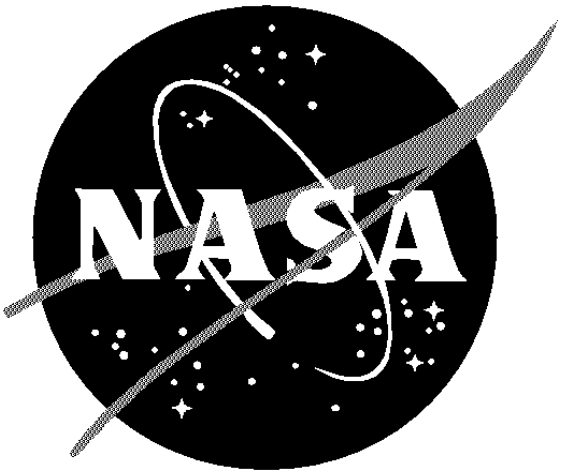

National Aeronautics and
Space Administration

March 5, 1999

AO-99-OES-01

ANNOUNCEMENT OF OPPORTUNITY

Lightweight Synthetic Aperture Radar (LightSAR)

Proposals Due May 10, 1999

OMB Approv

LIGHTWEIGHT SYNTHETIC APERTURE RADAR (LightSAR)

NASA Announcement of Opportunity
Soliciting Proposals
for
Period Ending
May 10, 1999

AO-99-OES-01
Issued March 5, 1999

Office of Earth Science
National Aeronautics and Space Administration
Washington, DC 20546

Table of Contents

Table of Contents (Continued)

APPENDICES

[Not Used]

1.0 DESCRIPTION OF THE OPPORTUNITY

The National Aeronautics and Space Administration (NASA) announces the opportunity to conduct scientific investigations as part of the LightSAR Program. The LightSAR Program is intended to accomplish unique Earth Science basic and applied research from low-earth orbit using innovative, streamlined management and implementation approaches.

1.1 Introduction

The LightSAR Program will carry out Earth Science investigations by means of spaceborne observations with low total cost. Specific measurements that offer high scientific payoff for this program were identified by the LightSAR Science Working Group (LSWG) appointed by NASA in 1997. The findings and recommendations of this multidisciplinary group are summarized in Section 2. Proposals to the LightSAR Program will require a careful trade-off between science and cost, to produce a mission with the highest possible science value (defined as integrated science and cost) to NASA.

To meet the desired LightSAR Program launch date and cost goals, there are constraints limiting mission definition and development times. NASA envisions a LightSAR mission with the goal of launching an Earth-viewing satellite by the end of calendar year 2002, or earlier.

The NASA Headquarters Office of Earth Science (OES) will select the LightSAR mission. NASA will direct the award of a subcontract by the NASA-Jet Propulsion Laboratory (JPL) to implement the selected mission. JPL will manage the project for NASA and coordinate data requirements for NASA science investigators. Therefore, the successful Proposer and the JPL LightSAR Project Office are expected to work together as a single, seamless, integrated team committed to a successful mission.

The goals of the LightSAR program are scientific, commercial, and technological. Proposals will be required to include basic research and/or applied research (e.g., commercial applications development) and suitable technology demonstrations. In addition to this AO, separate NASA Research Announcements (NRAs) and solicitations may be issued (and funded separately) to solicit proposals for applied and basic science investigations using LightSAR images and data.

Proposers may envision potential future commercial opportunities that might arise as a result of performing the applied research envisioned in this AO. In that event, cost sharing of the effort or contribution of other resources by the Proposer may be appropriate. If resource sharing is proposed, suitable data rights provisions may be offered.

Proposers are notified that if commercial opportunities (which are beyond the research scope of this AO) are to be pursued, the Proposer should investigate license

requirements (See 15 U.S.C. 5601 *et seq*.). The conditions attached to a remote sensing license may affect the Proposer's considerations concerning potential commercialization and, thus, the extent to which resource sharing may be proposed. Since resource sharing will be part of the evaluation criteria, the Proposer should indicate the relationship of resource sharing to commercialization potential (if considered in the decision to resource share). If any license is required due to Proposer's unique requirements, such a license must be in place prior to contract award. For additional information, the Proposer should contact the Remote Sensing Licensing Coordinator, National Oceanic and Atmospheric Administration at 301-713-2074, Ext. 107.

In concert with the LightSAR program development, NASA has initiated the Earth Observations Commercial Applications Program - Synthetic Aperture Radar (EOCAP-SAR) to promote new markets for SAR products and services, as part of the NASA program to help U.S. industry maintain its competitive position in the international remote sensing marketplace. The Commercial Remote Sensing Program (CRSP) office at the John C. Stennis Space Center (SSC) manages EOCAP-SAR for the NASA OES.

1.2 Process

NASA will initially review all proposals and eliminate from further consideration any proposal deemed not responsive to the proposal instructions of this AO. The proposals that pass the initial review will be further evaluated for strengths and weaknesses, under the criteria set forth in Section 5.1. The proposal that represents the best value to the Government will be selected for contract negotiation. If no proposal meets these criteria, no selection will be made.

NASA makes no commitment to take procurement action as a result of this AO if the proposal arrangements are too restrictive and are not in the best interest of the U.S. Government. As such, the Proposers are expected to assume the cost of preparing a proposal in response to this AO at their own risk.

Prospective Proposers should attend the LightSAR AO Preproposal Conference and submit a Notice of Intent, as described below.

1.2.1 Preproposal Conference

A Preproposal Conference will be held on March 18, 1999, at the Crystal City Sheraton Hotel, Arlington, Virginia, from 9:00 a.m. to 3:00 p.m. By March 12, anyone planning to attend should furnish his/her name to the LightSAR AO Coordinator at the address in Section 4.4.3, together with the text of any specific question that should be answered at the Conference. Questions received after March 12 will be addressed only if time permits. A transcript of the proceedings will be sent to each attendee approximately two (2) weeks after the Conference.

1.2.2 Notice of Intent

Prospective Proposers are strongly encouraged to advise the LightSAR AO Coordinator of their intention to submit a proposal, so that necessary preparations can be made. The written Notice of Intent (NOI) should be received by April 5, 1999, should reference the LightSAR AO, and should include a list of team members, their organizations, addresses, and telephone numbers. If the proposal team has a non-U.S. member, a copy of the NOI should be sent to the NASA External Relations office at the address in Section 4.4.6.

NASA will not release information provided in an NOI, nor acknowledge or confirm receipt of an NOI.

1.3 Proposal Opportunity Period and Schedule

Proposers have 66 days from the official AO release date to prepare and submit their proposals, according to the following nominal schedule:

Official AO release date	March 5, 1999
Attendees List/ Questions for Preproposal Conference	March 12, 1999
Preproposal Conference	March 18, 1999
Notice of Intent due	April 5, 1999
Proposal due	May 10, 1999
Announcement of selection	July 1999
Anticipated Subcontract Award	August 1999

2.0 PROGRAM OBJECTIVES

The Earth Science Enterprise (ESE) uses NASA's space-based observing technology and scientific expertise for the study of planet Earth, an integrated system of land, ocean, atmosphere, ice, and biological processes. From the vantage point of space we are beginning to understand how the processes work and how they interact.

NASA recognizes that while different instruments can supply valuable information in a broad range of Earth science disciplines, it is impossible to satisfy all science disciplines with the resources of a single affordable spaceborne platform. Following the highly successful flights of the Shuttle Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) in 1994, NASA requested the Space Studies Board of the National Research Council (NRC) to evaluate the utility of a third SIR-C/X-SAR mission and to provide guidance in developing a strategy for a space-based, science-oriented interferometric small SAR.

> "Because of their all-weather, day-night capability, active microwave systems may represent the only reliable approach to collecting data on a given region at a particular time. In addition, ...the signals returned by radar systems are sensitive to the physical structure and moisture content of the surface being sensed, and may offer avenues to obtaining results that are important for research and application but are not otherwise obtainable." (NRC Report.)

Therefore, in 1997 NASA commissioned the LSWG to identify key science measurements that can best be addressed through advanced active microwave remote sensing. The working group identified and recommended those key measurements that would provide the best scientific payoff relative to the goals of OES. The entire report is available as a reference document at the LightSAR Web site, http://southport.jpl.nasa.gov/lightsar/.

The LightSAR program objectives summarized below are grouped into three broad categories: scientific, commercial, and technological.

2.1 Science Objectives

The science objectives for the LightSAR mission are grouped into a broad range of scientific disciplines. These groups represent specific areas where there is an immediate and obvious, unique need for investigations using active microwave remote sensing. These scientific topics listed below are in approximate priority order in the context of this AO.

2.1.1 Natural Hazards

Over the past two decades, space geodetic techniques, in particular the Global Positioning System (GPS), have proven to be powerful tools for studying movements

and deformations of the surface of the Earth and have led to major advances in understanding. But these measurements lack spatial continuity and require field equipment at each study site. Recent technological advances in spaceborne radar interferometry permit observation of millimeter-level surface deformation at 25 m resolution with worldwide accessibility. Derivation of the first differential interferometric maps of the co-seismic displacement of the June 28, 1992, Landers earthquake was arguably the most exciting recent result in earthquake geodesy. Nevertheless, at the present time, civilian spaceborne differential interferometry remains primarily a demonstration tool, because no mission dedicated to that purpose exists. The high-priority science goals of LightSAR are: (1) to refine our understanding of the earthquake cycle by determining millimeter-level interseismic and co-seismic vector deformation fields along faults and plate boundaries; (2) to monitor volcanoes for new activity and potential eruptions by determining millimeter-level deformation fields; and (3) to support additional natural hazards research using SAR as a rapid and weather-independent monitoring tool.

2.1.1.1 Crustal Deformation

The most challenging science goal for LightSAR is mapping slow Earth deformations. This includes the interseismic accumulation of strain leading up to earthquakes, as well as transient post-seismic strain relaxation following earthquakes. The main issue is that such signals are subtle, with millimeter-sized displacements and long wavelengths vulnerable to systematic measurement errors. The accumulation of strain in the Earth's crust is the first order indicator of future seismic hazard. The mission should allow for repeated measurement of surface change in seismically active areas along all continental margins, and it should provide worldwide accessibility to allow targeting of new and previously unidentified areas for study. Desired temporal coverage should support an interval of 8 days for any particular area, or 24 days for all areas. We also require a surface displacement resolution of 2-5 mm statistical height error to track and model wide-area deformation during and between major earthquakes. Specific high-priority zones should be imaged every orbit if possible, while other areas can be imaged no fewer than four times per year. In order to construct vector deformation fields, imaging must be accomplished from multiple directions.

2.1.1.2 Volcanic Hazards

The major observations in volcanology to be obtained by LightSAR are: (1) the spatial and temporal extent of deformation preceding and accompanying eruptions, which are key observables constraining models of magma migration; and (2) the spatial extent of new material produced during an eruption, derived from image decorrelation, which is an important diagnostic of the eruption process. As in earthquake studies, the mission should allow the measurement of surface change in volcanically active areas on a desired interval of 8 days for any particular area, or 24 days for all areas, with a surface displacement resolution of 1-3 cm statistical height error in order to track and model ground deformation prior to, during, and after volcanic eruptions or

intrusive events. Surface change caused either by the emplacement of new lava flows or by the collapse of volcanic craters should also be studied.

2.1.1.3 Other Hazards

There are a number of other natural hazards that could be studied. Since floods build with time, frequent revisitation and weather-independent images will be used to plan for flood mitigation. Post-flood images may be used for quantitative damage assessment, and may be useful for rapid assessment during the immediate post-flood period when the area may still be cloud covered from continuing storms. For the same reason, SAR images may also be useful for rapid damage assessment after major hurricanes, when cloud cover and damaged infrastructure (telephones, roads, bridges) make conventional surveys difficult. Correlation measurements of landslide-prone areas will be used to detect early signs of incipient ground failure and to help assess the size and destructive potential of such events. Documenting the evolution of the correlation signatures will provide insight for physical modeling of the disasters and for formulation of mitigation strategies. LightSAR will also measure surface change caused by human activity, such as subsidence due to fluid withdrawal from aquifers or hydrocarbon reservoirs.

2.1.2 Ice Sheet Mass Balance and Sea Level

Sustained development of coastal areas worldwide has made the global economy extremely vulnerable to changes in sea level. Ice sheets and glaciers contain a frozen reservoir totaling nearly 80% of the world's fresh water and are the primary source of future sea level rise. While the general retreat of mountain glaciers globally is believed to be responsible for approximately one quarter to one third of the current 2 mm/year increase in sea level, the majority of the remainder remains unidentified. However, it is likely the result of yet-undiscovered imbalances in the large polar ice sheets. Accordingly, the role of ice sheets and glaciers in the global water cycle, especially their impact on future sea level, is a critical objective of ESE.

There are three specific measurements that LightSAR should be able to make that will contribute significantly to this goal. The first two, glacier and ice sheet velocities and topography, are direct products of the interferometric capability of LightSAR. The third, monitoring of critical margins of ice sheets and glaciers, utilizes single-polarization amplitude SAR data. With the exception of the now-concluded European Remote-sensing Satellite (ERS)-1/2 tandem mission, there are no current or planned SAR interferometric missions to provide the first two types of measurements, and except for the recent Radarsat Antarctic Mapping Mission (AMM), lasting only 18 days, there is no SAR satellite designed to view the vast majority of Antarctica, where over 90% of the Earth's ice reservoir exists.

2.1.2.1 Glacier and Ice Sheet Velocities

Ice velocity is the fundamental parameter representing the dynamics of ice. It can be compared with "balance" velocities (determined from areal integration of the snow accumulation) to assess the state of equilibrium of any ice mass or portion of an ice mass. Even in the absence of accumulation data, the magnitude and direction of ice flow is a critical input to dynamic models of ice flow and, when compared with surface topography, can identify regions that are far from being in equilibrium.

The mission should allow investigations of these phenomena by interferometric measurements from different viewing directions to provide the full velocity vector over the greatest portion of the ice sheets possible. The desired repeat interval for ice objectives is 8 days, or less.

L-band interferometry has been successfully demonstrated on glaciers with SIR-C, but not over the drier snow on ice sheets. In terms of the expected sensitivity to ice displacement, an 8-day repeat cycle at L-band compares with a 2-day repeat cycle at C-band. Thus, displacements will be twice what have already been measured with the highly productive 1-day ERS-1/2 tandem data set. Based on the experience with tandem data, longer repeat periods will limit the ice areas over which displacements can be measured due to phase unwrapping difficulties. The accuracy of the LightSAR interferometric motion products will be better than 1 m/year and complementary to GPS measurements, which will help determine the final velocity fields.

2.1.2.2 Ice Surface Topography

The second interferometric product of ice sheets and glaciers is surface topography. Surface topography determines the magnitude and direction of the gravitational force driving the ice flow. Thus, the detailed shape of an ice sheet determines the boundaries of individual drainage basins contained within the ice sheet. In addition, the undulated character of the ice sheet surface provides proxy evidence of whether the ice flow is sliding over a well-lubricated bed or is frozen to the subglacial bed. Finally, the complete elevation field can be an invaluable aid to the interpolation of laser altimetry data (e.g., EOS GLAS), which inherently measure elevations only along very narrow corridors across the ice sheet.

With repeat-pass interferometry, surface topography and ice velocity are both contained in any single interferogram. However, because the displacement due to surface topography is fixed in time, while motion displacements accrue, sequential interferograms can separate these two essential data sets by a technique known as double differencing.

2.1.2.3 Ice Sheet and Glacier Boundaries

This is the most direct approach to detecting change but the most challenging in terms of deducing the cause of that change, given the delayed response character of

slow-moving ice. Nevertheless, SAR offers the advantage of viewing through clouds, which are frequently persistent at the edges of ice sheets and in mountainous terrain. By regularly imaging (once every 3-5 years) the Greenland and Antarctic Ice Sheets, LightSAR can contribute to building an unprecedented series of snapshots documenting the short-term evolution of these ice sheets. This objective is particularly germane given the recent and unexpected disintegration of large portions of ice shelves in the Antarctic Peninsula. Planimetric accuracies required for the intercomparison are about 100 m.

2.1.3 The Carbon Cycle

The global carbon cycle, especially as it relates to CO_2 and its important role as a greenhouse gas, is fundamental to the study of Earth's climate. SAR has contributed to this by enhancing our abilities to: (1) quantify the current rates of exchange of carbon dioxide between the atmosphere and the oceanic and terrestrial sources/sinks of carbon, (2) understand how changes in climate and the concentration of carbon dioxide will influence patterns of vegetation distribution and regrowth after disturbance, and (3) estimate how changes in climate will influence processes controlling patterns of carbon storage in terrestrial ecosystems, particularly in organic soils in high northern latitudes. While much previous work has focused on remote-sensing systems operating in the visible and near-infrared regions of the electromagnetic spectrum (e.g., MODIS, Landsat), research has also demonstrated that imaging radar systems provide useful information as well.

Notwithstanding the burning of fossil fuels, worldwide deforestation and afforestation practices are believed to have the highest impact on the net flux of greenhouse gases. Growing forests remove atmospheric CO_2 and sequester carbon in new or growing trees. The sequestration rate of carbon (biomass production) in tropical forests, for instance, could be as much as 10 to 20 tons/hectare per year. Natural disturbances to forests (such as fires, insects, and diseases) that result in large-scale mortality release large amounts of carbon to the atmosphere. Anthropogenic activities (such as deforestation and afforestation) also strongly influence the atmospheric carbon budget.

Since carbon is stored in the form of biomass in forests and this biomass is interdependent with factors such as nutrient fluxes, water availability, forest age, and temperature, monitoring the changes in biomass provides a critical piece of information to help us understand the global carbon cycle. Monitoring the other factors just mentioned is also important, to the extent that they influence the biomass variations. Balancing the carbon budget is still an unresolved issue. The biogeochemical cycles that determine the atmospheric concentrations of greenhouse gases are not yet completely understood. As we seek to provide a definitive answer to the global change question, our knowledge of land-atmosphere exchange at both the regional and global levels suffers from a lack of long-term observations of biomass. Among remote-sensing instruments, radar has been shown to have the unique abilities to respond to biomass over a usable range and give reliable temporal

information, since it sees through cloud cover. For an L-band radar, biomass values of up to 150-200 tons /hectare have been successfully retrieved.

2.1.3.1 Forest Regrowth and Biomass

Land cover change is one of the fundamental factors perturbing the global carbon cycle. In an IPCC assessment, conversion of forests to managed systems (pastures and croplands) in the tropics was estimated to release 1.6 ($\pm$) G_tC/y to the atmosphere. Conversely, the regrowth of the mid-latitude forests harvested a half-century ago may be absorbing 0.5 to 1.0 G_tC/y. In addition to identifying primary land conversion, successful efforts are underway using SAR to estimate regrowth in secondary forests, a key factor in carbon balances.

The SIR-C mission has demonstrated that a polarimetric L-band radar would enable monitoring patterns of forest regrowth following disturbance in many different forest ecosystems. The development of LightSAR, therefore, would enable ESE scientists to develop operational approaches for addressing topics (1) and (2) in Section 2.1.3, above. To clearly separate areas of disturbance from undisturbed areas and to produce the requisite accuracies in areal extent, a resolution of approximately 25 meters is desired.

2.1.4 The Hydrologic Cycle

The redistribution of solar energy over the globe is central to climate studies. Water plays a fundamental role in this redistribution through the energy associated with evapotranspiration, the transport of atmospheric water vapor, and precipitation. Residence time for atmospheric water is on the order of a week, and for soil moisture it ranges from a couple of days to months, which emphasizes the active nature of the hydrologic cycle.

Perhaps the most important role that the land surface plays in global circulation is the partitioning of incoming radiation into sensible and latent heat fluxes. The major factor involved in determining the relative proportions of the two heat fluxes is the availability of water, generally in the form of soil moisture. The role of soil moisture is equally important at smaller scales. Recent studies with mesoscale atmospheric models have similarly demonstrated a sensitivity to spatial gradients in soil moisture.

2.1.4.1 Soil Moisture

Soil moisture is an environmental descriptor that integrates much of the land surface hydrology and is the interface for interaction between the solid Earth surface and life. As central as this seems to the human existence and biogeochemical cycles, it is a descriptor that has not had widespread application as a variable in land process models. There are two primary reasons for this. First, while it can be measured at one point in time, it is a difficult variable to measure on a consistent and spatially comprehensive basis. Secondly, it exhibits very large spatial and temporal variability;

thus, point measurements have very little meaning. The practical result of this is that soil moisture has not been used as a variable in any of our current hydrologic, climatic, agricultural, or biogeochemical models.

Over the past decade or so, much research into the use of remote sensing to measure soil moisture has taken place. It is generally accepted that the only way to measure soil moisture to a depth exceeding a few centimeters is with a microwave instrument operating at L-band or lower frequencies. Passive microwave measurements from low-flying aircraft have proven measurement accuracies on the order of 3% volumetric soil moisture at spatial scales of a few tens of meters. Unfortunately, similar instruments operating in space require large antennas, presenting a significant technological challenge. Even if this technological challenge could be overcome, the resolution of these instruments would be limited to tens of kilometers. Given the large spatial variability of soil moisture and land cover over spatial scales much smaller than tens of kilometers, it is unclear how the resulting measurement would relate to the soil moisture at any given point inside such a large pixel.

Active microwave instruments provide an alternative way of measuring soil moisture. To estimate soil moisture from active microwave measurements, one has to separate the effects of surface roughness and soil moisture, making this generally a more challenging problem than the passive microwave case. However, several algorithms have been developed, ranging from empirical models to ones based on complex electromagnetic scattering theories. All of these algorithms seem to give similar results, with proven accuracies (when compared with in-situ measurements) on the order of 4% volumetric soil moisture at spatial scales of a few tens of meters. Furthermore, at least one of these algorithms has been applied to SIR-C data over the Washita site in Oklahoma, and the accuracy was verified using ground-truth data.

NASA/OES-sponsored research using the ERS SAR has demonstrated that spaceborne SAR systems can be used to monitor relative changes in soil moisture in fire-disturbed boreal forests. In these biomes, soil moisture is a key parameter in the estimation of rates of soil respiration. It has been estimated that climate warming will result in significant increases in soil respiration and release of carbon to the atmosphere in these biomes. Thus, the ability to monitor variations in soil moisture is essential for estimating future fluxes of carbon. Polarimetric capabilities are required in order to separate the effects of changes in soil moisture from changes in biomass and surface roughness. This will significantly improve models of soil respiration in the boreal region.

The redistribution of water is governed partly by atmospheric circulation. In recent years, models have been developed to trace circulation through space and time. Topographic roughness is a key parameter for such models, but one for which mapping data are mostly lacking. The ability to map large areas based on the radar backscatter coefficient was demonstrated by SIR-C for L-band. The application of this

technology to help refine circulation models will enable better understanding of water vapor transport, as well as general atmospheric motions.

2.1.4.2 Snow Properties: Snow Cover and Snow-Water Equivalence

Traditionally, satellite data have been used extensively to map snow-covered area—i.e., to determine whether a pixel is snow-covered or snow-free. In clear weather, optical sensors map the presence of snow best. A C-band dual-polarized SAR can map snow presence about 80% as well as the Landsat Thematic Mapper in all weather conditions, with the advantage that SAR can detect whether the snow is wet or dry. Snow cover data are incorporated into operational snowmelt forecasting schemes, but the size of a snow-covered area may not be a reliable indicator of the amount of water stored in the snowpack.

The most fundamental snow property in terms of water supply forecasting is the snow-water equivalence, which is the total amount of water the snow would yield at a point if it melted. Traditionally, this variable has been measured at several hundred snow courses throughout the mountainous regions of the western U.S. However, these snow courses do not adequately sample the terrain's variability—they are all on flat ground—and simple interpolation between snow courses does not produce useful results. Hence, the traditional snow course data provide only an index to the amount of water in a basin. They do not provide data that are accurate enough to calculate a water balance for the basin.

There is a need to estimate the spatial distribution of snow-water equivalence and its basin-wide integral. Experiments with SIR-C/X-SAR data show that direct measurement of snow-water equivalence is now within our technological capability.

With accurate estimates of snow-covered areas, detection of melting snow, and the measurement of the spatial distribution of snow-water equivalence, we will be able to better forecast melt on short and season-long time scales. Such forecasts will improve the management of reservoirs in areas of snowmelt runoff and thus improve the allocation of water for agriculture and other uses.

2.1.5 The Role of the Ocean in Climate Change

Synthetic aperture radar images of the oceans contain large amounts of information on both coastal and deep-ocean physical processes. This information is varied and impacts a rather wide variety of scientific oceanic disciplines. However, in the context of a LightSAR mission, probably the most significant contribution is the role of the oceans in climate change. The importance of this role has been established by numerous publications and has led to major observational and theoretical programs. These research activities will continue well past the lifetime of LightSAR and thus will be significantly enhanced by the data provided by LightSAR.

The world's oceans play an exceedingly important role in establishing global weather and its long-term average, climate. The oceans have the only significant heat capacity on the surface of the Earth, because (a) water has the largest specific heat of any known substance (save one), and (b) the seas cover 71% of the surface of the planet. The land heats up and cools down on diurnal time scales, and the atmosphere is far too tenuous to store heat in any concentration. Thus, if significant amounts of solar energy are to be stored or released on time scales exceeding a few days, the oceans must be looked to for the mechanisms of retention and release; they are well-known to provide those mechanisms.

2.1.5.1 Air-Sea Interaction and Ocean Climate Dynamics

Synthetic aperture radar images have recently been shown to display signatures that discriminate important air-sea interaction processes due to sensitivity to small-scale surface roughness. Although the roughness modulations are often small (on the order of a few percent), they nevertheless are quite apparent in the imagery and often mirror significant and extensive dynamics. For example, it is the interaction between the planetary boundary layer of the atmosphere and the upper ocean that establishes the interchange of heat, momentum, and moisture in both the lower and upper atmospheric regions. It is those fluxes that must be determined if we are to understand the processes that control the mean temperature of the Earth, its humidity and cloudiness, and the amount of carbon dioxide in the atmosphere. Changes in long-term heat storage and release are major factors in the establishment of climate variability. While problems such as increases in carbon dioxide concentrations in the atmosphere are clearly important, it must be remembered that water vapor is a more radiatively active gas than carbon dioxide and is much more variable in time and space.

Much, if not most, of the air-sea interchange occurs episodically during storms and high wind events. During these events, the surface of the sea is hidden from remote sensors such as visible and infrared scanners because of cloud cover. Furthermore, ship- and buoy-based measurements are inhibited or even compromised during such heavy weather episodes. Thus, it is not presently possible to make accurate observations during those times when the physics is most active. It is at these times that spaceborne SAR provides views of the sea surface that are difficult to obtain by any other means.

The most important LightSAR characteristics for oceanography are: (1) a wide swath—250 to 500 km—because the spatial scales of the important processes are well in excess of the so-called oceanic Rossby radius of deformation (typically 50 km at mid-latitudes); (2) dual polarization (HH and VV), because of the possibility of delineating atmospheric fluxes via differences in signatures of the two polarizations; and (3) repeated observations of the non-stationary processes at work, with a repeat time on the order of a week. Both open-ocean and coastal observations are desired, the latter because many important mechanisms go on near the edges of the

continental shelves. Many features visible in SAR images of coastal regions also benefit fishing, boating, shipping, and offshore oil interests.

The climate-oriented observational program would likely concentrate on a few areas of the ocean known to be important: the Gulf Stream, the Greenland/Labrador Seas, the Norwegian Sea, and the Pacific equatorial current systems (this is an example of a tropical region). Observations would be focused on places and times when other relevant ocean research programs were taking place, thus leveraging the resources and providing “sea truth” to the SAR. The details of the observational strategy to be used by LightSAR will depend on these in-situ programs.

2.2 Applied Science /Commercial Objectives

The questions posed and answers found in the grand scientific inquiry not only support scientific exploration and discoveries, but also may yield knowledge of substantial near term practical value to society.

Most NASA Earth Science missions yield a variety of practical applications of the resulting data. The applied research to be pursued in the scientific topics listed in Section 2.1, above, is likely to lead to potential commercial applications which may support cost sharing. For proposals in which this is the case, the applied research and the applications expected to be derived from performance of the proposed mission will be described.

2.3 Technology Objective

NASA has invested in new technology in support of LightSAR development through the Advanced Radar Technology Program and the LightSAR Payload Technology Alliance. These efforts have enabled NASA to take advantage of the best SAR technologies available in government and industry. Every effort should be made to incorporate technology advances that have potential to reduce cost and enhance performance, consistent with the restrictions imposed by cost, risk, and schedule. For more information on the LightSAR Payload Technology Alliance visit the LightSAR Web site, http://southport.jpl.nasa.gov/lightsar/.

2.4 Cost and Contribution

NASA has a goal of accomplishing its LightSAR objectives within the cost constraints presented in Section 3.1. The successful Proposer to this AO will design, build, launch, and operate the LightSAR system; process and distribute the acquired image data and related products; and conduct unique scientific investigations. Proposals offering cost sharing or the contribution of resources are encouraged.

2.5 Summary

While the objective of this AO is to enable/conduct unique scientific investigations for NASA's Earth Science Program as part of the LightSAR Program, the program also has goals to:

1. Enable U.S. industry to open new markets and create long-term businesses that will become sustained providers and consumers of valuable science and commercial SAR data; and

2. Demonstrate advanced technologies that reduce the cost and enhance the performance of future LightSAR missions.

More information is available at the following Web sites:

NASA Earth Science Enterprise - http://www.earth.nasa.gov

NASA LightSAR Project - http://southport.jpl.nasa.gov/lightsar/

3.0 GUIDELINES, REQUIREMENTS, AND CONSTRAINTS

The following sections describe the constraints, guidelines and requirements of the LightSAR Program. Specific directions and requirements for proposal preparation are included in Section 4.

3.1 Constraints

3.1.1 Available Funding

NASA desires the LightSAR mission to be implemented using the low cost, rapid development approaches pioneered in recent Earth and Space Science missions. To this end, NASA will limit the NASA funding, or NASA Mission Cost (NMC), of the mission selected under this AO while seeking the greatest possible scientific return for the government investment in this program.

Total cost to be addressed in the proposal includes mission management; spacecraft and instrument definition and development; mission systems integration and test; launch services; on-orbit operations; in-situ measurements necessary to enable optimum science return, which may include non-satellite or ground measurements; applied research investigations; processed data support for NASA Science Investigations; public and educational outreach support; algorithm development and data processing; calibration /validation; and data product archiving and distribution. All civil service or civil service support contractor resources must be proposed on a full cost basis. Funding currently budgeted for LightSAR development and operations, including JPL subcontract administration expenses (currently 10.9% of contract value), is presented below. Funding for NASA Science Investigators (selected outside of this AO), JPL project management, and JPL coordination of data requirements for NASA Science Investigators is provided separately (as needed) and is not included in the budget profile shown below.

NASA funding (as currently budgeted) in real year $M for the mission is:

FY1999	FY2000	FY2001	FY2002	Total
$5	$20	$31	$26	$82

FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	Total
$6.3	$8.4	$8.4	$8.4	$8.4	$2.1	$42.0

The nominal launch date assumed in the above funding profile is September 2002. NASA is prepared to consider adjusting the above funding (profile and/or total) if suitable justification is provided.

LightSAR Proposers are strongly encouraged to include resource sharing in their proposals. This will be considered in the evaluation process. Opportunities for commercialization and private investment may reduce the cost to NASA in

accomplishing mission science objectives. Proposals may include enhancements to the NASA minimum science mission. In return for cost sharing, NASA will consider innovative data management approaches that afford protection of commercial opportunities while maximizing non-proprietary scientific return.

Proposers may include international partners on their teams, as described in Section 3.3.

NASA does not intend to maintain a separate funding reserve for the LightSAR program. All proposed costs for enhancements to the science mission that exceed the LightSAR NMC will be borne by the successful Proposer. The combined NMC and proposing team cost share funding must contain reserves proportional to the project scope and degree of development risk.

3.1.2 Technical Maturity

The nominal launch date assumed in the above funding profile (Section 3.1.1) is September 2002. Alternate schedules may also be proposed, including an accelerated schedule to meet commercial needs. To meet these schedules, it is recognized that proposed new technology developments may be few, perhaps limited to necessary developments in the radar instrument and in ground data processing. Use of new technologies must be consistent with present technical maturity level and proposed launch schedule. The technology developments required for successful performance of the LightSAR mission must be identified in the proposal, along with an assessment of the present technology maturity, the risks involved and alternative approaches.

3.1.3 Launch Services

The proposal is expected to identify how a launch vehicle and all necessary launch services will be acquired. NASA seeks to take advantage of all reasonable sources of domestic commercial expendable launch vehicle (ELV) services, while assuring that NASA-funded payloads are not exposed to excessive risk. Accordingly, the demonstrated reliability of the proposed launch vehicle (foreign or domestic), the programmatic and technical risk associated with the proposed launch service, and the resultant probability of mission success will be evaluated. At least one successful prior launch of the proposed vehicle configuration (occurring before the scheduled LightSAR launch) is considered a minimum demonstration of launch vehicle reliability.

NASA funds may not be used to purchase a launch service using a non-U.S.-manufactured launch vehicle.

It is permissible to propose a NASA-provided launch. If a NASA-provided launch is proposed, it must be on a full cost basis and must be arranged through direct contact

by the Proposer. For proposal purposes, refer to Appendix B for costs/capabilities of launch services available for a NASA-provided launch.

3.1.4 NASA Science Investigators

NASA Science Investigators are defined as persons conducting basic and applied research in Earth Sciences under NASA OES sponsorship. The expected scope of LightSAR-related scientific research is identified in Section 2. NASA Science Investigators are selected through NRAs, AOs, unsolicited proposals, and similar means. NASA will take full advantage of the applications research activities that are currently sponsored by the EOCAP SAR program and will issue future NRAs (funded separately) for soliciting proposals for applications and scientific data analysis from this mission.

3.2 Requirements

3.2.1 Minimum Science Mission

The LSWG recommends that the highest priority science objectives, balancing scientific need and relevance against cost and complexity, are those that can be accomplished by repeat pass interferometry with an L-band (approximately 24 cm wavelength) SAR. Although an 8-10 day exact repeat time is desired, the maximum allowable time between repeat orbits is 30 days. The mission design life is to be five (5) years. These objectives include seismic and volcanic deformation mapping, vector ice sheet and glacier velocity mapping, topographic mapping and surface characterization, and hazard monitoring and assessment. All these primary objectives are integral to the OES Solid Earth and Natural Hazard strategic plan, are unique, and have broad multidisciplinary community support. The LSWG also finds that for the LightSAR mission to provide data to scientists studying the Earth's carbon and hydrologic cycles, a polarimetric capability would be required. Specific objectives to be met here include monitoring forest regrowth, estimating soil moisture, and estimating snow density. This constitutes the basic Minimum Science Mission and represents the minimum mission which must be accomplished in the event of a descope (e.g., to recover from problems without exceeding NMC).

For interferometric SAR observations it is necessary to optimize the wavelength of operation against temporal decorrelation, instrument sensitivity, and radar brightness for many surface terrains. It is also necessary to optimize observational strategies for atmospheric effects, such as propogation delays related to water vapor and the ionosphere. With years of ERS and Japanese Earth Resources Satellite (JERS) SAR data acquired, volumes of multi-frequency, multi-polarization SIR-C/X-SAR data analyzed, and the prospect of new advances from the multi-mode Radarsat observations, it has become clear that the longer wavelengths such as L-band are best suited to our identified repeat pass interferometry science measurements, where the radar return is relatively insensitive to local changes on the surface. Reduction of SIR-C/X-SAR data show that this wavelength is also a good choice in

polarimetric consideration. L-band multi-temporal and multi-polarization measurements best provide capabilities to monitor changes in (1) biomass due to forest regeneration, (2) soil moisture levels, and (3) snow density. Thus, the fundamental functional requirements for LightSAR specify L-band as the primary choice of frequency to meet the LightSAR science objectives.

Finally, a wide swath mode (250-500 km) would be required for oceanographic applications- they would also benefit from dual polarization capabilities (HH and VV).

SAR data provide unique information about Earth's surface and biodiversity, including critical data on natural hazards and data for use in resource assessments. SAR interferometric capabilities, which allow measurement of large-scale surface change at fine resolution, are required for monitoring surface topographic change and glacier ice velocity and, in many instances, for generating critical topographic data sets. Many recent literature citations have documented the contributions of interferometric radar to studies of earthquake mechanisms and propagation, volcanological hazard assessment, and refined measurements of the global ice-sheet mass balance.

Analysis of data from the SIR-C/X-SAR indicates that multiparameter (wavelength and polarization) SAR data can provide accurate land cover classification and forest growth estimates; biomass estimation; mapping of wetlands; measurements of snow density, soil moisture, and surface roughness; characterization of oil slicks; and monitoring of sea ice thickness. While optimal frequencies and polarizations for these measurements depend on the specific application and, in some cases, environmental conditions, the more limited multiparameter data set provided by LightSAR will nonetheless contribute to research in this area.

Proposals may include enhancements to the L-band SAR described herein.

3.2.2 Data Archive

All acquired NASA science data are to be maintained in an easily accessible data storage arrangement for a period of five (5) years following the end of the LightSAR mission. The proposal should address how soon after being acquired the data will be accessible in the archive, and the processing level of the archived data. It will be required to inform NASA of any contemplated actions that would result in the loss of science data in the archive in sufficient time for NASA to make alternate arrangements.

3.3 Guidelines

3.3.1 Teaming Arrangements

LightSAR proposals may contain innovative partnerships. Teaming arrangements with nonprofit institutions, NASA Centers (including JPL), Federally Funded Research and Development Centers (FFRDCs), or other national and international agencies

and organizations are encouraged. The Team Leader is defined as the entity that submits the proposal and signs the contract. If NASA institutional services are proposed, they must be on a full cost basis and must be arranged through direct contact by the Proposer.

This solicitation encourages U.S. commercial sector participation in every aspect and area of the proposed LightSAR mission. Best available commercial processes, business practices, and technologies are encouraged to optimize the effectiveness of the project and return best value science to U.S. taxpayers.

3.3.2 Role of JPL

The NASA Headquarters Office of Earth Science (OES) will select the LightSAR mission. NASA will direct the award of a subcontract by the NASA-Jet Propulsion Laboratory (JPL) to implement the selected mission. JPL will manage the project for NASA and coordinate data requirements for NASA science investigators. Therefore, the successful Proposer and the JPL LightSAR Project Office are expected to work together as a single, seamless, integrated team committed to a successful mission. The overall JPL role may be revisited, depending on the cost share and capability of the selected proposal.

3.3.3 International Participation

Participation by international partners in the LightSAR mission may include, on a no-exchange-of-NASA-funds basis, the contribution of all or a portion of the spacecraft, additional instrument(s), launch services, and/or communications, consistent with program goals. Any proposed international participation must include the provision of all requested cost, schedule, and management data in the proposal and subsequent reviews.

NASA-provided dollars may not be used to fund non-U.S. team members or to purchase a launch service from a non-U.S. source. However, the direct purchase of goods and/or services from non-U.S. sources by U.S. team members is permitted. LightSAR Proposers are advised that international purchases must meet NASA and Federal regulations and that these regulations may place an additional burden on the successful Proposer that should be explicitly included in discussions of the Proposer's cost, schedule, and risk management. Information regarding regulations governing the procurement of foreign goods or services is provided in Appendix E.

The system design shall be such that non-U.S. ground stations are not essential to obtain data and/or command/control the LightSAR satellite. If use of non-U.S. ground stations is proposed, such use must be consistent with any restrictions, or anticipated restrictions, that may be placed on the proposing team’s remote sensing space system operating license.

Participation by non-U.S. partners as team members must be endorsed in writing by these organizations and, where foreign government funding is provided, by the foreign government involved. All proposals with non-U.S. participants shall include a binding contractual agreement between the Team Leader and each non-U.S. organization, as described in Section 4.3. NASA recognizes that these contractual agreements may dictate that a separate agreement also be reached between a foreign government and NASA. If necessary, NASA is willing to assist in finalizing such a government-to-government agreement after selection.

3.3.4 Outreach and Opportunity

Programs that enhance the level of public understanding and awareness of Earth Science, by mass media, and/ or educational activities with primary and secondary educational institutions, are strongly encouraged.

Team members shall agree to use their best efforts to assist NASA in achieving its goal for the participation of small disadvantaged businesses, women-owned small businesses, Historically Black Colleges and Universities, and other minority educational institutions in NASA procurements. Investment in these organizations reflects NASA's commitment to increase the participation of minority concerns in the aerospace community, and is to be viewed as an investment in our future.

3.3.5 Additional Instruments

Instruments in addition to the instrument necessary to perform the minimum science mission may be flown, on a non-interference basis, on the LightSAR spacecraft. Proposals to add additional instruments which cannot be accommodated within the NASA cost limit are acceptable only if the funding for instrument development, integration, operation, and all data processing is provided from another source.

3.3.6 Mission Milestone Reviews

In order to assess progress and to provide NASA with necessary technical and programmatic insight, the proposed implementation approach should include a schedule of reviews (see Appendix N) for the entire LightSAR life cycle (Appendix I). The overall review plan should include a set of mission milestone reviews. Innovative implementation still requires management accountability. The Team Leader and the LightSAR Project Office must be accountable to NASA for the success of the mission and must be prepared to recommend mission termination when, in their judgment, mission success is not likely within the committed cost and schedule reserves.

4.0 PROPOSAL SUBMISSION GUIDELINES

4.1 General Overview

The following guidelines apply to the preparation of proposals in response to this AO. The material presented is a guide for the Proposer and is not intended to be all encompassing. The Proposer shall provide information relative to those items applicable or as otherwise required by the AO. The required proposal format, contents and instructions are summarized below. Failure to follow all proposal format, content and other instructions may result in reduced ratings during the evaluation process and could lead to rejection of the proposal.

4.1.1 Proposal Instructions

All documents must be typewritten in English, use the International System of units (SI), and be clearly legible. All cost estimates, including non-U.S. contributions, must be in U.S. dollars. Submission of proposal material by facsimile (fax), videotape, or Internet reference is not acceptable. All paper proposals and copies must be submitted on plain white paper only (e.g., no cardboard stock or plastic covers, no colored paper, etc.). Photographs and color figures are permitted if printed on recyclable white paper only. The original signed copy should be bound in a manner that makes it easy to disassemble for reproduction. Every side upon which printing appears will be counted against the page limits. In complying with page limits, no page should contain more than 50 lines of text and the type size should not be smaller than 12 points. Top, bottom and side margins of at least one inch should be used. Single or double column format is acceptable.

In addition to the bound paper volumes, the proposal shall also be provided on diskettes. These diskettes will be used primarily to assist evaluators with searches for information within the proposal. The actual evaluation will be performed utilizing *all* portions of the proposal submitted on paper. Only the text portion plus table and figure titles need to be provided on the diskettes; tables, figures and any other material of an essentially graphic nature need not be included. INFORMATION NOT INCLUDED IN THE PAPER VOLUME OF THE PROPOSAL SHALL NOT BE INCLUDED ON THE PROPOSAL DISKETTES. If the diskettes are found to include information which differs from the paper volume or are found to be defective (e.g., non-readable) the diskettes will be returned to the Proposer and the Proposer shall promptly provide replacement diskettes. Replacement diskettes will not be considered a late proposal under NFS 1815.208, Submission, Modification, Revision, and Withdrawal of Proposals. If necessary to segment the proposal on multiple diskette files either because of diskette space or other limitations, the files should be as large as possible and have a logical relationship to the proposal structure.

All information shall be provided on DOS-compatible (version 5.0 or higher), high-density (1.44 megabytes), 3-1/2" diskettes. All text portions of the proposal shall be

provided in Microsoft Word for Windows format (version 6.0 or earlier) and in ASCII (DOS) format on separate diskettes.

Three copies of each proposal diskette (all certified as virus-free) shall be provided. A brief description explaining the diskette file structure, naming conventions used and any other information that the Proposer feels may be helpful to use these files effectively for the intended purpose shall be included. These pages do not count toward the proposal page limit.

4.1.2 Proposal Format

The following requirements pertain to proposal format. The cover page, signature page(s), table of contents, reference list, personnel information, Executive Summary, certifications, fact sheet, fact sheet transparency, non-U.S. participant agreements, Statements of Work, cost spreadsheets and all other required contract documentation will not be counted against the page limits.

< Cover Page

The cover page must be signed by an official of the team leader's organization proposing to NASA who is authorized to commit the organization that is directly responsible for the proposal and its contents. The cover page must reference the LightSAR AO title and number and include the full names, signatures, titles, affiliations, addresses with zip codes, telephone and fax numbers, and electronic mail addresses of the authorizing official(s); and annual funding requirements for the mission in real year dollars by Government fiscal year, clearly identifying the amount requested from NASA and the amount to be contributed by the Proposer. This cover page should be attached to the front of the proposal.

< Signature Page

A signature page containing the endorsements of the implementing, funding and sponsoring proposal team member organizations must be forwarded with the proposal, immediately following the cover page. The signatures shall serve as endorsements of the proposed mission cost, schedule and implementation as defined by the proposal, and commit each institution to carry out its proposed responsibilities for the resources proposed. The signature page must reference the LightSAR AO title and number and include the full names, signatures, titles, affiliations, and addresses of the Project Manager, all applied science research investigators, and lead representatives from every organization represented on the team (including contributing and non-U.S. members), as well as the authorizing official from each organization represented on the team who is authorized to commit that institution to the proposed investigation. In the case of non-U.S. participants, signatures from the institutional and/or government funding providers must be included. The authorizing official signatures, phone numbers, addresses, etc., included on the cover page need not be repeated on the signature

page. Should it not be feasible to have all individuals sign the same sheet due to time or page constraints, more than one sheet may be used to enable concurrent signatures. Appendix M, Figure M-5 provides the format to be followed in preparing the signature page(s).

< Table of Contents

A table that lists the title and page number of the proposal's major subdivisions should follow the cover page.

< Executive Summary

The Executive Summary should provide an overview of all aspects of the investigation. This summary should be presented in five parts reflecting the major sections of the proposal (Science, Technical, Opportunity, Cost, and Management). It is recommended that the Executive Summary be constructed by writing abstracts of each of the five major sections and should serve as the Introduction and Summary for the proposal. The Executive Summary is limited to a maximum of 5 single-spaced typewritten pages, without reduction. No foldout pages are allowed.

< Fact Sheet

A separate one-page summary ("Fact Sheet") of the proposal shall be included with the Executive Summary, but is not included in the 5-page limit. This fact sheet shall reference the LightSAR AO title and number and include the following information, in order: identity of the team member organizations and their role and/or contribution; a brief vision statement; a brief statement of applied science objectives; a brief mission and system concept description; a brief description of proposed instrumentation; a brief description of how mission and system concept meets or exceeds minimum science requirements and (if cost sharing is proposed) a brief description of the market analysis; a brief list of instrument and spacecraft heritage (if any); the proposed launch service; cost; schedule; and cost/ schedule reserves. Other relevant information, including figures or drawings, may be included at the Proposer's discretion. This fact sheet is restricted to one (1) side of one page of paper. There are no restrictions on the type of paper upon which the fact sheet is printed (i.e., glossy paper is permitted). In addition, one transparency (viewgraph) of the fact sheet must be included.

< Proposal Body

The proposal body shall consist of five sections in order: "Science", "Technical", "Opportunity", "Cost" and "Management".

The Science, Technical and Opportunity sections together are limited to a maximum of 100 single-spaced typewritten pages, without reduction, including

illustrations and tables, and may contain no more than 5 foldout pages (28 x 43 cm) (i.e., 11 x 17 inches).

The Cost and Management sections together are limited to a maximum of 35 single-spaced typewritten pages, without reduction, including figures, tables, and charts. The proposed Statements of Work, contract list of deliverables, any requested supplemental plans, proposed contractual documentation, and the requested cost spreadsheets in the designated layouts will not be counted against the page limit.

The Science, Technical and Opportunity sections must provide a clear description of the approach to be used in attaining the scientific objectives of the mission, as well as the educational and/or social benefits and any commercial opportunities offered by the mission. These sections should contain enough background information to be meaningful to a reviewer who, although not necessarily a specialist, is generally familiar with the field.

The Cost and Management sections must provide a clear statement of all costs associated with the mission, along with the management approach to be used in attaining the mission objectives.

< Certifications

Certifications required by Federal law are included as Appendices J and K to this AO and should be appended to the proposal.

4.2 Proposal Content

The following sections describe in detail the content requirements of proposals.

4.2.1 Science

The Science Section shall contain all pertinent information that will allow the scientific merit of the proposed mission to be evaluated. Both basic and applied science objectives will be addressed. All of this information is counted as part of the proposal page limit.

SCIENTIFIC GOALS AND OBJECTIVES - This section shall describe how well the proposed mission addresses the stated LightSAR science objectives in terms of mission characteristics, image acquisitions, and instrumentation. The LightSAR science objectives are identified in Section 2, above.

This section shall also describe how the proposed mission addresses the Proposer's applied science objective(s) in terms of mission characteristics image acquisitions, and instrumentation. The proposed applied science investigation(s) and/or applications shall be described and justified. This description shall identify the

problem(s) to be addressed, the underlying physics, the required measurement(s), and the present state of knowledge with respect to the problem(s), including existing models and observations.

APPLIED SCIENCE TEAM - The Proposer's applied science/applications team members should be identified, together with their related area of expertise, experience, and role in the mission. The minimum number of investigators required to guide the development of the mission and prepare the necessary algorithms should be identified.

NATURE OF PROPOSED MISSION - This section shall present an end-to-end overview of the proposed mission. Note that the detailed mission description is furnished in the Technical Section, described below.

ANTICIPATED SCIENCE DATA RETURN - This section shall fully describe the science data to be acquired, processed, and distributed in the course of the mission. This description shall identify the quality (e.g., resolution, coverage, accuracy, etc.), and the quantity of acquired data (e.g., average and peak bits/orbit, bits/year, minutes/orbit and minutes/year, etc.), and the data acquisition spatial and temporal specifics. The Proposer should demonstrate that the data acquisition capability is derived from a spatial and temporal analysis that considers a variety of acquisition scenarios for each operating mode (e.g., including extreme cases, focused campaigns, etc.) to ensure the science objectives are met.

Proposals should identify the procedures, processes, and tools to be used in mission planning that will allow conflict resolution, and permit optimum use of LightSAR resources.

A plan for processing, distributing, and archiving the data should be included that describes the anticipated format of the final data products, data product generation, and data product dissemination, and explicitly describes data quality assessment (i.e., calibration, validation and evaluation) processes. Proposals should address how the data will be processed in a timely manner to Level 0 and Level 1 standard data products, which are defined as:

Level	Definitions
0	Reformatted raw signal data
1	Processed image data (one-look, complex, multi-look) at full resolution and reduced resolution, time referenced, annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (ephemeris) computed and placed in a header but not applied to the image data, and data that has been geometrically resampled and radiometerically corrected to radar backscatter cross section.

Notes: These are generic definitions. The proposal should provide more technical definitions. NASA Science Investigators will need both calibrated and uncalibrated Level 1 products. These products include single-look, complex, multi-look detected, polarimetric and interferogram products.

The proposal should describe the algorithms and the theoretical basis for the Level 0 and 1 data processing software to be developed by the Proposer. In addition, the proposal should describe the approach to producing calibrated data products.

The proposal should address how the data will be distributed in a timely manner. NASA will consider proposals for any data distribution arrangements that will provide the NASA Science Investigators with rapid and complete access to the science data. It may also be required to ship processed data from each scene to multiple NASA Science Investigators. The proposal should address NASA Science Investigator data rights; see also Appendix A, Section XII.

If needed to afford protection for potential commercial opportunities arising from a resource sharing proposal, a data management approach including appropriate data rights shall be included. The data management approach should address prioritization of data acquisition (e.g., allocation of SAR “on” time), including the resolution of conflicts between science and commercial data taking requests.

This section shall also describe the measurements to be made in support of the applied science objectives in the course of the mission, the observational data to be returned, and the approach to be used to analyze the data, to achieve the research objectives. Required data quality (spatial and temporal resolution, coverage, pointing accuracy, measurement precision, etc.), and quantity (number of bits, images, etc.) shall also be described. Plans for science validation and correlative measurement, algorithm development, and data processing and distribution shall be discussed. The expected results shall be described, and the relationship between the generated applied science data products and the potential commercial applications discussed.

INSTRUMENTATION - This section shall fully describe the proposed instrumentation and the criteria used for its selection. Instrumentation performance requirements should be related to the proposed science measurement objectives described above. The linkage between the required physical measurements and the proposed instrumentation should be detailed. A block diagram and an overall functional description for all instrumentation should be provided, together with a description of operational scenarios /modes. A summary should be provided of any instrumentation concept, feasibility or definition studies already performed. An assessment of the maturity of the instrumentation should be furnished, including design heritage and existing instruments, breadboards, brassboards, and prototypes. Identify use of advanced technology and its performance and/or cost benefits for LightSAR and/or future SAR missions. The technology/ development risks should be described and the plan to address them. A schedule for instrument development should be provided. The following preliminary information shall be provided:

- Size
- Mass with margins
- Power with margins (nominal, peak, duty cycle, standby)
- Data rate with margins
- Mechanical, electrical, and thermal layouts
- Ground and on-orbit calibration scheme
- Pointing requirements (knowledge, control, and stability)
- Command and control requirements
- Flight software development plan (use of existing or commercial off the shelf software shall be identified)

REFERENCES - List all references cited in the Science Section of the proposal. Cited references should be from the extant literature (i.e., widely available journals, books, etc.) or available as preprints.

4.2.2 Technical

The Technical Section shall detail the proposed technical implementation of the LightSAR mission. This section must also detail the expected products and end items associated with each mission phase (see Appendix I). The team may use its own processes, procedures, and methods. The use of innovative processes, techniques, and activities in accomplishing mission objectives is encouraged when total mission cost, schedule, and technical improvements can be demonstrated. The experience and qualifications of performing organizations shall be discussed.

MISSION DESIGN - This section shall fully describe the design, development, launch and operation of the proposed LightSAR mission. Mission design and development, including systems engineering and requirements flowdown and allocation, shall be described. Information on the proposed launch service, orbital parameters and a preliminary mission timeline indicating periods of data acquisition, data downlink, etc.

shall be included. The mission description shall also define the type and source of communications network interface required.

The rationale that justifies both the cost effectiveness and technical effectiveness of the mission design shall be described. A "Mission Traceability Matrix" showing how the proposed mission design is derived from the stated objectives, requirements, and constraints shall be included. The format of the Mission Traceability Matrix shall be as shown in Appendix M, Figure M-9. The rationale for the selection of launch vehicle must be provided. If not NASA-provided, the prior demonstrated flight record and qualification history of the launch vehicle shall be provided. The proposal shall identify any innovative features of the mission design that minimize total mission costs, such as the use of commercial off-the-shelf technology.

SPACECRAFT - This section shall describe the spacecraft design approach, particularly as it relates to new versus existing hardware and redundant versus single-string hardware. It shall fully identify the spacecraft and describe its characteristics and requirements. A preliminary description of the spacecraft design with a block diagram showing the spacecraft subsystems and their interfaces shall be included, along with a description of the flight software and a summary of the estimated performance of the spacecraft. The flight heritage and/or rationale used to select the spacecraft and its subsystems, major assemblies, and interfaces shall be described. In addition, an assessment of the technical maturity of each subsystem and critical component shall be provided. This “Spacecraft Technical Maturity Matrix” shall define the technology readiness level (as defined in Appendix M, Figure M-1) of each item, along with a rationale for the assigned rating. The Spacecraft Technical Maturity Matrix is counted as part of the proposal page limit. The format of the Spacecraft Technical Maturity Matrix shall be as shown in Appendix M, Figure M-8.

Subsystem characteristics and requirements shall be described to the greatest extent possible. Such characteristics include: mass, volume, and power requirements; pointing knowledge and accuracy; new developments needed; spaceflight qualification plan; and logistics support. Any design features incorporated to effect cost savings shall be identified. A summary of the resource elements of the spacecraft design concept, including key margins, shall be provided. The rationale for margin allocation shall also be provided. Those design margins that are driving costs shall be identified.

Plans for all phases of software development, including the use of existing (including "commercial off-the-shelf") software, shall be described. The method planned for development and validation of flight software shall be addressed.

The method for resolving any major open spacecraft issues, major systems trades, and technology development planned in Phase B (see Appendix I) shall be addressed. A schedule for the spacecraft development must be included.

PAYLOAD INTEGRATION - This section shall characterize the interface between the science instrumentation and the spacecraft. The planned process for physically and analytically integrating the science payload with the spacecraft shall be described. Along with a description of the payload layout and configuration, the accommodation of the science instrumentation by the spacecraft shall be addressed as follows:

- Instrument location constraints
- Mechanical/structural interface
- Field of view, alignment and pointing
- Baffling or other protection
- Thermal environment/temperature limits
- Data collection and storage
- Data processing (onboard and on the ground)
- Telemetry
- Commands
- Timing (clocks)
- Environmental sensitivities (electrical cleanliness, magnetic fields, contamination, etc.)

MANUFACTURING, INTEGRATION, AND TEST - This section shall describe the manufacturing strategy to produce and verify the hardware/software necessary to accomplish the mission. It shall include a description of the main processes/ procedures planned in the fabrication of flight hardware and software development; use of production personnel resources; incorporation of new technology /materials; and the preliminary test and verification program.

The approach, techniques, and facilities planned for manufacturing, integration, test and verification, and launch operations phases, consistent with the proposed schedule and cost, shall be described. A preliminary schedule for manufacturing, integration, and test activities shall be included. A description of the planned end items, including engineering and qualification hardware, shall be included. The use of any existing test facilities and processes shall be described.

GROUND AND DATA SYSTEMS - This section shall discuss the ground operations support required for the proposed investigation. The approach to the development of the ground data system (GDS), including the use, if any, of existing facilities shall be described. Any mission-unique facilities must be adequately described. Include a block diagram of the GDS showing the end-to-end concept (acquisition through archiving) for operations and data flow to the subsystem level. Describe the use of standards, such as Consultative Committee for Space Data Systems (CCSDS) recommendations or commercial standards, on the space/ground communications link. Describe all communications, tracking, and ground support requirements, including space /ground link spectrum requirements and licensing approach. Describe the software development approach and its relationship to the flight system software development.

MISSION OPERATIONS - This section shall describe the planned approach for managing mission operations and all flight operations support, including mission planning. A description of the operational phase of the mission shall be included. Operational constraints, viewing requirements, and pointing requirements shall also be identified. Describe any special communications, computer security, tracking, or near real-time ground support requirements, and indicate any special equipment or skills required of ground personnel.

The acquisition of data and the processing of that data both onboard the spacecraft and on the ground shall be described. The plan for processing the data after it has been delivered to the ground shall be discussed, including the method and format of the data reduction, data validation, and preliminary analysis. The process by which data will be prepared for archiving shall be discussed.

Specific features incorporated into the flight and ground system design that lead to low-cost operation shall be identified. The use of any existing mission operations facilities and processes shall be described, as well as any new facilities required to meet mission objectives.

4.2.3 Opportunity

This section shall describe the benefits offered by the mission beyond the scientific benefits brought by obtaining and distributing the desired data. These benefits may be educational and/or social.

EDUCATIONAL AND PUBLIC OUTREACH - This section shall discuss the degree to which this investigation will generate educational opportunities and contribute to the Nation's educational initiatives. The involvement of teachers and/or students in the investigation shall be documented here, as will any educational activities to be implemented. Coordination and collaboration with educational institutions shall be discussed. Activities to enhance the level of understanding and awareness of Earth Science by the public shall be described.

SMALL DISADVANTAGED BUSINESSES, WOMEN-OWNED SMALL BUSINESSES, HISTORICALLY BLACK COLLEGES AND UNIVERSITIES, AND OTHER MINORITY EDUCATIONAL INSTITUTIONS - This section shall describe the opportunities offered by the mission for small disadvantaged and women-owned small businesses, Historically Black Colleges and Universities, and other minority educational institutions. This section shall describe the type and percentage of work, expressed as a percentage of the proposed total contract price/cost, to be performed by these entities.

4.2.4 Cost

Proposals submitted in response to this AO must be of sufficient cost detail to enable NASA to make a fair and reasonable assessment of the NASA Mission Cost (NMC)

and the Total Mission Life Cycle Cost (TMLCC) of the proposed mission. The term "cost" is defined as dollars actually expended for accomplishment of the mission during a given time period. Cost differs from "funding", which is defined in the Funding Profile section below. The NMC represents the NASA-funded portion of the mission. The TMLCC is the total amount of resources used to produce the mission; that is, the NMC plus, if appropriate, all non-NASA-funded contributions. This includes direct and indirect costs that contribute to the mission, regardless of funding sources.

If cost sharing, dependent on the realization of potential commercial applications, is part of the proposal, the proposal shall contain a plan that describes how its goals for LightSAR will be achieved. The plan should address the Proposer's vision of the future. The plan must clearly describe the business market, identify the sources of market data, and identify any assumptions about the market. Describe the impact and status of any relevant licenses. Most importantly, the financing plan, sources of funding, and evidence of funding commitment shall be presented. Perceived risk should be quantified and discussed. Content may follow Proposer's standard practices. A brief summary of the complete plan should be included in the proposal body. The complete plan may be provided as an attachment (not counted against page limit).

The NMC for a LightSAR mission must include the full cost of all civil service support to the mission, including applied science research investigators, technical advisors, facilities, etc., unless contributed by their agency. If contributed, these resources must be included in the TMLCC.

Direct costs that can be specifically identified with a LightSAR mission include: (a) salaries and other benefits for employees who work directly on the mission, (b) materials and supplies used directly in support of the mission; (c) various costs associated with office space, equipment, facilities, and utilities that are used exclusively to produce the mission; and (d) costs of goods or services received from other segments or entities that are used to produce the LightSAR mission.

Indirect costs include resources that are jointly or commonly used to produce two or more types of products but are not specifically identifiable with any of the products. Typical examples include labor overheads, material handling, cost of money (COM), general administration, general research and technical support, security, rent, employee health and recreation facilities, operating and maintenance costs for buildings, equipment, and utilities.

Cost estimating procedures shall be based upon generally accepted cost accounting principles and practices and must be in accordance with the Proposer's approved accounting system. Additional information on cost principles, procedures and definitions are found in the Federal Acquisition Regulations (FAR) in parts 30 and 31.

The methods by which the cost estimates are derived shall be described. If an estimate is based on heritage, the performance and cost parameters that the

proposed system has in common with the previous or existing system shall be provided. An analysis of the impact of the referenced heritage on the risk of the proposed mission and on the proposed mission cost estimate shall also be provided. If cost models are used, a description of the model and the assumptions used to derive the cost estimates shall be documented. Identify any “discounts” assumed in the cost estimates for business practice initiatives or streamlined technical approaches. Describe how these have been incorporated in the cost estimate.

Copies of applicable forward pricing rate agreements shall be provided. Costing of Federal Government elements of proposals must follow the agency cost accounting standards for full cost. If no standards are in effect for the agency, the Proposers must then follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board. NASA Centers may submit full cost proposals based on the instructions in the NASA Financial Management Manual, Section 9091-5, Cost Principles for Reimbursable Agreements.

All costs, including non-U.S. contributions, must be in U.S. Government real year dollars. Real year dollars are current fiscal year (FY) dollars adjusted to account for inflation in future years. The inflation rate index provided in Appendix M, Figure M-2 shall be used to calculate all real year dollar amounts unless an industry forward pricing rate is used and documented. Where cost phasing is requested, the cost plan shall provide data by U.S. Government fiscal year (October 1 - September 30) for Phases C/D and E and by Government fiscal quarter for Phase B. Requests for cost by "Phase" refer to Phases B, C/D, and E as defined in Appendix I. Costs shall be broken down to the system or subsystem level, as requested, in accordance with the Proposer’s Work Breakdown Structure (WBS), which shall be included for reference.

Separate Summaries of Elements of Cost by mission phase and Government fiscal year (fiscal quarter for Phase B) shall be provided at the appropriate WBS level for each major mission organization (i.e., the applied science research investigators, each NASA-funded team member, each contributor, and each subcontract exceeding $500,000) as defined below. In addition, a roll-up Summary of Elements of Cost shall be provided for each organization. Appendix M, Figure M-3 is provided as a template for these costs. This format can be expanded to show additional phases and fiscal years. Major categories of cost shall be provided at the subsystem level for the flight system and at least the system level for all other items. The value of reserves shall be included and separately identified by WBS at the system level. A mission level Summary of Elements of Cost for the total NMC and the total TMLCC, which represents the total of all separate Summaries, shall also be provided, but need not be broken down by skill categories, overhead centers, etc.

The Summaries of Elements of Cost shall contain the following direct and indirect elements:

- DIRECT LABOR HOURS - Show productive hours by individual skill categories for Phases B, C/D, and E.

- DIRECT LABOR COSTS - The labor costs shall be itemized by skill categories for Phases B, C/D, and E.

- LABOR OVERHEAD - Overhead shall be itemized by cost centers (engineering, manufacturing, etc.) for Phase B and as totals by fiscal year for Phases C/D and E. Rates shall be documented for Phases B, C/D, and E.

- SUBCONTRACTS - Supporting information shall be provided for all subcontracts exceeding $500,000 for phases B, C/D, and E. This detail shall include name/address, cost, fee/profit, type of contract, number of quotes solicited/ received, basis of selection, affiliation with the Prime, type of business, type of cost and price analysis accomplished, concise basis of estimate, and basis of selection.

- MATERIALS - Supporting detail for major vendors (exceeding $500,000) in Phases B, C/D, and E shall include WBS element, fiscal year or quarter, description, vendor name/address, quantity, and current/proposed unit prices. Material burden rates shall be documented for Phases B, C/D, and E.

- TRAVEL - Travel shall be summarized as totals for Phases B, C/D, and E.

- OTHER DIRECT COSTS - Other direct costs shall be summarized as totals for Phases B, C/D, and E.

- GENERAL AND ADMINISTRATIVE (G&A) EXPENSE - G&A expense represents the institution’s general and executive offices and other miscellaneous expenses related to business. G&A expense shall be itemized by cost pool for Phase B and summarized as totals for Phases C/D and Phase E. Rates shall be documented for Phases B, C/D, and E.

- COST OF MONEY (COM) - COM represents interest on borrowed funds invested in facilities and is not reimbursable. COM shall be itemized by indirect pools and overhead centers for Phase B and summarized as totals by fiscal year for Phases C/D, and E. Rates shall be documented for Phases B, C/D, and E.

- PROFIT/FEE - Document the basis, rate, and amount of fee for Phases B, C/D, and E.

- ESCALATION FACTORS - Document the escalation factors used to determine real year dollars for Phases B, C/D, and E.

In addition to the Summaries of Elements of Cost, the Proposer shall provide the following mission level information:

- Total costs will always equal total funding at program completion.

- SUMMARY OF COST RESERVES - A time phased summary of cost reserves shall be presented by Phase for all WBS elements that contain reserve. The proposed cost by element, the amount of reserve for each element, and the reserve as a percentage of the TMLCC for each element shall be provided. A rolled up summary of cost reserves, which represents a total of reserves for all WBS elements, shall also be provided.

- TOTAL MISSION LIFE CYCLE COST PHASING - Appendix M, Figure M-4 is provided as a template for the TMLCC phasing by fiscal year. Resources provided as contributions/investments or cost shares shall be included and clearly identified as separate line items. This is the only chart where NASA-funded costs and contributions/investments by other partners are presented together.

- DESCOPE OPTIONS - The cost savings associated with each descope option presented in the Management Section shall be time-phased and provided for all mission phases.

- FUNDING PROFILE - Provide a profile of required NASA-funding by fiscal year. The funding profile is derived from the cost profile that is the basis of the proposal. The funding for a given fiscal year is determined from the estimated costs in that year, less the funding carried over from the previous fiscal year, plus the forward funding needed to cover the costs of the first month in the following fiscal year, plus the forward funding required for “unfilled orders”. Unfilled orders refers to long lead items for which funding and costing takes place in different Government fiscal years. Because of forward funding, costs will not equal funding in any given fiscal year. Total costs shall equal total funding at program completion.

A complete cost plan as defined above is required. In addition, a Cover Sheet shall be provided that contains the level of information contained on a SF1448, Proposal Cover Sheet (see Appendix G), with entries for (1) Phase B, (2) Phase C/D, (3) Phase E, and (4) the total mission.

4.2.5 Management

The Management Section shall summarize the management approach and the facilities and equipment required. This section sets forth the Proposer's approach for managing the work, the recognition of essential management functions, and the overall integration of these functions. This section shall specifically discuss the decision-making process to be used by the team, focusing particularly on the roles,

responsibilities and authority of the proposing team Project Manager (PM) in that process relative to each of the contributing team member organizations. The Management Section shall provide insight into the organizations proposed for the work, including the internal operations and lines of authority, together with internal interfaces and relationships with NASA/ JPL, other team members, major subcontractors, and applied science research investigators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities. The use of innovative processes, techniques, and activities by the proposing team in accomplishing its objectives is encouraged when cost, schedule, and technical improvements can be demonstrated.

MANAGEMENT PROCESSES AND PLANS, SCHEDULES AND PROCUREMENT STRATEGY - This section shall describe the management processes and plans, schedules, and procurement strategy necessary for the logical and timely pursuit of the work, accompanied by a description of the work plan. This section shall also describe the proposed methods of hardware and software acquisition. Specifically, it shall include the following, as applicable:

- Capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment.

- Management processes which the mission team proposes to:

  - develop and maintain the hardware and software requirements and specifications;

  - manage and control development progress;

  - manage and conduct technology development;

  - manage and conduct design;

  - manage, review, and control changes to hardware/software, documentation, etc.;

  - manage and conduct mission systems engineering and integration;

  - manage and conduct procurement, including long-lead item acquisitions, make or buy decisions, subcontract management, etc.;

  - manage, control, and allocate resources, including reserves;

  - manage and conduct the testing and verification programs, including final checkout and calibration;

  - manage and conduct launch operations;

- manage and conduct mission operations;
- manage and conduct a continuous system validation process that demonstrates flight and ground segment capabilities on an incremental basis (e.g., through the use of an end-to-end system test bed);
- manage and conduct data processing and distribution;
- coordinate with team members and document agreements;
- provide NASA/ JPL with insight;
- report progress to NASA/ JPL;
- manage the resolution of conflicts impacting the project; and
- manage and conduct proposed applied and/or basic research.

- Specific decision-making process to be used in all aspects of the mission, including mission descoping and distribution of reserves, and the individual authorized to make those decisions in such cases.
- Availability of proposed personnel on the team to successfully administer the mission contract and subcontracts and to technically monitor the implementation.
- A document tree that describes key proposed documentation, including development schedule and current status of each document.

The mission schedule and workflow should be clearly laid out, including critical path, schedule margins, deliveries of end items and major interdependencies. The method for internal review, control, and direction shall be discussed, including whether or not a form of performance measurement system will be used.

ROLES, RESPONSIBILITIES, AND EXPERIENCE OF TEAM MEMBERS - The roles, responsibilities, time commitment, and experience of all key personnel must be described in this section, with particular emphasis placed on the responsibilities assigned to the Project Manager and other key personnel. In addition, information shall be provided which indicates what percentage of time will be devoted to the mission, the duration of service, and how changes in personnel will be accomplished. (Note: The experience of the applied science research investigators is addressed in the Science Section and does not need to be included in this section.)

- TEAM PROJECT MANAGER - The role, responsibilities, time commitment, and experience of the team Project Manager shall be discussed. Provide a reference point of contact including address and phone number.

< OTHER KEY PERSONNEL - The roles, responsibilities, time commitments, and experience of other key personnel in the team shall be described.

The management organizational structure of the team must be described in the proposal. The proposal must identify the teaming approach to be used and describe the responsibilities of each team member and their contributions to the mission. The work of these individuals and institutions must be accounted for in the cost element breakdowns provided in the Cost Section.

Of special interest is the organizational approach and plan for efficient and effective management of the multi-organizational interfaces between cooperating partners and team members. Particular emphasis shall be placed on the organizational relationships of the PM. The capability of the team to respond quickly and effectively to problems and inter-organizational conflicts must be demonstrated. Proposed lines of communication and authority must be demonstrated.

The contractual/financial responsibilities and relationships of all team members, including contributions, must be described. The mechanisms (contracts, subcontracts, cooperative agreements, memoranda of agreement, etc.) by which organizations commit to participate as partners on a proposing team must be clearly identified. Include a description of incentives and fee strategy, where appropriate, and their rationale. The proposal signature page must include the signature of an official from each organization represented on the team or contributing to the mission who is authorized to commit that organization to the proposed mission. Failure to include any such authorization may be grounds for rejection of the proposal. Non-U.S. organizations and funding sources participating as team partners must also meet this requirement.

Information on procurement of long lead items and proposed major and critical subcontracts, including procurement activities of all team partners, must be provided. The information shall consist of, at a minimum, name of the item, scope of the work to be performed, name and location of supplier or subcontractor, proposed award schedule, deliverable items and delivery schedule, proposed performance assurance requirements, and contingency plans if a supplier or subcontractor fails to perform. Describe the relationships and controls you will exercise over suppliers and subcontractors from both cost and schedule standpoints.

The experience (successes *and* failures) of team partners in managing projects of similar scope, including cost and schedule performance within the last ten years shall be discussed.

COST MANAGEMENT - The specific means by which costs will be tracked, managed and reported to the Government shall be defined. A Work Breakdown Structure (WBS) and WBS dictionary, consistent with the plans set forth elsewhere in the proposal, shall be included. Specific reserves and the timing of their application, if needed,

shall be described within the proposal. This shall include the strategy for maintaining reserves as a function of cost-to-completion. All funded schedule margins must be identified. The relationship between the use of such reserves, margins and potential descope options, and their effect on cost, schedule and performance, shall be fully discussed.

RISK MANAGEMENT AND DESCOPE OPTIONS - This section shall describe the approach to, and plans for, risk management to be taken by the team, both in the overall mission design and in the individual systems and subsystems. Particular emphasis shall be placed on describing how the various elements of risk will be managed to ensure successful accomplishment of the mission within cost and schedule constraints. In the event risks cannot be managed successfully and mission objectives must be revised, this section shall describe the descope options and viable contingency options (e.g., additional reserves, etc.) available to the team, their phasing, and their effect on mission performance. This section shall identify the latest possible dates at which descope options may be implemented and the procedure by which they would be accomplished.

MISSION ASSURANCE - This section shall describe the process by which mission success is assured and achieved. This section shall describe mission assurance plans, including specific plans for reviews, problem/failure resolution, inspections, quality assurance, reliability, parts selection and control, and software validation activities compatible with industry best practices, ISO 9000 quality standards, and the Mission Assurance Guidelines in Appendix N. A table similar to that shown in Appendix M, Figure M-6 shall be used to illustrate compatibility of the Proposer's own mission assurance processes with the Mission Assurance Guidelines and Requirements.

SAFETY - This section shall describe the process by which safety standards are met and hazards mitigated. The mission team member responsible for implementing the system safety program for the proposed mission shall be identified. Past experiences of this mission team member in implementing system safety program from previous missions shall be described. This section shall also describe all safety plans and practices to be used in mission development. These plans and practices shall be compliant with the Safety Requirements in Appendix O. This section shall also address the mission's compliance with NASA Safety Standard (NSS) 1740.14, "Guidelines and Assessment Procedures for Limiting Orbital Debris", which can be found in the Program Library (see Appendix G).

REVIEWS, AUDITS AND INSIGHT - Propose a schedule of mission reviews (both NASA/ JPL and internal), including reviews of technical and programmatic status and any other informal reviews intended to report status and accomplishments, discuss problems, and provide technical and programmatic information to JPL. Include review description, content, planned schedule and duration, planned documentation and schedule for document delivery. The proposed implementation of mechanisms that will provide NASA/ JPL insight into the mission shall be described.

Describe the audit process from contract award through performance and contract close-out.

FACILITIES AND EQUIPMENT - All major facilities, laboratory equipment, and ground-support equipment (GSE) (including those of the team's proposed contractors and those of NASA and other U.S. Government agencies) essential to the mission in terms of its system and subsystems are to be indicated, distinguishing insofar as possible between those already in existence and those that will be developed in order to execute the mission. The outline of new facilities and equipment shall also indicate the lead-time involved and the planned schedule for construction, modification, and/or acquisition of the facilities.

STATEMENTS OF WORK (SOWs) - Provide Statements of Work/Task Plans for Phase B, Phase C/D, and Phase E covering all aspects of the mission. These documents shall cover all phases and include, as a minimum, Scope of Work, Deliverables (with emphasis on science data products), and Government Responsibilities (as applicable). Example SOWs and Task Plans are available in the Program Library (see Appendix G).

CONTRACTUAL REQUIREMENTS - In order to expedite mission contract awards, Proposers are required to propose mission contract terms, conditions and deliverables. An example specimen contract is available in the Program Library (Appendix G). If no exceptions are taken, the sample generic contractual documents will be used as the basis for selected mission contract formulation.

4.3 International Participation

Participation of non-U.S. mission team members is allowed under the guidelines discussed in Section 3.3.3. Participation by non-U.S. partners as team members must be endorsed in writing by these organizations and, where foreign government funding is provided, by the foreign government involved. All proposals with non-U.S. participants shall include a binding contractual agreement between the Team Leader and each non-U.S. organization. The agreement must clearly identify the intended role of the non-U.S. organization, the business relationship with the rest of the team, the resources being provided, and any data rights agreements. The agreement must also clearly commit to make available to the partnership, within an identified time that is compatible with the mission’s proposed milestones, all identified resources upon selection. Appendix F contains specific language to be included in these agreements. The documented agreement must be signed by an official with the authority to commit his/her organization’s resources.

NASA recognizes that these contractual agreements may dictate that a separate agreement also be reached between a foreign government and NASA. If necessary, NASA is willing to assist in finalizing such a government-to-government agreement

after selection. If such government-to-government agreements are required, they must be requested in the proposal.

Non-U.S. institutions providing only applied science research investigators are not required to submit a formal agreement, but should submit a commitment letter. The Letter of Commitment must clearly identify the intended role of the organization in the proposed mission and the resource(s) being provided, and must clearly commit identified resources to the mission upon selection as the LightSAR mission. The Letter of Commitment must be signed by an official with the authority to commit his/her organization's resources. Letters of Commitment do not count as part of the page limit for proposals.

4.4 Submittal of Proposals

4.4.1 Certification

The original copy of all proposals shall include a signature page(s) signed by an institutional official from each organization represented on the team authorized to certify institutional support and sponsorship of the investigation as well as concurrence in the management and financial parts of the proposal. This requirement includes all non-U.S. organizations. Additional certifications identified in Appendices J and K are required by law and must also be included.

4.4.2 Quantity

All Proposers must provide 35 copies of their bound paper proposal, including the original signed proposal, on or before the proposal deadline. The proposals must be numbered sequentially from 1 to 35 in the upper right-hand corner of the cover page; the original signed proposal should be number 1. In addition to the 35 requested proposal copies, all Proposers must provide 15 copies of all foldout pages and color diagrams. The requirements for submittal of diskette copies of the proposal are defined in Section 4.1.1.

4.4.3 Submittal Address

All proposals shall be mailed to the following address:

LightSAR AO Coordinator
Code Y
400 Virginia Avenue SW, Suite 700
Washington, DC 20024

Phone: 202-554-2775 (for delivery only)
Fax: 202-554-2970
Email: oesresponse@hq.nasa.gov

4.4.4 Submittal Deadline

All proposals must be received on or before 4:00 p.m. Eastern Time on May 10, 1999. Proposals received after the established closing date and time will be treated in accordance with NASA's provisions for late proposals (NFS 1815.208, Submission, Modification, Revision, and Withdrawal of Proposals).

4.4.5 Notification

NASA will notify Proposers in writing that their proposals have been received. Proposers not receiving this confirmation within two weeks after submittal of their proposals should contact NASA at the address given in Section 4.4.3.

4.4.6 Proposals Involving International Participation

The procedures for submission of proposals with non-U.S. participants are the same as those for strictly U.S. proposals, as previously outlined in this section. Additionally, one copy (over and above the copies identified in Section 4.4.2) of any proposal that includes non-U.S. participants shall be sent to:

Office of External Relations
Code IY, Ref. AO-99-OES-01
National Aeronautics and Space Administration
Washington, DC 20546 U.S.A. Phone: 202-358-0793

5.0 PROPOSAL EVALUATION, SELECTION, AND IMPLEMENTATION

5.1 Evaluation Criteria

The selection of the proposal that best meets the scientific and programmatic objectives stated in the AO is the fundamental aim of the proposal evaluation process. The information requested in Section 4 will enable the evaluation panel to determine how well the proposing team understands the complexity of the proposed mission, its technical risks, and any challenges which require specific action during Phase B. This information will also enable the evaluation panel to select the proposal which best meets all guidelines and constraints, and which addresses all elements viewed necessary for mission success.

The proposal will be evaluated in a manner that provides emphasis on the science value of the mission, which will be assessed by integrating the science and cost evaluations of the mission.

Science value will be rated at approximately the same weight as the combination of Technical and Opportunity. Technical will be approximately equal in importance to Management and will be weighted significantly greater than Opportunity.

A general description of evaluation criteria for each of the five proposal sections follows. The degree to which a LightSAR mission proposal meets the various criteria will be determined by the evaluators and ratings assigned.

5.1.1 Science Evaluation Criteria

Each proposal will be evaluated for its scientific return, feasibility, risk-managed incorporation of advanced technologies, resiliency and the probability of success. Scientific return will be evaluated as to how well the proposed mission addresses the LightSAR basic science objectives and Minimum Science Mission requirements. The degree to which the quality and the quantity of acquired data meet the science objectives will be assessed. In addition, the timeliness of dissemination of mission data product(s) to the broad user community and the methods to be employed will be considered. The proposed mission planning procedures, processes, and tools, including the approach for conflict resolution and the approach to data management (including appropriate data rights) will be evaluated for their soundness, completeness and specificity. The overall scientific merit of the proposed applied science investigations will be assessed, as measured by: the scientific justification of the proposed investigations, the coherence of the traceability between the proposed scientific objectives and the measurements required to fulfill these objectives (i.e., instrument functional requirements), as well as the traceability between the instrument functional requirements and the instrument/ mission engineering requirements. Feasibility will be determined by evaluating the degree to which the mission will address the stated scientific goals and objectives; the degree to which the instrument set can provide the necessary data; the basis of scientific

understanding for retrieving the information content of the observations; the adequacy of any proposed correlative measurements to calibrate and/or validate the observations; the approach to data quality assessment, production of calibrated science data products, and external data product dissemination; and the capability of the proposed system to provide the predicted quality and quantity of acquired data. The proposed instrumentation will be evaluated for soundness, achievability, and the feasibility of making the required measurements. The differences in available descope and contingency options, if any, will be assessed in order to determine the mission's scientific resiliency in the event that development problems lead to reductions in scope. Risk mitigation plans will also be considered. Finally, the probability of success will be determined by considering the experience, expertise, and organization of the team; the overall risk associated with the science objectives; and the soundness of the proposed instrumentation.

5.1.2 Technical Evaluation Criteria

The Technical evaluation will consider the adequacy of the proposed approach to developing all mission elements (e.g., flight segment, ground and data systems, mission operations, etc.) and executing the mission, as well as the Proposer's understanding of the processes, products, and activities required. The Mission Traceability Matrix will be evaluated to assess the derivation of the proposed mission design from the stated objectives, requirements, and constraints. The technical approach will be examined in its entirety to ensure that: (1) all elements and processes are addressed; (2) weaknesses and design issues are understood and plans for resolution have been identified; (3) fundamental design trades have been identified and studies planned; and (4) primary performance parameters have been identified and minimum thresholds established. The overall approach (including schedule), the specific design concepts, and the known hardware/software will be evaluated for soundness, achievability, and maturity. The evaluation will consider proposed technologies, including commercial off-the-shelf technology, their benefit to the mission and potential risk. Resiliency and margins will be a consideration in the evaluation. The probability of success will be determined by evaluating the experience and expertise of the technical organizations and the programmatic and technical risk associated with the mission design and technical approach, including the launch service. The Spacecraft Technical Maturity Matrix will be evaluated to determine the maturity level of the proposed spacecraft design. The reliability and capability of the launch vehicle will be evaluated. In addition, innovative features, processes, or approaches will be rewarded if shown to be cost-effective and sound.

5.1.3 Opportunity Evaluation Criteria

The information provided in the Opportunity Section will demonstrate the Proposer's plans for educational and public outreach programs, and opportunities for small disadvantaged and women-owned small businesses and minority educational institutions. Relevance to the current NASA and National strategies will also be evaluated, as well as the plans for monitoring and assessing progress in these

areas. Educational program activities will be evaluated on their potential impact for different educational levels. Public information programs will be evaluated for their potential to excite and involve the public. The extent of participation at the prime or subcontract level of small disadvantaged businesses, women-owned small businesses, Historically Black Colleges and Universities, and other minority educational institutions will be evaluated.

5.1.4 Cost Evaluation Criteria

The information provided in the Cost section will be used to evaluate the adequacy and realism of the total proposed cost within the constraints established in this AO for the LightSAR mission. The intent of the cost evaluation process will be to appraise the total mission cost and determine the overall risk associated with the cost elements. The basis, heritage and quality of the cost estimates and the probability that the mission can be achieved within the proposed schedule for the proposed resources (including NASA funding and contributions/investments) will be assessed. The same evaluation standards will be applied to NASA-provided and contributed/invested resources. If resource sharing is proposed, evaluation will focus on the financing plan, evidence of funding commitment, status of any required licenses, the potential commercial market, and plans for expanding the market and creating sustained providers and consumers of SAR data, in order to measure the viability of the proposed resource sharing plan. Given the risks associated with full-up end-to-end missions, the adequacy of cost measures to decrease the risk to mission success will be evaluated. The clarity of the relationship between identifiable technical and schedule risks and the planning, identification, tracking, and application of reserves will be assessed.

5.1.5 Management Evaluation Criteria

The information provided in the Management section will demonstrate the Proposer's plans, processes, organization and personnel for managing and controlling the development and operation of the mission and will be evaluated on the soundness, completeness and specificity of the approach and the probability that the management team can assure mission success. The soundness and completeness of the approach will be determined by reviewing the organizational structure (including roles, responsibilities, accountability, and decision making process), the key personnel, and the processes, plans, and strategies the team will use to manage the various mission elements (including contributions) and provide NASA/ JPL insight. Criteria will include clear lines of authority; clean interfaces; prudent scheduling and cost control mechanisms and review processes; demonstrated awareness of all necessary management processes, etc. The probability of mission success will consider, for both NASA-funded and contributing organizations, the experience, expertise, and commitment of key personnel, as well as the organizations to which they are attached; past cost performance by the team leader and major partners on similar missions; the proposed contractual arrangement between JPL and the mission team as well as between team members,

including contractual performance and incentives; the adequacy of facilities and equipment proposed for the mission; the adequacy of proposed mission assurance and safety plans, including compatibility with the Mission Assurance Guidelines and Requirements and compliance with the Safety Requirements; the adequacy of the team's approach to risk management, including descoping options; and the adequacy of the management and control mechanisms. The quality and specificity of the proposed Statements of Work and other required contractual documentation will be evaluated to assess the maturity of the mission management approach. Innovative management processes and plans which are expected to improve performance and reduce costs will be rewarded.

5.2 Evaluation and Selection Process

Proposals received in response to this AO will be reviewed and selected in accordance with the procedures stated in NFS 1872.4 as modified by this section. Evaluation panels, using scientific, technical, management and administrative peers and experts, will assess the strengths and weaknesses of each proposal and will provide the NASA Headquarters Office of Earth Science with a summary report.

The scientific and technical aspects of each compliant proposal will be assessed in accordance with the evaluation criteria in Section 5.1 by individuals who are scientific peers of the Proposers and technical experts. Concurrently, the implementation aspects (management, cost, and opportunity) will be evaluated by management, cost and technical experts. After the individual evaluations, the Science, Technical, Management, Cost and Opportunity panels will meet to consider the total quantitative and qualitative aspects of the evaluations in order to integrate the findings of the individual reviewers. The evaluation panels may also prepare questions requesting clarification, which will be transmitted to the appropriate Proposers for prompt response. For purposes of clarification, the panel may request oral proposal presentations and conduct fact-finding by making on-site visits to the Proposers' facilities. The panel will provide ten days' notice of such visits.

After these evaluations, the panels will meet in plenary in order to integrate the separate panel results. Panel evaluation reports will represent the final product of the combined evaluation team.

The LightSAR Evaluation Executive Committee, consisting of the Evaluation Chairperson and the chairs of the individual evaluation panels will, upon consideration of the reports of the evaluation panels, integrate the science return and cost evaluations of each proposal to provide an assessment of science value. The committee will then categorize all proposals in accordance with the category definitions contained in NFS 1872.4. On the basis of these categorizations and review and recommendation of the LightSAR Program Office, the Associate Administrator for Earth Science will select the proposal to be implemented.

Certain key provisions concerning selections are also given in Appendix A.

5.3 Contract Administration and Funding

It is anticipated that JPL will negotiate and award a contract to implement the selected proposal. A post-selection survey may be conducted by the JPL LightSAR Project Office to ensure that commitments of equipment, technical resources, facilities, and letters of agreement between affiliated mission team members reflect the written proposal, Statements of Work, and other proposed contract documents.

6.0 CONCLUSION

LightSAR is an exciting, innovative approach to accomplishing important Earth Science investigations in the 21st century. Besides its science, LightSAR offers new frontiers that will further U.S. national objectives and promote practical applications of Earth remote sensing. With this Announcement, NASA invites innovative partnership/ implementation strategies to make LightSAR a reality.

Ghassem R. Asrar
Associate Administrator
Office of Earth Science
NASA Headquarters

APPENDIX A

GENERAL INSTRUCTIONS AND PROVISIONS

[Per NFS 1872.705-1]

I. Instrumentation and/or Ground Equipment

By submitting a proposal, the investigator and institution agree that NASA has the option to accept all or part of the offeror's plan to provide the instrumentation or ground support equipment required for the investigation or NASA may furnish or obtain such instrumentation or equipment from any other source as determined by the selecting official. In addition, NASA reserves the right to require use, by the selected investigator, of Government instrumentation or property that becomes available, with or without modification, that meets the investigative objectives.

II. Tentative Selections, Phased Development, Partial Selections, and Participation with Others

By submitting a proposal, the investigator and organization agree that NASA has the option to make a tentative selection pending a successful feasibility or definition effort. NASA has the option to contract in phases for a proposed experiment, and to discontinue the investigative effort at the completion of any phase. The investigator should also understand that NASA may desire to select only a portion of the proposed investigation and/or that NASA may desire the individual's participation with other investigators in a joint investigation, in which case, the investigator will be given the opportunity to accept or decline such partial acceptance or participation with other investigators prior to a NASA selection. Where participation with other investigators as a team is agreed to, one of the team members will normally be designated as its team leader or contact point.

III. Selection Without Discussion

The Government reserves the right to reject any or all proposals received in response to this AO when such action shall be considered in the best interest of the Government. Notice is also given of the possibility that any selection may be made without discussion (other than discussions conducted for the purpose of minor clarification). It is therefore emphasized that all proposals should be submitted initially on the most favorable terms that the offeror can submit.

IV. Foreign Proposals

See AO Section 3.3.3.

V. Treatment of Proposal Data

It is NASA policy to use information contained in proposals and quotations for evaluation purposes only. While this policy does not require that the proposal or quotation bear a restrictive notice, offerors or quoters should place the following notice on the title page of the proposal or quotation and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. Information (data) contained in proposals and quotations will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice. To prevent inadvertent disclosure, proposal data shall not be included in submissions (e.g., final reports) that are routinely released to the public.

RESTRICTION ON USE AND DISCLOSURE OF
PROPOSAL AND QUOTATION INFORMATION (DATA)

The information (data) contained in [insert page numbers or other identification] of this proposal or quotation constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed for other than evaluation purposes; provided, however, that in the event a contract is awarded on the basis of this proposal or quotation the Government shall have the right to use and disclose this information (data) to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

VI. Status of Cost Proposals (U.S. Proposals Only)

The investigator’s institution agrees that the cost proposal is for proposal evaluation and selection purposes, and that following selection and during negotiations leading to a definitive contract, the institution may be required to resubmit cost information in accordance with FAR 15.403-5.

VII. Late Proposals

The Government reserves the right to consider proposals or modifications thereof received after the date indicated, should such action be in the interest of the Government.

VIII. Source of Space Transportation System Investigations

Investigators are advised that candidate investigations for Space Transportation System (STS) missions can come from many sources.

IX. Disclosure of Proposals Outside Government

NASA may find it necessary to obtain proposal evaluation assistance outside the Government. Where NASA determines it is necessary to disclose a proposal outside the Government for evaluation purposes, arrangements will be made with the evaluator for appropriate handling of the proposal information. Therefore, by submitting a proposal, the investigator agrees that NASA may have the proposal evaluated outside the Government. If the investigator or institution desire to preclude NASA from using an outside evaluation, the investigator or institution should so indicate on the cover. However, notice is given that if NASA is precluded from using outside evaluation, it may be unable to consider the proposal.

X. Equal Opportunity (U.S. Proposals Only)

By submitting a proposal, the investigator and institution agree to accept the following clause in any resulting contract:

EQUAL OPPORTUNITY

During the performance of this contract, the Contractor agrees as follows:

(a) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(b) The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. This shall include, but not be limited to, (1) employment, (2) upgrading, (3) demotion, (4) transfer, (5) recruitment or recruitment advertising, (6) layoff or termination, (7) rates of pay or other forms of compensation, and (8) selection for training, including apprenticeship.

(c) The Contractor shall post in conspicuous places available to employees and applicants for employment the notices to be provided by the Contracting Officer that explain this clause.

(d) The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(e) The contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding the notice to be provided by the Contracting Officer, advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.

(f) The Contractor shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(g) The Contractor shall furnish to the contracting agency all information required by Executive Order 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor. Standard Form 100 (EEO-1), or any successor form, is the prescribed form to be filed within 30 days following the award, unless filed within 12 months preceding the date of award.

(h) The Contractor shall permit access to its books, records, and accounts by the contracting agency or the Office of Federal Contract Compliance Programs (OFCCP) for the purposes of investigation to ascertain the Contractor's compliance with the applicable rules, regulations, and orders.

(i) If the OFCCP determines that the Contractor is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, the contract may be canceled, terminated, or suspended in whole or in part, and the Contractor may be declared ineligible for further Government contracts, under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against the Contractor as provided in Executive Order 11246, as amended, the rules, regulations, and orders of the Secretary of Labor, or as otherwise provided by law.

(j) The Contractor shall include the terms and conditions of subparagraph 1 through 9 of this clause in every subcontract or purchase order that is not exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subcontractor or vendor.

(k) The Contractor shall take such action with respect to any subcontract or purchase order as the contracting agency may direct as means of enforcing these terms and conditions, including sanctions for non-compliance; provided, that if the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of direction, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

Xl. Patent Rights

(a) For any contract resulting from this solicitation awarded to other than a small business firm or nonprofit organization, the clause at 1852.227-70, "New Technology", shall apply (suitably modified to identify the parties). Such contractors may, in advance of contract, request waiver of rights as set forth in the provision at 1852.227-71, "Requests for Waiver of Rights to Inventions".

(b) For any contract resulting from this solicitation awarded to a small business firm or nonprofit organization, the clause at FAR 52.227-11, "Patent Rights--Retention by the Contractor (Short Form)" (as modified by 1852.227-11) shall apply (suitably modified to identify the parties).

[Per NFS 1852.227-14]

XII. Data Rights

For any NASA contract resulting from this solicitation, the clause at FAR 52.227-14, "Rights in Data - General" (as modified by NFS 1852.227-14) shall apply (suitably modified to identify the parties).

[Per FAR 52.219-8 and NFS 1852.219-76]

XIII. Participation Of Small, Small Disadvantaged, And Women-Owned Small Businesses, And Minority Institutions

Offerors are advised that, in keeping with Congressionally mandated goals, NASA seeks to place a fair portion of its contract dollars, where feasible, with small disadvantaged business concerns, women-owned small business concerns, Historically Black Colleges and Universities, and minority educational institutions, as these entities are defined in FAR 52.219-8 and NFS 1852.219-76. For this Announcement of Opportunity, NASA has established a goal of 8 percent for the participation of these entities at the prime or subcontractor level. This goal is stated as a percentage of the total contract value.

NASA encourages all offerors to propose to meet or exceed this goal to the maximum extent practicable and to encourage the development of minority businesses and institutions throughout the contract period. Offerors will be evaluated on the proposed goal for participation of the entities listed above in comparison with the 8 percent goal and on the methods for achieving the proposed goal.

[Not Used]

APPENDIX B

LAUNCH SERVICES INFORMATION

This appendix provides performance, interface, and cost information for NASA-provided expendable launch services. Launch services acquired from NASA to launch a LightSAR payload must be managed in accordance with NASA Management Instruction (NMI) 8610.23.

The Medium-Light Expendable Launch Vehicle (MLELV or "Med-Lite") launch services include launch on the Delta 7320, with three strap-on Solid Rocket Motors (SRMs), and the Delta 7420, with four strap-on SRMs. The Small Expendable Launch Vehicle Services (SELVS-KSC) launch services include launch on Taurus 2210, with a 92-inch fairing, Taurus 2110, with a 63-inch fairing, and Pegasus XL vehicles. User's Guides for the MLELVs and SELVS-KSC launch vehicles are not currently available.

Figures B-1 and B-2 depict the payload mass capabilities of the available ELVs for circular orbits of 28.5° and Sun-Synchronous inclinations.

Figures B-3, B-4, B-5, B-6, and B-7 depict the payload fairing envelopes of the Delta, Taurus and Pegasus XL launch vehicles. The Taurus envelopes include sample envelopes (A, B1, and B2) for a generic payload to which the LightSAR payload is not constrained; the static envelope may be used.

Figure B-8 is a schedule of typical launch service activities. Standard NASA launch service contracts provide for payload/ launch vehicle integration, analysis, and post-flight mission data evaluation. NASA also provides payload processing at the launch site, technical oversight of the launch vehicles, mission unique launch vehicle modifications, and coordination of mission-specific integration activities, as well as NASA contract administration, technical and mission support, and launch service contract oversight.

Table B-1 shows the annual funding required to perform a typical mission for each launch service. Funding estimates are in real year dollars and assume a fiscal year 2002 launch. Costs for launches after 2002 may be calculated by applying the inflation indices in Appendix M, Figure M-2. Any cost penalties associated with payload caused launch delays are not included in this estimate.

Additional information about NASA-provided launch services may be obtained from

Frank Stone
Advance Mission Integration Manager
Mail Code VB-B2, NASA
Kennedy Space Center, FL 32899

e-mail: StoneFS@kscgws00.ksc.nasa.gov
Phone: 407-476-3625
FAX: 407-853-4357

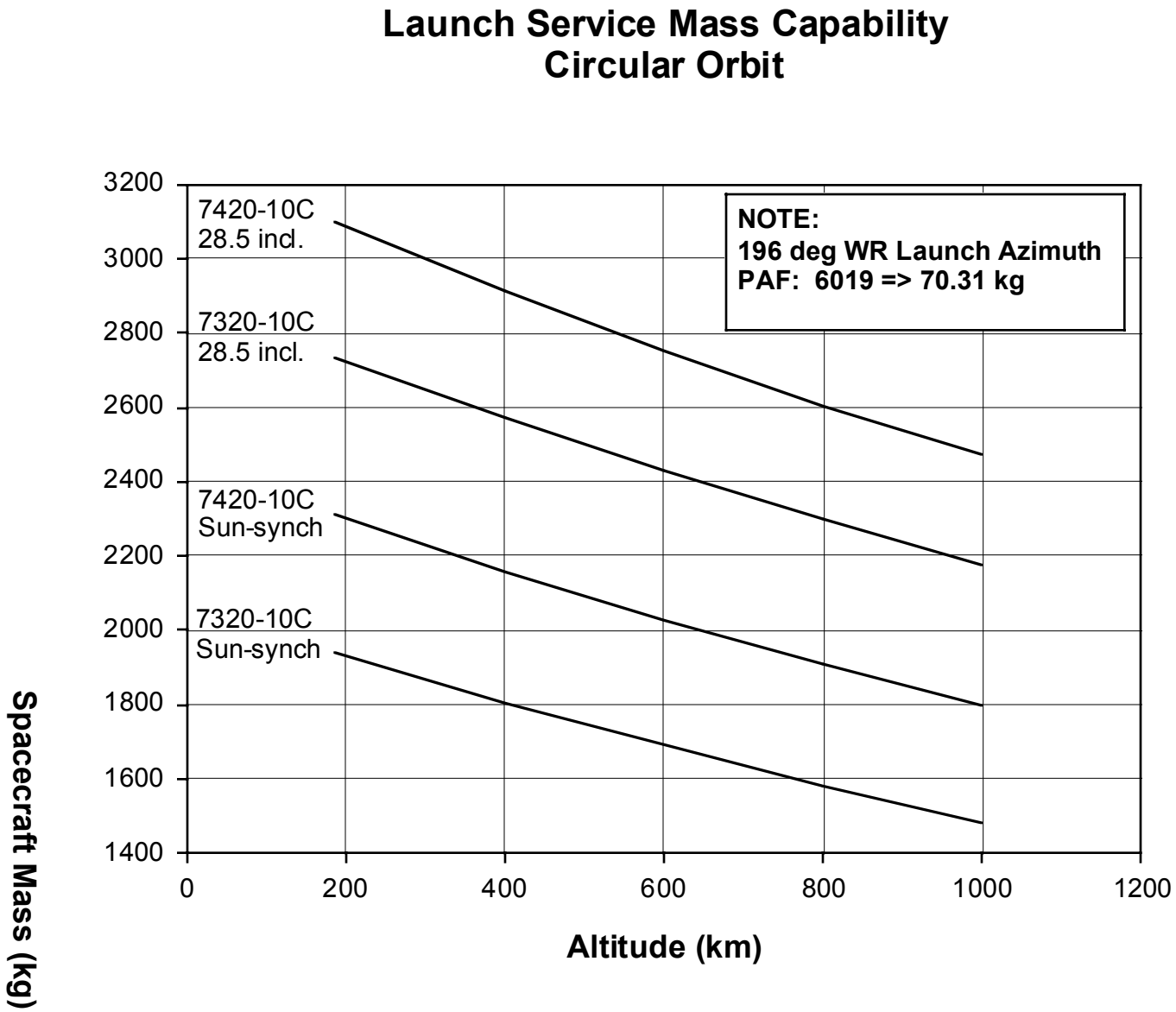

Figure B-1. MLELV Payload Mass Capability for Circular Orbits

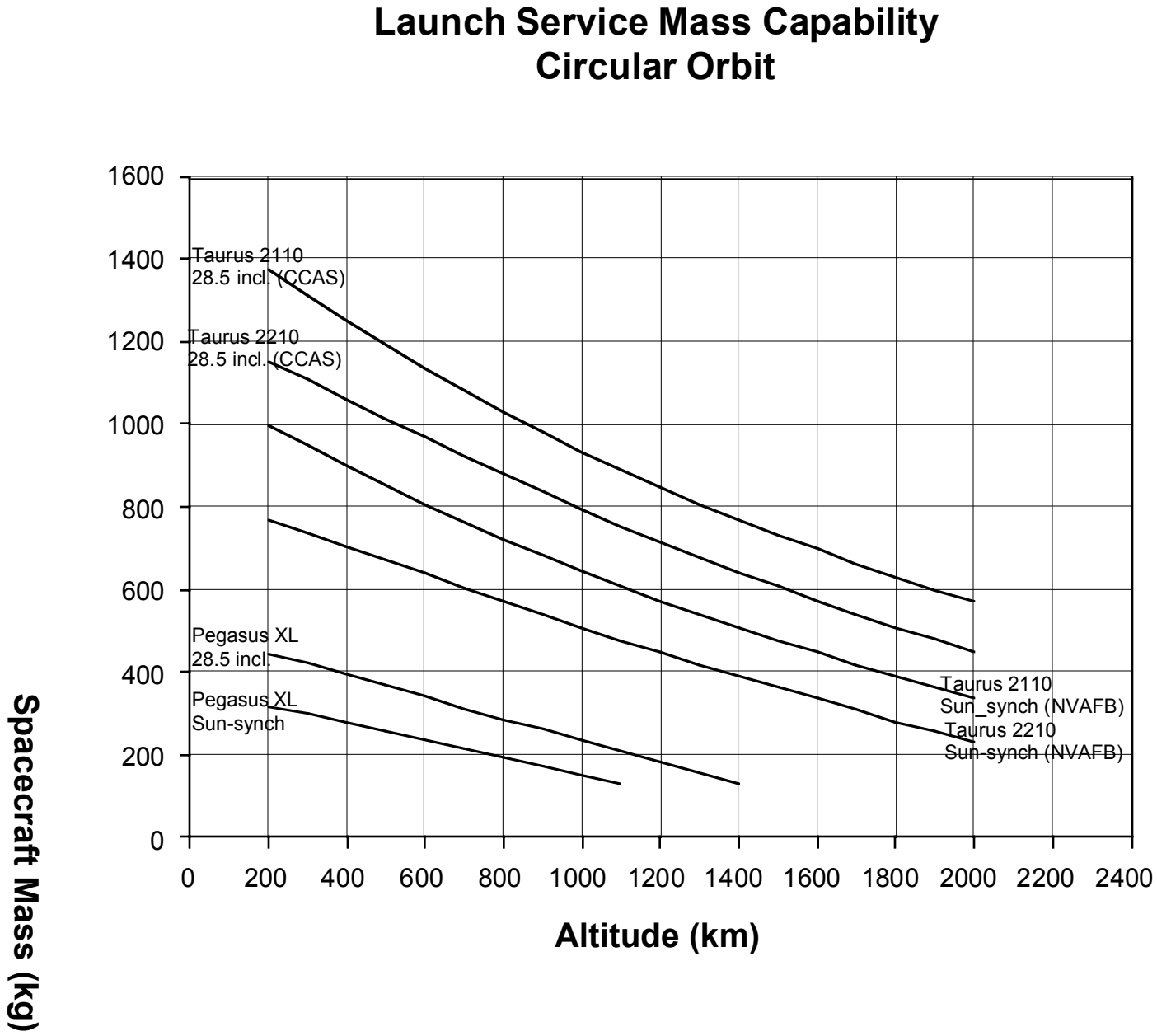

Figure B-2. SELVS-KSC Payload Mass Capability for Circular Orbits

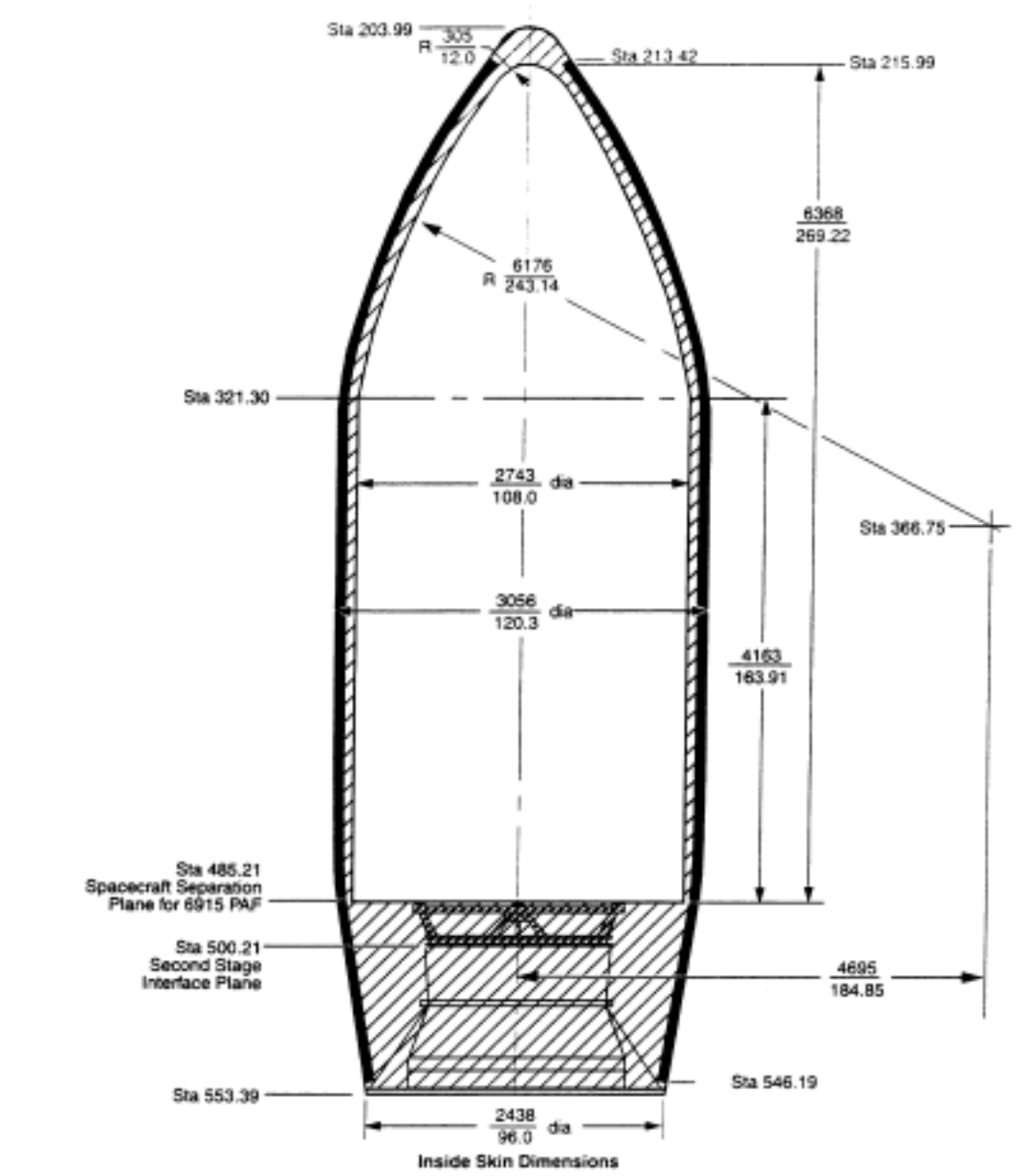

Figure B-3. Payload Envelope, MLELV 3m (10ft) Diameter Fairing

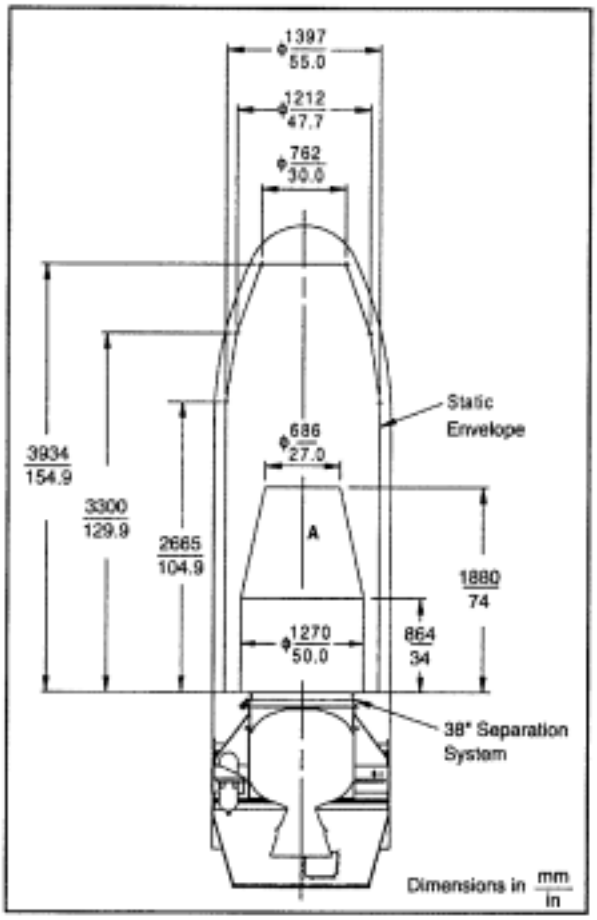

Figure B-4. Taurus 2110 63" Payload Fairing Static Envelope with 38.810" Diameter Payload Interface

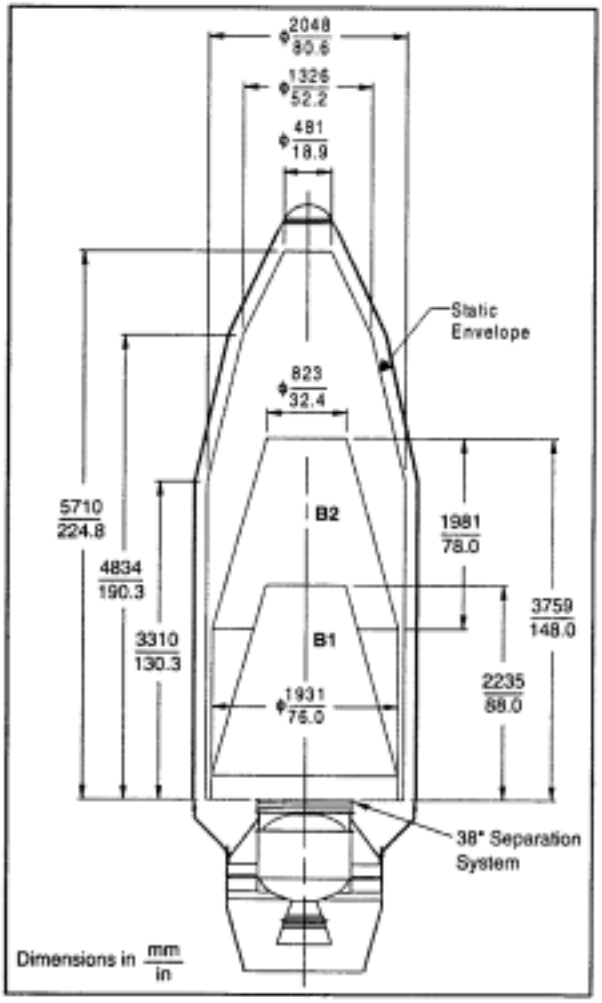

Figure B-5. Taurus 2210 92" Payload Fairing Static Envelope with 38.810" Diameter Payload Interface

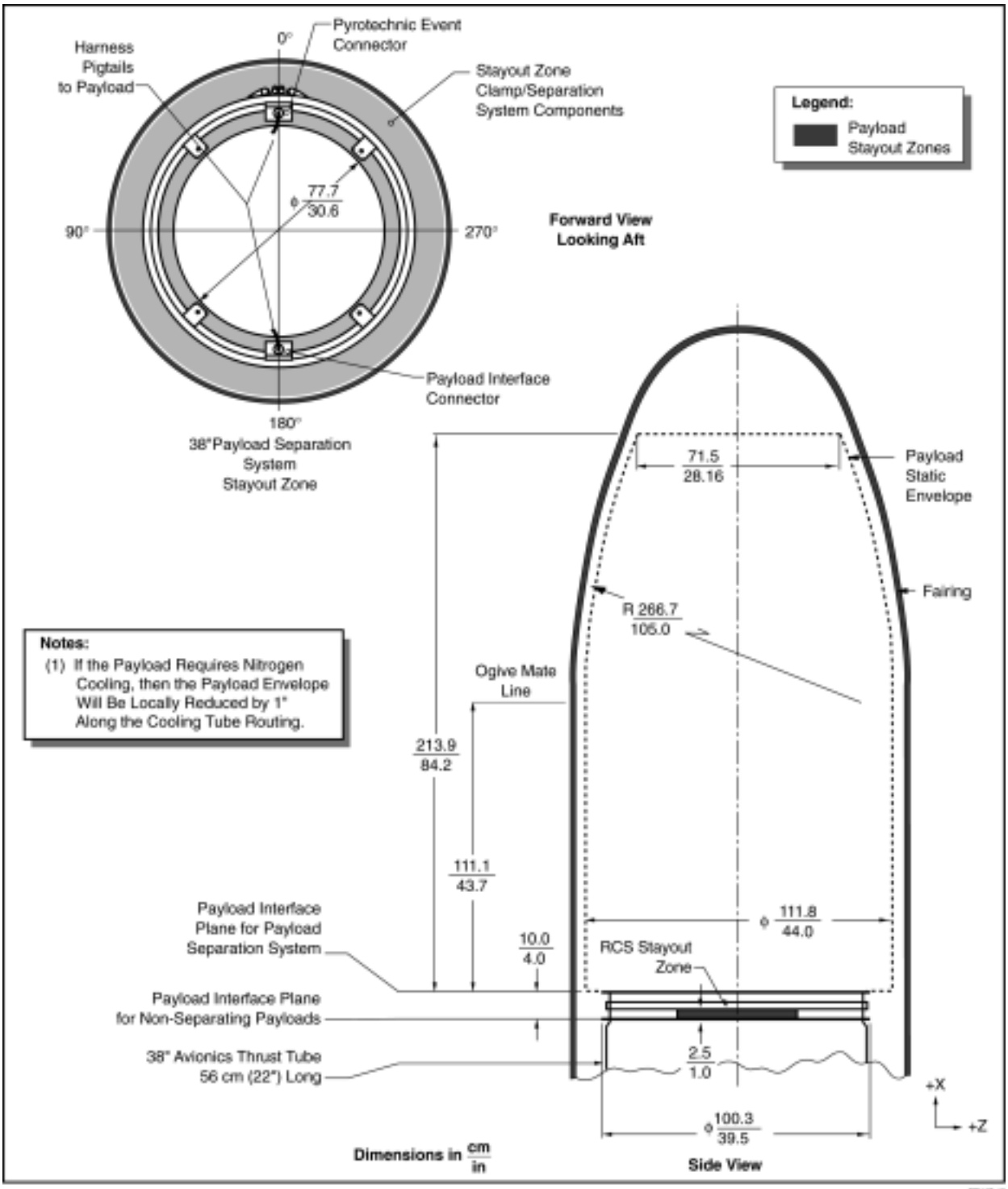

Figure B-6. Pegasus XL Payload Fairing Static Envelope with 38.810" Diameter Payload Interface

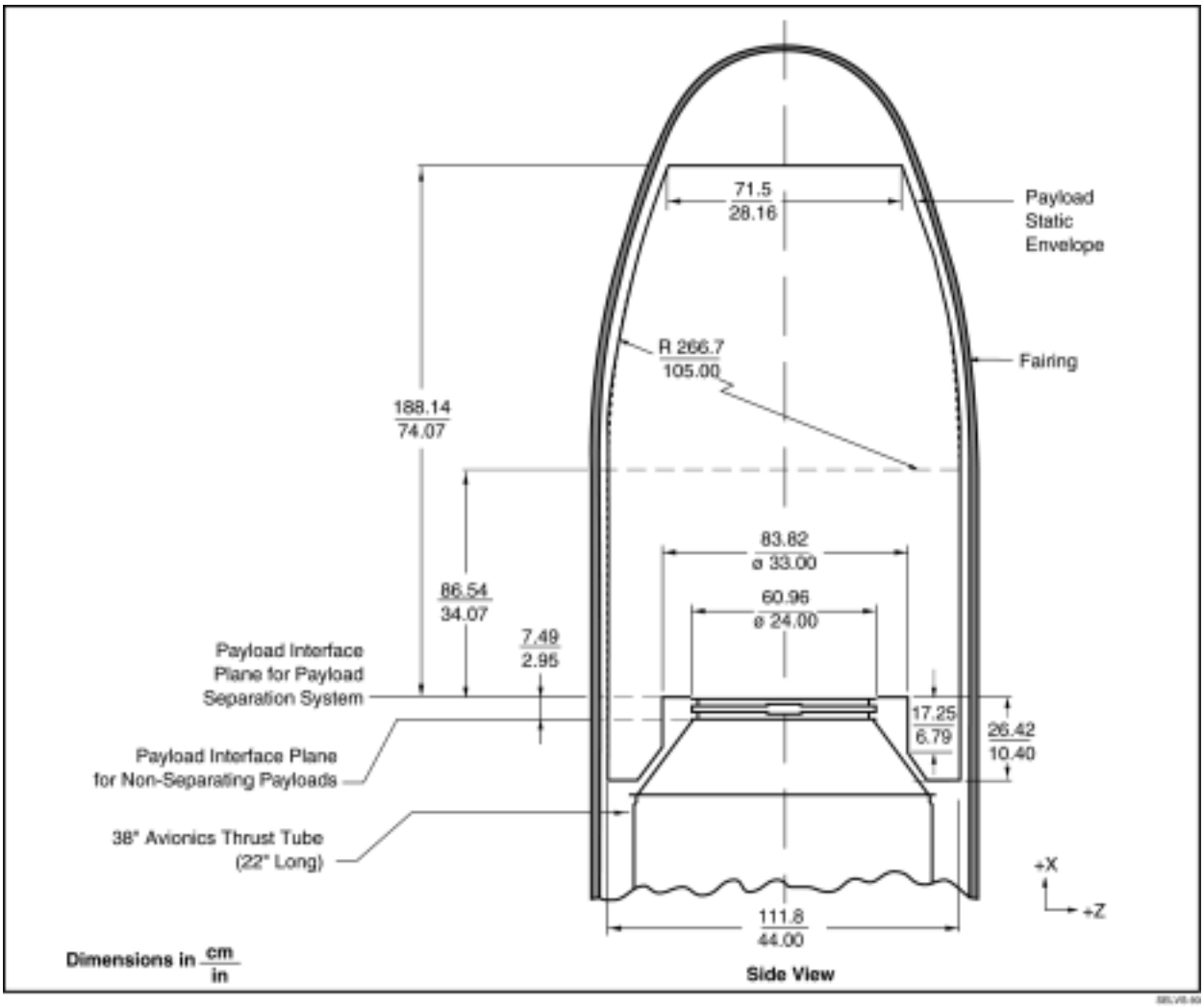

Figure B-7. Pegasus Payload Fairing Static Envelope with 23.250” Diameter Payload Interface

Agency	Milestones	Weeks 100 90 80 70 60 50 40 30 20 10 0
Spacecraft	Spacecraft Questionnaire	L-104 Launch
Spacecraft	Spacecraft Dynamics Mathematical Model	L-90 Initial L-48 Final
Spacecraft	Spacecraft Environ. Test Document	L-84
Launch Vehicle	Mission Specification	L-84 Initial
Spacecraft	Spacecraft Drawings	L-78 Initial L-44 Final
Launch Vehicle	Coupled Dynamic Loads Analysis	L-68 Initial L-26 Final
Spacecraft	Pre-Launch Safety Package	L-58
Spacecraft	Mission Analysis Inputs	L-54 Prelim L-38 Final
Spacecraft	S/C Program Requirements Doc.	L-52
Launch Vehicle	Mission Analysis Report	L-44 Prelim L-28 Final
Spacecraft	Spacecraft Launch Site Procedures	L-18

Figure B-8. Typical Mission Integration Activities

Table B-1. Launch Service Costs Summary ($ in Millions)

LAUNCH SERVICE	FY'00	FY'01	FY'02	FY '03	TOTAL COST
SELVS-KSC Pegasus	Under Review	Under Review	Under Review	Under Review	Under Review
SELVS-KSC Taurus	Under Review	Under Review	Under Review	Under Review	Under Review
MED-LITE Delta 7320-10	Under Review	Under Review	Under Review	Under Review	Under Review
MED-LITE Delta 7420-10	Under Review	Under Review	Under Review	Under Review	Under Review

NOTE: Assumes a Fiscal Year 2002 launch, in real year dollars.

APPENDIX C

[Not Used]

[Not Used]

APPENDIX D

[Not Used]

[Not Used]

APPENDIX E

REGULATIONS GOVERNING PROCUREMENT OF FOREIGN GOODS OR SERVICES

The following Federal Acquisition Regulation (FAR) clauses apply to the purchase of foreign goods and services and may be included in contracts resulting from this Announcement of Opportunity:

FAR 52.225-1	Buy American Certificate (Dec 1989)
FAR 52.225-3	Buy American Act -- Supplies (Jan 1994)
FAR 52.225-7	Balance of Payments Program (Apr 1984)
FAR 52.225-8	Buy American Act -- Trade Agreements -- Balance of Payments Program Certificate (Jan 1994)
FAR 52.225-9	Buy American Act -- Trade Agreements -- Balance of Payments Program (Jan 1994)
FAR 52.225-10	Duty-Free Entry (Apr 1984)
FAR 52.225-11	Restrictions on Certain Foreign Purchases (Aug 1998)
FAR 52.225-18	European Union Sanction for End Products (Jan 1996)
FAR 52.225-19	European Union Sanction for Services (Jan 1996)
FAR 52.225-21	Buy American Act -- North American Free Trade Agreement Implementation Act -- Balance of Payments Program (Jan 1997)

The Proposer is directed to the Federal Acquisition Regulation for further information on these regulations.

[Not Used]

APPENDIX F

ELEMENTS TO BE INCLUDED IN ARRANGEMENTS BETWEEN U.S. PROPOSAL TEAM LEADERS AND COOPERATING FOREIGN PARTIES

The following elements should be included in arrangements between the proposing team leader and foreign Parties contributing to or cooperating in activities under the LightSAR Announcement of Opportunity.

SCIENCE DATA RIGHTS

Unless otherwise agreed between NASA and the selected LightSAR Proposal Team Leader, all science data resulting from this cooperative activity will be made available to all users without restriction at no more than the cost of dissemination, through appropriate data archives in the United States and [foreign country]. In the event that reports or publications based upon this data are copyrighted, the Parties and NASA shall have a right under the copyright to reproduce, prepare derivative works from, perform, display, and distribute copies of such copyrighted work for their own purposes royalty-free.

EXCHANGE OF TECHNICAL DATA AND GOODS

The Parties are obligated to transfer only those technical data (including software) and goods necessary to fulfill their respective responsibilities under this agreement, in accordance with the following provisions:

1. The transfer of technical data for the purpose of discharging the Parties' responsibilities with regard to interface, integration, and safety shall normally be made without restriction, except as required by national laws and regulations relating to export control or the control of classified data. If design, manufacturing, and processing data and associated software, which is proprietary but not export controlled, is necessary for interface, integration, or safety purposes, the transfer shall be made and the data and associated software shall be appropriately marked. Nothing in this article requires the Parties to transfer goods or technical data contrary to national laws and regulations relating to export control or control of classified data.

2. All transfers of proprietary technical data and export-controlled goods and technical data are subject to the following provisions. In the event a Party finds it necessary to transfer goods which are subject to export control or technical data which is proprietary or subject to export controls, and for which protection is to be maintained, such goods shall be specifically identified and such technical data shall be marked with a notice to indicate that they shall be used and disclosed by the receiving Party and its related entities (e.g., contractors and subcontractors) only for the purposes of fulfilling the receiving Party's responsibilities under the

programs implemented by this Agreement, and that the identified goods and marked technical data shall not be disclosed or retransferred to any other entity without the prior written permission of the furnishing Party. The receiving Party agrees to abide by the terms of the notice, and to protect any such identified goods and marked technical data from unauthorized use and disclosure, and also agrees to obtain these same obligations from its related entities prior to the transfer.

3. All goods, marked proprietary data, and marked or unmarked technical data subject to export control, which are transferred under this Agreement, shall be used by the receiving Party exclusively for the purposes of the programs implemented by this Agreement.

LIABILITY

If the successful proposing team has elements of foreign cooperative activity, a cross-waiver of liability may be required at the appropriate time.

APPENDIX G

CONTENTS OF THE PROGRAM LIBRARY

Virtual library of the LightSAR program comprises various sites and links on the World Wide Web, as listed below.

Current versions of NASA directives may be obtained from URL
http://nodis.hq.nasa.gov

Current versions of NASA technical standards may be obtained from URL
http://standards.nasa.gov

Earth Science Enterprise Strategic Plan is available at URL
http://www.earth.nasa.gov/visions/stratplan/indet.html

Federal Acquisition Regulations (FARs) are available at URL
http://www.arnet.gov/far/

LightSAR Science Requirements and Mission Enhancements document is at URL
http://southport.jpl.nasa.gov/lightsar/

NASA FAR Supplements (NFSs) are available at URL
http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm

NASA Financial Management Manual is accessible at URL
http://www.hq.nasa.gov/fmm/

Samples of contractual documents cited in the basic AO are available at URL
http://essp.gsfc.nasa.gov/essplib/
http://southport.jpl.nasa.gov/lightsar/specimen_contract.htm

[Not Used]

APPENDIX H

AO ACRONYMS

AO	Announcement of Opportunity
AMM	Antarctic Mapping Mission
ASCII	American Standard Code for Information Interchange
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
COM	Cost of Money
CRSP	Commercial Remote Sensing Program
CVCM	Collected Volatile Condensable Mass
DOS	Disk Operating System
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic, and Electro-Mechanical
EEO	Equal Employment Opportunity
ELV	Expendable Launch Vehicle
EOCAP	Earth Observations Commercial Applications Program
EOS	Earth Observing System
ERS	European Remote-sensing Satellite
ESE	Earth Science Enterprise
ESSP	Earth System Science Pathfinder
FAR	Federal Acquisition Regulation
Fax	Facsimile
FFRDC	Federally Funded Research and Development Center
FMEA	Failure Modes and Effects Analysis
FY	Fiscal Year
G&A	General and Administrative
GDS	Ground Data System
GIDEP	Government Industry Data Exchange Program
GLAS	Geoscience Laser Altimeter System
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment mission
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HH	Horizontal linear polarized beam transmitted and received
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JERS	Japanese Earth Resources Satellite
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
Landsat	Visible/near visible band Earth-imaging series of satellites
LightSAR	Lightweight Synthetic Aperture Radar
LSWG	LightSAR Science Working Group
LRR	Launch Readiness Review
MLELV	Medium-Light Expendable Launch Vehicle

MODIS	Moderate Resolution Imaging Spectrometer
MRR	Mission Readiness Review
MTPE	Mission To Planet Earth (now known as Earth Science Enterprise)
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NHB	NASA Handbook
NMC	NASA Mission Cost
NOI	Notice of Intent
NPD	NASA Policy Directive
NRA	NASA Research Announcement
NRC	National Research Council
NSS	NASA Safety Standard
OAR	Operational Acceptance Review
OES	Office of Earth Science
OFCCP	Office of Federal Contract Compliance Programs
PAF	Payload Attach Fitting
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PM	Project Manager
Radarsat	C-band imaging radar satellite of the Canadian Space Agency
SAR	Synthetic Aperture Radar
SE	Support Equipment
SELV	Small Expendable Launch Vehicle
SELVS	Small Expendable Launch Vehicle Services
SF	Standard Form
SI	International System of Units
SIR-C	Shuttle Imaging Radar - C
SOMO	Space Operations Management Office
SOW	Statement of Work
SRR	System Requirements Review
SRM	Solid Rocket Motor
SSC	John C. Stennis Space Center
TML	Total Mass Loss
TMLCC	Total Mission Life Cycle Cost
TRL	Technology Readiness Level
URL	Universal Resource Locator
USGCRP	U.S. Global Change Research Program
VCL	Vegetation Canopy Lidar Mission
VV	Vertical linear polarized beam transmitted and received
WBS	Work Breakdown Structure
WTR	Western Test Range
WWW	World Wide Web
X-SAR	X-band Synthetic Aperture Radar

APPENDIX I

GLOSSARY OF TERMS

NASA MISSION COST

That portion of the proposed mission cost to be funded by NASA, including full costing of non-contributed civil service resources.

PHASE B

Project Formulation period that includes definition and preliminary design.*

PHASE C/D

Project Implementation period that includes detail design and development, mission launch, and operational validation.*

Phase E

Project Implementation period that includes mission operations, data collection, processing, distribution, and archiving.*

SCIENCE RETURN

The combination of the proposed mission's relevance to the science priorities, goals and objectives of the Earth Science Enterprise and LightSAR Program; overall scientific merit; and quality, quantity, relevance and timeliness of deliverable science data products.

SCIENCE VALUE

An assessment of the relationship between science return and the proposed NASA Mission Cost.

TOTAL MISSION LIFE CYCLE COST

The total proposed mission cost, which is the sum of the NASA Mission Cost and all contributions from the selected proposal Team partners.

*Note: Phase B/C/D/E notation, referring to a calendar sequence of project milestones defined in the now-superceded NHB7120.5, is retained only for cost estimation consistency in AO proposals.

[Not Used]

APPENDIX J

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1265.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
(b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification;
(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.
(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name	AO Number and Title
Printed Name and Title of Authorized Representative	
Signature	Date
Printed Proposal Team Leader Name	Proposal Title

[Not Used]

APPENDIX K

CERTIFICATION REGARDING LOBBYING

As required by S1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Organization Name	AO Number and Title
Printed Name and Title of Authorized Representative	
Signature	Date
Printed Proposal Team Leader Name	Proposal Title

[Not Used]

APPENDIX L

[Not Used]

[Not Used]

APPENDIX M

CHARTS AND TEMPLATES

Technology Definitions

Technology Readiness Levels (TRL), Research vs. Development, Relevant Cross-cutting Processes

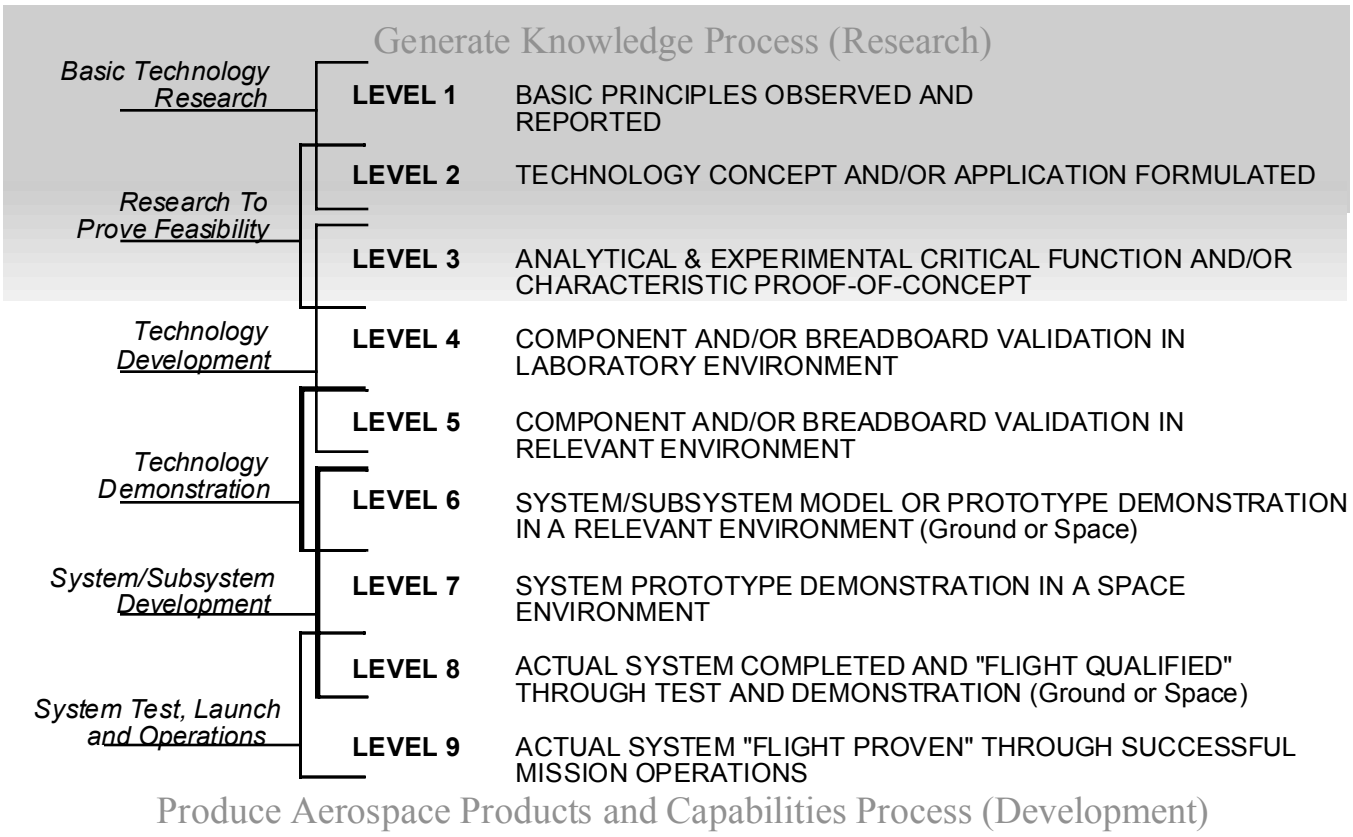

Figure M-1. Technology Readiness Level Definitions

Fiscal Year	Inflation Rate
FY 1999	3.8%
FY 2000	4.1%
FY 2001	3.9%
FY 2002	3.9%
FY 2003	3.9%
FY 2004	3.9%
FY 2005	3.9%
FY 2006 and Outyears	3.9%

Figure M-2. NASA Inflation Index

SUMMARY OF ELEMENTS OF COST
(BY PHASE, FISCAL YEAR AND WBS LEVEL)

	PHASE		
	FY/Quarter	FY/Quarter	Total
	Base Rate Cost	Base Rate Cost	Cost
Direct Labor			
Labor Hours: (by skill categories)			
TOTAL HOURS			
Labor Costs ($): (by skill categories)			
TOTAL DIRECT LABOR COSTS			
Overhead (%, $) (by cost centers)			
Subcontracts			
Materials			
Material Burdens (%, $)			
Travel			
Other Direct Costs			
SUBTOTAL			
G&A Expense (%, $) (by cost pools)			
SUBTOTAL			
Cost of Money (%, $) (by indirect pools & overhead centers)			
Profit/Fee (%, $)			
TOTAL COST PLUS FEE			

* This exhibit can be used for all Phases and WBS levels.

Figure M-3. Summary Of Elements Of Cost

TOTAL MISSION LIFE CYCLE COST PHASING

Item	FY1	FY2	FY3	FY4	FY5	.....	FYn	Total Real Yr $
Phase B	$	$						$
Phase C/D	$	$	$	$	$		$	$
Phase E	$	$	$	$	$		$	$
Launch Services	$	$	$	$	$		$	$
Ground System	$	$	$	$	$		$	$
Other (specify)	$	$	$	$	$		$	$
Other	$	$	$	$	$		$	$
Reserves	$	$	$	$	$		$	$
Total Cost to NASA	$	$	$	$	$		$	$
Additional Contributions by Organization (U.S. or non-U.S.) to:								
Total Phase B	$	$	$	$	$		$	$
- Organization A								
- Organization B								
Total Phase C/D	$	$	$	$	$		$	$
- Organization A								
- Organization B								
Total Phase E	$	$	$	$	$		$	$
- Organization A								
- Organization B								
Launch Services Costs	$	$	$	$	$		$	$
- Organization A								
Ground System	$	$	$	$	$		$	$
- Organization A								
- Organization B								
Other	$	$	$	$	$		$	$
Contributed Costs Total	$	$	$	$	$		$	$
					Mission Totals			$

Figure M-4. Total Mission Life Cycle Cost Phasing

Mission: LightSAR Announcement of Opportunity, AO-99-OES-01

Project Manager:	_____(signature)_____	_____
Proposal Team Leader	Name Title, Affiliation, Address	Date
Authorizing Official:	_____(signature)_____	_____
Proposal Team Leader	Name Title, Affiliation, Address	Date
Lead Representative:	_____(signature)_____	_____
Proposal Team Member “A”	Name Title, Affiliation, Address	Date
Authorizing Official:	_____(signature)_____	_____
Proposal Team Member “A”	Name Title, Affiliation, Address	Date
Lead Representative:	_____(signature)_____	_____
Proposal Team Member “B”	Name Title, Affiliation, Address	Date
Authorizing Official:	_____(signature)_____	_____
Proposal Team Member “B”	Name Title, Affiliation, Address	Date
Investigator:	_____(signature)_____	_____
Proposal Team Member “C”	Name Title, Affiliation, Address	Date
Authorizing Official:	_____(signature)_____	_____
Proposal Team Member “C”	Name Title, Affiliation, Address	Date
Investigator:	_____(signature)_____	_____
Proposal Team Member “D”	Name Title, Affiliation, Address	Date
Authorizing Official:	_____(signature)_____	_____
Proposal Team Member “D”	Name Title, Affiliation, Address	Date

Figure M-5. Sample Signature Page

Mission Assurance Element	Check all that apply	Applicable Plan, Document, Review or Program
1. Mission Assurance Program		
2.1 Quality System		
2.2 Standards		
2.3 Non-Conformance Reporting		
2.4 Operating Time		
3. Reviews		
System Requirements Review		
Preliminary Design Review		
Critical Design Review		
Pre-Environmental Test Review		
Mission Readiness Review		
Launch Readiness Review		
Operational Acceptance Review		
Annual Operation Reviews		
4.1 Parts Program		
4.2 Materials and Processes Program		
4.3 Reliability Program		
4.4 Software Development Program		
5. Verification Program		
6. Contamination Control Program		

Figure M-6. Mission Assurance Compatibility Table

[Not Used]

Figure M-7. Science Traceability Matrix

Name of Hardware Item	Item Description	Maturity Level	Rationale for Maturity Assessment

Figure M-8. Technical Maturity Matrix

Science Measurement Requirement	Mission Requirement	Instrument Requirement	Spacecraft Requirement	Ground System Requirement	Operations Requirement

Figure M-9. Mission Traceability Matrix

APPENDIX N

MISSION ASSURANCE GUIDELINES AND REQUIREMENTS

1. INTRODUCTION

The purpose of this document is to establish requirements and guidelines for the Proposer in developing and implementing an appropriate mission assurance program. Each section of this document contains high-level requirements and a series of guidelines for implementing these requirements. These guidelines can be tailored to meet the specific needs of the proposed mission and each team member's internal processes, but must meet the intent of each requirement.

The Proposer shall develop and implement an appropriate mission assurance program in accordance with standard aerospace industry practices and the specific needs of the mission. The Proposer, together with the LightSAR Project Office, will continually review and verify the proper implementation of this mission assurance program.

2. MISSION ASSURANCE

2.1 Quality System

The Proposer shall define and implement a quality system based on ANSI/ASQC Q9001-1994 that meets the intent of ISO 9001. The Proposer's quality system shall encompass all LightSAR flight hardware, flight software and ground support equipment development, as well as mission operations for flight hardware, software, ground support equipment and operations. This quality system shall be described in a product assurance requirements document and plan for the LightSAR project.

2.2 Standards

The Proposer shall impose NASA and industry design and development standards that help assure that the required mission lifetime and performance are met in the expected environments.

2.3 Non-Conformance Reporting

The Proposer shall utilize a reporting system for problems, failures and non-conformances. They may use their own system or the JPL web-based problem reporting system. At a minimum, each report shall document the problem, failure, or non-conformance description, verification of cause, and corrective action. Non-conformance reporting guidelines and requirements are summarized in Table 2.3-1.

Table 2.3-1. Non-Conformance Reporting Guidelines/ Requirements

HARDWARE/SOFTWARE AFFECTED	DEVELOPMENTAL PROBLEM LOG	FORMAL NON-CONFORMANCES
Engineering Models (Electronic)	Not required*	Starting with qualification environmental testing
Flight Electronics	Not required	Starting with first application of power at board level
Flight Mechanical Assemblies	Not required	Starting with assembly flight design qualification acceptance test
Software	Not applicable	Subsequent to software acceptance and when used with flight hardware
Support Equipment (SE) Hardware/Software	Not applicable	Subsequent to SE acceptance in use with flight hardware
Part Failures	Not applicable	For any part failure from certified flight lot

*Note: Recommended as a means to record incidents for future reference.

Informal reporting, starting early in the development phase with breadboards, prototypes, and engineering models, is encouraged. Informal problem reporting can be documented with a simple log, and will complement the design file, reviews and later formal reporting.

Copies of formal reports, including an indication of the appropriate risk rating as defined in Table 2.3-2, will be furnished JPL LightSAR Project Office within 24 hours of initiation. Closure of each report shall be approved by the Proposer's product assurance representative and reviewed by JPL.

Table 2.3-2. Failure Rating Chart For Risk Assessment

Failure Effect Rating (Ignoring Redundancy)			**Failure Cause/Corrective Action Rating**
Negligible			Known Cause/Certainty in Corrective Action No possibility of recurrence.
Significant	2	2	Unknown Cause/Certainty in Corrective Action No possibility of recurrence.
Major	3	3	Known Cause/Uncertainty in Corrective Action Some possibility of recurrence.
		4	Unknown Cause/Uncertainty in Corrective Action Some possibility of recurrence.
Reports with failure ratings inside this box are designated “Red Flag” reports			

2.4 Operating Time

All subsystems shall accumulate as much operating time as possible both prior to integration and as an integrated Facility. The goal is 100 hours of operating time prior to integration and an additional 1000 hours (including system thermal/vacuum testing) as an integrated system prior to Launch.

Operating time includes time operated with replacement parts inserted due to a failure during cumulative operation of the system or subsystem.

3. REVIEWS

To assure that satisfactory progress is being made, competent and independent assessment teams shall periodically review mission implementation.

Required Mission Reviews will concentrate on critical technical and programmatic aspects of the system and mission, and include participation by the LightSAR Project Office. Additional reviews should be conducted by the Proposer to identify and resolve potential problems before they reach formal, high-level system reviews. The LightSAR Project Office will assess the thoroughness, competence and independence of the total review process.

3.1 Required Mission Reviews

The required Mission Reviews are the Preliminary Design Review (PDR), the Critical Design Review (CDR), the Mission Readiness Review (MRR), and the Operational Acceptance Review (OAR). The review chairman, in concert with the LightSAR Project Office, appoints independent key technical experts as review team members. Every effort will be made to maintain continuity of the chairman and the key technical experts for the duration of the mission. Other experts will be added or deleted from the review

team according to the needs and phase of the mission. The scope and function of these required reviews is as follows:

Preliminary Design Review (PDR): The PDR shall occur near the end of the mission Definition Phase. The purpose of the PDR is to examine preliminary designs for technical feasibility and to assess the mission design as it relates to the mission requirements. The PDR should also confirm:

- final design and test plans for each subsystem
- final interface control documents
- mission integration and verification plans
- complete programmatic plan through launch
- requirements flow-down traceability
- risk identification and mitigation plans, including descopes
- comprehensive cost, schedule and resource plans
- complete ground system architecture
- comprehensive system engineering plan
- final definition of mission science requirements
- final definition of environmental design/test requirements
- mission assurance planning including reliability analyses, qualification and selection of electronic parts/ materials/ processes, quality assurance activities
- preliminary hazards list
- reliability analysis for inherited flight hardware and software or their designs
- thoroughly defined roles and responsibilities of all LightSAR Team members

The Proposer will conduct the PDR, with participation from the LightSAR Project Office.

Critical Design Review (CDR): The CDR is conducted after the design has been completed, but prior to the start of flight hardware manufacturing or coding of the flight software. It will emphasize implementations of design approaches, results of design and reliability analyses and prototype testing, completeness and control of the design documentation, final fabrication plan, status of safety surveys, mission operations planning, as well as test planning for all flight systems. Long lead procurements and manufacturing may be initiated prior to CDR as required to meet schedule.

The Proposer will conduct the CDR, with participation from the LightSAR Project Office.

Mission Readiness Review (MRR): The MRR is conducted near the end of the Development Phase. The MRR shall verify that all system elements meet the requirements of the mission and are ready to proceed into final launch preparations. The MRR shall verify that testing to validate the readiness of the flight hardware and

software has been completed with no unacceptable open issues. The MRR should also cover:

- determination of completion of testing flight hardware and software
- verification of system requirements
- verification and documentation of hardware and software configuration
- identification of outstanding safety risks
- approved procedures for safe handling
- disposition of waivers, deviations, open issues
- compatibility of spacecraft and ground support equipment
- end-to-end system level testing verification
- launch vehicle and launch operations readiness
- on-orbit checkout and operational certification plans
- orbital operations plans
- mission operations, ground system and data processing system readiness
- evaluation of the acceptance data packages

The Proposer will conduct the MRR, with participation from the LightSAR Project Office.

Operational Acceptance Review (OAR): The OAR shall take place following completion of on-orbit checkout and operational verification activities, approximately 90 days following launch. This review is to certify system performance and operational readiness of the LightSAR system. All open issues from the MRR must be resolved before the OAR.

The Proposer will conduct the OAR, with participation from the LightSAR Project Office.

3.2 Recommended Additional Formal Reviews

Additional formal, top-level reviews that supplement the required Mission Reviews are recommended.

System Requirements Review (SRR): The SRR should be the first major mission review during the Definition Phase. The purpose of this review is to finalize mission science, operations and technical requirements. Traceability among these requirements should be demonstrated.

Pre-Environmental Test Review (PER): The PER should be held prior to the full system integration and functional test in preparation for environmental testing. The purpose of this review is to assess the readiness of the flight hardware, software and required environmental test facilities to begin acceptance testing. The PER should also cover:

- design changes since CDR
- status of non-conformances
- test documentation (plans, procedures, waivers) and facilities/personnel readiness
- hardware and software configuration (documented and verified)
- mission operations status

Launch Readiness Review (LRR): The LRR should be held just prior to launch to confirm readiness to launch. The LRR should also cover:

- disposition of all open work items
- launch system readiness
- ground system readiness

Annual Operation Reviews (AORs): The AORs should occur at one-year intervals following the Operational Acceptance Review, to address status, plans, and funding matters of mutual interest to the Proposer and the LightSAR Project Office.

3.3 Peer Reviews

Engineering peer reviews should occur during all phases of the project life cycle. These technical reviews provide participants with a detailed understanding of the design's ability to meet higher-level requirements. Effective peer reviews will enable significant streamlining of the content of higher level formal reviews described in 3.1 and 3.2. Topics that should be addressed in the peer reviews are:

- requirements validation
- interface control design verification
- parts and materials review
- analyses and studies
- safety issues
- risk assessment, resolution and contingency plans
- procurements
- confirmation of technology items
- hardware and software configuration management
- detailed cost, schedule and resource availability
- manufacturability and testability
- integration and test planning, including test anomalies and resolution

4. RELIABILITY

4.1 Parts Program

The Proposer shall implement a parts program that assures mission reliability and performance requirements are met. A list of all Electrical, Electronic, and Electro-mechanical (EEE) parts should be prepared during design, maintained during hardware build, and furnished at scheduled reviews.

The Proposer will use Grade 2 parts unless there is a significant adverse impact to cost and schedule. Grade 1 parts will be used where there is a significant reduction of risk to the mission at a minimal impact to cost and schedule. Management, selection, application, evaluation, and acceptance of all parts should be controlled through a parts control board, or similar documented parts control system. The parts control board /system will determine requirements for qualification, fabrication, and screening for all other parts, based on part failure history, GIDEP Alerts and Problem Advisories, new/unknown technology, or other similar concerns. DPA performance, when required, should be in accordance with the Proposer's DPA procedure.

All EEE parts should be selected, or the design otherwise implemented, to meet the maximum predicted mission ionizing radiation level requirements and to minimize Single Event Upsets (SEU) and be latch up immune.

The Proposer should monitor Government Industry Data Exchange Program (GIDEP) reports for parts problems applicable to LightSAR. All EEE parts should be derated in accordance with the guidelines in MIL-STD-975, or equivalent. Failure analysis should be performed on flight parts/ components that fail after final assembly.

4.2 Materials and Processes Program

The Proposer shall implement a Materials and Processes program that assures mission reliability and performance requirements are met. A list of materials, processes, and appropriate usage records should be prepared during design, maintained during hardware build, and furnished at scheduled reviews. Management, selection, application, evaluation, and acceptance of materials and processes should be controlled through a materials and processes control board, or similar system.

Materials with a total mass loss (TML) <1.00% and a collected volatile condensable mass (CVCM) <0.10% should be used on the LightSAR spacecraft. NASA Reference Publication 1124 entitled "Outgassing Data for Selecting Spacecraft Materials" may be used as a guide for materials selection.

4.3 Reliability Program

The Proposer shall plan and implement a reliability program that enhances the expected mission lifetime. The reliability program tasks should effectively, efficiently, and responsively interact with systems engineering, hardware design, parts selection, and systems safety. The reliability program takes its lead from the project implementation plan in which mission objectives, task responsibilities, and

schedules are addressed. The reliability program should at least respond to the following objectives:

I. By Design
   a) Provide for graceful degradation/ degraded operation not catastrophic failure.
   b) Eliminate unnecessary parts and components to reduce series complexity.
   c) Promote failure workarounds that allow continued successful but degraded operation.
   d) Isolate failure impact so that effects do not propagate to other functions.
   e) Ensure that failure of non-critical functions do not affect critical functions.
   f) Show that electrical stress applied to parts and devices meets derating requirements over the extremes of operating temperature range, voltage temperature range, and current variations.
   g) Show that parts meet total dose and single event effects radiation requirements.
   h) Verify that the reliability process is flowed down consistently to subcontractor(s) and suppliers.

II. In Manufacture
   a) Assure that hardware is assembled as-designed.
   b) Assure that specified manufacturing processes are followed.

III. In Test
   a) Verify that the finished product meets specification.
   b) Verify that the finished product functions as-designed.

A Failure Modes and Effects Analysis (FMEA) should be performed early in the design process to identify problem areas that require corrective action, and updated as the design matures. MIL-STD-1629A "Procedures for Performing a Failure Mode, Effects and Criticality Analysis", or equivalent, can be used as a guide. The FMEA should be available for review by the LightSAR Project Office.

4.4 Software Development Program

The Proposer shall employ a structured program for software development. The program shall address appropriate development life cycle phases, such as requirements analysis, design, code and unit test, integration and build test, performance verification, and maintenance. The program shall include internal and external software reviews to validate software requirements, software design, operating characteristics, and external interface requirements. Software requirements, external interface specifications and user guides shall be identified and document during the preliminary design process. Code produced shall be structured, error-free, and maintainable.

The Proposer should employ a software configuration management process to manage requirements, code, documentation, and data, and to track and report on the status of changes to them. The process should include a means to record, track and disposition identified discrepancies in the product (i.e., non-conformance control).

5. VERIFICATION

The Proposer shall conduct a verification program to ensure that the flight hardware meets the specified mission requirements. The program should comprise a logical sequence of activities, including analytical investigations, functional demonstrations, physical measurements, and tests that simulate expected environments. Documentation of the verification program should include a system performance verification matrix, environmental test matrix, plans, procedures, and reports.

6. CONTAMINATION

The Proposer shall establish and conduct a contamination control program consistent with mission requirements.

APPENDIX O

FLIGHT AND GROUND SAFETY REQUIREMENTS

The Proposer shall implement a system safety program in accordance with the requirements imposed by the appropriate launch range and launch service provider. Although safety requirements are mandatory and non-negotiable, tailoring of safety requirements to fit the specific mission is done through the applicable safety organization(s).

The purpose of this document is to serve as a resource to the Proposer for complying with necessary NASA safety requirements.

The following documents describe the safety program implementation and deliverables required to launch space hardware safely, and may reference other requirements that must be met to gain access to the launch site.

KHB 1710.2C	Kennedy Space Center Safety Practices Handbook Note: Applies to Western Test Range (WTR) where KSC has jurisdiction for reviewing procedures and facilities)
EWR 127-1	Eastern and Western Range Safety Requirements.

The following documents describe orbital debris assessment requirements.

NPD 8710.3	NASA Policy For Limiting Debris Generation
NSS 1740.14	Guidelines and Assessment Procedure for Limiting Orbital Debris, NASA Safety Standard

[Not Used]