EXHIBIT A

Statement of Work

For the

Project Name

Version X

Month Day, Year

Document Change Record

Revision	Date	Description of Change
1.0	MM/DD/YYYY	Basic version at contract effective date.

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1 Introduction and Definitions

1.1 Introduction

This Statement of Work (SOW) details the work to be performed by the project name Contractor (Contractor) and its team members for the National Aeronautics and Space Administration (NASA) Life Cycle Formulation and Implementation Phases A through F. The successful proposal was selected under the NASA Announcement of Opportunity (AO) AO Title. The Principal Investigator (PI)-Managed Mission Costs (PIMMC) includes:

- Delivery of the Instrument and instrument simulator ready for integration onto the selected platform (Phases A-C);
- Development and delivery of functional algorithms and ground processing system (Phases B-D);
- Supporting a science team that will contribute directly to the successful implementation of the investigation (Phases A-E);
- Required calibration and validation activities (Phases C-E);
- Science team and of key management, Instrument, and engineering staff (Phase D);
- Operations, product generation, and data analysis during the proposed prime mission lifetime of the investigation (Phase E-F); and
- Close out of the investigation once the investigation has been concluded (Phase F).

PROVIDE DESCRIPTION OF PROJECT

1.2 Definitions

Contractor	Prime, and specifically the project name Project Team, including all subcontractors and partners.
Host	NASA provided access to space, including all necessary services required to place the Instrument into an orbit and under specific conditions that will allow the Contractor to acquire the necessary scientific measurements to meet the science requirements.
Host Spacecraft	The Host-provided spacecraft, bus, or observatory.
Host Ground System	The NASA-selected Host-provided Ground System that provides the spacecraft uplink and downlink and data transfer to the Instrument Ground System.
Instrument	The Class X project name Instrument, summary of instrument.
Assembly	A functional subdivision of a component consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are an integrated set of fully populated circuit cards, a gear train, and an integrated set of optical parts.
Subsystem	A functional subdivision of an Instrument consisting of two or more components. Examples are an in-flight calibration subsystem, scanning subsystem, pointing control subsystem, and thermal control subsystem.
Component	A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are electronic box, actuator, encoder, blackbody calibration source. An equivalent term is Module.
Simulator	The software Simulator of the Instrument provided to the Host for inclusion in the Flight Vehicle Test Suite (FVTS) Flight Segment Emulator (FSE).
Instrument Project	The totality of Contractor-provided project management, science investigation, development and deployment of science Instrument, algorithm development, science data processing, dissemination and archival, Instrument operations, and end of Instrument closeout.
Instrument Operations Center (IOC)	Facility located at the project determination site that serves as a secure central command center for all Instrument operations.
Mission Operations Center (MOC)	NASA-selected and Host-provided control center for uploading Instrument commands to the Host Spacecraft and receiving Instrument science and housekeeping data from the Host

	spacecraft.
Science Operations Center (SOC)	Facility located at the project determination site that serves as a secure central command center for all science operations.
Shall	Means the imperative. Compliance and formal traceability and verification by the Contractor is mandatory. Any deviations from these contractually-imposed mandatory requirements require a formal change implemented through a written contract modification.
Will	Designates the intent of NASA or the Government.
May	Terms "may" or "can" denote discretionary privilege or permission

2 Scope of Work

The Contractor shall apply the necessary personnel, expertise, materials, services, equipment, facilities, institutional systems, software, and technical and management processes to accomplish the requirements contained herein. This Statement of Work (SOW) is organized using the following Contract Line Item Number (CLIN) structure:

CLIN 1 - Phases A and B (Formulation):

CLIN 1 covers the requirements for both the Phase A, Concept Development, and Phase B, Preliminary Design effort, for the Instrument. The Phase A and Phase B activities in the Formulation Phase focus on refining the Instrument and data processing concepts and also on the successful completion of a Preliminary Design Review (PDR). Based on the content and results of the PDR, the Instrument Project will undergo a confirmation review by the appropriate NASA Directorate Program Management Council (DPMC) for final authorization to proceed with the subsequent development phases leading to delivery of the Instrument and an Instrument simulator. The Contractor's design activities shall cover all Instrument implementation activities, including those relevant to Instrument and Host interface definition, ground system definition, integration, test, characterization, calibration, verification, and qualification of the Instrument. The Contractor's design activities shall include all necessary and required activities to result in the execution of a successful Systems Requirement Review (SRR)/Mission Definition Review (MDR) in Phase A, an Integrated Baseline Review (IBR), a successful PDR in Phase B, including support for the Key Decision Point (KDP)-C, confirmation review.

CLIN 2 - Phase C (Implementation):

CLIN 2 covers the work the Contractor shall perform for the NASA Life Cycle Implementation Phase. The Implementation Phase focuses on the detailed design and development Phase; the Instrument and ground system critical design, engineering analyses, development, fabrication, assembly, integration, test characterization, calibration, verification, and delivery of the fully qualified flight Instrument, ground system, and instrument simulator to a NASA-selected host or to storage. Implementation includes data processing algorithm development and test. These activities include all pertinent Phase C activities, including execution of a successful Instrument level Critical Design Review (CDR), Systems Integration Review (SIR), Test Readiness Reviews/Pre-Environmental Review (TRR/PER)(s), Systems Acceptance Review / Pre-Ship Review (SAR/PSR), and KDP-D.

CLIN 3 – Phases D, E, and F (Integration/Test/Launch and Science Operations):

CLIN 3 covers the work the Contractor shall perform for the NASA Life Cycle Integration and Science Operations Phase. This Phase focuses on integration to a host spacecraft and launch (Phase D); data processing software development and testing; the science operations and analyses following Instrument commissioning (Phase E); and project closure and data archiving (Phase F). These activities include all pertinent Phase D, E, and F activities, including execution of a successful Operations Readiness Review (ORR), Payload Safety Introduction Briefing (PSIB), Safety Reviews (SR), Safety and Mission Success Review (SMSR), Flight Readiness Review (FRR), Post Launch Assessment Review (PLAR), Instrument On-Orbit operations, Decommissioning Review (DR), Disposal Readiness Review (DRR), and support for the KDP-E and KDP-F reviews.

CLIN 4 – Indefinite Delivery/Indefinite Quantity (IDIQ):

CLIN 4 includes only those activities that are not required under the PIMMC, such as planning and implementing the integration of the Instrument to the NASA selected platform (Phase D), investigation costs during any potential gap between the delivery of the completed Instrument (end of Phase C) and the start of integration of the Instrument to the designated spacecraft (start of Phase D), launch delays driven by the host platform, support for the establishment and management of the hosting effort, and other cost outside of the PI's control.

3 Documentation

3.1 Applicable Documents

The following documents are applicable to this SOW to the extent specified herein; Applicable Documents are requirements and have the same force and effect as any other requirements document (e.g., SOW):

Earth System Science Pathfinder (ESSP) Program Plan, Appendix XX	Program Level Requirements Appendix (PLRA), project name Project
Federal Acquisition Regulation (FAR) 52.227-16	Additional Data Requirements
FAR 52.215-2	Audit and Records-Negotiation
NASA Procedural Requirement (NPR) 7120.5F	NASA Space Flight Program and Project Management Requirements
NPR 7123.1C	NASA Systems Engineering Processes and Requirements
NPR 7150.2C	NASA Software Engineering Requirements
NPR 8705.4A	Risk Classification for NASA Payloads
NPR 9501.2E	NASA Contractor Financial Management Reporting
Exhibit B Rev X	Data Requirements List (DRL) / Data Requirements Description (DRD)
Exhibit C Rev X	Mission Assurance Requirements (MAR)
Others if needed	

When a conflict in requirements exist between this SOW and the applicable documents listed above, the Contractor shall notify the Contracting Officer in writing of such conflict and request written direction from the Contracting Officer as to how to proceed.

3.2 Reference Documents

The following documents are for reference only. The requirements of the contract and this SOW (including any applicable document in Section 3.1) establish the contractual obligations of the parties.

Goddard Space Flight Center (GSFC) Standard (STD) 1000 Rev G	Goddard Technical Standard: Rules for the Design, Development, Verification, and Operation of Flight Systems (GOLD Rules)
S-120A-2015	Mass Properties Control for Space Systems Standard
Contractor project name Proposal selected under the AO number	Basis upon which this contract award is made and is utilized as the basis upon which the requirements of this contract are based

When apparent conflicts exist between this contract and these reference documents, the Contractor shall notify the Contracting Officer that there is such a conflict and request direction from the Contracting Officer as to how to proceed.

3.3 Documentation and Contract Data Requirements List

The Contractor shall develop, deliver, and maintain all documentation required by Contract Exhibit B, Data Requirements List (DRL)/Data Requirements Description (DRD), even if these documents are not otherwise referenced within this SOW. The Contractor shall preserve, for a period of three (3) years after acceptance of all deliverable items (see Federal Acquisition Regulation (FAR) 52.227-16, Additional Data Requirements), all documentation required to maintain a traceable record of engineering and programmatic decisions and hardware characteristics and performance, whether formal or informal. NASA reserves the right to review this documentation at any time upon written request by the Contracting Officer.

4 Management

The Contractor shall:

1. Manage the functions necessary to perform the contract tasks outlined herein, including the planning, organizing, staffing, directing, configuration and risk management, and controlling of all contract activities so that the requirements can be achieved in the most efficient manner;

2. Develop and maintain a Formulation Agreement (FA) (DRL/DRD PM-01) to establish the technical and acquisition work that shall be conducted during the formulation phase to define the schedule and funding requirements during Phases A and B for that work. The Formulation agreement shall address any technology that is not at TRL 6 and describe the specific activities and risk mitigation plans, the responsible organizations, models, and key tests to ensure that the technology maturity reaches TRL 6 by PDR;

3. Develop and maintain a Project Management Plan (PMP) (DRL/DRD PM-07) to establish the technical and acquisition work that shall be conducted during the implementation phase to define the schedule and funding requirements during Phases C, D, E and F for that work;

4. Provide a yearly report of any technical information concerning any invention, discovery, improvement or innovation made by the Contractor in the performance of work under this contract for the purpose of determining title and rights (DRL/DRD PM-13); and

5. Provide a Contract Final Report (CFR) (DRL/DRD PM-15) to comprehensively explain the results achieved under this contract.

4.1 Work Breakdown Structure

The Contractor shall:

1. Develop and maintain a Contract Work Breakdown Structure (CWBS) and CWBS dictionary (DRL/DRD PM-04) to organize the project effort into work elements in order to manage the execution and report of the status of the Instrument;

2. Develop and maintain the CWBS with a clear breakdown of the effort for the generation and monitoring of costs and lower level schedules;

3. Develop and maintain the CWBS and companion element descriptions to CWBS level 3, except for CWBS 5.0 Payload, which shall be provided at level 4; and

4. Provide lower-level insight within level 4 Payload elements if there are procurements or subcontracts within that element.

NOTE: CWBS levels for this effort are as follows:

- *Level 1: Contract*
- *Level 2: CLIN*
- *Level 3: All CWBS*
- *Level 4: CWBS 5.0 (Payload) Elements*

4.2 Schedule Management

The Contractor shall:

1. Develop and maintain an ongoing status of the Instrument project in an Integrated Master Schedule (IMS) (DRL/DRD PM-03), which incorporates tasks and dependencies/logic for all project elements and provides a top-level summary of key project events across the span of the project;

2. Include the lower level detailed schedules, consistent with the structure of the CWBS;

3. Ensure that the density of milestones incorporated into the task schedules includes a minimum of two (2) milestones per month at the rolled-up/top level of the schedule;

4. Establish task linkages and incorporate these linkages into these schedules to support what-if analyses and critical path analyses;

5. Include and highlight the critical path(s) in the IMS;

6. Incorporate work progress indicators in the task schedules, for example percentage completed for each task, updates to start and finish dates, and any increase or decrease in durations.

7. Control changes to the schedule baselines to preserve planning accuracy; and

8. Develop and maintain a one page Project Summary Master Schedule (PSMS) showing the major reviews, the major milestones, high-level linkage of tasks, schedule reserve, and the critical path (included in the Monthly Progress Status Report (MPSR) DRL/DRD PM-02).

4.3 Financial Management

The Contractor shall:

1. Develop and maintain a financial management, control, and reporting system, which shall apply to all financial resources allocated to the Instrument Project;

2. Institute the necessary procedures and controls to establish a financial methodology for budget planning and revision, budget and account control, account authorization, accurate cost accrual recording, routine management monitoring, plan vs. actual reporting to be in alignment with CWBS levels stated in Section 4.1 (above), status reporting and, as necessary, timely intercession and correction;

3. Provide any additional financial data and support as required by the Contracting Officer (e.g., per FAR 52.215-2, Audit and Records-Negotiation; reporting of and support for Unfilled Orders Outstanding per NPR 9501.2E, NASA Contractor Financial Management Reporting);

4. Provide report of financial status on a monthly basis in accordance with the requirements of NASA Form 533M financial management reports (DRL/DRD PM-05); and

5. Provide a yearly report of NASA property in the custody of the Contractor (DRL/DRD PM-12).

4.4 Configuration Management Plan

The Contractor shall:

1. Develop, document, and maintain a configuration management system to manage and control hardware, software, and documentation for the entire Instrument Project; and

2. Develop and maintain the Configuration Management Plan (CMP) (DRL/DRD PM-06), which defines the Contractor's configuration management system that will be implemented for the Instrument flight hardware and software, and documentation.

4.5 Risk Management

The Contractor shall:

1. Develop and maintain the Risk Management Plan (RMP) (DRL/DRD PM-08) for the Instrument Project to ensure successful achievement of the Instrument Project objectives within the established resource, funding, and schedule constraints;

2. Provide for regularly scheduled continuous risk assessments; and

3. Provide a risk summary (included in the MPSR DRL/DRD PM-02).

4.6 Descope Plan

The Contractor shall:

1. Develop and maintain the descope plan (included in the PMP DRL/DRD PM-07) which identifies prioritized actions to recover cost or schedule savings through a reduction or deletion of requirements, science objectives, technical content, or other effort(s);

2. Stipulate the specific descope actions, specify the schedule decision points for the effective execution of the action, and estimate the projected cost and schedule savings associated with each action in the descope plan; and

3. Forbid execution of any descope actions unless implemented in advance and in writing by the Contracting Officer.

4.7 Earned Value Management

The Contractor shall:

1. Establish and maintain in the performance of this contract, an Earned Value Management System (EVMS), in accordance with contract clause I.8, NASA FAR Supplement (NFS) 1852.234-2,Earned Value Management System (Deviation) (included in the PMP DRL/DRD PM-07), including flowing down EVMS requirements to applicable subcontractors;

2. Utilize effective earned value methods to accurately status contract cost, schedule, and technical performance;

3. Provide monthly reports of the correlation and integration of these systems and processes for early indication of cost and schedule problems, and their relation to technical achievement (included in MPSR DRL/DRD PM-02);

4. Present the Performance Measurement Baseline (PMB) plan (included in the IBR DRL/DRD RE-04) to NASA prior to PDR, and subsequently, when required, following major changes to the baseline; and

5. Include in the PMB, the entire technical scope of work consistent with Contract schedule requirements and assignment of adequate resources.

4.8 Information Technology (IT) Security Management Plan

The Contractor shall develop and maintain the IT security management plan (DRL/DRD PM-11) that complies with NFS 1852.204-76, Security Requirements for Unclassified Information Technology Resources, for access to NASA IT Systems.

4.9 Conflicts of Interest Avoidance Plan

The Contractor shall:

1. Develop and maintain the conflicts of interest avoidance plan (DRL/DRD PM-14); that complies with NFS 1852.237-72, Access to Sensitive Information; and

2. Require all Subcontracts to abide by the overall conflicts of interest avoidance plan.

4.10 Meetings

The Contractor shall lead, conduct, participate in, and/or support a variety of informal meetings as set forth below.

4.10.1 Weekly Status Meetings

The Contractor shall:

1. Provide a weekly verbal status to NASA ESSP Program Office (ESSPPO) regarding the Instrument Project progress and performance;

2. Provide a weekly written status to NASA ESSPO regarding the Instrument Project progress and performance; and

3. Track and report status of all open action items in the weekly meetings.

4.10.2 Monthly Status Meetings

The Contractor shall present (telephonically or in person) a Monthly Progress Briefing (MPB) covering all aspects of the Instrument Project, including the project cost and schedule status, technical status, peer review results, staffing plans, and subcontractors' cost, schedule, technical, and staffing status in accordance with MPSR (DRL/DRD PM-02).

NOTE: NASA may choose to participate in the Monthly Status Meetings in person at the Contractor's specified facility to reduce the amount of travel and number of key Contractor personnel who may be supporting the Monthly meetings.

4.10.3 Technical Interchange Meetings (TIMs)

A TIM is an informal meeting to exchange perspectives on the current state of Instrument progress and to discuss technical aspects of the Instrument for a wider audience.

For Each TIM, the Contractor shall:

1. Provide the agenda for hosting a TIM within fourteen (14) calendar days before the TIM is to be held;

2. Provide any presentation materials for the TIM within seven (7) calendar days before the TIM is to be held; and

3. Provide the minutes as well as any presentation material updates associated within seven (7) calendar days after the TIM.

4.10.3.1 TIMs for Phases A/B

The Contractor shall:

1. Plan on average one (1) domestic trips per year to host a TIM at a NASA designated facility; and

2. Plan on average two (2) domestic trips per year to host a TIM at the Contractors' specified location.

4.10.3.2 TIMs for Phase C

The Contractor shall:

1. Plan on an average of four (2) domestic trips per year to host a TIM at a NASA designated facility; and

2. Plan on average four (2) domestic trips per year to host a TIM at Contractors' specified location.

4.10.3.3 TIMs for Phases D/E/F

The Contractor shall:

1. Plan on an average of two (1) domestic trips per year to host a TIM at a NASA designated facility; and

2. Plan on average two (1) domestic trips per year to host a TIM at the Contractors' specified location.

Note: There may be additional meetings through the use of teleconference or other means that do not require Contractor travel.

4.11 Reviews

The Contractor shall lead, conduct, participate in, and/or support a variety of formal and informal reviews as set forth below.

4.11.1 Engineering Peer Reviews

The Contractor shall:

1. Conduct, chair, and host, at the Contractor's specified location with NASA participation, Engineering Peer Reviews (EPR), (DRL/DRD RE-01) prior to the formal contractor- led reviews required in Section 4.11.3 to provide a focused, in-depth technical review of the evolving design and development of a subsystem or engineering discipline area, and provide an examination of design, analysis, manufacturing, integration, testing, operations, drawings, processes and data as applicable to the review focus;

2. Document its approach and plan for conducting these EPRs (included in the Systems Engineering Management Plan (SEMP) DRL/DRD SE-06);

3. Provide necessary subject matter expertise to support each EPR;

4. Define and implement an EPR plan for the hardware and software subsystems (or engineering discipline areas) of the Instrument based on scope, complexity and acceptable risk; and

5. Report the results of the EPRs at the relevant formal contractor-led reviews.

4.11.2 Heritage Reviews

The Contractor shall:

1. Conduct heritage reviews for any hardware that has been previously developed and exists, any software previously developed, products that are to be Build-To-Print (BTP), or products that are available as Commercial-Off-The-Shelf (COTS). These reviews may be conducted through a TIM, as part Formal Contractor-led Reviews required in Section 4.11.3, in EPRs, or presented as a standalone meeting;

2. Prepare all materials for the heritage review(s) (DRL/DRD MA-02);

3. Document the compliance of previously developed designs, processes, software, and hardware included in the EPRs (DRL/DRD MA-02). The prepared materials and documented proof of compliance is the required deliverable; and

4. Assume ownership and responsibility for related risk mitigations.

4.11.3 Formal Contractor-Led Project Reviews

Formal contractor-led reviews are major milestones in the Instrument life cycle where the Contractor formally presents information to a NASA Standing Review Board (SRB), which consists of a SRB Chair and a panel of Government experts or to an independent review team.

For each of the below reviews, the Contractor shall:

1. Prepare, host, and present all reviews in accordance with NPR 7120.5 and NPR 7123.1 and the stated DRL/DRD;

2. Document any planned tailoring of the NPR 7120.5 and NPR 7123.1 requirements in the FA (for Phase A/B reviews) or PMP (for Phase D-F reviews), as applicable;

3. Support the development and finalization of the agenda;

4. Support the development and finalization of the Terms of Reference (ToR);

5. Develop and present all necessary review material to meet the requirements of this contract and the ToR;

6. Coordinate review preparations with NASA by sharing plans, draft presentation charts and supporting documentation to the extent necessary to demonstrate that the Contractor is prepared for the review per the ToR;

7. Support all necessary pre-briefings and pre-reviews and respond to/resolve all questions/action items;

8. Conduct the review at the Contractor's specified location;

9. Respond to, manage, report status, and resolve all Requests for Action (RFAs); and

10. Prepare, host, and conduct a "delta" review of the non-compliant areas, including delivery of updated DRL/DRD data items, if NASA determines the success criteria for a review are not fully met.

4.11.3.1 Formal Contractor-Led Project Reviews for Phases A/B

The Contractor shall:

1. Conduct a SRR/MDR (DRL/DRD RE-02), which evaluates whether the functional and performance requirements defined for the Instrument are responsive to the mission requirements. Ensures the preliminary project plan and requirements will satisfy the mission;

2. Conduct a PDR (DRL/DRD RE-03), which evaluates the completeness/consistency of the planning, technical, cost, and schedule baselines developed during formulation. Demonstrates that the preliminary design meets all system requirements with acceptable risk and within the cost and schedule constraints; and

3. Conduct an IBR (DRL/DRD RE-04), which verifies the completeness, realism, and accuracy of the Contractor PMB.

4.11.3.2 Formal Contractor-Led Project Reviews for Phase C

The Contractor shall:

1. Conduct a CDR (DRL/DRD RE-05), which demonstrates that the maturity of the design is appropriate to support proceeding with full-scale fabrication, assembly, integration, and test. Determines that the technical effort is on track to complete the flight and ground system development and mission operations, meeting mission performance requirements within the identified cost and schedule constraints;

2. Conduct SIR (DRL/DRD RE-06), which ensures segments, components, and subsystems are on schedule to be integrated into the system, and integration facilities, support personnel, and integration plans and procedures are on schedule to support integration;

3. Conduct a TRR/PER(s) (DRL/DRD RE-07), which ensures that the test article (hardware/software), test facilities, support personnel, and test procedures are ready for testing and data acquisition, reduction, and control; and

4. Conduct a SAR/PSR (DRL/DRD RE-08), which verifies the completeness of the Instrument in relation to their expected maturity level, assesses compliance to stakeholder expectations, and ensures that the Instrument has sufficient technical maturity to authorize its shipment to the designated host facility or storage facility.

4.11.3.3 Formal Contractor-Led Project Reviews for Phases D/E/F

The Contractor shall conduct an ORR (DRL/DRD RE-09), which ensures that all instrument and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflect the deployed state of the Instrument and are operationally ready.

4.11.4 Formal NASA-Led Project Reviews

The Contractor shall support NASA by attending, presenting, and delivering documentation required for each of the below reviews, if requested.

4.11.4.1 Formal NASA-Led Project Reviews for Phases A/B

The Contractor shall support in the preparations and presentation at the project name KDP-C Review (DRL/DRD RE-10), which determines if the readiness of the instrument is sufficient to progress to final design and fabrication phase C.

4.11.4.2 Formal NASA-Led Project Reviews for Phases D/E/F

The Contractor shall:

1. Support in the preparations and presentation at the PSIB (DRL/DRD RE-11), which provides a forum for the project to introduce the mission to the Payload Safety Working Group (PSWG) and other authorities and allows for early identification of any safety concerns associated with the Instrument;

2. Support in the preparations and presentations at the SR I-III (DRL/DRD RE-12), which reviews all the documentation, safety requirements, waivers, hazards, etc. to verify all have been satisfactorily addressed at each stage;

3. Support in the preparations and presentation at the SMSR (DRL/DRD RE-13), which provides the knowledge, visibility, and understanding necessary for senior safety and engineering management to proceed with launch;

4. Support in the preparations and presentation at the FRR (DRL/DRD RE-14), which evaluates the readiness of the mission and the hardware, software, ground systems, personnel, and procedures for a safe and successful launch and flight/mission;

5. Support in the preparations and presentation at the project name KDP-E Review (DRL/DRD RE-10), which determines if the readiness of the mission is sufficient to progress to operations and sustainment phase E;

6. Support in the preparations and presentation at the PLAR (DRL/DRD RE-15), which evaluates the readiness of the mission to proceed with full, routine operations. Evaluates the status, performance, and capabilities of the mission evident from the flight operations experience since launch;

7. Support in the preparations and presentation at the DR (DRL/DRD RE-16), which evaluates the readiness of the mission to conduct closeout activities including final delivery of all remaining project deliverables and safe decommissioning of space flight systems and other project assets;

8. Support in the preparations and presentation at the project name KDP-F Review (DRL/DRD RE-10), which determines if the readiness of the mission is sufficient to progress to closeout phase F; and

9. Support in the preparations and presentation at the DRR (DRL/DRD RE-17), which evaluates the readiness of the mission and the flight system for execution of the spacecraft disposal event.

4.12 Access

The Contractor shall:

1. Provide access during contract performance to all records and data that underlie and support the cost, schedule, technical, and risk data reported;

2. Allow access by NASA to all Contractor and subcontractor facilities used for the project name Instrument project, and shall provide any required badging and training for certifications needed for that access; and

3. Notify NASA ten (10) working days in advance of and permit NASA attendance at all Contractor and subcontractor/supplier reviews, audits, tests, meetings, and other activities within the scope of the contract.

5 Systems Engineering and Management

The Contractor shall:

1. Develop and maintain a systems engineering and management approach to manage and verify requirements, perform risk assessments, conduct systems analyses and trade studies, sponsor peer reviews, manage interface control documentation, manage systems technical budgets, and guide an integrated design and test process, including flow-down, integration, and systems management for related subcontractor efforts in accordance with the Systems Engineering Management Plan (SEMP) (DRL/DRD SE-06);

2. Account for all interrelated design, interface, test and operational considerations, including electrical, structural, mechanical, thermal, optical, calibration, test, mission operations and data subsystems, interfaces within the Instrument, as well as the interface from the Instrument to the host spacecraft, and the interface from the Instrument ground system and the host ground system;

3. Develop and maintain the Concept of Operations (CONOPS) (DRL/DRD SE-04), which serves as the Instrument user's guide and is a self-contained document such that a reader not familiar with project name can obtain a reasonably complete understanding of the Instrument without needing to refer to another document or drawing. The CONOPS is also meant to be a reference document for the project name Instrument Project and data users during operations, including: Instrument operators, Government Personnel, scientists, and the general public; and

4. Provide an End Item Acceptance Data Package (EIDP) (DRL/DRD SE-14), which will ensure that the deliverable end-items are in accordance with contract requirements prior to delivery to the Contractor-provided host mission spacecraft and launch vehicle provider, or to storage. The EIDP documents the design, fabrication, assembly, test, and integration of the hardware and software being delivered.

5.1 Requirements Management

The Contractor shall:

1. Perform sufficient design analysis to derive lower-tiered requirements, resolve requirements conflicts, confirm predicted performance, evaluate operational margins, and assess design compatibility with expected launch and on-orbit environmental conditions;

2. Develop and maintain a Verification and Validation (V&V) plan (included in the SEMP DRL/DRD SE-06) that documents the V&V approach and method (e.g., inspection, analysis, demonstration, and test) for meeting project name Instrument Project requirements;

3. Develop and maintain the Instrument Requirements Document (IRD) (DRL/DRD SE-07), which provides the top-level instrument requirements, allocations, and budgets required to meet the Baseline Science Requirements in the PLRA; and

4. Develop and maintain the requirements verification matrix (DRL/DRD SE-09), which provides the traceability, documentation, and status of the requirements verification activities.

5.2 Interface Management

The Contractor shall:

1. Develop and maintain a plan for defining and controlling the physical, functional, and electronic interfaces within the Instrument, Instrument to Host, and Instrument GSE to Host GSE (included in the SEMP DRL/DRD SE-06); and

2. Develop and maintain the Interface Control Document (ICD) (DRL/DRD SE-08), which defines the interfaces and constraints between major systems of the Contractor's mission and science elements.

5.3 Analysis and Modeling

The Contractor shall:

1. Perform and document analyses of the design characteristics and test data as required ensuring that the Instrument meets performance requirements (DRL/DRD AM-01); and

2. Develop the analytical models necessary to support the completion of designs, analyses, and associated documentation (DRL/DRD AM-04, AM-07, and AM-21).

Note: The Contractor may submit existing analyses for any level-of-assembly for which space qualification has been demonstrated to comparable requirements.

5.4 Technical Performance Measures

The Contractor shall:

1. Implement a plan for managing Key Technical Parameters (KTP) including tracking, trending, reporting status, and changes to technical resources and performance budgets (included in the SEMP DRL/DRD SE-06);

2. Generate, maintain, and control technical resource budgets for critical technical resources and critical performance margins including mass, volume, on-orbit average operational power, on-orbit peak operational power, survival power, and data rate;

3. Provide monthly KTPs status and margins (included in the MPSR DRL/DRD PM-02); and

4. Adhere to the AIAA Standard S-120A-2015, GSFC STD 1000 Rev G Gold Rules, or JPL Flight Project Practices margin/contingency guidelines for these budgets unless an equivalent margin/contingency guideline has been accepted in advance in writing by the Contracting Officer.

6 Safety and Mission Assurance

The Contractor shall:

1. Provide the personnel, materials, and facilities necessary to implement and maintain a comprehensive Safety and Mission Assurance (SMA) Program that is commensurate with a Category D mission (per NPR 7120.5) with a Class D payload (per NPR 8705.4);

2. Comply with the project name Mission Assurance Requirements (MAR) document in Contract Exhibit C.

3. Apply to the Contractor's efforts for both the Instrument and ground support equipment, including requirements definition, verification and validation planning, design and development, procurement, manufacturing and fabrication, assembly, integration and test, ground operations and testing, and shall encompass ancillary support functions such as handling and shipping, test record keeping and associated documentation of test data analyses, and all aspects of configured flight article control; and

4. Develop a Mission Assurance Implementation Plan (MAIP) (DRL/DRD MA-01) that addresses the requirements stipulated in the MAR.

7 Science

The Contractor shall:

1. Provide the personnel, materials, equipment and facilities necessary to achieve the science requirements of the Instrument Project;

2. Oversee and direct the science elements and is wholly responsible for accomplishing the project name Instrument Project; and

3. Support the development and maintenance of the project name PLRA.

Note: The project name PLRA, commonly referred to as Level 1 requirements, will be an appendix to the ESSP Program Plan. The PLRA documents the baseline and threshold science requirements based on the selected proposal and according to the following definitions:

4. *Baseline Science Requirements – That mission which, if fully implemented, accomplishes the entire set of scientific objectives identified at the initiation of the mission, and captured in Section 7.2.*

5. *Threshold Science Requirements – The minimum scientific requirements below which the investigation is not considered justifiable for the proposed cost, and captured in Section 7.3.*

The PLRA establishes the baseline for project implementation, including the Level 1 requirements as well as the agreements among the Program Executive, Program Scientist, cognizant SMD Division Director, managing Center Director, implementing Center Director, and Program Manager.

NASA will baseline the PLRA at SRR/MDR and will update and approve the PLRA at KDP-C. Section 7.1 through 7.3 of this SOW contain extracts from the most recent version of the PLRA as of the signature for this SOW. A modification to this SOW will be enacted once the PLRA is baselined.

7.1 Science Team Management

The Contractor shall:

1. Form a project name science team, which shall be led by the PI. The purpose of the project name science team is to provide a working forum for project name scientists with the common goal of maximizing the scientific return of the project within existing resources. The project name science team provides a forum to address open issues and conflicts resulting from ongoing project analyses and trade studies;

2. Hold and chair face to face science team meetings as needed; and

3. Define and maintain the working agendas for the project name science team meetings.

7.1.1 Science Team Management for Phases A/B

The Contractor shall:

1. Develop and maintain the Algorithm Theoretical Basis Document (ATBD) (DRL/DRD SE-05), which documents Level 0 (raw) data to Level 1 Science data processing algorithms;

2. Support the development and maintenance of the IRD (DRL/DRD SE-07);

3. Support the development and maintenance of the CONOPS (DRL/DRD SE-04);

4. Support the development and maintenance of the characterization and calibration plan (included in the SEMP DRL/DRD SE-06);

5. Support the development and maintenance of the preliminary instrument operations plan (included in the CONOPS DRL/DRD SE-04);

6. Perform a preliminary design of the elements that implement the acquisition and routing of the raw science data stream and any temporary buffering of this data in order to minimize the risk of data loss;

7. Perform a preliminary design of the elements that implement the conversion of the raw data into valid research quality data and data products (included in the ATBD DRL/DRD SE-05); and

8. Perform a preliminary design of the elements that implement the acquisition, validation, data processing, and eventual data distribution to a designated NASA Earth Science Division (ESD) assigned data center and archiving of the investigation's science data including public access.

7.1.2 Science Team Management for Phase C

The Contractor shall:

1. Support the development and maintenance the elements for the acquisition and routing of the raw science data stream (included in the CONOPS DRL/DRD SE-04); and

2. Support the development and maintenance the elements for the acquisition, validation, data processing, data distribution, and data archiving to a designated NASA ESD assigned data center (included in the CONOPS DRL/DRD SE-04).

7.1.3 Science Team Management for Phases D/E/F

The Contractor shall:

1. Support in the operation of the elements that implement the acquisition and routing of the raw science data stream;

2. Support the Instrument operation and observation planning;

3. Convert the raw data into valid research quality data and data products; and

4. Support in the operation of the elements that implement the acquisition, validation, data processing, data distribution, and data archiving to a designated NASA ESD assigned data center.

7.2 Baseline Science Requirements

The Contractor shall mature the Instrument Project so that it meets the baseline science requirements, unless they cannot be met due to an approved project descope.

Place PLRA Baseline Requirements here:

7.3 Threshold Science Requirements

The Contractor shall meet or exceed the following threshold science requirements in the event of an approved Instrument Project descope to the baseline science requirements.

Place PLRA Threshold Requirements here:

8 Instrument

The Contractor shall:

1. Support in the development and maintenance of functional and performance requirements, allocations, flow-down, and traceability of Instrument requirements (included in the IRD DRL/DRD SE-07and Requirements Verification Matrix DRL/DRD SE-09);

2. Support in the development and maintenance of the Interface Management Process (IMP), which shall include a discussion regarding the interface management responsibilities at the boundaries between system elements (included in the the ICD DRL/DRD SE-08); and

3. Support in the development of key Instrument-to-spacecraft interfaces (included in the ICD DRL/DRD SE-08).

Note: The initial identification of Instrument-to-spacecraft interfaces are as follows:

- *Insert key Instrument to spacecraft interface characteristics*

The Contractor shall obtain approval from the ESPPO for changes or updates identified beyond the key interface characteristics.

8.1 Instrument Management

8.1.1 Instrument Management for Phases A/B

The Contractor shall:

1. Provide the personnel, materials, equipment, and facilities necessary to mature the proposed Instrument to a preliminary design; and

2. Develop and maintain a mass properties report (included in the Test Reports DRL/DRD IT-02), which documents the mass properties and mass margins for the Instrument and its major components/subsystems.

8.1.2 Instrument Management for Phase C

The Contractor shall:

1. Build and qualify the Instrument satisfying all baseline science requirements (see Section 7.2);

2. Deliver the Instrument for integration onto the NASA selected Host spacecraft or to storage;

3. Procure and/or fabricate all required flight-grade parts, components, and subassemblies,

including required thermal blanketing;

4. Develop and maintain the required integration and test planning, including test objectives, test scenarios, and objective success criteria (DRL/DRD IT-01);

5. Perform all required subsystem-level alignment, functional, performance, calibration, and qualification tests;

6. Perform system-level assembly, integration, alignment, test, calibration, and environmental qualification;

7. Support the development and maintenance of a verification and test program that verifies and demonstrates the Instrument's full compliance with functional, performance, and environmental requirements (included in the SEMP DRL/DRD SE-06);

8. Control, record, and archive build records, including photographic records (included in the EIDP DRL/DRD SE-14); and

9. Prepare, document, and archive the as-run test procedures and/or test reports including associated data analysis (DRL/DRD IT-02).

8.2 Instrument Calibration

8.2.1 Instrument Calibration for Phases A/B

The Contactor shall develop a characterization and calibration plan (included in the Instrument Assembly, Integration, and Test Plan DRL/DRD IT-01), which will perform a preliminary design of the elements used to calibrate the Instrument during ground testing and to monitor and analyze the on-orbit calibration.

8.2.2 Instrument Calibration for Phase C

The Contractor shall:

1. Characterize the Instrument stray light rejection and internal light scattering based on analysis and measurements at the component level or above (included in the Test Reports DRL/DRD IT-02); and

2. Calibrate the Instrument during ground testing and provide the characterization and calibration report (included in the Test Reports DRL/DRD IT-02).

8.2.3 Instrument Calibration for D/E/F

The Contactor shall monitor, analyze the on-orbit calibration, and if necessary provide update to the characterization and calibration report (included in the Test Reports DRL/DRD IT-02).

8.3 Instrument Operations and Ground Systems

8.3.1 Instrument Operations and Ground Systems for Phases A/B

The Contractor shall:

1. Support in the development and maintenance of the necessary requirements development (included in the IRD DRL/DRD SE-07 and Requirements Verification Matrix DRL/DRD SE-09);

2. Support in the development and maintenance of the preliminary design efforts required to mature the design of the Instrument operating capability, including involvement of all engineering disciplines required to address the various physical and functional design elements of the IOC, SOC, and the interfaces to the host provided MOC and associated ground system (included in the ICD DRL/DRD SE-08);

3. Support in the development and maintenance of design analysis to derive lower-tiered requirements, resolve requirements conflicts, confirm predicted performance, evaluate operational margins, and assess design compatibility with expected launch and on-orbit environmental conditions;

4. Address, at a minimum, the following specific aspects in the preliminary design: the layout and interconnect of the operations components and operational facilities, staffing strategy, data buffering and archival strategies, observation planning, and coordination with providers of data necessary for the operation of the Instrument; and

5. Develop and maintain the preliminary instrument operations plan (included in the CONOPS DRL/DRD SE-04) including, but not limited to, routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity, and on-orbit calibration operations.

8.3.2 Instrument Operations and Ground Systems for Phase C

The Contractor shall:

1. Develop and maintain the Instrument Operation Procedures (IOP)s (included in the CONOPS DRL/DRD SE-04), which provides the operation procedures of the IOC and SOC to the MOC for the purposes of supporting launch operations, on-orbit checkout, and science operations planning of the elements that provide for the acquisition, processing, storing, and distributing of Instrument/science data;

2. Support in the preparation, documentation, and archive the as-run test procedures and/or test reports of the IOC and SOC for the purposes of supporting launch operations, on-orbit checkout, and science operations (included in the Test Reports DRL/DRD IT-02);

3. Develop all of the required operator interfaces at the IOC to display, monitor, and analyze the Instrument operating state, operating condition, and trended behavior;

4. Develop and maintain the baseline instrument operations plan (included in the CONOPS DRL/DRD SE-04) including, but not limited to, routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity, and on-orbit calibration operations;

5. Build of associated commands and command loads (included in the CONOPS DRL/DRD SE-04);

6. Provide effective communication means for contact and coordination among the IOC, SOC, and MOC (included in the CONOPS DRL/DRD SE-04);

7. Support the development and test for final verification of all science products and determination of science campaign objectives; and

8. Support the development of the plans and procedures for anomalous operation of the project name flight and ground systems (included in the CONOPS DRL/DRD SE-04).

8.3.3 Instrument Operations and Ground Systems for Phases D/E/F

The Contractor shall:

1. Operate the IOC and SOC for the purposes of supporting launch operations, on-orbit checkout, and science operations planning of the elements that provide for the acquisition, processing, storing, and distributing of science data;

2. Operate all of the required operator interfaces at the IOC to display, monitor, and analyze the Instrument operating state, operating condition, and trended behavior;

3. Support the Instrument operation and observation planning;

4. Support the build of associated commands and command loads;

5. Provide effective communication means for contact and coordination among the IOC, SOC, and MOC;

6. Host virtual meetings of the science team to evaluate/prioritize operations as needed;

7. Operate the nominal observation plans including: routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity and on-orbit calibration operations;

8. Report anomalous operations and non-conformances within 24-hours to NASA; and

9. Generate weekly status reports (see Section 4.10.1).

Note: Initially these reports shall be on a daily basis until directed by NASA to transition to a weekly reporting cadence. If operations are not nominal, then daily reports shall continue until the operations become nominal. Once the commissioning phase is complete, the Contractor shall develop weekly status reports including the Instrument on-orbit health and status, as well as key Instrument performance parameters.

8.4 Ground Support Equipment

8.4.1 Ground Support Equipment for Phases A/B

The Contractor shall:

1. Support in the development and maintenance of the necessary requirements development and preliminary design efforts required to mature the design of the Ground Support Equipment (GSE) required for handling, operating, testing, checking, calibrating, storing, and shipping the Instrument, including handling and alignment fixtures; test fixtures; calibration targets, other stimulus, and their controllers;

2. Support in the development and maintenance of the necessary requirements development and preliminary design efforts required to operate and test the Instrument with the spacecraft, launch vehicle, interface simulators, purge equipment, and shipping containers; and

3. Include the involvement of all engineering disciplines required to address the various physical and functional design elements of the GSE.

8.4.2 Ground Support Equipment for Phase C

The Contractor shall:

1. Design, build, assemble, and validate GSE required for handling, operating, testing, calibrating, storing, and shipping the Instrument, including handling and alignment fixtures, test fixtures, calibration targets and other stimulus and their controllers;

2. Design, build, assemble, and validate GSE required to operate and test the Instrument, interface simulators, purge equipment and shipping containers;

3. Train personnel in the operation and use of the GSE and in the applicable constraints and restrictions related to that use; and

4. Support the development and maintenance of the operational procedures for use of the GSE with flight hardware (included in the CONOPS DRL/DRD SE-04).

Note: Any Contractor GSE directly interfacing with flight interfaces shall satisfy the applicable requirements of the project name MAR.

9 Software

9.1 Software Management

The Contractor shall design, implement, and verify the software in accordance with the Software Management and Development Plan (SMDP) (DRL/DRD SW-02) and the project name MAR.

9.1.1 Software Management for Phases A/B

The Contractor shall:

- Perform a preliminary design of the flight and ground support software required for the functional operation of the Instrument, Instrument Simulator, IOC, SOC, and GSE required to test out the Instrument flight and ground systems;
- Develop and maintain the software compliance matrix (DRL/DRD SW-01), which specifies compliance of the Contractor's processes with each Software Engineering Requirement (SWE) from NPR 7150.2C;
- Support in the development and maintenance of the software requirements (included in the IRD DRL/DRD SE-07 and Requirements Verification Matrix DRL/DRD SE-09);
- Support in the development and maintenance of the preliminary instrument operations plan (included in the CONOPS DRL/DRD SE-04) including, but not limited to, routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity, and on-orbit calibration operations; and
- Support in the development and maintenance of the software test plan (included in the Instrument Assembly, Integration, and Test Plan DRL/DRD IT-01).

9.1.2 Software Management for Phase C

The Contractor shall:

- Implement, and verify all required flight and ground support software required for the functional operation of the Instrument, Instrument Simulator, IOC, SOC, and GSE required to test out the Instrument flight and ground systems;
- Support in the development and maintenance of the baseline instrument operations plan (included in the CONOPS DRL/DRD SE-04) including, but not limited to, routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity, and on-orbit calibration operations;
- Develop final versions of the Software Test Plan (included in Instrument Assembly, Integration and Test Plan DRL/DRD IT-01);
- Support in the development and maintenance of the Instrument Operation Procedures

(IOP)s (included in the CONOPS DRL/DRD SE-04);

- Provide documented test procedures and test reports consistent with the software test requirements defined in the Software Requirements Specification (included in the Test Reports DRL/DRD IT-02); and

- Conduct Software TRR(s) (DRL/DRD RE-07) for Software covering the acceptance of all software items.

9.2 Instrument Simulator Software

The Contractor shall design, implement, and verify the Instrument Simulator for use during development and operations. The Flight and Ground Software Version Description (Included in the EIDP DRL/DRD SE-14) shall include a detailed description of the differences between the Instrument Simulator and the Instrument.

The Contractor shall deliver incremental versions of the Instrument Simulator during Flight Software Development. The deliveries are expected to coincide with flight software development, such that a simulator is available to test each delivered version of flight software.

9.3 Instrument Ground Support Equipment Software

The Contractor shall:

- Design and deliver all ground support software necessary to operate, monitor, test, and calibrate the Instrument;

- Provide an effective operator interface for the operation and control of the Instrument;

- Provide algorithms and other computational means to analyze and interpret Instrument housekeeping and science telemetry; and

- Provide means for capture and archival of all relevant test data.

9.4 Software Test Bed

The Contractor shall:

- Maintain a software test bed used for development and testing of the flight and ground software;

- Utilize this test bed during software testing and for testing software updates during Instrument environmental testing and operation;

- Develop a test procedure for checking out software updates during Instrument operations (included in Instrument Assembly, Integration, and Test Plan DRL/DRD IT-01); and

- Provide a detailed list of differences between the software test bed and the flight

Instrument (included in the EIDP DRL/DRD SE-14).

NOTE: The Software Test Bed may be the same system as the Instrument Simulator, or it may be a software-specific test bed which is used for software verification and regression testing.

10 Host Operations and Ground Systems Support

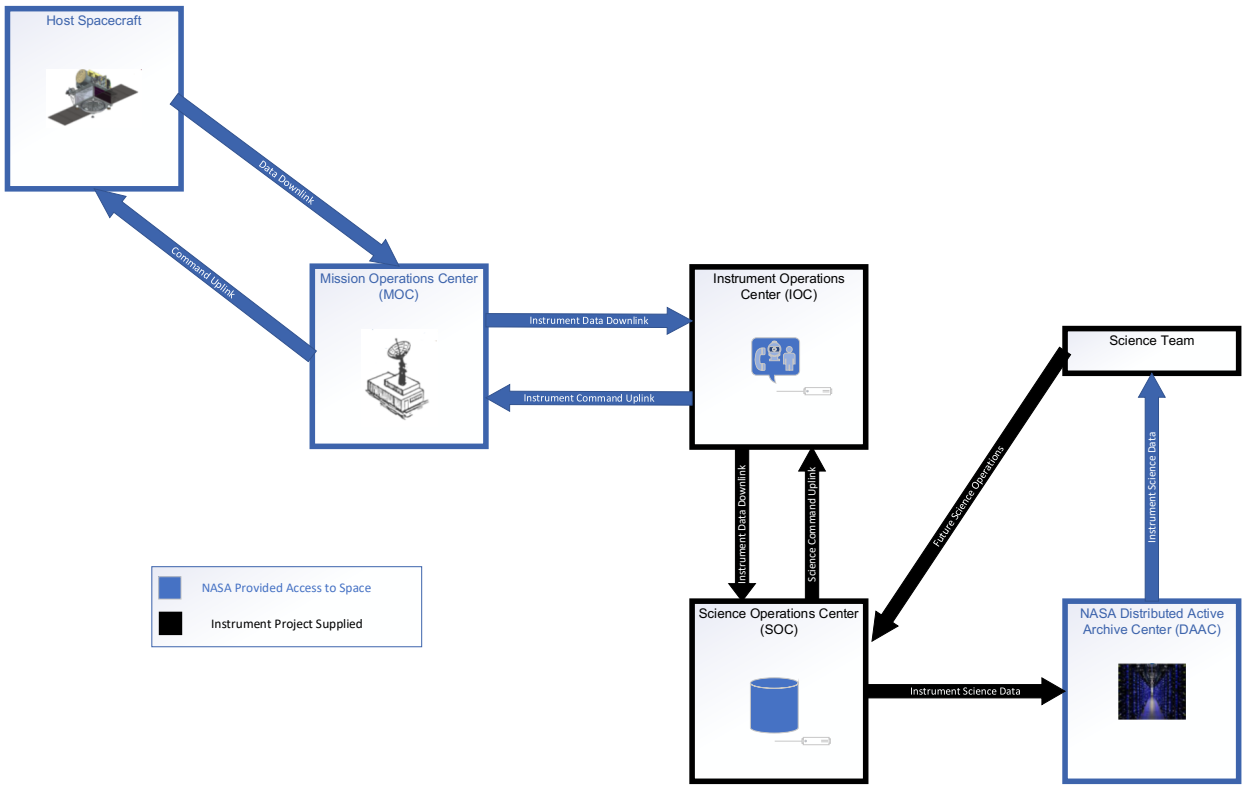

Figure 1: Spacecraft to Instrument Operations Delegation

10.1 Host Management

10.1.1 Phases A/B

The Contractor shall provide support to NASA during development of Host interface requirements among the IOC, SOC, MOC, the Instrument Ground system, and the NASA selected DAAC.

10.1.2 Phase C

The Contractor shall:

- Support all Host operations and ground systems reviews as requested by NASA; and
- Provide support to NASA during all host mission operations development and testing such as end to end ground systems testing and operational readiness tests.

10.1.3 Phases D/E/F

The Contractor shall:

- Support all Operations and Ground Systems reviews as requested by NASA; and
- Provide support to NASA during all host mission operations development and testing such as end to end ground systems testing and operational readiness tests.

11 IDIQ Task Orders (CLIN 4)

Any activities not included in the PI-managed cost cap will be funded under the IDIQ and include:

- Investigation costs during any potential gap between the delivery of the completed Instrument and the start of integration of the Instrument to the designated spacecraft;
- Support for integration to the NASA selected Host platform;
- Contractor provided subject matter experts (SME) to review on-orbit Host performance, Ground System, and Mission Operations selection criteria for the Host Services request for proposal (RFP); and
- Contractor support for additional NASA reviews required in the management of the Host effort;
- Design, trades, and development of Instrument modifications to address incompatibilities with the selected Host platform.