrate self compatibility and survivability (operating and non-operating) when exposed to the RF environment which may be experienced in orbit, and during the ground and launch site modes of operation. The Observatory will be in flight configuration as much as possible, with simulation of solar arrays. Electroexplosive devices or electrical equivalents shall be installed to demonstrate immunity to EMI. Subsystems and instruments shall either be on or off depending on the test objective. A command receiver sensitivity test shall be conducted to verify that receiver performance is not degraded by any Observatory operations. Any specific instrument or subsystem sensitivities shall be factored into the tests performed. Testing shall also verify that any RF generated by the spacecraft does not affect the launch vehicle. For emissions tests, testing shall be performed with the Observatory in its noisiest modes as appropriate for the test conditions. For susceptibility tests, testing shall be performed with the Observatory in its most

sensitive modes.

During EMI/EMC susceptibility testing the GLAS instrument may request reduced energies at certain bandwidths to avoid damaging the instrument. The Offeror shall ensure that during all susceptibility tests all emissions are within the energies agreed to by the GLAS instrument team. These levels will be available from the GLAS instrument team before the pre-environmental review.

8.3. Optical and Mechanical Alignments

The Offeror shall measure and verify the position and orientation of the GLAS instrument on the Observatory after integration, pre- and post- vibration (vibration, acoustics and pyro shock), pre- and post- thermal vacuum testing, before shipping to the launch site, and after shipping to the launch site.

The Offeror shall verify the alignments by measuring the position and orientation of a single alignment cube located on the GLAS instrument with respect to the Observatory master reference cube. The cube positions shall be measured and verified to within an absolute pointing knowledge of less than or equal to 50 microradians and a resolution of less than or equal to 5 microradians.

8.4. Attitude Control Subsystem Phasing
8.5. Solar Array Integration *(required only if integrated at the Observatory level)*
8.6. Flight Payload Attach Fitting Fit Check
8.7. Mass Properties Measurements
8.8. Vibration Test
8.9. Acoustic Test
8.10. Shock Test
8.11. Solar Array Deployment
8.12. Thermal Vacuum Test

a. The first cycle of thermal vacuum testing shall ramp to the hot plateau and remain at plateau to bakeout volatile materials until the cleanliness levels are achieved.

b. The Observatory shall undergo at least four (TBR) thermal vacuum cycles prior to thermal balancing.

c. The Offeror shall recommend the number of test instrumentation temperature monitoring points proposed for GLAS during thermal vacuum testing

d. The Offeror shall provide chamber feedthroughs to support GLAS targets and measurements. Special connectors, such as for fiber optics, will be provided by the Instrumenter. The Offeror shall route and support all required cabling and stimuli inside the thermal vacuum chamber. *Vacuum via oil-diffusion pump is not acceptable.*

NOTE THAT THE GLAS LASER WILL BE OPERATED AT FULL TRANSMIT POWER

AT SPECIFIC TIMES DURING OBSERVATORY I&T,
INCLUDING THERMAL/VACUUM TESTING

8.13. Thermal Balance Test
8.14. Cleanliness, Control, Validation and Monitoring

If CDRL 17, Contamination/Cleanliness Control Plan, completely defines the Offeror's approach, enter no text in Section 8.15 except a reference to the CDRL.

The Offeror shall allow time for periodic GLAS cleaning by the Instrumenter.

8.15. End-to-End Functional Test

The Offeror shall conduct threaded end-to-end functional tests to demonstrate signal integrity "from photon to eyeball" as the Observatory is integrated. Each test shall build upon previous test results to build confidence in system-level performance. The following top-level test cases shall be conducted:

8.15.1. GLAS/Spacecraft with GLAS target test

a. GLAS target to GLAS
b. GLAS to EOS Data Operations System (EDOS)/EOS Operations Center (EOC) (science data and bus telemetry)
c. GPS to Spacecraft

8.15.2. Spacecraft/GLAS Compatibility Test Van (CTV) test

a. CTV S Band link
b. CTV X Band link
c. GPS and Spacecraft systems interference

8.15.3. Spacecraft to EOS Operations Center (EOC)

a. Flight Operations Training (FOT) command and control
b. FOT training

8.15.4. GLAS/Spacecraft to EOC test

a. FOT Training
b. Flight dynamics test

8.15.5. GLAS/Spacecraft to Science Computing Facility (SCF) test

a. GLAS to Instrument Support Terminal (IST)
b. GLAS to Data Acquisition and Archive Center (DAAC)
c. GLAS to SCF and user facility

8.15.6. End-to-end science data flow test

8.15.7. End-to-end command and control, and telemetry test

8.15.8. Launch site functional test

a. GLAS housekeeping and science data
b. Spacecraft housekeeping, and command and control
c. CTV test

8.15.9. Launch pad test

a. GLAS/Spacecraft housekeeping and science
b. Communications test

The Offeror shall propose any additional test cases aimed at demonstrating the Observatory end-to-end compatibility with ground facilities and mission operations.

9.

OBSERVATORY STORAGE, TRANSPORTATION AND HANDLING

The Observatory storage, transportation and handling requirements are detailed in the following two sections: the storage approach, and transportation and handling approach.

If CDRL 14, Transportation and Handling Plan completely defines the Offeror's approach, enter no text in Section 9 except for a reference to the CDRL. Otherwise, the Offeror shall add text wherever needed in this section to completely define the original RSA storage, transportation and handling.

9.1. Storage Approach

On-site storage includes:

- Storage
- Storage methods
- Contamination control
- Environmental controls and monitoring equipments.

The Offeror shall define the new activities in the following paragraphs appropriate to the on-site storage effort. Include a definition of the number of days storage offered for LAM.

9.1.1. Storage

Include payload envelope accommodation.

The GLAS instrument shall be stored in a climate-controlled environment maintained between 18° C and 24° C, at 40% to 60% relative humidity.

9.1.2. Storage Methods

Include EGSE, MGSE, battery and other limited life special precautions offered.

9.1.3. Contamination Control

Show methods and cleanliness levels achieved. If CDRL 17, Contamination/Cleanliness Control Plan completely defines the Offeror's approach, enter no text in Section 9.1.3 except for a reference to the CDRL.

9.1.4. Environmental Controls and Monitoring Equipment

If CDRL 17, Contamination/Cleanliness Control Plan completely defines the Offeror's approach, enter no text in Section 9.1.4 except for a reference to the CDRL.

9.2. Transportation And Handling Approach

The transportation and handling approach requirements include:

- Shipping container
- Transportation methods
- Contamination control
- Environmental controls
- Launch site.

The Offeror shall define the activities in the following paragraphs appropriate to the transportation and handling approach.

9.2.1. Shipping Container

Include payload envelope accommodation

9.2.2. Transportation Methods

Include the ground support equipment, EGSE, MGSE, fueling carts, and lifting slings.

9.2.3. Contamination control

Methods and cleanliness levels. If CDRL 17, Contamination/Cleanliness Control Plan completely defines the Offeror's approach, enter no text in Section 9.2.3 except for a reference to the CDRL

9.2.4. Environmental Controls

If CDRL 17, Contamination/Cleanliness Control Plan completely defines the Offeror's approach, enter no text in Section 9.2.4 except for a reference to the CDRL.

9.2.5. Launch site.

If CDRLs 11 and 12, Observatory Launch Site Operations and Test Plan/Procedures, completely define the Offeror's approach, enter no text in Section 9.2.5 except for a reference to the CDRL

10.

OBSERVATORY LAUNCH SITE AND OPERATIONS

The LAM launch readiness date is July 1, 2001 (TBR), from the Western Test Range.

The Offeror shall describe any new activities at the launch site beginning with the arrival of the Observatory, including final testing and preparations, fueling, transportation between buildings and the launch vehicle, launch vehicle integration and testing, and removal of systems after launch. Suggested launch site activities to describe include:

- *Schedule*
- *Government-furnished facilities and resources needed*
- *Planned fueling methods*
- *Cleaning and cleanliness*
- *Special test equipment*
- *Communications.*

Link appropriate parts of this Section to CDRL 11, Observatory Launch Site Operations and Test Plan, CDRL 12, Observatory Launch Site Operations and Test Procedures, and CDRL 13, Missile System Prelaunch Data Package.

10.1. Schedule

The Offeror shall provide 30 days of on-orbit support following the launch.

The launch activities schedule shall be consistent with the top-level schedule in Section 3.10.

10.2. Government-furnished Facilities and Resources

The Offeror shall add new text wherever needed in this section to completely define the original RSA government-furnished facilities and resources.

10.3. Planned Fueling Methods

The Offeror shall add text wherever needed in this section to completely define the original RSA planned fueling methods.

10.4. Cleaning and Cleanliness

If CDRL 17, Contamination/Cleanliness Control Plan, completely defines the Offeror's approach, enter no text in Section 10.4 except a reference to the CDRL. Otherwise, the Offeror shall add text wherever needed in this section to completely define the original RSA cleaning and cleanliness.

10.5. Special Test Equipment

Identify any special Offeror equipment needed on the launch tower or in the blockhouse

10.6. Communications

Identify communication links proposed between locations at the launch site to perform Observatory end-to-end testing and to support the Observatory on the launch vehicle up to the point of launch.

11.

OPERATIONAL FLIGHT SOFTWARE MAINTENANCE

Operational flight software maintenance requirements include:

- Software management practices
- Configuration management
- On-orbit flight software management.

Each is more fully described in the following paragraphs.

11.1. Software Management Practices

The Offeror shall identify any change to the RSA software management practices and methodologies used for the development of flight software or for the modification of existing flight software. The Offeror shall identify applicable standards, development & test platforms used including hardware and software development applications, and the software integration & test approach and environment used to validate software performance.

11.2. Configuration Management

The Offeror shall identify changes to the configuration management practices, including the use of development and maintenance folders, revision control, test results recording and traceability, methodology for retest of failed software tests, and software baselining. Link this Section with CDRL 15, Engineering Change Proposals, Deviations and Waivers.

11.3. On-Orbit Flight Software Management

The Offeror shall identify changes to the approach for upgrading flight software while the spacecraft is on-orbit. The Offeror shall identify the methodology for analyzing software problems or new requirements, developing and testing new or modified code including any simulation environments, the approach for uploading the software uploads to the spacecraft, and the methodology for validating new flight software on the spacecraft. In addition, the Offeror shall identify the nature of the government's rights and access to flight software source code.

12.

OPERATIONS SUPPORT AND TRANSITION

The Offeror shall identify any changes to the RSA approach how the mission operators will be trained and certified, and how transition from implementation under the offeror to operation under the Government will take place. Link this Section with CDRL 8, Spacecraft Operations Description Manual. If CDRL 10, Flight Operations Support Plan, completely addresses the Offeror's approach, enter no text in Section 12 and reference the CDRL.

Specific requirements in operations support and transition include:

- Mission planning support
- Flight operations training
- Documentation
- Operations transition plan
- On-orbit check-out
- Anomaly resolution support
- Operations products use.

The requirements are detailed in the following sections.

12.1. Mission Planning Support

The Offeror shall identify the level of effort provided during the mission planning process for ensuring that mission operations personnel and assets are adequately addressed for the development of the mission operations concept including operational scenarios, spacecraft communications, observatory operations, safety, transition, on-orbit check-out, anomaly support, and flight software maintenance.

12.2. Flight Operations Training

The Offeror shall identify the flight operations training, both formal and informal, to be provided to adequately prepare the flight operations team (FOT) for observatory operations. Specifically, the Offeror shall describe how the FOT shall have access to the spacecraft and Observatory for their participation during integration and testing activities for the purposes of on-the-job training. The Offeror shall identify the extent of classroom and non-classroom training, FOT certification methods used, simulations used during training, and the types of anomaly scenarios and workarounds that may be necessary for particular types of anomalies.

12.3. Documentation

The Offeror identify and describe all documentation to be provided, such as commented flight software source code, functional and data flow descriptions of the observatory, system and subsystem descriptions, spacecraft command and telemetry formats, Observatory operations and command sequences, operations manuals including safety concerns, and anomaly resolution scenarios.

12.4. Operations Transition Plan

The Offeror shall identify the support provided for transition of the Observatory's operations to the Government. Included shall be the level of effort provided for testing, validation, and transition to operations. The Offeror shall identify specifically when and to what level of responsibility the Offeror and the Government has at each stage of transition, culminating in the final transition to the Government.

12.5. On-Orbit Check-Out

The Offeror shall identify the methodology for on-orbit checkout once the Observatory has been placed into its orbit. This shall include the approach for executing the initial sequencing of the Observatory's functions and the methodology for validating performance and status telemetry received. The Offeror shall describe the sequencing of subsystem check-out and shall culminate the on-orbit check-out with a full system test of the Observatory.

12.6. Anomaly Resolution Support

The Offeror shall describe the extent of anomaly resolution support provided to assist the FOT in analyzing trending data and real-time telemetry and resolving spacecraft anomalies during the life of the Observatory. The offeror shall identify personnel and facilities that shall be made available for anomaly resolution support.

12.7. Operations Products Use

The Offeror shall describe any products used for or resulting from spacecraft design, integration, and testing to be provided that may be utilized for the development of mission operations personnel and the ground system. This shall include any unique ground system hardware and software, spacecraft and ground system simulators, detailed test results and trending and safety data collected during I&T, and spacecraft operations planning and scheduling tools.

13.

MISCELLANEOUS

The following table maps the paragraphs in the Mission Implementation Specification to the CDRL items they reference.

SPECIFICATION/CDRL MATRIX

MISSION IMPLEMENTATION SPECIFICATION	CDRL
4.2 Interface Definition and Maintenance	2 External Interfaces, Models and Analysis
4.5 Configuration Management	15 ECPs, Deviations and Waivers
4.8 Failure Modes and Effects Analysis	16 FMEA and Critical Items List
5 Contamination Control	17 Contamination/Cleanliness Control Plan
6 Mission Performance Verification	1 Mission Performance Verification Plan
7 Spacecraft Integration and Test	6 S/C and Observatory I&T Plan
8 Observatory Integration and Test	6 S/C and Observatory I&T Plan
8.15 Cleanliness, Control, Validation & Monitor	17 Contamination/Cleanliness Control Plan
9 Storage, Transportation and Handling	14 Transportation and Handling Plan
9.1.3 Contamination Control 9.1.4 Environmental Control 9.2.3 Contamination Control 9.2.4 Environmental Control	17 Contamination/Cleanliness Control Plan
9.2.5 Launch Site	11 Observatory Launch Site Ops & Test Plans 12 Observatory Launch Site Ops & Test Procs
10 Observatory Launch Site Support and Ops	11 Observatory Launch Site Ops & Test Plans 12 Observatory Launch Site Ops & Test Procs 13 Missile System Prelaunch Data Package
10.4 Cleaning and Cleanliness	17 Contamination/Cleanliness Control Plan
12 Operations Support and Transition	8 S/C Operations Description Manual 10 Flight Operations Support Plan

The following table maps the CDRL items to the paragraphs in the Mission Implementation specification where they are referenced.

CDRL/SPECIFICATION MATRIX

CDRL	MISSION IMPLEMENTATION SPECIFICATION
1 Mission Performance Verification Plan	6 Mission Performance Verification
2 External Interfaces, Models and Analysis	4.2 Interface Definition and Maintenance
6 S/C and Observatory I&T Plan	7 Spacecraft Integration and Test 8 Observatory Integration and Test
8 S/C Operations Description Manual	12 Operations Support and Transition
10 Flight Operations Support Plan	12 Operations Support and Transition
11 Observatory Launch Site Ops & Test Plans	9.2.5 Launch Site 10 Observatory Launch Site Support and Ops
12 Observatory Launch Site Ops & Test Procs	9.2.5 Launch Site 10 Observatory Launch Site Support and Ops
13 Missile System Prelaunch Data Package	10 Observatory Launch Site Support and Ops
14 Transportation and Handling Plan	9 Storage, Transportation and Handling
15 ECPs, Deviations and Waivers	4.5 Configuration Management
16 FMEA and Critical Items List	4.8 Failure Modes and Effects Analysis
17 Contamination/Cleanliness Control Plan	5 Contamination Control 8.15 Cleanliness, Control, Validation & Monitor 9.1.3 Contamination Control 9.1.4 Environmental Control 9.2.3 Contamination Control 9.2.4 Environmental Control 10.4 Cleaning and Cleanliness

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT F
Master Schedule

LASER ALTIMETRY MISSION
MASTER SCHEDULE - MILESTONES

The following milestones, defined in the Mission Implementation Specification, Section 3.10, are the major events requiring Offeror support in the LAM implementation schedule. The Offeror may wish to attend italicized events marked *(info only)*.

MILESTONE	DATE CONSTRAINT	SITE
Launch Vehicle Selection	Within 3 months ARO	GSFC
MTPE Confirmation Review	*April - May 1998*	*GSFC (info only)*
S/C-GLAS Data Simulator .	4 months ARO (TBR)	FOB Offeror's Site
GLAS-S/C Work Group	4 to 6 months ARO	GSFC or Offeror
MDR	9 to 11 months ARO (TBR)	Offeror's Site
GPS Engr Model Avail.	November 1998 (TBR)	Offeror's Site
GPS Flight Model Avail.	January 1999 (TBR)	Offeror's Site
GLAS CDR	*February 1999*	*GSFC (info only)*
MTPE IAR	*April 1999 (TBR)*	*GSFC (info only)*
GF GLAS Data Simulator	May 30, 1999 (TBR)	FOB GSFC
S/C Drill Template Avail.	Mid 1999 (TBR)	FOB Offeror's Site
GF GLAS Mass Model	Mid 1999 (TBR)	FOB GSFC
S/C-to-Ground Simulator	July, 1999 (TBR)	FOB Offeror's Site
MOR	Approx L -18 months (~12/99)	GSFC
MTPE IAR	*April 2000 (TBR)*	*GSFC (info only)*
GLAS PER	*July 2000*	*GSFC (info only)*
S/C IIRR	2 to 4 weeks before GLAS Delivery	Offeror's Site
GLAS PSR	September 2000	GSFC
GLAS Delivery	October 30, 2000 (TBR)	FOB GSFC
Observatory PER	2 to 4 weeks before Qualification Testing	Offeror's Site
FOR	Approx L - 3 months (~3/01)	GSFC
MTPE IAR	*April 2001 (TBR)*	*GSFC (info only)*
PSR	No later than L - 2 months (~5/01)	Offeror's Site
Launch Readiness	July 1, 2001	WTR
SYSTEM ACCEPTANCE	L + 30 days	GSFC

Acronyms & Abbreviations

Avail.	Available	*Info*	Information
ARO	After Receipt of Order	L	Launch
CDR	Critical Design Review	MDR	Mission Design Review
FOB	Free On Board	MOR	Mission Operations Review
FOR	Flight Operations Review	MTPE	Mission To Planet Earth
GF	Government Furnished	PER	Pre-Environmental Review
GLAS	Geoscience Laser Altimetry System	PSR	Pre-Ship Review
GPS	Global Positioning System	S/C	Spacecraft
GSFC	Goddard Space Flight Center	TBR	To Be Reviewed
IAR	Independent Annual Review	WTR	Western Test Range
IIRR	Instrument Integration Readiness Review		

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT G

Offer Format and Instructions

LASER ALTIMETRY MISSION (LAM)
REQUEST FOR OFFER
INSTRUCTIONS

Each Rapid Spacecraft contract holder may submit one offer for the LAM system.

The LAM offer shall consist of the following sections. For electronic submission, provide a single file for Sections 1-6, and one file for each CDRL (Section 7).

Section 1. EOS/LAM Spacecraft Performance Specification (SPS)
Only new and changed portions of the Performance Specification attached to the RSA contract need be submitted. Offerors may interpret and tailor LAM requirements marked "TBR" to best fit their spacecraft and still meet the mission performance requirements. A complete LAM SPS with change bars will be required of the selected Offeror between the time of selection and award of the delivery order. Summarize the changes in the attached SPS Deviation Matrix.

Section 2. EOS/LAM Mission Implementation Specification (MIS)
Only new and changed portions of the MIS attached to the RSA contract need be submitted. Offerors may interpret and tailor LAM requirements marked "TBR" to best fit their spacecraft and still meet the mission performance requirements. A complete LAM MIS with change bars will be required of the selected Offeror between the time of selection and award of the delivery order. Summarize the changes in the attached MIS Deviation Matrix.

Section 3. Interim Proposed Payment Events and Completion Criteria
If the payment events and/or completion criteria will be modified for the LAM effort, a complete listing shall be provided. Payment events and completion criteria shall be provided in accordance with the RSA contract. If no modifications are proposed, Offeror shall reference the RSA contract.

Section 4. LAM System Price Summary
The Offeror shall complete the attached LAM System Price Summary Form in accordance with the instructions on Page 36. The Offeror shall propose one total price for the LAM effort, and the incremental prices of Option 1 (TAURUS XL Launch Vehicle Accommodation) and Option 2 (LMLV-2 Launch Vehicle Accommodation). The Offeror shall also provide any additional rationale deemed necessary to substantiate the proposed price(s), including deviations from the RSA contract NTE price.

Section 5. Performance Based Payment Schedule
The Offeror shall provide a time-phased graphic and numeric profile identifying:

1. the performance based payments and percentages
2. cost incurred at the time of each payment
3. funding requirements at the time of each payment (i.e., including forward funding for subcontractors, materials, etc.)

After selection, the selected Offeror shall provide a cost and manpower profile (phased by month) for the LAM effort.

Section 6. Updated Relevant Experience and Past Performance
Only recent (since July, 1997) Relevant Experience and Past Performance information relevant to the proposed core system need be submitted.

Section 7. CDRL Items 1, 6, 10, 14, and 17
(reference the contract CDRL for complete list)

Any additional material submitted will be disregarded.

Number of copies required:
1 Electronically delivered copy (see instructions below)
1 hard copy, black and white, suitable for reproduction

INSTRUCTIONS FOR ELECTRONIC SUBMISSION OF RESPONSES
The electronic submission of responses to this RFO shall be contained in a single Microsoft Word '95 file, excluding CDRL's which are to be individual files. The media shall be 3.5" diskettes or PC-formatted compact disk (CD-ROM). Graphics are to be embedded into the electronic files and are to be either JPEG or GIF format. No single graphic is to exceed 100 Kilo-Bytes.

Responses to this RFO shall be uploaded to the RSDO Web Site.

Once received, any file containing a virus will not be opened.

Offer Due Date: Hardcopy and electronic
December 12, 1997, 2:00 PM EST
Hardcopy to Rapid spacecraft Development Office
NASA Goddard Space Flight Center, Code 401.5
Greenbelt, MD 20771

Following is a list of Government Furnished Equipment (reference contract clause G.5) for the LAM effort:

Description	Qty	Value	Date of Del'y to Contractor
GLAS Data Simulator (MIS 4.2, 7)	1		5/99 (TBR)
GLAS Mass Model (MIS 4.2, 7)	1		Mid 1999 (TBR)
GPS (SPS 4.1.4):			
Flight Model TurboStar Receivers	2		Jan 99 (TBR)
Engineering Model TurboStar Receiver	1		Nov 98 (TBR)
Flight Antennas	2		Jan 99
Flight and Spare RF Cables	2		Jan 99
Compatibility Test Van	1		Obs Qual Test
GLAS Instrument and Shipping Container	1		Oct 00
GLAS GSE	1		Oct 00

Funding Profile:
Following is a suggested funding profile which is compatible with current budget plans. The final profile may be adjusted relevant to offered price.

FY98	FY99	FY00	FY01
9%	32%	38%	21%

PERFORMANCE SPECIFICATION DEVIATION SUMMARY MATRIX

The Offeror shall show for each numbered section of the Spacecraft Performance Specification whether the LAM text is the SAME as the RSDO contract, MODIFIED, or DELETED.

SECTION HEADING	SAME/MODIFIED/DELETED
1. SCOPE	
2. REFERENCE DOCUMENTS	
3. SPACECRAFT PERFORMANCE CHARACTERISTICS	
3.1 Observatory Performance	
3.1.1 Launch Vehicle Compatibility	
3.1.2 Orbit Compatibility/Constraints	
3.1.3 Cleanliness Levels Required	
3.1.4 Design Lifetime	
3.2 Spacecraft Performance	
3.2.1 Mass Characteristics	
3.2.2 Electrical Payload Power	
3.2.3 Propulsion Performance	
3.2.4 Attitude Control Performance	
3.2.5 Command and Data Handling Performance	
3.2.6 Communications Performance	
3.2.7 Thermal Control	
3.2.8 Electrical	
3.2.9 Radiation Tolerance	
4. SUBSYSTEM CHARACTERISTICS	
4.1 Overall Spacecraft Architecture	
4.1.1 Structural/Mechanical Subsystem	
4.1.2 Power Subsystem	
4.1.3 Propulsion Subsystem	
4.1.4 Attitude Control Subsystem	
4.1.5 C&DH Subsystem	
4.1.6 Communications Subsystem	
4.1.7 Thermal Control Subsystem	
4.1.8 Spacecraft Flight Software	
4.1.9 Spacecraft Ground Support Equipment	
4.1.10 Not Applicable	
4.1.11 Not Applicable	
5. PAYLOAD ACCOMMODATIONS	
5.1 Physical Requirements	
5.2 Electrical Power, Data and Command Interface	
5.3 Software Applications	
5.4 Payload Environmental Requirements	
5.5 Safety	
5.6 Ground Support Equipment	
5.7 Operational Factors	
6. OPTIONS	

MISSION IMPLEMENTATION DEVIATION SUMMARY MATRIX

The Offeror shall show for each numbered section of the Mission Implementation Specification whether the LAM text is the SAME as the RSDO CONTRACT, MODIFIED, or DELETED

SECTION HEADING	SAME/MODIFIED/DELETED
1. Scope	
2. REFERENCE DOCUMENTS	
3. PROGRAM MANAGEMENT	
3.1 Non-Mission Specific Delivery Order Management (Special Studies)	
3.2 Scheduling and Program Control	
3.3 Quality Management	
3.4 Documentation Systems	
3.5 Reviews and Audits	
3.6 Government Insight	
3.7 Subcontract Management	
3.8 Risk Management	
3.9 Resource Management (Staffing, Facilities, etc.)	
3.10 Implementation Schedule	
4. SYSTEMS ENGINEERING	
4.1 Requirements Analysis	
4.2 Interface Definition and Maintenance	
4.3 Reliability Analysis	
4.4 Safety	
4.5 Configuration Management	
4.6 Instrument and Mission Accommodations	
4.7 Mission Design and Analysis	
4.8 Failure Modes and Effects Analysis	
5. CONTAMINATION CONTROL	
6. MISSION PERFORMANCE VERIFICATION	
6.1 Core System Integration and Test, Observatory Integration & Test	
6.2 On-Orbit Verification	
7. SPACECRAFT INTEGRATION AND TEST	
8. OBSERVATORY INTEGRATION AND TEST	
8.1 Instrument Integration	
8.1.1 Responsibilities and Safety	
8.1.2 GLAS Delivery and Bench Check-Out	
8.1.3 Mechanical Integration	
8.1.4 Electrical Integration	
8.1.5 Instrument Comprehensive Performance Test	
8.1.6 GLAS Radiator Temperature Control	
8.2 EMI/EMC/ESD Test	
8.3 Optical and Mechanical Alignments	
8.4 Magnetic Survey	
8.5 Attitude Control Subsystem Phasing	

SECTION HEADING	SAME/MODIFIED/DELETED
8.6 Solar Array Integration (only if integrated at the Observatory level)	
8.7 Flight Payload Attach Fitting Integration	
8.8 Mass Properties Measurements	
8.9 Vibration Test	
8.10 Acoustics Test	
8.11 Shock Test	
8.12 Solar Array Deployment	
8.13 Thermal Vacuum Test	
8.14 Thermal Balance Test	
8.15 Cleanliness, Control and Monitoring	
8.16 End-to-End Functional Test	
9. STORAGE, TRANSPORTATION AND HANDLING	
9.1 Storage	
9.1.1 Storage Location.	
9.1.2 Storage Methods	
9.1.3 Contamination Control	
9.1.4 Environmental Control	
9.2 Transportation Handling	
9.2.1 Shipping Container	
9.2.2 Transportation	
9.2.3 Contamination Control	
9.2.4 Environmental Control	
9.2.5 Launch Site	
10. OBSERVATORY LAUNCH SITE SUPPORT AND OPERATIONS	
10.1 Schedule	
10.2 Government-furnished facilities and resources needed	
10.3 Planned fueling methods	
10.4 Cleaning and cleanliness	
10.5 Special Test Equipment	
10.6 Communications	
11. OPERATIONAL FLIGHT SOFTWARE MAINTENANCE	
12. OPERATIONS SUPPORT AND TRANSITION	
12.1 Flight Operations Training	
12.2 Documentation	
12.3 Operations Transition Plan	
12.4 On-Orbit Check-out	
12.5 Anomaly resolution support	
13. MISCELLANEOUS	

Instructions For Completing the Price Summary Form

Core System

Identify the name of the Master Contract core system proposed for LAM, the Master Contract NTE price and the LAM core system firm fixed price. Do not include increases/decreases for mission unique requirements.

List, by element, all adds/deletes from the core system price which are not due to spec changes (i.e., mission unique requirements). Examples include less risk due to known payload, duration of firm fixed price quote, parallel build, etc. Prices are not required.

Applicable Options

Identify only those options which are currently included in the master contract and are applicable to the LAM offer. List each option with the Master Contract NTE price and the LAM firm fixed price.

Mission Unique Requirements

Identify each mission unique requirement (e.g., by subsystem) required to meet the LAM performance and mission implementation specs. Identify the associated price increase/decrease in the LAM Offer FFP column.

Total LAM Offered Price

Total Offered Price includes the price of the Core System + the price of applicable options + the price of mission unique requirements.

LAM Options

Identify the total price of the increase/decrease for options 1 and 2. These are stand-alone prices and should not be included in the Total LAM Offered Price, unless one or both are already included in the offered core system price. If included in the core system price, indicate $0 in the (+/-) column.

LAM SYSTEM PRICE SUMMARY FORM
$K

	Master Contract NTE	LAM Offer FFP
Core System *(identify master contract core system)*	$ _____	$_____
(list by element adds and deletes from master contract core system price, without mission unique requirements)		
1)		
2) *(Narrative only, no prices)*		
3)		
...		
Applicable Options *(as included in Master Contract)*		
(list each option)		
1)	$	$
2)	$	$
3)	$	$
…	_____	_____
Total Applicable Options	**$**	**$**
Mission Unique Requirements		
(list each requirement; identify spec paragraph reference)		
1)		$
2)		$
3)		$
…		_____
Total Mission Unique Requirements		**$**

TOTAL LAM OFFERED PRICE	$

(LAM Core System Price + Options + Mission Unique)

LAM OPTIONS	**(+/-)**
1. TAURUS XL Launch Vehicle Accommodation (per SPS 3.1.1.a)	$
2. LMLV-2 Launch Vehicle Accommodation (per SPS 3.1.1.b)	$

LASER ALTIMETRY MISSION
RAPID SPACECRAFT RFO

ATTACHMENT H

Evaluation Factors and Relative Importance

LAM EVALUATION CRITERIA

Offers will be evaluated by the LAM Evaluation Team in accordance with the Mission Suitability factor, the Relevant Experience and Past Performance factor, and the Price factor.

The Price Factor is significantly less important than the combined importance of the Mission Suitability Factor and the Relevant Experience and Past Performance Factor. As individual Factors, the Price Factor is less important than the Mission Suitability Factor but more important than the Relevant Experience and Past Performance Factor.

I. MISSION SUITABILITY FACTOR

Paragraph references are to the SPS (Spacecraft Performance Specification) and the MIS (Mission Implementation Specification).

<u>Mission Performance</u>

The Government will evaluate the adequacy and completeness of the Offeror's approach toward:

1. 100 μrad attitude control accuracy (SPS Para 3.2.4.2 and 4.1.4)
2. 50 μrad real-time attitude knowledge precision (SPS Para 3.2.4.3 and 4.1.4)
3. GLAS mass, including CM and MOI affects (SPS Para 3.2.1, 4.1.1 and 5.1.1)
4. GLAS continuous power requirement (SPS Para 3.2.2, 4.1.2 and 5.2.1)
5. Nadir and zenith fields of view (SPS Para 5.1.1.5)
6. Command and Data Handling performance (SPS Para 3.2.5, 4.1.5 and 5.2.2)
7. Spacecraft jitter contribution (SPS Para 5.1.1.6.2)
8. Operations eye safety (SPS Para 5.5; MIS Para 4.4)
9. Launch vehicle (SPS Para 3.1.1)
10. Mission orbit (SPS Para 3.1.2)
11. Cleanliness (SPS Para 3.1.3; 5.4; MIS Para 5, 8.15, 9.1.3, 9.1.4, 9.2.3, 9.2.4, 10.4)
12. Design lifetime (SPS Para 3.1.4)
13. Propulsion (SPS Para 3.2.3 and 4.1.3)
14. Attitude performance (SPS Para 3.2.4 and 4.1.4)
15. Communications Performance (SPS Para 3.2.6, 4.1.6 and 5.2.2.1)

The Government will also evaluate any changes or special considerations the Offeror identifies for the core system with regard to thermal control, EMI/EMC, and software performance.

Mission Implementation

The Government will evaluate the adequacy of the Offeror's approach towards:

1. Mission performance verification (MIS Para. 6)

2. Observatory Integration and Test (MIS Para 8)

3. Launch site support (MIS Para 10)

4. Flight software maintenance (MIS Para 11)

5. Flight operations (MIS Para 12)

6. The Government will evaluate the Offeror's systems engineering approach with regard to requirements definition, interface definition, and reliability. (MIS Para 4)

7. The Government will evaluate the proposed schedule for adequacy in support of the implementation. (MIS Para 3.10)

II. PRICE EVALUATION FACTOR

1. The Government will perform a price analysis to determine reasonableness of the offered price(s) as follows:

   a. Analysis of the price offered for the LAM system in comparison to the firm fixed price(s) of the core system and relevant options included in the master contract.

   b. Analysis of the price offered for mission unique requirements.

   c. Analysis of the prices offered for the TAURUS XL and LMLV-2 options.

   d. Analysis of the cost of performance-based financing.

2. The Government will evaluate the Offeror's proposed milestone and payment profile to determine reasonableness and consistency with the Offeror's anticipated funding requirements for the build and delivery cycle.

III. RELEVANT EXPERIENCE AND PAST PERFORMANCE FACTOR

The Government will evaluate any recent changes (since July 31, 1997) to the information provided by the Offeror under the RSA procurement, particularly with regard to recent flight history and environmental qualification, as provided by the Offeror or by other sources.