

# **ATTACHMENT A**

## **RAPID III**

### **DRAFT**

# **STATEMENT OF WORK**

**June 9, 2009**

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# RAPID III STATEMENT OF WORK

## 1.0 Introduction

This Statement of Work (SOW) describes the baseline set of requirements for the delivery of a spacecraft via the Rapid Spacecraft Acquisition (RSA) “Rapid III” contract. The Rapid III contract serves as a rapid and flexible means for the Government to acquire spacecraft and related services in support of the science and technology missions of the National Aeronautics and Space Administration (NASA). Under the contract RAPID III Contractors offer spacecraft and related services to be purchased via Government placed Delivery Orders (DO).

Specific mission requirements will be defined in the DO issued for each mission. The spacecraft designs and services may be tailored, as needed, to meet the unique needs of each mission.

Spacecraft designs and related services being offered through the Rapid III contract are required to comply with a baseline set of safety and quality requirements defined in the Rapid III Mission Assurance Requirements (MAR) document. Like the SOW and other requirements, the safety and mission assurance requirements may be tailored by each mission to meet their specific needs.

This Contract may be utilized by other United States Federal Government Departments and Agencies.

## 2.0 Scope

The Scope of Work encompasses all the required effort from receipt of a RAPID III DO for a specific mission, through the launch, delivery, on-orbit checkout and acceptance of the spacecraft.

Each RAPID III spacecraft is offered inclusive of the deliverables and services outlined in this SOW and the Rapid III MAR. The SOW and mission specific requirements for each mission shall be as defined in the DO issued for that mission. DOs will be issued by the Government in accordance with the ordering procedures contained in the contract schedule. DOs for non-standard services may also be issued by the Government.

## 3.0 Documents & Requirements

### 3.1 Applicable Documents

These documents apply directly to the performance required, and contain provisions that constitute requirements of this SOW on the Rapid III Contract DOs to the degree specified in

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Section 4.0. All mission specific applicable documents, including but not limited to those listed below, will be specified on each DO.

<u>Document Title</u>	<u>Doc #</u>	<u>Rev:</u>
Rapid III Mission Assurance Requirements (MAR)	TBD	TBD
Mission Requirements Specification	(Mission Specific)	
Mission Operations Concept	(Mission Specific)	
Instrument Interface Requirements	(Mission Specific)	
Launch Vehicle Interface Requirements	(Mission Specific)	

### 3.2 Reference Documents

These documents contain information relating to the work required by this SOW on the Rapid III Contract Delivery Orders. The mission specific reference documents will be specified on each DO.

<u>Document Title</u>	<u>Doc #</u>	<u>Rev:</u>
TBD	(Mission Specific)	

### 3.3 Requirements Precedence

In the event of a conflict in requirements between this SOW and the MAR or any other referenced document, the requirements of this SOW shall take precedence. Applicable documents take precedence over Reference documents.

### 3.4 Requirements Verbs

In this SOW, a requirement is identified by “shall”, a good practice by “should”, permission by “may” or “can”, expected outcome or action by “will” and descriptive material by “is” or “are” (or other verb form of “to be”).

## 4.0 Work Performed by the Contractor

### 4.1 Standard Services

For this contract, the effort to produce a mission specified RAPID III Core Spacecraft (i.e. spacecraft bus), with selected RAPID III Core Spacecraft Options and all mission-unique modifications required in the DO, developed in accordance with the related System Performance Verification Plan, results in a product called the mission specific “Core Spacecraft.”

The effort to integrate one or more payload instrument(s), and to qualify the combined payload instrument(s) and Core Spacecraft, in accordance with the DO and related System Performance Verification Plan, results in a system called an “Observatory”. The integration of only one

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instrument shall be assumed in the baseline effort although more instruments may be required in a mission specific DO.

A spacecraft for a specific mission placed via a DO may be a combination of a RAPID III Core Spacecraft and RAPID III Options as contained in the contract schedule, as well as Mission Specific Modifications to the applicable Core Spacecraft and its associated Options.

The complete set of technical requirements as contained in the DO shall be applicable to the Core Spacecraft, the Core Spacecraft Options and the Mission Specific Modifications.

### **4.1.1 Core Spacecraft(s)**

The Contractor shall develop, implement, integrate, and test a Core Spacecraft that is ready for payload integration, as well as satisfy all related requirements of Section 4.3., Standard Services. The Core Spacecraft and its development shall conform to the applicable: a.) System Performance Specification; b.) System Performance Verification Program Plan; and c.) Rapid III Mission Assurance Implementation Plan (MAIP); provided by the Contractor with the RAPID III core spacecraft proposal and incorporated in the RAPID III contract. If applicable, the Core Spacecraft may be modified per Section 4.1.3, Mission Specific Modifications.

### **4.1.2 Core Spacecraft Option(s)**

The Contractor may provide performance options to the RAPID III Core Spacecraft. If provided, the Contractor shall develop, implement, test, and qualify performance Option(s) to the Core Spacecraft such that the combined Core Spacecraft and Core Options are ready for payload integration, and satisfy all of the requirements of Section 4.3. The Option(s) to the Core Spacecraft and their development shall conform to the applicable: a.) System Performance Specification, b.) System Performance Verification Program Plan; and c.) Rapid III Mission Assurance Implementation Plan (MAIP); provided by the Contractor, with the RAPID III core spacecraft proposal and incorporated in the RAPID III contract. If applicable, the core spacecraft options may be modified per Section 4.1.3.

### **4.1.3 Mission Specific Modifications**

In order to meet the unique requirements of a DO for a specific mission, the Contractor may modify their RAPID III Core Spacecraft and Core Spacecraft Options. These modifications shall be applied as necessary for the adaptation of the RAPID III Core Spacecraft, core options, and implementation effort under the contract, to meet the requirements of the mission specific DO. The extent of the modifications may include, but are not limited to, the addition of performance parameters; changes to any performance parameter; changes to System Performance Verification Program Plan, and Launch Site Operations and Test Plan; the addition of new specifications, requirements, analyses, tests, reports, hardware, software or support; adaptation of baseline hardware or software configurations; changes to baseline schedules, reviews, funding profiles, and milestones; and the modification of the contract deliverable items list. It is expected that in some cases the extent of modifications required to meet the specific mission requirements may be extensive.

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### **4.1.4 Mission Observatory**

The Contractor shall integrate the mission payload-instrument(s) with the mission Core Spacecraft, qualify the resulting Observatory, provide launch support and flight operations support, and satisfy all of the requirements of Section 4.3.

### **4.2 Non-Standard Services**

The Government may issue non-standard service DOs. The Contractor shall provide all personnel, facilities, materials, and other resources needed to perform non-standard services as ordered under this contract.

#### **4.2.1 Mission Specific Non-Standard Services**

Non-standard services ordered under this section shall be directly related to a specific mission under an existing DO. The services ordered and the applicable requirements will be described in the mission specific Request for Offer (RFO) and resulting DO.

Non-standard services may be ordered for the following types of efforts:

- a) Special Studies;
- b) Analyses;
- c) Contractor-provided Mission Operations and/or Network Services including, but not limited to, control and operation of the spacecraft via control centers, flight software maintenance, networks, and/or data processing and storage facilities;
- d) Services and facilities in support of a Government Resident Office; and,
- e) Anomaly support after on-orbit acceptance of the spacecraft;

Acceptance criteria will be specified in the DO

#### **4.2.2 Non-Mission Specific Non-Standard Services**

Non-standard services ordered under this section are independent of any mission specific DO, but may address issues associated with possible future missions. The services ordered and applicable requirements will be described in an RFO and the resulting DO.

These DOs may be issued for the following types of efforts:

A. Studies and analyses related to a core spacecraft or to a potential mission spacecraft, which include, but are not limited to: performance capability, modeling parameters, modifications, launch vehicle compatibility, instrument interface and compatibility, integration and testing, launch support and on-orbit checkout.

B. Tasks, including but not limited to: core spacecraft design envelope enhancement, core spacecraft modifications, verification testing, core spacecraft technology update feasibility, and the definition, review and update of processes.

#### **4.2.3 Non-Mission Specific Hardware**

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The Government may order flight systems and/or components at a level below an integrated spacecraft, which meet requirements specified in a Non-Mission Specific DO. The flight systems and/or components shall be accompanied with all documentation (e.g. analysis, certifications, and data) that are specified in the Non-Mission Specific DO.

Acceptance criteria will be specified in the Non-Mission Specific DO.

### **4.3 Standard Services Implementation**

This section describes the effort required of the Contractor upon receipt of a DO for Standard Services.

The Contractor shall provide all facilities, services, personnel and other resources necessary for the implementation of all efforts necessary to meet the mission specific DO requirements.

Acceptance criteria will be specified in the Mission Specific DO.

#### **4.3.1 Program Management**

The Contractor shall provide a Program Management (PM) function that is responsible for control and coordination of all activities on each mission specific DO. The PM function shall serve as the central point of contact with the Government for information for all activities under the DO.

##### **4.3.1.1 Government Insight and Surveillance**

The Contractor's PM function shall provide to the Government reporting and real-time insight into program status, as well as, technical and programmatic performance information on all of the Contractor's responsibilities and activities performed under the DO.

Insight is defined as the understanding necessary to knowledgeably concur with the Contractor's actions through watchful observation, inspection, or review of program events, documents, meetings, tests, audits, hardware, etc., without approval/disapproval authority.

The Government will define the specific insight that it requires in each mission specific DO. Should the Government identify non-compliance with requirements, a difference in interpretation of test results or in requirements, the Government will take action to ensure compliance.

The Contractor shall notify the Government Contracting Officer, the Government resident office or the appropriate Government operations organization or personnel of meetings, reviews, operations or tests in sufficient time to permit meaningful Government participation.

The Contractor shall grant access for NASA mission assurance and other representatives to conduct audits, assessments, or surveys upon notice or as otherwise requested by the Government. The Contractor shall supply documents, records, equipment, and a work area within the Contractor's facilities.

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In addition to any other Government on site auditing functions, the Contractor shall provide full time office space for a minimum of two Government project representatives from six months after the award of a DO until three months after delivery and acceptance of product.

### **4.3.1.2 Control of Sensitive Information**

The Contractor shall implement appropriate management systems which prevent the improper dissemination of competition sensitive information associated with the mission efforts of a Principal Investigator.

### **4.3.1.3 Documentation**

The Contractor shall develop, produce, deliver, and maintain all documentation required by the Contract Data Requirements List (CDRL) identified in the mission specific DO. CDRL items shall be delivered in accordance with Rapid III CDRL Table 1, SOW Data Items and the CDRL table contained in the Rapid III MAR, Clause J, Attachment E of the Contract.

All efforts, including the performance of tests and analyses not otherwise explicitly stated in other parts of the SOW, but determined jointly by the Contractor and the Government to be mission critical, shall be performed and documented by the Contractor.

All documentation, data and analyses generated for, or applicable to, the DO effort, shall be made available to the Government upon request at the Contractor's facility.

### **4.3.1.4 Spacecraft Project Reviews**

For the baseline delivery the requirements of this section supersede the requirements of MAR Section 8.1 and MAR DID 8-1.

The Contractor shall conduct reviews and provide for timely reporting of project status to the Government. This shall include discussions on problem areas and timely transfer of technical information to the Government, including progress and status on achieving major project milestones and materials required by the Government for systems review and evaluation.

Program Monthly Status Reviews (MSRs) shall be conducted at the Contractor's facility.

At a minimum, the Contractor shall present the following information at the Program Status Reviews:

1. Status of work being performed including appropriate schedule progress and metrics;
2. Milestone Monitoring - The Contractor shall report on the progress made toward accomplishing each of the planned project milestones. Each report shall include a listing of major accomplishments and a discussion of any problems associated with each milestone as well as their resolution;
3. Changes to design parameters such as weight, power profile, communications, system performance, etc.;
4. Resource allocations and margins (e.g. telemetry, commands, power, weight, data storage, processor capability, etc.);

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5. Status of technical issues;
6. Descriptions and status of technical problems and the resolutions;
7. Subcontract technical performance; and
8. Performance assurance status including non-conformance and failure report dispositions.

The Contractor shall provide technical and management support to certify the Core Spacecraft or Observatory readiness at the following baseline set of spacecraft systems reviews:

Spacecraft Systems Reviews *	Length (Days)	Location	CDRL Deliverable
S/C Requirements Review (SRR)	2	Contractor's Facility	CDRL 15A
S/C Preliminary Design Review (PDR)	3	Contractor's Facility	CDRL 15B
S/C Critical Design Review (CDR)	3	Contractor's Facility	CDRL 15C
Instrument Integration Readiness Review (IIRR)	2	Contractor's Facility	CDRL 15D
Observatory Pre-Environmental Review (PER)	2	Contractor's Facility	CDRL 15E
Observatory Pre-Ship Review (PSR)	2	Contractor's Facility	CDRL 15F
Observatory Acceptance Review (OAR)	1	Government Site	CDRL 15G

\* A list of reviews and requirements will be specified in each mission specific delivery order.

The Government will chair the system reviews and provide Requests for Action (RFAs) to the Contractor for the Contractor's response. The Contractor shall provide to the Government formal responses to all RFAs as required by MAR Section 8. The above reviews shall form the baseline set of project contract milestones as called out in Section I.86 of the Contract. These milestones will be modified as needed for each mission specific DO.

In addition to the above reviews, the Contractor shall provide support to various mission reviews. As a baseline, support of the following mission reviews shall be assumed:

Mission Reviews *	Length (Days)	Location
Flight Operations Review (FOR)	2	Government Site
Flight Readiness Review (FRR)	1	Launch Site

\* A list of reviews and requirements will be specified in each mission specific delivery order.

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The purpose of the Flight Operations Review is for the Government Integrated Independent Review (IIR) to determine the state of readiness of the Flight Operations Ground Systems to support prelaunch, launch and flight operations.

The purpose of the Flight Readiness Review is for the Government to determine the state of readiness for all flight and ground systems to support launch and operations. It determines the final go/no-go decision to proceed into the launch countdown.

### **4.3.1.4.1 Spacecraft Requirements Review (SRR) Requirements**

The Contractor shall host and provide data for the Spacecraft Requirements Review. The Contractor shall summarize and provide understanding of all mission requirements driving the spacecraft design and shall provide a flow-down of the mission requirements down to the spacecraft subsystem requirements, based on the mission specific design offered.

Draft interface documents shall have been prepared and reviewed for understanding and ready for signature. Mission specific core spacecraft modifications shall be confirmed and understood sufficiently to proceed with the spacecraft detailed design.

For the SRR, the Contractor shall provide the data and information described in CDRL 15A, SRR Information Requirements. The Contractor shall present details of its plan to proceed to and achieve the next major milestone.

At or before the SRR, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The SRR shall be considered complete upon satisfactory close-out of all SSR, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.2 Spacecraft Preliminary Design Review (PDR) Requirements**

The Contractor shall host and provide data for the Spacecraft Preliminary Design Review. The Contractor shall summarize and provide understanding of all mission requirements driving the spacecraft design and shall provide a flow-down of the mission requirements down to the spacecraft subsystem component box requirements, based on the mission specific design offered.

The interface documents shall have been updated and the changes reviewed for understanding and ready for signature. Mission specific core spacecraft modifications shall be confirmed and understood sufficiently to define all the functional components and long lead parts requirements.

For the PDR, the Contractor shall provide the data and information described in CDRL 15B, PDR Information Requirements. The Contractor shall also present details of their plan to proceed to and achieve the next major milestone.

At or before the PDR, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

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The PDR shall be considered complete upon satisfactory close-out of all PDR, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.3 Spacecraft Critical Design Review (CDR) Requirements**

The Contractor shall host and provide data for the Spacecraft Critical Design Review. The Contractor shall summarize and provide understanding of all mission requirements driving the spacecraft design and shall provide a flow-down of the mission requirements down to the spacecraft subsystem and component parts requirements, based on the mission specific design offered.

The interface documents shall have been updated and the changes reviewed for understanding and ready for signature. Mission specific core spacecraft modifications shall be confirmed and understood sufficiently to define all components and parts and to proceed with manufacturing.

For the CDR, the Contractor shall provide the data and information described in CDRL 15C, CDR Information Requirements. The Contractor shall present details of its plan to proceed to and achieve the next major milestone.

At or before the CDR, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The CDR shall be considered complete upon satisfactory close-out of all CDR, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.4 Instrument Integration Readiness Review (IIRR) Requirements**

The Contractor shall host and provide data for the IIRR. The purpose of the IIRR is to show that all work on the spacecraft development has been completed and that the spacecraft is ready to be integrated with the flight payload-instrument(s).

For the IIRR, the Contractor shall provide the data and information described in CDRL 15D, IIRR Information Requirements. The Contractor shall present details of its plan to proceed to and achieve the next major milestone.

At or before the IIRR, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The IIRR shall be considered complete upon satisfactory close-out of all IIRR, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.5 Observatory Pre-Environmental Review (PER)**

The Contractor shall host and provide data for a PER. The purpose of the PER is to determine that the Integrated Observatory and all associated test facilities, ground support equipment (GSE), procedures and personnel are ready to support the Observatory level environmental and performance testing.

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For the PER, the Contractor shall provide the data and information described in CDRL 15E, PER Information Requirements. The Contractor shall present details of its plan to proceed to and achieve the next major milestone.

At or before the PER, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The PER shall be considered complete upon satisfactory close-out of all PER, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.6 Observatory Pre-Ship Review (PSR)**

The Contractor shall host and provide data for a PSR to verify and document that the Observatory, GSE, shipping equipment and procedures, launch operations systems and procedures, as well as the flight operations systems and procedures, flight and ground software and networks have satisfactorily completed their development and are ready to perform in accordance with their mission requirements.

For the PSR, the Contractor shall provide the data and information described in CDRL 15F, PSR Information Requirements. The Contractor shall present details of its plan to proceed to and achieve the next major milestone.

At or before the PSR, the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The PSR shall be considered complete upon satisfactory close-out of all PSR, and earlier, RFAs and acceptable delivery of all required CDRLs.

### **4.3.1.4.7 Observatory (Post-Launch) Acceptance Review (OAR)**

Following the launch and on-orbit checkout of the Observatory, the Contractor shall conduct an OAR to present a documented summary of the performance of launch events, show the results of flight evaluations, verify and document that a thorough Observatory checkout has been completed and show that the Observatory is meeting all required mission performance and ready for handover of operations to the flight operations team.

For the OAR, the Contractor shall provide the data and information described in CDRL 15G, OAR Information Requirements.

At or before the OAR the Contractor shall provide other CDRL submissions per the Rapid III CDRL and the Rapid III MAR.

The OAR shall be considered complete upon satisfactory close-out of all OAR, and earlier, RFAs and acceptable delivery of all required CDRLs.

The Contractor shall provide to the Government project an acceptable End Item Data Package in compliance with Rapid III MAR Section 16 and DID 16-1.

**4.3.1.5 Engineering Change Proposals, Deviations and Waivers**

In accordance with CDRL 14, Engineering Change Proposals (ECP), Deviations and Waivers, the Contractor's PM function shall be responsible for the timely reporting, submission and negotiation with the Government on all ECPs.

**4.3.2 Systems Engineering**

The Contractor shall perform the necessary systems engineering required to ensure that the core spacecraft, options, and modifications meet all of the performance, interface, and implementation requirements of the mission specific DO.

The systems engineering effort shall include the analyses and flow-down of technical requirements and allocation of system budgets for the Core Spacecraft, Core Spacecraft options, and mission specific modifications, as well as requirements for GSE and communications links. The effort shall also include definition and maintenance of all interface documents, verification of all defined and derived requirements, technical risk evaluations, system design tradeoff analyses, on orbital performance analysis, flight software requirements analysis (see Section 4.3.6, Flight Software) and lower level requirements (e.g. subsystem, components, assemblies, parts).

**4.3.2.1 Requirements Analyses and Allocations**

The Contractor shall conduct complete analyses of the mission requirements which fully establish, define, maintain and control allocations.

An appropriately updated index of analyses and allocations shall be maintained by the Contractor. The results of all analyses shall be made available by the Contractor for Government review at each subsequent major project review.

**4.3.2.2 Interface Definition, Verification and Control**

The Contractor shall specify all interfaces not explicitly defined by the Government. These interfaces shall be defined, documented, verified and controlled for the duration of the DO, by the Contractor.

External interfaces, models, and analysis shall be documented in accordance with CDRL 6. Telemetry and command requirements shall be documented in accordance with CDRL 5.

**4.3.2.2.1 Spacecraft/Payload-Instrument Interface**

The Contractor shall define and maintain all design interface information between the spacecraft and the Government provided payload-instrument. The Contractor shall participate in the preparation and maintenance of the Instrument Interface Control Documents (IICD) as defined in CDRL 2.

The responsibility for writing, maintenance and configuration management of the IICD shall reside with the Contractor. The Government shall maintain approval authority over the IICD.

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The Contractor shall provide analytical models and shall perform all analyses and tests required to ensure proper electrical, mechanical, thermal, and operational compatibility between the Core Spacecraft and the Government provided payload-instrument(s).

### **4.3.2.2.2 Observatory/Ground Operations Interface - Mission Specific**

The Contractor shall participate in the preparation and maintenance of the Flight Operations Ground System Interface Control Document (OPS-ICD). The Contractor shall submit Flight Operations Ground System Interface documentation as defined in CDRL 7.

**The responsibility for writing, configuration management, and gaining approval of the OPS-ICD shall reside with the Government.**

A flight operations readiness end-to-end interface verification test of the Observatory to the Flight Operations Ground System shall be performed by the Contractor prior to the final flight mate to the launch vehicle. The test shall demonstrate commanding and telemetry capability between the Observatory and the Mission Operations Control Center. The Contractor shall perform all analyses and tests required to ensure proper operational compatibility between the Observatory and the Government provided Flight Operations Ground Systems. The Contractor shall develop, maintain and provide all technical and programmatic documentation required to ensure successful operation of the Observatory, including the requirements outlined in CDRL 13, Spacecraft Operations Description Manual and CDRL 12, Flight Operations Support Plan.

### **4.3.2.2.3 Observatory/Launch Vehicle Interface**

The Contractor shall participate in the preparation and maintenance of the Observatory-to-Launch Vehicle Interface Control Documents (LV-ICD). The Contractor shall submit Launch Vehicle documentation in accordance with CDRL 8.

**The responsibility for writing, configuration management, and gaining approval of the LV-ICD shall reside with the Government.**

A flight ready mechanical fit check and an electrical interface verification test of the Core Spacecraft (or Observatory) to the launch vehicle interface shall be performed by the Contractor prior to the final flight mate to the launch vehicle interfaces. The mechanical fit check and electrical interface verification test shall be performed at the Contractor's location prior to shipment to the launch site. The Government, or launch service provider, shall supply a test payload attach fitting which simulates the launch vehicle side of the interface. The Contractor shall provide the analytical models and shall perform all analyses and tests required to ensure proper electrical, mechanical, thermal, and operational compatibility between the Observatory and the Government provided launch vehicle and launch vehicle environments. The Government, through the launch service provider, will provide for three (baseline) cycles of Coupled Loads Analysis. The Contractor shall develop, maintain and provide all technical and programmatic documentation required to ensure a successful launch activity, including documentation in accordance with CDRL 10, Observatory Launch Site Operations and Test Plan, and CDRL 11, Observatory Launch Site Operations and Test Procedures.

**4.3.2.4 Design and Performance Verification Analyses**

The Contractor shall perform and document all analyses of the data and information from the design, qualification testing, acceptance testing, compatibility testing and on-orbit testing of the Contractor's hardware and software that are required to ensure that the program shall meet its specifications and objectives.

**4.3.3 Safety and Mission Assurance Management**

The contractors baseline spacecraft design and associated services shall comply with the requirements of the Rapid III Safety and Mission Assurance Requirements (MAR) including the delivery of all MAR required contract data items.

The Government may alter the baseline safety and mission assurance requirements to meet the needs of each specific mission and will be documented in the mission specific DO.

**4.3.4 Spacecraft Systems Implementation**

For the baseline effort, requirements of this Section supersede the requirements of the Rapid III MAR Sections 9.1, 9.2, 9.3 and 9.4.

The Contractor shall develop and implement a System Performance Verification Program Plan in accordance with CDRL 3.

The Contractor shall develop and provide a System Performance Verification Matrix in accordance with CDRL 4.

**4.3.4.1 Core Spacecraft**

The Contractor shall produce and verify the performance of a core spacecraft that meets all of the requirements, specifications, and interfaces defined in the mission specific DO and the mission specific Core Spacecraft Performance Specification (CDRL 1).

**4.3.4.2 Core Spacecraft Interface Simulator**

The Contractor shall provide a Core Spacecraft Interface Simulator(s) for use by mission elements for interface verification of the instruments. This Interface Simulator need not be mission specific but may be adaptable by the Contractor to meet the requirements of the mission specific DO. The Interface Simulator shall be made available by the Contractor as required by the mission schedule.

**4.3.4.3 Core Spacecraft Integration and Test (I&T)**

The Core Spacecraft design shall be verified by a combination of analyses and test on engineering models, prototype, proto-flight or heritage flight hardware and software.

Prior to instrument integration, the Contractor shall integrate and test all Core Spacecraft to payload-instrument interface hardware and software. The Core Spacecraft shall undergo a comprehensive performance test that tests all functionality and performance to demonstrate readiness for observatory level integration.

The Core Spacecraft shall be tested with calibrated and maintained GSE.

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The Contractor shall run compatibility testing with the flight operations ground control system as defined in the DO.

### 4.3.4.4 Observatory Integration and Test

To the extent defined in the mission specific DO, the Contractor shall plan and conduct integration of the Core Spacecraft and payload instrument(s) to form an Observatory. The Contractor shall plan, manage, and execute Observatory level interface verification, system test, environmental test, and support mission payload specific tests as defined in the DO. At no time shall any test, functional or environmental, expose the payload instrument to environments, signals, or other conditions that exceed the limits specified in the Contractor's Instrument Interface Control Document (CDRL 2).

The Contractor's integration and test program shall include at a minimum:

- 1) Electrical interface testing performed prior to integration of any assembly, component or subsystems into the next higher assembly. At a minimum, pin out configuration, impedance, and signal characteristics shall be verified.
- 2) Performance testing shall be performed immediately prior to and immediately after the environmental test exposures program as necessary to fully understand the cause of failure. Performance testing shall verify 100% functionality of all components (including functionality of redundant systems, if applicable).
- 3) Electromagnetic Compatibility Environmental testing shall be performed to demonstrate self compatibility of the Core Spacecraft and payload instrument(s). Compatibility of the Observatory with the launch vehicle and launch site as defined by the applicable specifications for each shall also be demonstrated.
- 4) Thermal-vacuum environmental testing shall be performed to demonstrate that all Observatory components function properly in their intended operational environment.
- 5) A set of environmental tests to verify Core Spacecraft component performance given the expected structural loads, acoustic-vibration limits, sine vibration limits, mechanical shock limits, and pressure profile induced during all phases of the mission.
- 6) An end-to-end test with the spacecraft flight operations control center to verify spacecraft compatibility with ground system software and hardware.
- 7) Performance verification testing of the Core Spacecraft and Observatory shall include comprehensive testing of all functions of the spacecraft including redundancy and redundant side switching. Additionally, the test shall include a simulated launch simulation sequence and simulated on-orbit sequences for a minimum of five mission-typical orbits including solar eclipse simulations.

The Contractor shall submit for Government approval a written justification for each analysis that the Contractor plans to perform in lieu of testing.

The Contractor shall submit for Government approval a written justification for each environmental test or environmental exposure level that the Contractor does not plan to perform.

**4.3.4.5 Core Spacecraft/Observatory Storage**

When required by the DO, the Contractor shall provide appropriate ground storage for the Core Spacecraft or Observatory prior to launch. This activity shall encompass storage, storage maintenance, and post-storage activities necessary to bring the Core Spacecraft to integration readiness or the Observatory to launch status. This shall include, but not be limited to, the storage and maintenance of spare parts and GSE. The Contractor shall submit storage related documentation in accordance with CDRL 9.

**4.3.4.6 Shipment of the Core Spacecraft or Observatory and Ground Support Equipment**

The Contractor shall be responsible for the shipment of the Core Spacecraft and Observatory between the places of manufacture, integration and test, storage and launch operations. The Contractor shall provide all appropriate shipping containers and handling equipment. The Contractor shall provide for the shipment of necessary GSE required to support the Core Spacecraft/Observatory during each phase of test, integration and launch preparation. Transportation and Handling plans shall be documented in accordance with CDRL 9.

**4.3.5 Launch Operations Support**

The Contractor shall provide launch support of the completed Observatory. This shall include launch vehicle interface definition, design verification and management, Observatory launch preparation and launch support. The Government will make the final go/no-go decision for launch. The baseline launch support activity shall include the following efforts:

1. Launch Site Safety - Prior to shipment of the Observatory and associated equipment to the launch site, the Contractor shall prepare and provide safety related documentation as required by the launch site safety and launch range organizations. The Contractor shall submit the Missile Safety Prelaunch Safety Package (MSPSP) in accordance with MAR and CDRL MA 3-7. The Government will provide to the Contractor launch site related information for all Government Furnished Equipment, including the payload-instrument(s), for inclusion in the MSPSP.
2. Launch Operations Planning - This effort requires the development and maintenance of interfaces with all entities that play a role in Observatory launch. This involves coordinating, planning and performing all tasks which are necessary to implement a successful launch. The Contractor shall provide technical and management support of meetings to define launch related interfaces.
3. Launch Simulations - This effort encompasses the conduct, analyses and evaluation of pre-launch training and simulations of the launch (through orbit insertion). Two training simulations plus one launch rehearsal shall be conducted.
4. Pre-launch Integration and Test - The Contractor shall perform all tasks necessary to integrate, test and prepare the Observatory for launch at the launch site. Hazardous test procedures and other safety related deliverable documentation shall be provided to the launch range safety in accordance with the MAR.
5. Launch Operations - The Contractor shall provide all required integration, safety, and engineering support to process the Observatory through the ground processing facilities, launch facility and the launch vehicle. In addition, the Contractor shall support the actual

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launch, post-launch orbit insertion, perform Observatory initialization, deployments and preparation for on-orbit performance verification testing. All activity will be under Government direction from launch through separation of the Observatory from the launch vehicle.

### **4.3.6 Flight Software**

The Contractor shall treat the software component of firmware, which consists of computer programs and data loaded into a class of memory which cannot be dynamically modified by the computer during processing (e.g., programmable read-only memories, programmable logic arrays, digital signal processors, etc.), as software for the purposes of this SOW.

#### **4.3.6.1 Flight Software Requirements, Development, Verification, and Testing**

The Contractor shall perform all analyses and systems engineering required to allocate (from core spacecraft and subsystem requirements) and identify software requirements, and to develop the necessary design specifications. Software requirements traceability to RAPID III Core Spacecraft and subsystem requirements shall be provided. The Contractor shall also describe the documentation system, source code generation and use, and the methods of maintaining equipment in accordance with CDRL 12, Flight Operations Support Plan.

Requirements, design, and code walkthroughs or inspections shall be conducted at the Contractor's facility at the appropriate points in the software developmental life-cycle to ensure the validity of the requirements, design, and source code. These walkthroughs or inspections shall be open to Government participation. The coding, debugging, developer testing efforts, walkthroughs results and programmer's notes shall be documented and made available at the Contractor's facility for Government review.

The Contractor shall provide all the resources necessary to verify and validate all the software developed for the Core Spacecraft.

The Contractor shall perform all Flight Software Assurance activities called out in the Rapid III MAR.

#### **4.3.6.2 Software Maintenance**

The Contractor shall maintain the flight software (FSW) along with the environments and emulators necessary to develop and verify these systems until on orbit acceptance of the spacecraft.

The DO may modify this requirement to require Contractor maintenance of FSW through completion of the baseline mission. The Contractor shall seek Government approval before suspending software maintenance operations.

The Contractor shall retain FSW Documentation for the complete software lifecycle development until the end of the baseline mission life. This documentation will be used for

maintenance of the system and shall be accessible to the Government for review until the end of the baseline mission life.

#### **4.3.6.3 Flight Software Development & Maintenance System (SDMS)**

The Contractor shall provide the necessary ground based hardware, software, procedures, and documentation to allow the Government to maintain the FSW after on-orbit acceptance. This hardware, software, procedures, and documentation shall be referred to as the Software Development and Maintenance System (SDMS). The SDMS shall contain the hardware platform(s) and software used in development of the FSW, including all simulators, emulators, compilers, debuggers, linkers, test software and procedures/scripts used for test. The SDMS shall contain all tools and utilities required to format executable code for uplink to the spacecraft.

The Contractor shall provide a ground reference image of the FSW in use on the spacecraft at the time of spacecraft acceptance.

#### **4.3.7 Flight Operations Interfaces and Support**

Under the baseline effort the Government will provide the Flight Operations Systems and Manpower. The mission specific DO may require that the spacecraft supplier provide the systems and manpower to support the Flight Operations through the end of the mission life.

##### **4.3.7.1 Flight Operations Ground System Interface Definition**

The Contractor shall provide Observatory compatibility with the Flight Operations Ground Systems as specified in the mission specific DO.

The Contractor shall work closely with the Government mission engineers to perform communications, command, control and operational requirements trade analyses.

The Contractor shall provide all necessary interfaces to the ground systems as defined in the Observatory requirements documents contained in the mission specific DO. This shall include all necessary system documentation, interface control document inputs, databases and test efforts.

##### **4.3.7.2 Training and Support for Flight Operations Team**

The Contractor shall provide support to the mission flight operations team for training and preparations for on-orbit initialization, checkout, performance verification and anomaly resolution.

The Contractor shall provide to the Government a Spacecraft Operations Description Manual (CDRL 13) to support the launch and early orbit operations and checkout. The manual shall be of sufficient detail to provide a basis for troubleshooting and isolating spacecraft anomalies by the flight operations team. The manual shall include written and diagrammatic descriptions of the flight hardware, flight component box interfaces and software functionality.

**4.3.7.3 On-orbit Performance Verification**

The Contractor shall perform an on-orbit performance verification program confirming that the Spacecraft performance is in accordance with the mission requirements, the Core Spacecraft Performance Specification (CDRL 1), all interface specifications and the System Performance Verification Program Plan (CDRL 3).

As a minimum this shall include:

**1. Spacecraft On-orbit Checkout:**

This Contractor shall verify the post-launch performance and state-of-health of the Core Spacecraft and payload-instrument(s). The proper function and performance of all systems shall be verified. The Government will provide payload-instrument performance evaluation support.

**2. Spacecraft to Flight Operations Ground Systems Interface Verification:**

This effort shall be performed by the Contractor after the Observatory on-orbit performance and state-of-health have been confirmed. The test shall verify proper operations of the Observatory to Flight Operations Ground System interfaces and to provide the necessary calibrations.

**3. OAR and Presentation Package (Reference Section 4.3.1.4.7 and CDRL 15G):**

The completed OAR Presentation review package shall summarize the on-orbit Observatory performance after checkout. The presentation results shall be used to determine initial mission success and final payment milestone completion status.

In association with the OAR, the Contractor shall provide to the Government an acceptable End Item Data Package in compliance with Rapid III MAR Section 16 and MAR-DID 16-1.

**4.3.7.4 Support to On-Orbit Operations**

The Contractor shall provide support to resolve all on-orbit spacecraft anomalies. Baseline support shall be through the period of on-orbit operations verification testing, instrument activation and calibration, handover to the flight operations team and on-orbit acceptance.

After on-orbit acceptance, in the event of a spacecraft anomaly, the Government will modify the DO to address each specific anomaly. The Contractor shall support the resolution of on-orbit anomalies until the end of the baseline mission life or as defined in the DO. The DO may be modified to extend the mission life.

**4.4 Mission Specific Options**

To be specified in the mission specific DO.

**5.0 Government Furnished Equipment (GFE)**

To be specified in the mission specific DO.

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### 6.0 SOW Acronyms List:

A/R	As Required
CDR	Critical Design Review
CDRL	Contract Data Requirements List
DID	Data Item Description
DO	Delivery Order
EMC	Electromagnetic Compatibility
EMI	Electro-Magnetic Interference
ESD	Electrostatic Discharge
FSW	Flight Software
GFE	Government Furnished Equipment
GSE	Ground Support Equipment
I&T	Integration and Test
ICD	Interface Control Document
IRD	Interface Requirements Document
IDIQ	Indefinite Delivery Indefinite Quantity
IICD	Instrument ICD
IIRR	Instrument Integration Readiness Review
LV	Launch Vehicle
LV-ICD	Launch Vehicle Interface Control Document
MAIP	Mission Assurance Implementation Plan
MAR	Mission Assurance Requirements
MSPSP	Missile System Prelaunch Safety Package
MSR	Monthly Status Review, Program
NASA	National Aeronautics and Space Administration
OAR	Observatory Acceptance Review
OPS-ICD	Flight Operations Ground System ICD
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PI	Principal Investigator
PSR	Pre-Ship Review
RF	Radio Frequency
RFP	Request for Proposal
RFO	Request for Offer (Request for Proposal for a Delivery Order)
S&MA	Systems Safety and Mission Assurance
SDMS	Software Development & Maintenance System
SOW	Statement of Work
SPS	Systems Performance Specification
SRR	(Spacecraft) Systems Requirements Review