

Model Statement of Work  
For  
Solar Dynamics Observatory  
(SDO)  
Phase A Concept Study

17 January, 2002

# **INTRODUCTION**

## **I SCOPE**

The intent of this model statement of work (SOW) is to define the tasks that could be performed during the period allocated for the concept studies effort. The concept studies period consists of the period of time reserved for both Phase A and the Bridge Phase. This document also provides guidelines for the preparation of the Concept Study report.

The Concept Study Report shall contain the following: the executive summary including the investigation fact sheet; the science discussion; technical approach; management plan; Phase B/C/D/E study plan; cost plan; and Appendices. When changes have been made to any data provided with the original proposal as a result of the concept study, these changes from the proposal should be clearly identified. The content of each requirement is discussed in the subsequent paragraphs.

## **II TASKS**

The tasks designated in this statement of work (SOW) describe the work required to formalize the instrument systems requirements, instrument/spacecraft interfaces and accommodations, and detailed cost and schedule for the activities as related to the design/build/test/integration of the SDO Instrument and integration of the instrument to the spacecraft, launch and mission operations activities.

### **PHASE A Study**

#### **1.1 Scope of Work**

The PI/Institution team shall provide the personnel, equipment and facilities to perform the analyses required to define the SDO instrument science investigation, education and public outreach, science payload, spacecraft compatibility, and mission operations, ground, and data systems. The SDO investigation shall produce the deliverables required for the Phase A Study, defined in Section 1.1.15 of this document.

##### **1.1.1 Science Investigation Definition**

The PI/Institution team will refine and describe the instrument science investigation. This includes refining the descope options of the baseline instrument mission defined in the proposal. The science team shall produce an instrument science requirements document.

### **1.1.2 Education and Outreach**

The PI/Institution team shall document the instrument education, outreach, technology, and small disadvantaged business plan. This will include education program activities, public awareness, small disadvantaged business participation in the instrument mission, and new technology proposed for the investigation.

### **1.1.3 Technical Approach Definition and Requirements Analysis**

The PI/Institution team shall refine and document the existing instrument design overview that included requirements flow down and traceability from the instrument science requirements to the spacecraft, instrument mission operations, ground, and data systems requirements and design implementations.

### **1.1.4 Mission /Spacecraft Design**

The PI/Institution team shall refine and document the instrument mission design that fully describes the operational phase of the mission from launch to end of mission, including data delivery to the SDO Data Center. The instrument team will provide technical support for the formulation of mission design, instrument and spacecraft interface design, integration, test, launch support, and mission support. By the nature of being a concept study, both spacecraft bus and instrument designs may be modified to best accommodate the most efficient implementation for the mission. Major trade decisions made during the formulation period should be outlined, along with a discussion of why a particular path was chosen.

The spacecraft provider will be responsible for developing the spacecraft interface control document for SDO. The PI organization shall provide the spacecraft provider with all pertinent information regarding the instrument interfaces to the spacecraft.

### **1.1.5 Science Payload**

The PI/Institution team shall refine and document the science payload, which consists of the SDO instrument. This document includes instrument subsystem requirements and characteristics, such as mass, power, volume, pointing, and relevant critical performance requirements of each Detector/Optics as appropriate, and a summary of new developments required with a space qualification plan for those new developments. The document will include system budgets with design margins and the rationale for those margins.

### **1.1.6 Payload Integration**

The PI/Institution team shall refine the instrument interface requirements, and provide a document that includes power, mechanical, thermal, command and telemetry, EMC and

contamination interface requirements. The team shall provide a preliminary instrument integration and test plan, which describes the integration and testing flow of the instrument into an integrated, qualified system, and the integration and testing strategy of the instrument package with the spacecraft.

### **1.1.7 Manufacturing, Integration, and Test**

The PI/Institution team shall document the manufacturing, integration and testing strategy that will produce and test the flight hardware and software required accomplishing the mission. This includes spacecraft integration and testing, the integration and test of the instrument package to the spacecraft, and the environmental test flow. The description shall include the main processes and procedures planned in the fabrication of flight hardware, software, production personnel resources, incorporation of new technology/materials, and the preliminary test and verification program. It shall identify and describe the facilities and planned end items. It will include a schedule.

### **1.1.8 Facilities Identification**

The PI/Institution team shall describe any new facilities required to execute the investigation. This includes a Science Operations Center, a Ground Station Facility, and other fabrication facilities.

### **1.1.9 Product Assurance and Safety**

The PI/Institution team shall describe the planned product assurance and safety processes, which assure that the product meets specifications.

### **1.1.10 Management Plan**

The PI/Institution team shall establish, implement and maintain a project management system for the full term of the Concept Study. This will include refining and providing details on the management plan provided in the Proposal. This refined plan shall include team member responsibilities, management processes/plans, schedules, risk management, government furnished property, services, and facilities, and reporting and reviews.

The PI/Institution shall further support the SDO mission by participation in NASA/GSFC/SDO programmatic and technical meetings and reviews as appropriate. Weekly interface meetings with the spacecraft provider will be conducted. The purpose of these meetings is to exchange technical data regarding the mission requirements and spacecraft to instrument interfaces. These meetings are open to all participants, who are encouraged to participate as frequently as it is possible. The GSFC Program office and Project Scientist will evaluate the impact of any recommended design changes.

### **1.1.11 Concept Study Plan**

The PI/Institution shall generate/refine a study plan.

### **1.1.12 Cost Plan**

The PI/Institution team shall refine the existing detailed WBS and update the WBS based cost estimate for Phase A through E. This cost estimate will use time phased labor estimates, labor rates, overhead rates, and G&A rates in accordance with standard practices and procedures for each team member. The cost estimate shall include all reserves required to implement an appropriate risk management approach as discussed in paragraph D.3 of this SOW.

### **1.1.13 Resumes**

The PI/Institution team shall update the Science Team resumes and provide resumes for Key Project Personnel.

### **1.1.14 Statement(s) of Work**

The PI/Institution team shall develop draft contract SOWs for each contract option (Phase B, C/D, and E) for the ground system, spacecraft, and instrument. The SOWs will include scope of work for each phase, deliverables for each phase, potential requirements for Government facilities and/or Government services, and schedules for the entire mission.

### **1.1.15 Deliverables**

The PI/Institution team shall deliver a Phase A Concept Study Report (see Section III) that outlines the technical, cost, and management data required by NASA HQ for instrument selection.

### **1.1.16 Government Responsibilities**

The Government (NASA's GSFC) shall provide the SDO Mission Project Management.

## **III PHASE A STUDY REPORT**

The study report shall contain the following:

### **A. Executive Summary**

The executive summary should provide an overview of the investigation and a fact sheet, including its scientific objectives; technical approach; management plan; and cost estimates.

## **B. Science Investigation Description**

This section shall describe any science investigation changes resulting from the Proposal submittal. Rationale for changes shall be discussed.

The PI/Institution shall provide inputs for the generation of science requirements, and the definition and requirements for the SDO Science Operations Center. Included in this task is the definition of the pre-and post-launch data analysis effort, the types and amounts of computer hardware required for the flight data analysis and the methodology of data storage and data/command flow to and from the Flight Ops Centers to the science community.

## **C. Technical Approach**

Detail the method and procedures for the definition, design, development, integration, ground operations, and flight operations of the instruments. This section shall also detail the expected products and end items associated with each phase.

### **C.1 Design Approach**

Describe the instrument design approach, particularly as it relates to new versus existing hardware/designs. It shall fully identify the instrument systems and describe its characteristics and requirements. A description of the flight system design with a block diagram of flight element subsystems and their interfaces shall be included, along with a description of the flight software and a summary of estimated performance of the flight system. The instrument flight heritage shall be described

A preliminary definition of industry or other standards that will be utilized in the design effort shall be prepared.

### **C.2 Software Definition and Management**

The PI/Institution shall define all of the software required for acceptance testing and operations (flight and ground based). The development of all software shall be described in a Software Development and Management Plan, which is a deliverable item under the next phase of this mission (Phase B).

### **C.3 Technology Development**

A description of any technologies planned for development shall be defined as well as descope options and decision points for high-risk technologies.

## **C.4 Interface Definition**

SDO AO sections 5.1.2 and 5.1.3 contain the spacecraft bus description, which includes current interface assumptions and spacecraft capabilities. The instrumenters shall provide rationale for proposed changes to the baseline assumptions.

Other interface requirements not currently covered on the SDO AO sections 5.1.2 and 5.1.3 shall be provided. These shall include as a minimum definition of:

- Field of Views
- Attitude performance (jitter, pointing, knowledge and control)
- Maneuver rates or special maneuvers (i.e. for calibration purposes)
- Calibration requirement (ground and on-orbit)
- Environmental sensitivities (electrostatic and magnetic cleanliness)
- Contamination sensitivities (particulate and/or molecular, purge equipment, purge gas testing, optical witness sample (OWS) program)
- Instrument operations and ground segment and data distribution.

## **C.5 Manufacturing, Integration and Test**

This section shall describe the manufacturing strategy to produce and test the hardware/software necessary to accomplish the instrument design, fabrication, testing, and launch support. It shall include a description of the main processes and procedures planned in the fabrication of flight hardware, software, production personnel resources, incorporation of new technology/materials, and a test and verification program. Describe the approach for the transition from design to manufacturing and specify data products, which will be used to assure producibility and adequate tolling availability.

A traceability matrix, showing how the proposed instrument design complies with stated objectives, requirements, and constraints of the proposed investigation shall be included.

The approach, techniques, and facilities planned for integration, test and verification, and launch operations phases, consistent with the schedule and cost, shall be described. A schedule for the instrument's manufacturing, integration and test activities shall be included. A description of planned end items, including engineering and qualification hardware, shall be included.

Description of the amount of support required for all these activities shall also include ground support equipment and manpower needed to support observatory level integration and testing activities at the various facilities.

### **C.5.1 GSE Definition**

The PI/Institution shall define the necessary ground support equipment for the handling and integration of the instrument to the spacecraft. This includes equipment required for assembly, testing and handling the instrument on the spacecraft. Mechanical ground support equipment shall include lift slings, alignment equipment, calibration equipment,

prototype test fixtures, purge regulator carts, and shipping containers. Electrical ground support equipment shall include the bench checkout system (for use at the black box level), software development system, software IV&V system, data simulators, other electronic laboratory equipment necessary for the support of spacecraft integration and observatory testing.

### **C.5.2 Facilities**

Provide a description of any new, or modifications to existing facilities, laboratory equipment, and ground support equipment (GSE) (including those of the subcontractor's, NASA, or other government agencies) required to execute the investigation. 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.

### **C.6 Product Assurance and Safety**

Describe the process by which the product quality is assured to meet the customer's specifications, including identification of trade studies, the parts selection strategy, and the plans to incorporate new technology. This section shall also describe the product assurance plan, including plans for problem/failure reporting, inspections, quality control, parts selection and control, safety assurance, and software validation.

The PI/Institution shall describe the Mission Assurance Requirement program, The Performance Assurance program for the SDO Instrument in a Performance Assurance Implementation Plan (software and hardware), contamination control plan, configuration management plan, system safety implementation plan, and a safety and health plan. The Living With a Star Mission Assurance Requirements document shall be considered as a starting point for the SDO mission. A DRAFT copy of this document is included in the SDO AO Library. Note that NASA will provide the expendable launch vehicle and the spacecraft.

### **C.7 Mission Operations, Ground and Data System**

The instrument PI/Institution shall describe the operational phase of the instrument from launch to the end of mission. Include information on the preliminary mission time line, indicated periods of data acquisition, data downlink, etc. Describe the plan for processing, distribution and archiving of the data, including the necessary resources to accomplish that goal.

### **D. Management**

The PI/Institution shall prepare, use and maintain a Work Breakdown structure (WBS) and a PERT type schedule (subject to GSFC review) of sufficient detail to support effective management of the program. The PI/Institution shall ensure that all objectives are accomplished within schedule and the estimated cost of the task, and provide timely visibility of the overall progress.

## **D.1 Management Processes**

Describe the approach for managing the work; the recognition of essential management functions, and the overall integration of these functions shall be described in this section. This section shall specifically discuss the decision making process to be used by the team, focusing particularly on the roles of the Project Scientist and Project Manager in that process. The management plan gives insight into the organizations proposed for the work, including the internal operations and lines of authority with delegations, together with internal interfaces and relationships with NASA, major subcontractors, and associated investigators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities.

These processes should include, but are not limited to: requirements development, systems engineering, integration and test, configuration management, schedule management, team coordination, progress reporting, performance measurement, resource management, Education and Public Outreach. Describe proposed methods of hardware and software acquisition.

## **D.2 Schedules**

Define the schedule and workflow for the complete mission life cycle. Describe methods and tools to be used for internal review, control, and direction. Schedules for all major activities including Education and Public Outreach, interdependencies between major items, deliveries of end items, critical paths, schedule margins, and long lead procurement needs clearly identified.

In addition, instrumenters shall develop a preliminary PERT and GANTT schedule, which contains GSFC approved critical milestones down to the subsystem level for the instrument design and development activities (Phase B, C, D). These schedules will be integrated into the project level schedule, with monthly updates, for Phases B, C, and D milestone tracking. These schedules shall be included with all details in the concept study report.

## **D.3 Risk Management**

Describe the approach to, and plans for risk management and mitigation plans for the overall instrument design and for individual system components. Particular emphasis placed on describing how the various elements of risk, including new technologies, will be managed to ensure successful accomplishment of the mission within cost and schedule constraints.

A summary of margins and reserves in cost and schedule should be identified by project element and year. The specific means by which integrated costs, schedule, and technical performance will be traced and managed should be defined. Specific reserves and the timing of their application shall be described. Management of the reserves and margins,

including who manages the reserves and when and how the reserves are released shall be discussed.

#### **D.4 Government Furnished Property, Services, & Facilities**

Delineate the Government furnished property, services, facilities, etc., required to accomplish all phases of the instrument development within the mission.

#### **D.5 Property, Services & Facilities**

Describe the assumptions of what functions, hardware/software, labor support, etc., will be provided by the spacecraft/mission team.

#### **D.6 reporting and Reviews**

Describe the approach to reporting progress to the Government and the reviews the Government is invited to attend to provide independent oversight. The process, including the individual or organization responsible for reporting integrated cost, schedule, and technical performance shall be discussed. A description of the information to be presented shall be included.

The PI/Institution organization shall support monthly technical and scientific exchange meetings as required. The PI/Institution shall also support technical peer review meetings as required. The frequency and location of those will be decided during Phase A.

Instrument developers shall submit monthly (533M) and quarterly (533Q) financial management reports as required by the contract. They shall be prepared to the WBS Level II, by elements of cost and associated WBS. All financial management reports shall contain explanations of variances from planned expenditures.

The PI/Institution organization shall provide the necessary resources to prepare technical and programmatic data packages for distribution and presentation at NASA reviews. Advance draft copies of the presentation shall be submitted to the GSFC/SDO project for review prior to the formal presentation. Anticipated reviews for the Phase A, B, C, D periods include:

Independent Assessments – A continuous process of peer reviews lead by a Langley Research Center technical evaluation team.

Initial Confirmation Review – Held at completion of Phase A.

Systems Requirements Review (SRR) – Confirms that the requirements and their allocations contained in the system/segment specifications are sufficient to meet project objectives. Successful completion of the SRR freezes program/project requirements.

Confirmation Review (CR)/Non-Advocate Review – Demonstrates that the implementation plan for the mission, consisting of technical, cost and management resources is adequate to achieve the mission goals.

Preliminary Design Review (PDR) – Demonstrates that the preliminary design meets the established system requirements with acceptable risk. It also authorizes the project to proceed to the final design.

Critical Design review (CDR) – Confirms that the project's system, subsystem, and component design is sufficient to allow for orderly hardware/software manufacturing, integration, and testing, and represents acceptable risk. Successful completion of the CDR freezes the design. This review occurs after the design has been completed but prior to the start of manufacturing flight components or the coding of software. The developer shall emphasize implementations of design approaches as well as test plans for flight systems including the results of engineering model testing.

Pre-Environmental Review (PER) — This review occurs prior to the start of environmental testing of the flight instrument. The developer shall present the readiness of the flight hardware and software, and facilities for system level test and evaluate the environmental test plans.

Pre-Ship Review (PSR) - This review shall take place prior to shipment of the observatory to the launch site. The developer shall present evidence to show that testing has been completed with no unacceptable open issues and will evaluate the readiness of the hardware and software for flight. The developer shall address the testing on flight hardware and software, verification and documentation of the hardware and software configuration, identification of outstanding safety risks, disposition of waivers/deviations/open issues, compatibility of spacecraft and ground support equipment, and orbital operations plans

Flight Readiness Review (FRR) – Verifies the system elements constructed for use, and the existing support elements, such as the launch site, space vehicle and booster, are ready for launch. This review will be conducted at the launch facility to verify overall readiness of flight hardware and software, and ground and launch support resources to achieve the mission flight objectives.

Operational Readiness Review (ORR) – Verifies that the flight segment processes and procedures are in place.

Mission Readiness Review (MRR) and Launch Readiness Review (LRR) – Evaluate the readiness of the flight systems, ground system, supporting facilities, and operations personnel to support the launch.

Flight Operations Review (FOR) - The developer shall emphasize the final orbital operations plans as well as the compatibility of the flight components with ground support equipment and the ground network, including summary results of the network compatibility tests.

Mission Operations Review (MOR) – This Mission-oriented review occurs before significant integration and test (I&T) of the flight systems and ground systems. The developer shall present the status of the system components, including the ground system, network operations, the operational interfaces with the flight system, and orbital operations plans.

## **E. Cost Plan**

The cost plan shall provide information on the anticipated costs for all phases (including the 3 month Bridge Phase between Phase A and B) of the instrument development, fabrication, testing, and instrument integration, integration to the spacecraft, operations, and Education and Public Outreach within the mission. A detailed cost program with cost or pricing data as defined in FAR 15.401 is required for Phases B/C/D/E. Discuss the basis of estimate, as well as the use of heritage or commonality with other programs. All costs, including all external contributions received shall be included.

It is anticipated that during the period of performance of the proposed mission, NASA will implement full cost accounting for NASA Centers or other Government laboratories. To plan for this, any contributions provided by NASA Centers, including civil servant services, as well as the cost for the use of Government facilities and equipment shall be included. All direct and indirect costs associated with the work performed at NASA Centers shall be full cost accounted.

The inflation index provided in the SDO AO, Appendix B, Table B-5 shall be used to calculate all real-year and fiscal year dollar amounts, unless an industry forward pricing rate is used. If something other than the provided inflation index is used, the rates used shall be documented.

All costs shall include all burdens and profit/fee in real-year and fiscal year dollars by fiscal year, assuming the inflation rates used by NASA or specifically identified industry forward pricing rates.

### **E.1 Preliminary Design, Development, and Operations Cost Estimate**

This section provides a detailed cost proposal for performing definition, design, development, fabrication, testing, and instrument integration, instrument to spacecraft integration, and Education and Public Outreach within the mission. Cost shall correlate with the plans set forth in the Science, Technical Approach, and Management sections of the study.

#### **a. Contract Pricing**

Work Breakdown Structure – A Work Breakdown Structure (WBS) shall be included. The WBS for the instruments shall be described to the box level. All other elements of

the WBS shall be to the major task level (e.g., Project Management, Systems Engineering, Ground Support Equipment).

**b. Workforce Staffing Plan**

Provide a work force staffing plan, which is consistent with the Work Breakdown Structure. This work force staffing plan shall include all team member organizations and cover all management, technical, and support staff. The work force staffing plan shall be phased by months.

**c. Pricing Technique**

Describe the process and techniques used to develop the Phase B/C/D/E cost proposal. Provide a description of the cost-estimating model(s) and techniques used in the Phase B/C/D/E cost estimate. Discuss the heritage of the models and or techniques applied to this estimate, including any known differences between missions contained in the model's data base and key attributes of the proposed mission. Include the assumptions used as the basis for the Phase B/C/D/E cost and identify those which are critical to cost sensitivity in the investigation. Identify and "discounts" assumed in the cost estimates for business practice initiatives or streamlined technical approaches. Describe how these have been incorporated in the cost estimate and will be managed by the investigation team.

**d. Phase B/C/D/E Time. Phased Cost Summary**

Provide a summary of the total Phase B/C/D/E costs by element of cost. The Phase B/C/D/E cost summary shall be developed consistent with the proposed WBS and shall include all costs to NASA along with all contributed costs. The Phase B/C/D/E cost summary shall also be phased by month. In addition, provide separate cost breakouts between Phase B, Phase C/D, and Phase E costs.

**e. Cost Elements Breakdown by WBS**

Provide cost elements breakdown to the levels described in paragraph "a" of the section.

**i. Direct Labor**

- (1) Explain the basis of labor hour estimates for each of the labor classifications.
- (2) State the number of productive work-hours per month
- (3) Provide a schedule of direct labor rates used in the proposal
- (4) If available, submit evidence of Government approval of direct labor rates for proposal purposes for each labor classification for the proposed performance period.

ii. Direct Material

- (1) Submit a summary of material and parts costs for each element of the WBS.

iii. Subcontracts

(1) Identify fully each effort to be subcontracted, and list the selected or potential subcontractors, locations, amount budgeted/proposed, and types of contracts. Explain the adjustments, if any, and the indirect rates (or burdens) applied to the subcontractors; proposed amounts anticipated. Describe fully the cost analysis or price analysis and the negotiations conducted regarding the proposed subcontracts.

iv. Other Direct Costs

(1) Travel, Relocation, and Related Costs: Provide a summary of the travel and relocation costs including the number of trips, duration, and purpose of the trips.

(2) Consultants: Indicate the specific task area or problem requiring consultant services. Identify the proposed consultants, and state the quoted daily rate, the estimated number of days, and associated costs (such as travel), if any, state whether the consultant has been compensated at the quoted rate for similar services performed in connection with Government contracts.

(3) Other: Explain and support any other direct costs included in the Phase B/C/D/E proposal in a manner similar to that described above.

v. Indirect Costs:

(1) List all indirect expense rates for the team member organizations. Indirect expense rates include labor overhead, material overhead, general and administrative (G&A) expense, and any other cost proposed as an allocation to the proposed direct costs.

(2) If the proposal includes support services for which off-site burden rates are used, provide a schedule of the off-site burden rates. Include a copy of the company policy regarding off-site vs. on-site efforts.

(3) If available, submit evidence of Government approval of any/all projected indirect rates for the period of performance. Indicate the status of rate negotiations with the cognizant Government agency.

## **E.2 Total Investigation Cost Estimate**

This section shall summarize the estimated costs to be incurred in Phases A through E, including ground segment costs; and cost of activities associated for social or educational benefits. The total mission cost estimate shall be consistent with the proposed WBS.