

Geostationary Operational Environmental Satellite (GOES) R Series

Flight Project

Spacecraft

Statement of Work

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Goddard Space Flight Center
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GOES-R Spacecraft

Statement of Work

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1.0 Introduction

The National Oceanic and Atmospheric Administration (NOAA) operates a system of Geostationary Operational Environmental Satellites (GOES) to provide continuous weather imagery and monitoring of meteorological and space environment data to protect life and property across the United States. Two GOES satellites remain operational at all times providing coverage for the eastern United States and most of the Atlantic Ocean and the western United States and Pacific Ocean basin. An on-orbit spare satellite is maintained to permit rapid recovery from a failure of either of the operational satellites. GOES satellites provide critical atmospheric, oceanic, climatic and space weather products supporting weather forecasting and warnings, climatologic analysis and prediction, ecosystems management, and safe and efficient public and private transportation. The GOES satellites also provide a platform for solar and space environmental observations. Auxiliary communications services are provided for GOES data rebroadcast, data collection platform relay, low resolution imagery, emergency weather communications, and satellite aided search and rescue. GOES supports all of the Mission Goals and links to the NOAA Strategic Plan and NESDIS Concept of Operations.

The GOES program currently consists of three series of satellites. The GOES-I/M series (8-12) is the current operational series. Transition to the GOES-N/P series spacecraft bus has commenced with the successful launch of GOES-13 in 2006. The GOES-I/M and –N/P series share the same generation primary instrument payload. The GOES-R series represents a generational change in both spacecraft and instrument capability, with initial launch capability in late 2014. GOES-R is a collaborative development and acquisition effort between NOAA and the National Aeronautics and Space Administration (NASA). The acquisition of the end-to-end GOES-R system includes spacecraft, instruments, launch services, and all associated ground system elements.

Program activities occur at NESDIS Headquarters and the NASA Goddard Space Flight Center. Additional information can be found at the following URL: <http://www.nesdis.noaa.gov>, and <http://www.osd.noaa.gov>.

1.1 Goals and Objectives

One of NOAA's principal missions is to provide forecasts and warnings for the United States, its territories, adjacent waters and ocean area for the protection of life and property and enhancement of the national economy. This mission requires the capability to acquire, process and disseminate environmental data on an extensive spatial range (global, regional and local) on a variety of time scales. These data include, but are not limited to: global imagery; cloud and precipitation parameters; atmospheric profiles of temperature, moisture, winds, aerosols, and ozone; surface conditions concerning ice, snow and vegetation; ocean parameters and sea-surface temperature; and solar and in-situ space environment conditions.

The government is preparing for the procurement of the next-generation GOES series to continue its mission through new requirements specified in the GOES-R Level I Requirements Document and Mission Requirements Document (MRD). The first satellite of this new series, designated as GOES-R, will provide the first major improvement in instrument technology since GOES-I was launched in 1994. The GOES-R series will introduce other new technologies in both the Space and Ground Segments. These advances will improve the nation's ability to monitor and forecast weather and environmental phenomena with a significant increase in the number of products. Complexity, availability requirements and cost considerations will drive GOES-R operations towards increasing automation compared to earlier GOES systems.

1.2 Mission Overview

A general overview of the GOES-R System is given in Figure 1. GOES-R satellites will have two operational locations; 75 degrees west and 137 degrees west longitude. Any GOES-R series satellite stored on-orbit will be located at 105 degrees W. The primary instrument is the Advanced Baseline Imager (ABI) that will provide hemispheric, synoptic, and mesoscale imagery for global and CONUS forecasting and severe weather warning. Secondary instruments include the Extreme ultraviolet and X-ray Irradiance Sensor (EXIS), Solar Ultraviolet Imager (SUVI), Space Environment In-Situ Suite (SEISS), Magnetometer (MAG), and Geostationary Lightning Mapper (GLM). Additionally, GOES-R will provide a set of communications services (Unique Payload Services) in support of the Data Collection System (DCS), Low-Rate Information Transmission (LRIT), Search-and-Rescue Satellite Aided Tracking (SARSAT), and Emergency Managers Weather Information Network (EMWIN).

1.3 Scope

This Statement of Work (SOW) defines those tasks to design, analyze, develop, fabricate, integrate, test, evaluate, deliver GOES R series satellites and support launch and post launch of GOES-R Series (hereinafter called GOES-R) spacecraft, supply and maintain the Ground Support Equipment (GSE), and support the Satellite Operations Control Center (SOCC). The Contractor **shall** provide the personnel, materials, facilities and other resources to design, fabricate, integrate, test, deliver GOES R satellites and provide pre-launch, launch and post-launch support and training under the basic contract. Listed below is a summary of the GOES-R scope:

- a) Two spacecraft (SC); GOES-R and GOES-S
- b) Critical spare units for two (2) SC
- c) Two sets of the Electrical System Test Equipment (ESTE)
- d) Two Flight Software Development Environments (FSDEs)
(One for delivery and one for use by contractor)
- e) Source and Executable Flight Software Code
- f) Magnetometer and Algorithms
- g) Six Satellite Simulators
- h) One (1) Life Test Battery
- i) One (1) Qualification/I&T Battery
- j) Two (2) Flight Batteries
- k) One (1) Flight Spare Battery
- l) Twelve (12) Battery Test Cells
- m) All Mechanical and Electrical Ground Support Equipment (MGSE and EGSE)
- n) All GSE Software and software source code.

For the basic contract, the Contractor **shall** provide all data and documentation deliverables in accordance with GOES-R Series Contract Data Requirement List (CDRL) 417-R-SCCDRL-0015.

1.4 Applicable Documents

1. 417-R-SCCDRL-0015; GOES-R Series Contract Data Requirement List (CDRL)
2. 417-R-PSPEC-0014; GOES-R Spacecraft Functional and Performance Specification (F&PS)
3. 417-R-RAD-0061; GOES-R Series, Project Resource Allocation Document (PRAD)
4. 417-R-SCMAR-0011; GOES-R Spacecraft Mission Assurance Requirements (SCMAR)
5. GSFC-STD-1001; Criteria for Flight Project Critical Milestone Reviews
6. P417-R-LIST-0142; GOES R Acronym and Glossary Dictionary
7. **TBS**; Space Environment In-Situ Suite (SEISS) Radioactive Source Specification
8. NPR 7123.1A; NASA Systems Engineering Processes and Requirements
9. AFSPCMAN 91-710; AIR FORCE SPACE COMMAND MANUAL 91-710, VOLUME 2, 1 JULY 2004 RANGE SAFETY USER REQUIREMENTS MANUAL VOLUME 2 - FLIGHT SAFETY REQUIREMENTS
10. NASA-STD-8719.13B; NASA Software Safety Technical Standard
11. NASA-STD-8739.8; NASA Software Assurance Standard
12. ISO 14644-1; Classification for Air Cleanliness

1.5 Reference Documents

1. P417-R-CONOPS-0008; GOES-R Concept of Operations (CONOPS)
2. P417-R-PLN-0083; GOES-R Test and Evaluation Master Plan (TEMP)
3. P417-R-PLN-0141; GOES-R Integrated Independent Review Plan (IIRP)
4. GSFC 500 PG-8700.2.7 ; Design of Space Flight Field Programmable Gate Arrays
5. GSFC-STD-7000; GENERAL ENVIRONMENTAL VERIFICATION STANDARD (GEVS) For GSFC Flight Programs and Projects. April 2005
6. GSFC-STD-1000; Rules for the Design, Development, Verification, and Operation of Flight Systems Revision C.2 - December 12, 2006
7. NASA NPR 7120.5D; NASA Space Flight Program and Project Management Requirements. March 6, 2007
8. NASA NPR 8000.4; Risk Management Procedural Requirements (Revalidated 2/1/07)
9. NASA NPR 7150.2; NASA Software Engineering Requirements

1.6 Definitions & Terminology

The term “**shall**” designates a requirement.

The terms “**will**” and “**is**” designate statements of fact or intentions of the Government and are not to be interpreted as contractor requirements.

The term “**should**” designates a desired level of performance the Government would like the contractor to strive towards achieving.

The term “**(TBD)**” means, “To be determined”. This is applied to requirements or values that have not been defined. The Contractor **shall** propose a requirement or value and provide a rationale for all TBD requirements.

The Contractor **shall** coordinate all TBD requirement proposals with the Government and other contractors.

The Contractor **shall** request and obtain approval from the Government before proceeding with implementation of the proposed TBD value.

The term “**(TBR)**” means, “To be reviewed”. This is applied to requirements or values that are subject to review by the Government and the contractor. The Contractor **shall** review and suggests a modified value and rationale for all TBR requirements. The “TBR” provides an indication that the value may change upon review.

The Contractor **shall** coordinate all TBR requirement proposals with the Government and other contractors.

The Contractor **shall** request and obtain approval from the Government before proceeding with implementation of the proposed TBR value.

The term “**(TBS)**” means, “To be supplied. The Government will supply TBS data or details. The Government will provide a date or milestone to resolve each TBS requirement.

The term “Government” **shall** be defined as Government personnel and Government support contractor personnel.

2.0 Spacecraft #1

2.1 Program Management

The Contractor **shall** perform the necessary direct management functions and provide a management structure responsible for overall project control to assure that all requirements of this contract and all attachments are accomplished within cost and on schedule.

2.1.1 Program Management Office

The Contractor **shall** perform the direct management functions and provide a management structure responsible for overall project control to assure that all requirements of this contract and all attachments are accomplished within cost and on schedule.

The Contractor **shall** establish a Program Management Office (PMO) responsible for the leadership and overall direction of all phases of the work specified in this SOW.

The Contractor **shall** provide a full-time Program Manager through the acceptance of the final satellite.

The Program Manager **shall** have corporate authority to assure that the contract cost, schedule and technical requirements are fully met.

The Contractor **shall** initiate communication with the Government through the Contracting Officer's Technical Representative (COTR) that includes, but is not limited to, e-mail and telephone contact, weekly telecons with the Government team, and one-on-one contact between the Government and its support contractors and Contractor discipline engineers, to be coordinated by the COTR. The Government will provide a list of project personnel authorized to communicate with the Contractor.

The Contractor **shall** establish a Subcontract Management and Control System which provides technical direction and sub-contract management to ensure performance, cost, and schedule requirements are accomplished.

The Contractor **shall** develop and maintain a Master Action Item Data Base (MAID) listing all Request for Actions (RFA) or Action Items from formal reviews, Government status reviews, internal technical reviews, peer reviews, all other reviews by the contract, technical meetings, telecons, etc. (TBS), listing author and origin (PDR, telecon, etc.) of the RFA, person responsible for closure, wording of the RFA, response, persons(s) authorizing final closure, due date, date closed, and a column for Government concurrence.

The Contractor **shall** upload the MAID to the GOES-R government portal and send notification to the NASA document manager and COTR.

The Contractor **shall** provide access to the MAID through a Contractor provided secure web site that is available to the Government at any time.

The Contractor **shall** retain closed action items in the MAID.

The Contractor **shall** retain all documents and test data for a minimum of 6 years after contract completion and deliver a copy to the COTR.

The Contractor **shall** plan for and implement team building and training activities with the Government in conjunction with reviews and meetings.

The Contractor **shall** establish Working Groups for the resolution of issues or at the Government's request.

The Contractor **shall** establish a charter for each working group which specifies the group's objective, membership, and meeting schedule.

The Contractor **shall** dissolve Working Groups once the objective of the group has been accomplished to the satisfaction of the Government.

The Contractor **shall** support Mission Operations Support Team (MOST) activities, which will be lead by a Government Mission Operations Manager (MOM).

2.1.2 Resource Management

The Contractor **shall** establish, implement and maintain a Resources Management System (RMS) for planning, authorizing, analyzing and controlling the total resource effort for each WBS element, by spacecraft, and for tracking and reporting manpower, materials, cost, schedule, travel and subcontract performance.

The RMS **shall** be consistent with the contract Work Breakdown Structure and provide timely and traceable incorporation of contract changes, and document the effect on the resource management baseline.

The Contractor **shall** track non-recurring and recurring costs separately.

The Contractor **shall** use the RMS to provide traceable incorporation of contract changes and document the effect on the resources management baseline.

The Contractor **shall** utilize a scheduling tool for the generation and reporting of project schedules that is compatible with the latest version of Microsoft Project.

2.1.2.1 Configuration Management

The Contractor **shall** manage the generation, configuration control, and distribution of all requirements, documents, data, drawings, software and hardware to develop and deliver all satellites.

The Contractor **shall** control changes to each satellite separately.

The Contractor **shall** establish, implement, and maintain a Government approved Configuration Management (CM) System that provides control of configured items, all flight hardware and software, all GSE hardware and software, and all documentation developed under this contract.

The Contractor **shall** review all applicable changes to configuration controlled documents managed by the Government in order to determine their feasibility and provide the Government with the estimated impact with respect to performance, schedule, and cost.

The Contractor **shall** post to the GOES-R Portal, as generated or changed, all technical and programmatic documentation generated on the contract that includes but is not limited to, letters, contractual documents, CDRLs, system engineering reports, design memos, internal technical

memoranda, schematics, design specifications and test procedures.

The Government will post on the GOES-R Portal Government deliverables and technical documentation generated in support of this contract.

The Contractor **shall** notify the selected Government personnel by e-mail that a document has been posted on the website. The Government will provide similar notification to the Contractor.

The Contractor **shall** develop, implement and maintain a Software Configuration Management System that provides baseline management and control of software requirements, design, source code, build files, data and documentation.

The Contractor **shall** employ a source code version control tool to check in/check out current or previous versions of a source file.

The Contractor **shall** establish a Configuration Control Board(s) to review and approve changes to the prototype and flight models, software, GSE and all controlled documents.

The Contractor **shall** submit Class I change requests to the Government for approval before implementation of the change

The Contractor **shall** submit Class II changes to the Government for concurrence with the classification.

If the Government determines that a Class II classification is incorrect the Contractor **shall** resubmit the change as a Class I change.

2.1.2.2 Information Technology Management

The Contractor **shall** provide all the information technology resources to support all work required by this contract.

The Contractor **shall** establish a joint Contractor/Government working group to define acceptable requirements and methods for GOES-R Series data systems. These systems include access via the internet, provisions for protected email, transmission of all contractor, subcontractor, vendor proprietary data, ITAR/Export Controlled information, Government For Official Use Only information, and NASA unclassified sensitive information between program elements and facilities.

The Government will establish and maintain a secure website, accessible by the Contractor and selected Government personnel, for document delivery and the exchange of information.

The Contractor **shall** establish a documentation system capable of supporting the transfer of all data, documentation, and drawings.

The Contractor **shall** supply and maintain all hardware and software to support the electronic delivery of CDRL items and other information as required.

The Contractor **shall** develop and maintain all of the necessary hardware, software, office space, internet access, and operational support for a Test Data Analysis System (TDAS) which is capable of providing the Government access to spacecraft and integrated instrument raw test data in real-time (**TBR**) and processed data for analysis purposes.

The Contractor **shall** provide the Government with remote access to TDAS, Risk Management

Systems, and contractor intranet systems.

The Contractor **shall** make available all contractor and subcontractor documentation, data, analysis, schedules, formal and informal reviews, and other information generated for, or related to the GOES-R effort, whether deliverable or not, to the Government upon request.

The Contractor **shall** provide, utilize, and maintain video conferencing, telephone conferencing, and internet conferencing at the Contractor's facilities for interaction between the Contractor and the Government.

2.1.3 Risk Management

The Contractor **shall** establish, implement and maintain a Risk Management (RM) process wherein the program/project team is responsible for identifying, analyzing, planning, tracking, controlling, and communicating the risks (and the steps being taken to handle them) both within the team and with management and stakeholders.

The Contractor **shall** document the specific implementation of the continuous RM process in a Risk Management Plan (RMP). The plan shall be a controlled document and shall be maintained by the Contractor throughout the program/project life cycle.

The Contractor **shall** develop and maintain a Risk List throughout the project life cycle (may also be database or spreadsheet), listing all risks along with potential impacts to the program/projects.

The Contractor **shall** prioritize the risk list to indicate which risks have the highest probability, which have the highest consequences, and which risks represent the greatest threat to mission success.

The Contractor **shall** provide access to the Risk List through a Contractor provided secure web site that is available to the Government at any time.

The Contractor **shall** communicate status of all the items on the Risk List, in particular primary (red) risks (those having both high probability and high impact/severity) on a regular basis and as a minimum through the monthly reviews.

The Contractor **shall**, prior to accepting a red risk, request and secure Government concurrence and provide supporting rationale that all reasonable mitigation options (within cost, schedule, and technical constraints) have been instituted.

The Contractor **shall** retain due date, current status information, and justification for final closure, date closed, and provisions for Government concurrence for items on the Risk List.

The Contractor **shall** retain all risk related analyses, documents and data for the life of the contract.

The Contractor **shall** manage and coordinate the resolution of problems or anomalies within the risk management system.

2.1.4 Government Resident Office

The Contractor **shall** provide access, office space, furniture, printers, copier(s), facsimile machine(s), phones, and broadband access to the internet and contractor's intranet through

launch of the last spacecraft for three (3) NASA residents and three (3) Government visitors.

The Contractor **shall** provide access, office space, furniture, facilities, networked printers, copier(s), facsimile machine(s), phones, and broadband access to the internet and contractor's intranet at the I&T facility for an additional twenty five (25) visiting Government and/or GFP Instrument Contractor representatives during instrument integration and test activities.

The Contractor **shall** ensure unencumbered non-escort access by the Government and Government support personnel to all Contractor and subcontractor facilities where program work is performed.

If necessary, the Contractor **shall** execute Non-Disclosure Agreements with Non-NASA Government support contractors. NASA support contractors are covered by H.22 of the contract.

The Contractor **shall** allow the Government representatives to bring Government or support contractor-owned computers, mobile phones, and personal digital assistants (PDAs) into the office space provided.

The Contractor **shall** allow visiting representatives to bring notebook computers, mobile phones, and PDAs into and out of the facilities.

The Contractor **shall** provide Government visitors the capability to print from their notebook computers.

The Contractor **shall** provide conference room available for use by the Government capable of accommodating fifteen people which is equipped with a teleconferencing system.

The Contractor **shall** provide parking sufficient to accommodate all Government representatives at all locations where program work is being performed.

All badges, car passes, and passes for access, including computer entry and exit passes, **shall** be valid for at least 12 months before revalidation is required.

If the contractor requires training for entry into any facilities, the contractor **shall** provide the necessary training to Government representatives.

The training requirements for Government representatives **shall** not exceed that required of the contractor's employees.

Required facility training **shall** be provided to Government representatives on an agreed upon schedule.

The Contractor **shall** provide all protective clothing required for access to contractor and subcontractor facilities and necessary locker/storage for protective clothing.

2.1.5 Program Communication and Reviews

The Contractor **shall** provide the technical and administrative support for all program reviews and joint meetings.

Program reviews will be used by the Government as "control gates". Following the presentation of each review, a program evaluation will be made by the Government to determine if the Contractor has satisfactorily completed all work, and whether there are any program issues or deficiencies.

The Contractor **shall** develop and deliver a corrective action plan within 10 days for any issues or deficiencies found during a review.

The Contractor **shall** wait for Government approval of a corrective action plan for the issues or deficiencies prior to proceeding with the affected program development.

Unless otherwise stipulated, all reviews and meetings will be held at the contractor's facilities.

The Contractor **shall** document the review plan as part of the Program Management Plan.

2.1.5.1 Kick-Off Meeting

Approximately one month after contract award the Contractor **shall** prepare and conduct a Kick-Off Meeting covering a line-by-line review of the contract schedule and clauses, SOW, F&PS, GIRD, UIIDs, SCMAR and CDRLs.

The Contractor **shall** plan for a five (5) day Kick-Off meeting, not including action item resolution.

If the review is not complete in five (5) business days, the Contractor **shall** continue to conduct and support the review until the Government deems the review complete.

2.1.5.2 Teleconferences

The Contractor **shall** conduct bi-weekly executive teleconferences to present, review and discuss technical, risks, schedule, and cost information and to address MAID items and issues.

The Contractor **shall** conduct bi-weekly working group teleconferences to review and discuss technical information and to address MAID items and issues.

Once instrument integration and test (I&T) begins, the Contractor **shall** conduct daily on-site meetings and telecons with the Government team.

2.1.5.3 Project Management Reviews (PMR)

The Contractor **shall** prepare monthly PMR data packages for the purpose of reviewing the technical, risk, schedule, and cost status of the contract.

The PMRs will be held every other month (bi-monthly) at the Government's facility (**TBR**) through successful completion of the CDR, and then alternate between a Government designated facility and the Contractor's facility.

The first PMR **shall** be held 60 days after contract award.

2.1.5.4 Integrated Baseline Review (IBR)

Approximately four months after contract award the Contractor **shall** prepare and conduct an IBR that describes their performance measurement baseline for the contract.

The IBR **shall** include the EVMS plan, time phased expenditure plan, integrated master schedule, resource loading, cost accounts, work packages, all structured according to the work breakdown structure.

The IBR **shall** include a review of the Contractor's earned value assessment and reporting

systems.

The Contractor **shall** plan for a five (5) day IBR, not including action item resolution.

2.1.5.5 Technical Interchange Meetings (TIM)

The Contractor **shall** conduct TIMs requested by the Government for the purpose of discussing and resolving items of interest.

The Government will accept requests by the Contractor for TIMs

If the Contractor conducts TIMs with subcontractors for critical assemblies and subassemblies, the Contractor **shall** provide the Government 10 working days advanced notification so that Government representatives can be present.

2.1.5.6 Engineering Peer Reviews

The Contractor **shall** implement a program of periodic tabletop engineering peer reviews throughout the development life cycle to identify and address risks, problems, and issues as they arise prior to system level reviews.

The Contractor **shall** establish engineering review teams comprised of technical experts with experience relevant to the technology and requirements to be reviewed.

The Contractor **shall** insure for each review that some review team members are external to the GOES-R effort.

The Contractor **shall** provide a 10 working days advanced notification so that Government representatives can be present.

2.1.5.7 Software Reviews

The Contractor **shall** implement a program of periodic tabletop reviews throughout the development life cycle to identify and address risks, problems, and issues as they arise prior to system level reviews.

The Contractor **shall** establish software review teams comprised of technical experts with experience relevant to the technology and requirements to be reviewed.

The Contractor **shall** ensure for each review that some review team members are external to the GOES-R effort.

The Contractor **shall** provide a 10 working days advanced notification so that Government representatives can be present.

2.1.5.8 Test Reviews

The Contractor **shall** prepare and conduct table-top test reviews with Government personnel on the overall status and performance.

The Contractor **shall** include sub-assemblies and subcontracted subassemblies as well as instrument level test data in test data reviews.

The Contract **shall** submit a list of test reviews to the COTR for approval.

The Contractor **shall** conduct data reviews prior to the shipment of deliverable GSE.

The Contractor **shall** prepare and conduct reviews of the interim data during the qualification or acceptance test process of the spacecraft prior to the breakdown of any test setup, e.g., vibration testing, EMI/EMC testing or thermal vacuum testing, etc. so the Government can determine if the test data prove compliance with the requirements being verified or validated by the testing, and, prior to the PSR, so the Government can determine readiness. If the Government determines that the data does not prove compliance with the requirements, the Contractor shall resolve the non-compliances.

2.1.5.9 Instrument Receiving Reviews

The Contractor **shall** prepare and conduct an Instrument receiving review in conjunction with each instrument vendor prior to the shipping of the each instrument prototype model (PTM) or flight model (FM) and test equipment from the instrument vendor to the contractor to establish the readiness of the system and to evaluate the handling plans and procedures.

The Contractor **shall** plan for a one-day review or combine this activity with the Instrument pre-ship review for each instrument.

2.1.5.10 Design Reviews

The Contractor **shall** prepare and conduct Spacecraft Design Reviews for the Government that will be chaired by the Independent Integrated Review Team (IIRT). The reviews will cover all aspects of flight and ground hardware, software, integration, testing, and operations for which the Contractor has responsibility.

The Contractor **shall** conduct a dry run of each design review, with the Government team in attendance, approximately 2 weeks prior to the review.

The Contractor **shall** plan dry runs to be the same duration as the review.

The Contractor **shall** after each review document all RFAs in the MAID within 1 week of receipt.

Each design review **shall** be complete when approved by the Government.

If the Government determines that a delta review is required, the Contractor **shall** conduct such review at a time to be mutually agreed upon by the Government.

The Contractor **shall** provide responses to RFAs in accordance with the CDRL.

The Contractor **shall** prepare and conduct all design reviews in compliance with GSFC-STD-1001.

2.1.5.10.1 Systems Definition Review (SDR)

The Contractor **shall** prepare and conduct an SDR approximately six (6) months after contract award.

The Contractor **shall** plan for a three-day review.

2.1.5.10.2 Subsystem and Subcontract Reviews

The Contractor **shall** conduct PDR and CDR reviews of sub-systems whether these subsystems are provided by the Contractor or by a subcontractor.

Whether internal or external, sub-system and subcontract reviews **shall** be chaired by the Contractor and conducted by personnel not directly responsible for design or procurement of the hardware under review.

The Contractor **shall** provide the Government with at least 10 working days advance notification so that Government representatives can be present at any Subcontractor or Subsystem review.

The Contractor **shall** accommodate attendance by the Government and its support contractors to all subsystem and subcontractor reviews.

The Contractor **shall** provide the Government with a subcontractor review data package 10 working days prior to the review.

2.1.5.10.3 Preliminary Design Review (PDR)

The Contractor **shall** prepare and conduct a PDR at the conclusion of the preliminary design efforts and after testing the breadboard or brassboard models of critical subassemblies/assemblies.

The Contractor **shall** plan for a three-day review.

2.1.5.10.4 Critical Design Review (CDR)

The Contractor **shall** prepare and conduct a CDR prior to the start of manufacture of hardware unless the Contractor requests and receives approval from the COTR or Contracting Officer for an earlier start.

The Contractor **shall** plan for a four day review.

2.1.5.10.5 Design Modification Reviews

Upon Government determination, the Contractor **shall** hold a Design Modification Review for any Class II CCRs following CDR.

The Contractor **shall** plan for a three-day review.

2.1.5.10.6 Program System Integration Review (SIR)

The Contractor **shall** support the Government in the preparation and execution of the SIR. The SIR may be combined with another milestone review that the Contractor conducts such as CDR.

The Contractor **shall** plan for a five (5) day SIR.

2.1.5.10.7 Pre-Environmental Review (PER)

The Contractor **shall** prepare and conduct a PER prior to the start of environmental testing of the each spacecraft to establish the readiness of the system and to evaluate the environmental test plans and procedures.

The Contractor **shall** plan for a three (3) day PER.

2.1.5.10.8 Satellite Pre-Storage/Pre-Shipment Review (PSR)

The Contractor **shall** prepare and conduct a pre-storage review prior to placement of each satellite into storage at the Contractor's facilities.

The Contractor **shall** prepare and conduct a pre-ship review prior to shipping the satellite to NASA Kennedy Space Center (KSC) for launch integration.

The Contractor **shall** plan for three day pre-storage and pre-ship reviews.

2.1.5.11 Review Support

The Government will be required to conduct or participate in independent and external reviews.

The Contractor **shall** provide support to the Government for the Independent Review Team (IRT) reviews and Standing Review Board (SRB) reviews.

The Contractor **shall** attend and support Instrument design reviews.

The Contractor **shall** attend and support Ground Segment design reviews.

The Contractor **shall** support the MOR to be conducted by the Government.

The Contractor **shall** plan for a three (3) day MOR.

The Contractor **shall** support the MRR to be conducted by the Government. The MRR is the final approval review by GSFC Center Management that the GOES-R mission is ready for launch and operations

The Contractor **shall** plan for a one (1) day MRR.

The Contractor **shall** support the FRR to be conducted by the Government. The FRR is the final approval review by NASA that the GOES-R mission is ready for launch and operations.

The Contractor **shall** plan for a one (1) day FRR.

The Contractor **shall** support the LRR to be conducted by the Government. The LRR is conducted by the launch range and is the final review prior to actual launch that verifies the Launch System and Spacecraft/Payloads are ready for launch.

The Contractor **shall** plan for a one (1) day LRR.

The Contractor **shall** support the Flight Operations Review (FOR).

The Contractor **shall** plan for a three (3) day FOR.

The Contractor **shall** support the Operation Readiness Review (ORR).

The Contractor **shall** plan for a three (3) day ORR.

The Contractor **shall** support the Phase 0/I, II, III Safety Reviews at the Kennedy Space Center (KSC).

The Contractor **shall** plan for three (3) days for each of the Phase 0/I, II, III Safety Reviews.

2.2 Systems Engineering

2.2.1 Systems Engineering Management and Control

The Contractor **shall** establish a program-level systems engineering office that directly manages all systems engineering efforts for each spacecraft development.

The Contractor **shall** establish, maintain, and control resource budgets for all spacecraft resources in accordance with the GOES-R Series, Project Resource Allocation Document (PRAD) 417-R-RAD-0061.

The spacecraft resource budgets will be approved by the Government.

2.2.2 Systems Engineering Support

The Contractor **shall** provide a systems engineering to support the functional design and development of the spacecraft and incorporation of the instruments.

The Contractor **shall** address the total spacecraft design including performance margins and design approaches to assure achievement of the required spacecraft life, spacecraft operations concept, design integrity, failure modes, intra-system and inter-system compatibility, reliability and maintainability, producibility, safety, survivability, training, and testability.

The Contractor **shall** oversee all of the work associated with the development of the spacecraft.

2.2.3 System Designs, Analysis and Trades

The Contractor **shall** perform all system studies and trades and risk assessment to develop the design for the spacecraft.

2.2.4 Requirements and Specification Generation

The Contractor **shall** define, implement, and maintain a Systems Engineering Requirements Management System for managing, detailing, organizing, controlling, and linking the spacecraft requirements.

The Contractor **shall** utilize Telelogic DOORS® requirements management tool to capture, link, trace, analyze and manage changes to all requirements documentation.

The Contractor **shall** perform all systems analyses and systems engineering to derive lower-level performance requirements and develop the spacecraft system specification and design specifications for the spacecraft subsystems.

The Contractor **shall** document the allocation of requirements to the lower level specifications, showing the traceability of all requirements including performance and design drivers, and explicitly identifying any derived requirements.

The Contractor **shall** validate that the lower level requirements meets the highest level Government requirements.

Utilizing the validated requirements, the Contractor **shall** verify that lower level requirements are fully traceable to higher level requirements.

2.2.5 Performance Verification Plans and Procedures

The contractor **shall** establish a system performance verification program documenting the overall verification plan, implementation, and result which provide traceability from system requirements specification to launch and initial on-orbit capability. This will also provide the baseline for tracking on-orbit performance versus pre-launch capability.

The Contractor **shall** develop and maintain all necessary plans and procedures to verify that the GOES-R spacecraft meets all requirements described in the GOES-R Spacecraft Functional and Performance Specification, GIRD, UIIDs and GFP Instrument ICDs.

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

The Contractor **shall** map all requirements to specific verification test plans and procedures utilizing the DOORS data base.

The Contractor **shall** include the development of all verification reports, external reviews, and instrument requirements to be verified at the system level in verification plans and procedures.

2.2.6 Interface Definition and Control

2.2.6.1 Instrument Interfaces

The Contractor **shall** perform all systems analysis and engineering to define all aspects of the spacecraft-to-instrument interfaces.

The Contractor **shall** establish a joint Contractor/Government /Instrument Contractor Instrument Interface working group.

The Contractor **shall** designate a technical representative for each instrument.

The Contractor **shall** develop and maintain a complete spacecraft-to-instrument Interface Control Documents (ICDs) that meets all the requirements of the General Interface Requirements Document (GIRD) as well as the appropriate Unique Instrument Interface Document (UIID) for each instrument.

The Contractor **shall** utilize the Instrument Description Document (IDD) of each instrument, as the basis for the ICD between the spacecraft and the respective instrument.

The Contractor **shall** negotiate and document the spacecraft-to-instrument ICD with the respective Instrument Contractors.

The Contractors **shall** negotiate and document in the ICD any relevant alignment requirements not specified in GIRD or UIID.

The Contractor working with the Instrument Contractor **shall** define and document the location and orientation of instrument units on the spacecraft in the ICD.

2.2.6.2 Ground Interfaces

The Contractor **shall** perform all systems analyses and engineering to define all aspects of the

space communications interfaces.

The Contractor **shall** develop and maintain a space-to-ground interface control document (ICD) between the space and ground systems that meets all requirements in the space and ground specifications.

The Contractor **shall** negotiate the space-to-ground ICD with the Ground Segment Contractor.

2.2.6.3 Launch Vehicle Interfaces

The Contractor **shall** perform all systems analyses and engineering to define all aspects of the spacecraft-to-launch vehicle interface.

The Contractor **shall** provide technical support and satellite inputs required to develop the Spacecraft/Launch Vehicle Interface Control Document (ICD).

The Spacecraft/Launch Vehicle ICD will be developed and maintained by the Launch Vehicle Contractor.

The Contractor **shall** provide technical support required to perform Spacecraft to Launch Vehicle Integration and Test, including the verification of all Spacecraft/Launch Vehicle ICD requirements.

The Mission Specific Analyses will be developed by the Launch Vehicle Contractor. Spacecraft inputs to the Mission Specific Analyses, are required as part of Spacecraft/Launch Vehicle ICD development.

The Contractor **shall** provide technical support and spacecraft data required to develop the Mission Specific Analyses including. The Mission Specific Analysis will include but is not limited to the Preliminary Mission Analysis (PMA), Detailed Test Objectives (DTO), Performance and Guidance Accuracy Analysis, Trajectory Analysis, PLF Venting Analysis, RF Compatibility Analysis, RF Link Analysis, Spacecraft Separation Analysis, EMI-EMC Analysis, Payload Fairing Critical Clearance Analysis, Coupled Loads Analysis, and Integrated Thermal Analysis.

The Contractor **shall** provide technical support required to evaluate results of all Mission Specific Analyses developed by the launch vehicle contractor.

Launch base program requirements documents (PRDs) will be developed and maintained by the Launch Vehicle Contractor. PRDs will define spacecraft support requirements for launch base processing activities.

The Contractor **shall** provide technical support and spacecraft data required to develop launch base program requirements documents (PRDs).

2.2.7 Image Navigation and Registration (INR)

The Contractor **shall** perform all analyses and tests to verify that the spacecraft meets the interfaces required to ensure instrument INR performance. The INR interfaces include physical and data interfaces.

The Contractor **shall** conduct INR analyses and tests using flight-like environments and scenarios.

The Contractor **shall** perform performance verification of Space Segment INR for each instrument (**TBR**). Space Segment INR performance verification is defined as photons in through Level 1-B products out.

2.2.8 Contamination

The Contractor **shall** provide all resources to assure that appropriate contamination control is maintained through all phases the development and of integration and test of the spacecraft.

The Contractor **shall** be responsible for the monitoring of contamination (both particulate and molecular) from the beginning of the integration activities through the launch of the spacecraft.

The Contractor **shall** perform all cleaning required to maintain cleanliness at specified levels.

The Contractor **shall** accommodate instrument cleaning by the Instrument Contractors.

The Contractor **shall** report all contamination activities in accordance with the approved contamination control plan.

The Contractor **shall** provide a mass transport analysis and a particle generation analysis for the spacecraft.

The Contractor **shall** establish and document contamination allowances and budgets for performance degradation of spacecraft optical and thermal contamination-sensitive hardware are within the specification over the mission lifetime.

2.3 Safety & Mission Assurance

The Contractor **shall** provide all functions to support the performance assurance and verification effort for the spacecraft as documented in the GOES-R Spacecraft Mission Assurance Requirements (SCMAR).

2.3.1 Safety

The Contractor **shall** provide all resources and perform all work necessary to comply with safety requirements for the spacecraft as documented in the SCMAR 417-R-SCMAR-0011 and AFSPCMAN 91-710.

2.3.2 Parts Control

The Contractor **shall** provide all resources to perform parts control for the spacecraft as defined in the SCMAR.

2.3.3 Materials and Processes Control

The Contractor **shall** provide all resources to comply with the Materials and Processes Control requirements for the spacecraft as defined in the SCMAR.

2.3.4 Reliability

The Contractor **shall** provide all resources to comply with the Reliability requirements for the spacecraft as defined in the SCMAR.

The Contractor **shall** perform analyses and risk assessment to assist the Government in the development the Probability Risk Assessment (PRA). **(TBR)**

The Contractor **shall** incorporate instrument FMECAs and reliability data into the overall spacecraft reliability analysis.

2.3.5 Quality Assurance

The Contractor **shall** provide all resources to comply with the Quality Assurance requirements for the spacecraft as defined in the SCMAR.

2.3.6 Software Assurance

The Contractor **shall** provide all resources to comply with the Software Assurance requirements for the spacecraft as defined in the NASA-STD-8739.8, Software Assurance Standard.

2.3.6.1 Software Safety

The Contractor **shall** provide all resources to comply with the Software Safety requirements for the spacecraft as defined in the NASA-STD-8719.13B; NASA Software Safety Technical Standard.

The Contractor **shall** verify all safety-critical software on flight or flight-like hardware.

2.3.6.3 Software Verification and Validation

The Contractor **shall** implement a Software Verification and Validation (V&V) program to ensure that software being developed or maintained satisfies functional, performance, and other requirements at each stage of the development process, and that the final product meets customer requirements.

To assist in the Verification and Validation of the software requirements, the contractor **shall** develop and maintain under configuration control a Software Requirements Verification and Validation Matrix.

This matrix **shall** document the flow-down of each requirement to the test case and test method used to verify compliance and the test results.

The Matrix **shall** be incorporated in the overall System Performance Verification and Validation Plan and the System Performance Verification Matrix.

2.3.6.4 Independent Verification and Validation

NASA may perform an Independent Verification and Validation (IV&V) effort. This will require, but is not limited to, access to all software reviews and reports, contractor plans and procedures, software code, software design documentation, and software problem reporting data. The contractor **shall** permit electronic access to the required information or furnish soft copies of requested information to NASA IV&V personnel.

The Contractor **shall** review and assess all NASA IV&V findings and recommendations and implement corrective actions.

2.3.6.5 Software Problem Reporting and Corrective Action

The Contractor **shall** implement a process for Software Problem Reporting and Corrective Action that addresses reporting, analyzing and correcting software non-conformances and software test failures reported in Software Problem Reports (SPR's) throughout the development lifecycle.

The Contractor **shall** provide for a corrective action process that tracks every software nonconformance to its final disposition

2.4 Spacecraft

The Contractor **shall** provide all resources to design, analyze, fabricate, assemble, integrate, test, support launch and support on-orbit operations for the spacecraft.

The Contractor **shall** provide all resources to ensure all spacecraft technologies are at TRL 6 by PDR as defined by NPR 7123.1A - NASA Systems Engineering Processes and Requirements Table G-19 – Technology Readiness Levels.

The Contractor **shall** identify and document critical assemblies and subassemblies.

The Government will review and approve the list of critical assemblies and subassemblies.

2.4.1 Spacecraft Management

The Contractor **shall** perform the direct management functions and provide the management structure to plan, direct and execute all elements to develop the spacecraft bus.

The Contractor **shall** provide a full-time spacecraft manager through acceptance of the spacecraft.

The Contractor **shall** track schedule and cost data on the design and analysis of each spacecraft bus sub-system.

The Contractor **shall** track schedule and cost data on the fabrication, assembly, and test of each spacecraft bus sub-system.

2.4.2 Mechanical

The Contractor **shall** provide all resources, including analysis, to design and analyze the structure, mechanisms.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the structures and mechanisms subsystem for the spacecraft bus.

Unless otherwise specified, the Contractor **shall** provide all mounting hardware for the instrument units.

The Contractor **shall** integrate all instrument and spacecraft mechanical models into a satellite mechanical model.

2.4.3 Thermal

The Contractor **shall** provide all resources to design and analyze the thermal subsystem for the

satellite.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the thermal subsystem for the satellite.

The Contractor **shall** document in the ICD properties of any thermally conductive or isolating materials used at the interface of the instrument unit.

The Contractor **shall** integrate all instrument and spacecraft thermal models into a satellite thermal model.

2.4.4 Guidance, Navigation, & Control

The Contractor **shall** provide all resources to design and analyze the Guidance, Navigation, and Control subsystem of the satellite.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the Guidance, Navigation, and Control subsystem for the satellite.

2.4.5 Command & Data Handling

The Contractor **shall** provide all resources to design and analyze the command and data handling subsystem for the satellite.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the command and data handling subsystem for the spacecraft bus and instruments.

2.4.6 Communications

The Contractor **shall** provide all resources to design and analyze the communications payload and Auxiliary Communication Services Payloads for the satellite including the encryption and decryption of the communication interface.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the communication payload and Auxiliary Communication Services Payloads for the satellite including the encryption and decryption of the communication interface.

2.4.7 Electrical

The Contractor **shall** provide all resources to design and analyze the electrical distribution subsystem and the electrical power subsystem for the spacecraft bus.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the electrical distribution subsystem and the electrical power subsystem for the spacecraft bus.

2.4.7.1 Battery

The spacecraft contractor **shall** deliver one (1) life test battery built to flight design specifications and subject to environmental acceptance testing.

The spacecraft contractor **shall** deliver two (2) flight batteries built to flight design specifications and subject to environmental acceptance testing.

The spacecraft contractor **shall** deliver one (1) flight spare battery built to flight design

specifications and subject to environmental acceptance testing.

The spacecraft contractor **shall** deliver one (1) qualification/I&T battery built to flight design specifications and subject to environmental qualification testing.

The spacecraft contractor **shall** deliver twelve (12) battery test cells from the flight cell lot to the GSFC Battery Lab for performance testing.

The spacecraft contractor **shall** provide cell and battery design data and analysis to show an overall compliance with battery requirements, and provide cell acceptance data and all other data required in the Cell Test Data Package to demonstrate the adequacy of the cell design.

After cell fabrication and acceptance testing and prior to start of battery build, the Contractor **shall** provide cell acceptance data and all other data required in the Cell Test Data Package to demonstrate adequacy of each cell lot.

2.4.7.2 Battery Qualification and I&T

The spacecraft contractor **shall** furnish all personnel, facilities, services, and resources to perform GOES-R battery qualification test program.

The qualification battery **shall** consist of the flight cells, flight battery packaging with flight connectors, flight cell and flight battery voltage monitoring, and flight cell and flight battery temperature monitoring.

If cell voltage balancing is planned for flight, the qualification/life test battery **shall** incorporate the flight voltage balancing electronics and its planned flight use into the battery qualification testing.

The spacecraft contractor **shall** define, analyze, and document the requirements for environmental tests associate with the battery qualification test program.

The spacecraft contractor **shall** conduct test data reviews with the Government after each environmental test during the battery qualification test program so that the Government can determine acceptability of data and whether it is safe to proceed.

After completion of the battery qualification test program, the battery will be used to support the spacecraft I&T test program.

2.4.7.3 Battery Life Testing

The spacecraft contractor **shall** furnish all personnel, facilities, services, and resources to perform GOES-R battery life test program.

The life test battery **shall** consist of the flight cells, flight battery packaging with flight connectors, flight cell and flight battery voltage monitoring, and flight cell and flight battery temperature monitoring.

If cell voltage balancing is planned for flight, the qualification/life test battery **shall** incorporate the flight voltage balancing electronics and its planned flight use into the battery life testing.

The spacecraft contractor **shall** define, analyze, and document the requirements for life tests associate with the battery life test program.

2.4.8 Propulsion

The Contractor **shall** provide all resources to design and analyze the propulsion subsystem for the spacecraft bus.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify the propulsion subsystem for the spacecraft bus.

2.4.9 Flight Software

The Contractor **shall** provide all resources to develop, verify, and maintain all aspects of flight software.

The Contractor **shall** classify all Spacecraft flight software as Class B software as defined in NASA-STD-8739.8 Software Assurance Standard.

The Contractor **shall** provide all resources to support verification and validation testing of all flight software.

The Contractor **shall** provide and maintain one FSDE, including hardware, software, procedures and associated documentation, to be used for the life cycle management, development and verification of the flight software at the Contractor's facility.

The Contractor **shall** provide and maintain one FSDE, including hardware, software, procedures and associated documentation for delivery to the Government for development, test and verification of software patches that may be required throughout the operational phase of the mission.

The Government will perform an independent assessment of all FPGA designs against the design guidelines contained in 500-PG-8700.2.7: Design of Space Flight Field Programmable Gate Arrays, using the information in the FPGA Design Data Package CDRL.

The Contractor **shall** provide resources to assist the Government's FPGA Independent Assessment, assess all review findings and recommendations, and implement corrective actions to address such findings and recommendations.

2.4.10 Magnetometer

The Contractor **shall** provide all resources to design and analyze the GOES-R Magnetometer.

The Contractor **shall** provide all resources to fabricate, assemble, test, integrate and verify the performance of the GOES-R Magnetometer.

The Contractor **shall** derive flow down requirements for hard and soft permanent magnetic fields for all flight equipment, materials, and tools used in the vicinity of the magnetometer sensors.

The Contractor **shall** provide all resources to develop, verify, and maintain the Level 1 b algorithms.

The Contractor **shall** deliver a correction scheme algorithm for use in real-time data processing to correct for any magnetic signature that exceeds magnetometer specification limits.

The Contractor **shall** provide all facilities for magnetometer testing.

The Contractor **shall** conduct a zero field test, at both bench and system level testing, of

magnetometer sensor zero offset.

The Contractor **shall** conduct a system level stray magnetic test that demonstrates each individual spacecraft complies with the stray magnetic field specification.

2.5 Ground Support Equipment (GSE)

GSE is defined as electrical ground support equipment (EGSE), mechanical ground support equipment (MGSE) and GSE Software.

The Contractor **shall** provide all resources to design and analyze all GSE used to develop, integrate, test and deliver the satellite.

The Contractor **shall** provide all resources to fabricate, assemble, test and verify all GSE required to develop and deliver the satellite.

The Contractor **shall** provide configuration control of all GSE.

The Contractor **shall** provide notification to the Government of any GSE configuration changes for all GSE that interface with the GFP Instruments prior to implementation of said change.

The Contractor **shall** provide all resources to develop and document all GSE interfaces in a GSE Interface Control Document (ICD).

The Contractor **shall** provide GSE for any parallel operations. **(TBR)**

The Contractor **shall** provide all the resources to provide radioactive sources, in accordance with SEISS Radioactive Source Specification **(TBS)**, for use with the SEISS both on and off the spacecraft.

2.5.1 GSE Software

The Contractor **shall** provide all resources to develop, verify, and maintain all aspects of non-flight software.

The Contractor **shall** classify all Spacecraft Simulator software as Class B software. **(TBR)**

The Contractor **shall** provide all resources to support verification and validation testing of all non-flight software.

The Contractor **shall** provide all resources to develop, verify, and maintain the development validation and verification software for the spacecraft.

2.5.2 Simulators

The Contractor **shall** furnish all resources to develop, deliver, integrate, test, and maintain all satellite, spacecraft, and instrument interface simulators.

The Contractor **shall** provide all resources to develop, document and deliver a spacecraft simulator for each Instrument Contractors. **(TBR)**

The Contractor **shall** provide all resources to document, receive, and integrate the instrument emulators into the satellite simulator.

2.6 System Integration and Test (I&T)

The Contractor **shall** furnish all resources to perform all integration and testing of the spacecraft bus, spacecraft, and satellite.

The Contractor **shall** provide all management functions to perform all integration and testing of the spacecraft bus, spacecraft, satellite, launch vehicle, and ground segment.

The Contractor **shall** develop and maintain all plans, procedures, and reports to perform all integration and testing of the spacecraft bus, spacecraft, and satellite.

The Contractor **shall** provide support required to perform Spacecraft to Launch Vehicle I&T, including the verification of all Spacecraft/Launch Vehicle ICD requirements.

The Contractor **shall** perform “safe-to-mate” procedures before electronically mating and powering on any avionics or instruments on the spacecraft.

The Contractor **shall** ensure that a “safe-to-mate” certification is confirmed prior to applying power to the Spacecraft.

The Contractor **shall** use calibrated GSE to support spacecraft integration and testing.

The Contractor **shall** provide Electro Static Discharge (ESD) protection for the spacecraft bus, spacecraft and satellite during all phases of I&T.

The Contractor **shall** provide and use bagging in addition to the instrument bagging provided by the Instrument Contractors.

The Contractor **shall** identify any discrepancy that may have an impact on orbital operations; constraints, alarms/limits, procedures, including the definition and development of orbital simulations to be used in Comprehensive Performance Tests (CPTs) and operator test training scenarios.

The Contractor **shall** be responsible for testing, monitoring, and compliance with ISO 14644-1 Class conformance during all I&T and launch processing facility operations.

2.6.1 Spacecraft Bus I&T

The Contractor **shall** completely test the onboard fault management system, including bus and instrument safing operations, on the spacecraft prior to implementing the formal baseline CPT of the spacecraft.

The Contractor **shall** ensure that following the successful execution of the fault management testing, all non-hazardous safing operations are enabled during subsequent system level tests and CPTs.

The Contractor **shall** establish and implement a system for trending and reporting unit, subsystem and spacecraft level performance during I&T.

The Contractor **shall** report performance trending results at the Spacecraft Pre-Environmental Review, and the Spacecraft Pre-Ship Review.

The Contractor **shall** hold at least two (2) Major Test Event (MTE) development I&T Working Groups for each of the following: EMI/EMC Testing, RF Airlink Testing, GFP Instrument

Integration, Spacecraft Mechanical Environments (Sine Vibration / Acoustics / Shock), Spacecraft Dynamic Interaction Test, Spacecraft Thermal Vacuum Testing, and Spacecraft Launch Base Testing.

The Government may delete the requirement for any single MTE development I&T Working Group session based on a maturity assessment, or subsequent flight article considerations.

2.6.2 Satellite I&T

The Contractor **shall** provide all resources to perform the integration of the instruments onto the spacecraft bus.

The Contractor **shall** organize working groups for each environmental test activity with membership consisting of contractor, Government, and instrument representatives.

The Contractor **shall** develop the Safe-To-Mate test procedure for the electrical integration of each GFP instrument to the spacecraft in concert with the GFP Instrument Contractor and the Government.

The Contractor **shall** provide the clean room area, office space, and support to each instrument team to aid in the effort associated with the Bench Acceptance Test (BAT) of each of the instruments after their arrival at the spacecraft integration and test facility.

The Contractor **shall** mount, align, and verify that instruments have been integrated to the spacecraft according to the instrument UIID and ICD.

Following instrument integration on the spacecraft, the Contractor **shall** be responsible for providing a gas purge to the instrument optical cavities during all storage, test, and transport operations if required by the instrument.

The Contractor **shall** measure and document the optical alignment of each instrument and support the subsequent checkout of instrument operability after instruments have been mounted to the spacecraft.

The Contractor **shall** integrate the Instrument Contractors' command and telemetry and limits databases.

The Contractor **shall** incorporate the Instrument Contractors' operational, testing, and contingency procedures into the satellite I&T procedures and the satellite operations handbook.

The Contractor **shall** provide access to each Instrument Contractor to inspect and clean the instruments as documented in the instrument ICD.

The Contractor **shall** ensure that GFP instrument EGSE is powered on, and properly connected to the spacecraft EGSE prior to any powered testing of a GFP instrument

The Contractor **shall** allocate and support 30 days (**TBR**) dedicated to GFP instrument functional testing prior to the start of environmental testing.

The Contractor **shall** allocate and support 30 days (**TBR**) dedicated to GFP instrument testing during thermal vacuum.

The Contractor **shall** provide the required spacecraft orientation and access per GFP instrument test procedure.

Spacecraft testing may be conducted in parallel if the Government determines that it does not interfere with, or compromise GFP instrument testing.

The Contractor **shall** document instrument testing and inspection to be accomplished at the launch site in the ICD.

The Contractor **shall** align the instrument alignment reference frame to the spacecraft IRU reference frame.

The Contractor **shall** measure the alignment between the instrument alignment reference frame and the spacecraft IRU reference frame.

The Contractor **shall** integrate the instrument units onto the spacecraft including application of any interstitial materials as conductive enhancements. Selection and application of any interface materials require the concurrence of the Instrument Contractor and spacecraft contractor.

The Contractor **shall** provide all resources to measure dynamic interactions between spacecraft and instrument components.

The Contractor **shall** provide all resources to measure the spacecraft magnetic dipole.

The Contractor **shall** provide all resources to measure electromagnetic interactions between the spacecraft and instruments with all communications functions and instruments operating in an on-orbit mode.

The Contractor **shall** provide all resources to define, analyze, and document the requirements for all environmental tests associated with the spacecraft, instruments, and payloads.

The Contractor **shall** define each test, provide facilities, prepare tests, and operate each environmental test as defined in the SC F&PS.

The Contractor **shall** accommodate instrument requirements for environmental testing by providing testing periods prior to, during, and after each environmental test.

The Contractor **shall** conduct test data reviews with the Government after each test level during spacecraft level sine and acoustic testing so the Government can determine acceptability of data and provide authority to proceed.

The Contractor **shall** provide all purge gases for use by the instruments as documented in each instruments ICD.

2.6.3 Special Testing

The Contractor **shall** provide all resources for the development and execution of special tests.

The Contractor **shall** provide wideband data generated and recorded during pre-thermal vacuum testing, and thermal vacuum testing, for all radiometric instruments without use of any simulators.

The Contractor **shall** perform a Satellite Dynamic Interaction Test.

The Contractor **shall** perform a Modal Survey Test.

The Contractor **shall** perform a Radio Frequency (RF) Airlink Test

The Contractor **shall** perform a RF Compatibility Test for Auxiliary COMM Services.

The Government will provided use of the Compatibility Test Van (CTV).

The Contractor **shall** provide support for and participate in the GFP Instrument Calibration and Performance Tests

The Government will provide a complete list of special tests and their duration at CDR +60 days.

2.6.4 Satellite /Launch Vehicle I&T

The Contractor **shall** provide support for all activities associated with satellite to launch vehicle integration. This includes, but is not limited to: interface verification, integrated Satellite/Launch Vehicle test plan and procedure development, satellite to launch vehicle integration operations, ground processing facilities and GSE integration/readiness, and launch support efforts.

The Contractor **shall** provide support to the Government for the development of GFP LV contract launch base requirements documents, which include but are not limited to the Program Requirements Document (PRD), Launch Site Support Plan (LSSP), satellite test plans and procedures, and Payload Processing Requirements Document (PPRD).

2.6.5 End-to-End (ETE) Testing

The GOES-R Program will define a series of spacecraft-to-ground system End-to-End (ETE) tests. The ETE test program will focus on the validation and compatibility of flight and ground hardware, software, and communications interfaces in a mission operations context.

The Government Mission Operations Support Team (MOST) will manage the execution of the ETE testing.

The Contractor **shall** provide all resources for and execute five (5) ETE tests (**TBR**).

The Contractor **shall** provide all resources to support the development and review of ETE test plans and procedures as part of the joint mission operations, spacecraft, instrument, and ground system teams.

The Contractor **shall** provide a simulator for use where it is not practical, or feasible, to use a satellite flight element(s) for a given ETE test.

The Contractor **shall** submit a request to the Government and receive approval from the Government before using any simulator in an ETE test configuration.

2.6.6 Transportation and Handling

The Contractor **shall** provide all resources to transport the satellite, all spacecraft GSE, all instruments' GSE, and all other required items to and from all test facilities, as necessary, and to the launch site, safely and in a manner compatible with all applicable environmental

specifications and licensing requirements.

The Contractor **shall** perform final vehicle preparations and checkout at the launch site

The Contractor **shall** provide satellite GSE for integration and testing at the launch processing facility.

The Contractor **shall** provide multiple GSE for simultaneous spacecraft/satellite activities occurring at different locations.

The Contractor **shall** also provide the transportation and handling back to the Contractor's integration and test facility of all equipment shipped to the launch site remaining after the launch.

The Contractor **shall** provide all resources to design and analyze all shipping containers for subsystems, spacecraft bus, and the satellite.

The Contractor **shall** provide all resources to fabricate assemble and test and verify all shipping containers for subsystems, spacecraft bus, and the satellite.

2.6.7 Storage

The Contractor **shall** furnish all resources to provide storage of the satellite for up to five (5) years.

The Contractor **shall** furnish all resources to provide sustaining engineering during the storage of the satellite.

The Contractor **shall** furnish all resources to provide testing and refurbishment during storage of the satellite.

The Contractor **shall** remove the satellite from storage yearly and perform limited performance tests (LPT).

The Contractor **shall** perform a thermal vacuum test on the satellite if the satellite has been in storage for four (4) years prior to launch.

The Contractor **shall** perform a CPT after final removal of the satellite from storage.

2.7 Launch and Operations

The Contractor **shall** provide all resources to perform a CPT at the launch processing facility.

The Contractor **shall** provide all resources to support satellite fueling.

The Contractor **shall** provide all resources to perform an LPT after mating to the launch vehicle.

The Contractor **shall** furnish all resources to provide flight operations support for the satellite from launch through L+180 days (**TBR**) or the completion of orbital activation and performance verification, whichever is longer.

The Contractor **shall** provide all resources to analyze, plan, perform, coordinate, and document all phases of launch operations for the spacecraft from arrival at the Range through launch, including spacecraft servicing in the event of mission abort.

The Contractor **shall** establish a Flight Operations Office (FOO) responsible for the management

activities associated with the spacecraft flight operations.

The FOO **shall** be responsible for coordinating information exchange between the satellite development activities and the MOST.

The FOO **shall** be responsible for planning, reporting, development of operations review presentations, oversight of flight operations activities, and providing technical operations support for technical reviews.

The Contractor **shall** provide flight operations support at the NOAA SOCC from L-5 months (**TBR**) until delivery of the satellite to the Government (**TBR**).

The Contractor **shall** provide flight operations support at the Ground System contractor's facility from L-5 months (**TBR**) to launch.

The Contractor **shall** provide reference materials and support (**TBR**) in the development of flight operations and ground procedures, spacecraft and ground system testing, and performance verification of all products and deliverables for launch, satellite performance verification, storage, and nominal and contingency operations.

The Contractor **shall** ensure the launch and early orbit activation / performance verification engineering team are present at the NOAA SOCC for all launch and mission rehearsals in order to receive training and certification for launch operations.

The Contractor **shall** provide operations support 24 hours per day, 7 days per week until the satellite has completed all deployments and all maneuvers necessary to reach its test orbital location (90W).

The Contractor **shall** support the MOST, which is operating the satellite from the NOAA SOCC consoles through satellite performance verification.

2.7.1 Training

The Contractor **shall** provide 10 training sessions (**TBR**) for all aspects of operation of the satellite, including software.

The training **shall** include preparation of training materials for the operations of the satellite, instruments, and the satellite simulator and the training of the NOAA SOCC operations personnel in the operation of the spacecraft, instruments, and the satellite simulator.

The Contractor **shall** perform a minimum of three (3) (**TBR**) Launch Countdown rehearsals, during launch site processing, which include the introduction of simulated anomalies, launch countdown abort, hold, and recycle events.

2.7.2 Flight Training Simulator Support

The Contractor **shall** operate and maintain a simulator at the NOAA SOCC until the completion of orbital checkout of the satellite.

The Contractor **shall** provide 24-hour turnaround maintenance and repair support for the deliverable simulator(s) from L-5 months to L+180 days (**TBR**) or the completion of orbital activation and checkout, whichever is longer.

2.8 Post Delivery Support

The Contractor **shall** furnish all resources to provide sustaining engineering for the fifteen (15) years of the satellite life.

Sustaining Engineering **shall** include, but is not limited to advising the MOST on a continual basis, satellite and instrument trend and performance analysis, and satellite operations support during satellite anomaly investigation and resolution or contingency operations.

The Contractor **shall** investigate, resolve, and implement corrective action for satellite anomalies.

The Contractor **shall** provide support for decommissioning the satellite.

2.9 Special Studies & Tasks

The Contractor **shall** perform special studies and tasks as directed by the Government.

The studies and tasks will be requested on a task order basis as directed by the Contracting Officer.

2.10 Education and Public Outreach

The Contractor **shall** furnish all resources necessary to develop and implement a education and public outreach program for the GOES-R mission, including but not limited to posters, K-12 student teacher programs and training aides.

3.0 Spacecraft #2

This WBS element includes all sub-elements to level 3 as described in WBS element 1.0 to organize and describe the design, analysis, fabrication, assembly, integration, testing, delivery, launch and operation of the GOES-S satellite.

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