

**Geostationary Operational Environmental Satellite (GOES)  
R Series  
Flight Project  
Spacecraft**

**Work Breakdown Structure (WBS)  
Dictionary**

**January 24, 2008**



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**Version2.2**

**GOES-R Spacecraft  
Work Breakdown Structure (WBS)  
Dictionary**

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## **1.0 Spacecraft #1**

The Contractor will include within this WBS element at a minimum, all sub-elements to the level described in this document. This will assist the government in organizing, describing, and reporting the design, analysis, fabrication, assembly, integration, testing, and operation of the GOES-R satellite.

The Contractor will organize and report design and analysis separately from fabrication, assembly and test in separate WBS sub-elements.

The Contractor will organize and report non-recurring and recurring cost in separate WBS sub-elements.

## **1.1 Program Management**

### **1.1.1 Program Management Office**

This element defines the business and administrative planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish overall program objectives, which are not associated with specific hardware or software elements. This element includes project reviews and documentation, non-project owned facilities, and project reserves. It excludes costs associated with technical planning and management, and costs associated with delivering specific engineering, hardware and software products.

#### **1.1.1.1 Travel**

This element defines the travel and travel related expenses required to perform the GOES-R mission.

### **1.1.2 Resource Management**

This element defines the program control and management systems that provide for Work-Breakdown Structure (WBS) development, acquisition management, information technology management, resource management, Earned-Value Management (EVM), facilities, environmental, logistics and schedule management.

#### **1.1.2.1 Configuration Management**

This element defines the control of performance, functional and physical characteristics over the program and product life cycle. Configuration management is applied to requirements, documentation, software and hardware. Hardware includes qualification hardware; engineering, proto-flight, flight hardware; and ground support equipment.

#### **1.1.2.2 Information Technology Management**

This element defines the technical and management efforts to provided software and hardware infrastructure support.

### **1.1.3 Risk Management**

This element defines the continuous, iterative, and proactive process to manage risk and achieve mission success. The process involves identifying, analyzing, planning, tracking, controlling,

documenting, and communicating risks effectively. Risk is characterized by the combination of the probability or likelihood that the program will experience an event and the consequences, impact, or severity of the event, were it to occur.

#### **1.1.4 Government Resident Office**

This element defines the resources to 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 NASA residents and Government visitors.

#### **1.1.5 Program Communication**

This element defines the technical preparation and administrative support for all program reviews and joint meetings.

- a) Kick-Off Meeting
- b) Teleconferences
- c) Project Management Reviews (PMR)
- d) Technical Interchange Meetings (TIM)

#### **1.1.6 Design Reviews**

- a) Systems Definition Review (SDR)
- b) Subsystem Reviews
- c) Subcontract Reviews
- d) Preliminary Design Review (PDR)
- e) Critical Design Review (CDR)
- f) Design Modification Reviews
- g) Pre-Environmental Review (PER)
- h) Satellite Pre-Storage/Pre-Shipment Review (PSR)

#### **1.1.7 Miscellaneous Reviews**

The element defines the resources required for the following reviews:

- a) Integrated Baseline Review (IBR)
- b) Engineering Peer Reviews
- c) Software Reviews including the Software Test Readiness Review and the Software Qualification Review.
- d) Test Reviews
- e) Instrument Receiving Reviews

#### **1.1.8 Review Support**

The element defines the support to the Government for the following reviews:

- a) Independent Review Team (IRT) reviews
- b) Standing Review Board (SRB) reviews.
- c) Instrument design reviews.
- d) Ground Segment design reviews.
- e) Mission Operation Review (MOR).
- f) Management Readiness Review (MRR)
- g) Program System Integration Review (SIR)
- h) Flight Readiness Review (FRR).



- i) Launch Readiness Review (LRR).
- j) Flight Operations Review (FOR).
- k) Operation Readiness Review (ORR).
- l) Phase 0/I, II, III Safety Reviews at the Kennedy Space Center (KSC).

## **1.2 Systems Engineering (SE)**

Systems engineering is the technical and management efforts of directing and controlling an integrated engineering effort for the project. This element includes the efforts to define the spacecraft, conducting trade studies; the integrated planning and control of the technical program efforts of design engineering, software engineering, system architecture development, and integrated test planning, system requirements writing, configuration control, technical oversight, control and monitoring of the technical program. Documentation Products include mission/system requirements document (MSRD); interface control documents (ICDs); and verification and validation (V&V) plan. Excludes any design engineering costs.

### **1.2.1 Systems Engineering Management**

This element is the activities that directly manage all systems engineering efforts for each spacecraft development.

### **1.2.2 Systems Engineering Support**

This element is the systems engineering to support the functional design and development of the spacecraft and incorporation of the instruments.

### **1.2.3 System Designs, Analyses and Trades**

This element is the system studies and trades and risk assessment to develop the design for the spacecraft.

### **1.2.4 Requirements and Specification Generation**

This element is the activities that define, implement, and maintain a Systems Engineering Requirements Management System for managing, detailing, organizing, controlling, and linking the spacecraft requirements.

### **1.2.5 Performance Verification Plans and Procedures**

This element is the 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.

### **1.2.6 Interface Definition and Control**

#### **1.2.6.1 Instrument Interfaces**

This element is the systems analysis and engineering to define all aspects of the spacecraft-to-instrument interfaces.

### **1.2.6.2 Ground Interfaces**

This element is the systems analyses and engineering to define all aspects of the space communications interfaces.

### **1.2.6.3 Launch Vehicle Interfaces**

This element is the systems analyses and engineering to define all aspects of the spacecraft-to-launch vehicle interface.

### **1.2.7 Contamination**

This element is the resources to assure that appropriate contamination control is maintained through all phases the development and of integration and test of the spacecraft.

## **1.3 Safety and Mission Assurance (S&MA)**

This element is all resources to support the performance assurance and verification effort for the spacecraft as documented in the GOES-R Spacecraft Mission Assurance Requirements (SCMAR).

### **1.3.1 S&MA Management**

This element is all resources to manage the performance assurance and verification effort for the spacecraft as documented in the GOES-R Spacecraft Mission Assurance Requirements (SCMAR).

### **1.3.2 Safety**

This element is all resources to perform all work to comply with safety requirements for the spacecraft as documented in the SCMAR 417-R-SCMAR-0011 and AFSPCMAN 91-710.

### **1.3.3 Parts Control**

This element is all resources to perform parts control for the spacecraft as defined in the SCMAR.

### **1.3.4 Materials and Processes Control**

This element is all resources to comply with the Materials and Processes Control requirements for the spacecraft as defined in the SCMAR.

### **1.3.5 Reliability**

This element is all resources to comply with the Reliability requirements for the spacecraft as defined in the SCMAR.

### **1.3.6 Quality Assurance**

This element is all resources to comply with the Quality Assurance requirements for the spacecraft as defined in the SCMAR.

### **1.3.7 Software Assurance**

This element is all resources to comply with the Software Assurance requirements for the spacecraft as defined in the NASA-STD-8739.8, Software Assurance Standard.

### **1.3.7.1 Software Safety**

This element is 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.

### **1.3.7.2 Software Verification and Validation**

This element is all resources to 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.

### **1.3.7.3 Independent Verification and Validation**

This element is all resources to support Independent Verification and Validation efforts.

### **1.3.7.4 Software Problem Reporting and Corrective Action**

This element is all resources 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.

## **1.4 Spacecraft**

The spacecraft bus is the platform for carrying payloads, instruments, and other mission-oriented equipment in space to achieve the mission objectives. This element includes all design, analysis, fabrication, assembly, test efforts required to deliver the spacecraft subsystems for integration and test. This element does not include integration and test of the spacecraft bus, spacecraft, or satellite.

### **1.4.1 Spacecraft Management**

The Spacecraft Management element includes all resources related to systems engineering, project management of the bus hardware and software. As stated above, this element does not include integration and test with instruments, ground system, or launch vehicle.

### **1.4.2 Mechanical**

The Mechanical subsystem is the bus structure and mechanisms. It includes all resources related to the design, development, production, positioning, integration and test of the bus structure and mechanical parts. Any structure and mechanism support equipment is also included.

### **1.4.3 Thermal**

The Thermal subsystem is the active and passive devices, and thermal support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the active and passive thermal components.

### **1.4.4 Guidance, Navigation and Control (GN&C)**

The GN&C subsystem includes all orbit determination, orbit control, attitude determination and attitude control functions. It includes all related GN&C flight hardware components and propulsion interfaces; as well any necessary GN&C support equipment. It includes all activities

related to the design, development, production, integration, test, launch and on-orbit checkout of the above components.

#### **1.4.5 Command and Data Handling (C&DH)**

The C&DH subsystem is command and telemetry electronics, Spacewire and GN&C support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **1.4.5.1 C&DH Harnesses**

This element is the harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **1.4.6 Communications (COMM)**

##### **1.4.6.1 Space/Ground Communication**

The Communications subsystem is the, antennas, all active and passive Radio Frequency (RF) components including but not limited to MMICs, filters, hybrids, attenuators and communications support equipment. This includes the RF sections of the Telemetry, Tracking, and Command (TT&C) subsystem. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **1.4.6.2 Auxiliary Communication Services**

The Auxiliary Communication Services subsystem encompasses the structure, software, and support equipment of the GOES Rebroadcast service (GRB) and the Unique Payload Services. The Unique Payload Services consist of Data Collection System (DCS), Low-Rate Information Transfer (LRIT), Search-and-Rescue Satellite (SARSAT), and Emergency Managers Weather Information Network (EMWIN). It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **1.4.6.3 COMM Harnesses**

This element is the harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **1.4.7 Power**

This subsystem is the power generation, power conditioning, power storage, harnesses, cables, and electrical support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **1.4.7.1 Battery**

This element is the power storage. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **1.4.7.2 Solar Array**

This element is the power generation. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

### **1.4.7.3 Power Regulation and Conditioning**

This element is the power conditioning. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

### **1.4.7.4 Power Harnesses**

This element is the power distribution including all harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

### **1.4.8 Propulsion**

This subsystem is the tanks, plumbing, thrusters, propellants, and propulsion support equipment. It includes all activities related to the design, development, production, integration, test, launch and on-orbit checkout of the above components.

### **1.4.9 Flight Software**

The Flight Software subsystem for the Bus subsystem encompasses the flight software for components of the bus, to include the Thermal, GN&C, C&DH, Communications, Electrical, Magnetometer, and Propulsion elements. The primary activities for the Flight Software element are systems engineering, software project management, algorithm development, and subsystem integration and test. The activities of requirements analysis, design, coding and unit testing, and unit integration and testing are also included.

### **1.4.10 Magnetometer**

The Magnetometer instrument (subsystem) encompasses the magnetometer sensor, structure, mechanisms, and magnetometer support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

## **1.5 Ground Support Equipment (GSE)**

This element includes the resources all GSE required to assemble, integrate, and test the spacecraft.

### **1.5.1 Mechanical GSE (MGSE)**

This element includes the resources required to provide MGSE.

### **1.5.2 Electrical GSE (EGSE)**

This element includes the resources required to provide EGSE.

### **1.5.3 GSE and Simulator Software**

This element includes the resources required to provide non-flight software.

### **1.5.4 Simulators**

This element includes the resources required to provide spacecraft simulators.

## **1.6 Integration and Test (I&T)**

This element includes the resources required to perform the integration and test of the spacecraft bus, payloads, and instruments to form the satellite, transportation, handling, shipment and storage through delivery of the satellite.

### **1.6.1 Spacecraft I&T**

This element includes the resources required to perform the integration and test of the spacecraft subsystems including the COMM and the magnetometer payloads onto the spacecraft bus.

### **1.6.2 Satellite I&T**

This element includes the resources required to perform the integration and test of the GFP instruments onto the spacecraft.

#### **1.6.2.1 Special Testing**

This element includes the resources required to perform Special Testing.

#### **1.6.2.2 End-to-End (ETE) Testing**

This element includes the resources required to perform ETE Testing.

### **1.6.3 Transportation and Handling**

This element includes the resources required to perform transportation and handling

### **1.6.4 Storage**

This element includes the resources required to provide storage of the spacecraft bus, spacecraft, GFP instruments, and satellite.

## **1.7 Launch and Operations**

This element includes the resources required after delivery and before acceptance of the satellite. These resources include launch site processing, pre-launch/flight operations support, and operations support through completion of satellite deployment and checkout.

### **1.7.1 Satellite/Launch Vehicle I&T**

This element includes the resources required to perform integration of the satellite onto the launch vehicle.

### **1.7.2 Flight Operations**

This element includes the resources required to flight operations support.

### **1.7.3 Operations Training**

This element includes the resources required to perform training for flight operations.

### **1.7.4 Simulator Maintenance**

This element includes the resources required to perform training for flight simulator support.

### **1.8 Post Acceptance Support**

This element includes the resources required to perform sustaining engineering support of the satellite after acceptance by the government.

### **1.9 Special Studies & Tasks**

This element includes the resources required to perform special studies and tasks as directed by the government.

### **1.10 Education & Public Outreach**

This element includes the resources required to perform education and public outreach.

## **2.0 Spacecraft #2**

The Contractor will include within this WBS element at a minimum, all sub-elements to the level described in this document. This will assist the government in organizing, describing, and reporting the design, analysis, fabrication, assembly, integration, testing, and operation of the GOES-R satellite.

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## **2.1 Program Management**

### **2.1.1 Program Management Office**

This element defines the business and administrative planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish overall program objectives, which are not associated with specific hardware or software elements. This element includes project reviews and documentation, non-project owned facilities, and project reserves. It excludes costs associated with technical planning and management, and costs associated with delivering specific engineering, hardware and software products.

### **2.1.2 Resource Management**

This element defines the program control and management systems that provide for Work-Breakdown Structure (WBS) development, acquisition management, information technology management, resource management, Earned-Value Management (EVM), facilities, environmental, logistics and schedule management.

#### **2.1.2.1 Configuration and Information Management**

This element defines the control of performance, functional and physical characteristics over the program and product life cycle. Configuration management is applied to requirements, documentation, software and hardware. Hardware includes qualification hardware; engineering, proto-flight, flight hardware; and ground support equipment.

### **2.1.2.2 Information Technology Management**

This element defines the technical and management efforts to provided software and hardware infrastructure support.

### **2.1.3 Risk Management**

This element defines the continuous, iterative, and proactive process to manage risk and achieve mission success. The process involves identifying, analyzing, planning, tracking, controlling, documenting, and communicating risks effectively. Risk is characterized by the combination of the probability or likelihood that the program will experience an event and the consequences, impact, or severity of the event, were it to occur.

### **2.1.4 Government Resident Office**

This element defines the resources to 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 NASA residents and Government visitors.

### **2.1.5 Program Communication**

This element defines the technical preparation and administrative support for all program reviews and joint meetings.

- a) Kick-Off Meeting
- b) Teleconferences
- c) Project Management Reviews (PMR)
- d) Technical Interchange Meetings (TIM)

### **2.1.6 Design Reviews**

- a) Systems Definition Review (SDR)
- b) Subsystem Reviews
- c) Subcontract Reviews
- d) Preliminary Design Review (PDR)
- e) Critical Design Review (CDR)
- f) Design Modification Reviews
- g) Pre-Environmental Review (PER)
- h) Satellite Pre-Storage/Pre-Shipment Review (PSR)

### **2.1.7 Miscellaneous Reviews**

The element defines the resources required for the following reviews:

- a) Integrated Baseline Review (IBR)
- b) Engineering Peer Reviews
- c) Software Reviews including the Software Test Readiness Review and the Software Qualification Review.
- d) Test Reviews
- e) Instrument Receiving Reviews



### **2.1.8 Review Support**

The element defines the support to the Government for the following reviews:

- m) Independent Review Team (IRT) reviews
- n) Standing Review Board (SRB) reviews.
- o) Instrument design reviews.
- p) Ground Segment design reviews.
- q) Mission Operation Review (MOR).
- r) Management Readiness Review (MRR)
- s) Program System Integration Review (SIR)
- t) Flight Readiness Review (FRR).
- u) Launch Readiness Review (LRR).
- v) Flight Operations Review (FOR).
- w) Operation Readiness Review (ORR).
- x) Phase 0/I, II, III Safety Reviews at the Kennedy Space Center (KSC).

## **2.2 Systems Engineering (SE)**

Systems engineering is the technical and management efforts of directing and controlling an integrated engineering effort for the project. This element includes the efforts to define the spacecraft, conducting trade studies; the integrated planning and control of the technical program efforts of design engineering, software engineering, system architecture development, and integrated test planning, system requirements writing, configuration control, technical oversight, control and monitoring of the technical program. Documentation Products include mission/system requirements document (MSRD); interface control documents (ICDs); and verification and validation (V&V) plan. Excludes any design engineering costs.

### **2.2.1 Systems Engineering Management**

This element is the activities that directly manage all systems engineering efforts for each spacecraft development.

### **2.2.2 Systems Engineering Support**

This element is the systems engineering to support the functional design and development of the spacecraft and incorporation of the instruments.

### **2.2.3 System Designs, Analysis and Trades**

This element is the system studies and trades and risk assessment to develop the design for the spacecraft.

### **2.2.4 Requirements and Specification Generation**

This element is the activities that define, implement, and maintain a Systems Engineering Requirements Management System for managing, detailing, organizing, controlling, and linking the spacecraft requirements.

### **2.2.5 Performance Verification Plans and Procedures**

This element is the 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.

## **2.2.6 Interface Definition and Control**

### **2.2.6.1 Instrument Interfaces**

This element is the systems analysis and engineering to define all aspects of the spacecraft-to-instrument interfaces.

### **2.2.6.2 Ground Interfaces**

This element is the systems analyses and engineering to define all aspects of the space communications interfaces.

### **2.2.6.3 Launch Vehicle Interfaces**

This element is the systems analyses and engineering to define all aspects of the spacecraft-to-launch vehicle interface.

## **2.2.7 Contamination**

This element is the resources to assure that appropriate contamination control is maintained through all phases the development and of integration and test of the spacecraft.

## **2.3 Safety & Mission Assurance (S&MA)**

This element is all resources 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**

This element is all resources to perform all work 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**

This element is all resources to perform parts control for the spacecraft as defined in the SCMAR.

### **2.3.3 Materials and Processes Control**

This element is all resources to comply with the Materials and Processes Control requirements for the spacecraft as defined in the SCMAR.

### **2.3.4 Reliability**

This element is all resources to comply with the Reliability requirements for the spacecraft as defined in the SCMAR.

### **2.3.5 Quality Assurance**

This element is all resources to comply with the Quality Assurance requirements for the spacecraft as defined in the SCMAR.

### **2.3.6 Software Assurance**

This element is 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**

This element is 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.

#### **2.3.6.2 Software Validation and Verification**

This element is all resources to implement a Software Validation and Verification (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.

#### **2.3.6.3 Independent Validation and Verification**

This element is all resources to support Independent Validation and Verification efforts.

#### **2.3.6.4 Software Problem Reporting and Corrective Action**

This element is all resources 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.

## **2.4 Spacecraft**

The spacecraft bus is the platform for carrying payloads, instruments, and other mission-oriented equipment in space to achieve the mission objectives. This element includes all design, analysis, fabrication, assembly, test efforts required to deliver the spacecraft subsystems for integration and test. This element does not include integration and test of the spacecraft bus, spacecraft, or satellite.

### **2.4.1 Spacecraft Management**

The Spacecraft Management element includes all resources related to systems engineering, project management of the bus hardware and software. As stated above, this element does not include integration and test with instruments, ground system, or launch vehicle.

### **2.4.2 Mechanical**

The Mechanical subsystem is the bus structure and mechanisms. It includes all resources related to the design, development, production, positioning, integration and test of the bus structure and mechanical parts. Any structure and mechanism support equipment is also included.

### **2.4.3 Thermal**

The Thermal subsystem is the active and passive devices, and thermal support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the active and passive thermal components.

#### **2.4.4 Guidance, Navigation and Control (GN&C)**

The GN&C subsystem includes all orbit determination, orbit control, attitude determination and attitude control functions. It includes all related GN&C flight hardware components and propulsion interfaces; as well any necessary GN&C support equipment. It includes all activities related to the design, development, production, integration, test, launch and on-orbit checkout of the above components.

#### **2.4.5 Command and Data Handling (C&DH)**

The C&DH subsystem is command and telemetry electronics, Spacewire and GN&C support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **2.4.5.1 C&DH Harnesses**

This element is the harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.6 Communications (COMM)**

##### **2.4.6.1 Space/Ground Communication**

The Communications subsystem is the, antennas, all active and passive Radio Frequency (RF) components including but not limited to MMICs, filters, hybrids, attenuators and communications support equipment. This includes the RF sections of the Telemetry, Tracking, and Command (TT&C) subsystem. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **2.4.6.2 Auxiliary Communication Services**

The Auxiliary Communication Services subsystem encompasses the structure, software, and support equipment of the GOES Rebroadcast service (GRB) and the Unique Payload Services. The Unique Payload Services consist of Data Collection System (DCS), Low-Rate Information Transfer (LRIT), Search-and-Rescue Satellite (SARSAT), and Emergency Managers Weather Information Network (EMWIN). It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **2.4.6.3 COMM Harnesses**

This element is the harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.7 Power**

This subsystem is the power generation, power conditioning, power storage, harnesses, cables, and electrical support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

##### **2.4.7.1 Battery**

This element is the power storage. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.7.2 Solar Array**

This element is the power generation. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.7.3 Power Regulation and Conditioning**

This element is the power conditioning. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.7.4 Power Harnesses**

This element is the power distribution including all harnesses, cables, and support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

#### **2.4.8 Propulsion**

This subsystem is the tanks, plumbing, thrusters, propellants, and propulsion support equipment. It includes all activities related to the design, development, production, integration, test, launch and on-orbit checkout of the above components.

#### **2.4.9 Flight Software**

The Flight Software subsystem for the Bus subsystem encompasses the flight software for components of the bus, to include the Thermal, GN&C, C&DH, Communications, Electrical, Magnetometer, and Propulsion elements. The primary activities for the Flight Software element are systems engineering, software project management, algorithm development, and subsystem integration and test. The activities of requirements analysis, design, coding and unit testing, and unit integration and testing are also included.

#### **2.4.10 Magnetometer**

The Magnetometer instrument (subsystem) encompasses the magnetometer sensor, structure, mechanisms, and magnetometer support equipment. It includes all resources related to the design, analysis, fabrication, assembly, and test of the above components.

### **2.5 Ground Support Equipment (GSE)**

This element includes the resources all GSE required to assemble, integrate, and test the spacecraft.

#### **2.5.1 Mechanical GSE (MGSE)**

This element includes the resources required to provide MGSE.

#### **2.5.2 Electrical GSE (EGSE)**

This element includes the resources required to provide EGSE.

#### **2.5.3 GSE and Simulator Software**

This element includes the resources required to provide non-flight software.

#### **2.5.4 Simulators**

This element includes the resources required to provide spacecraft simulators.

### **2.6 Integration and Test (I&T)**

This element includes the resources required to perform the integration and test of the spacecraft bus, instruments, payloads, launch vehicle, and ground system.

#### **2.6.1 Spacecraft I&T**

This element includes the resources required to perform the integration and test of the spacecraft subsystems including COMM and the magnetometer onto the spacecraft bus.

#### **2.6.2 Satellite I&T**

This element includes the resources required to perform the integration and test of the GFP instruments onto the spacecraft.

##### **2.6.2.1 Special Testing**

This element includes the resources required to perform Special Testing.

##### **2.6.2.2 End-to-End (ETE) Testing**

This element includes the resources required to perform ETE Testing.

#### **2.6.3 Transportation and Handling**

This element includes the resources required to perform transportation and handling

#### **2.6.4 Storage**

This element includes the resources required to provide storage of the spacecraft bus, spacecraft, GFP instruments, and satellite.

### **2.7 Launch and Operations**

This element includes the resources required to perform launch site processing, pre-launch flight operations support, and operations support through completion of satellite deployment and checkout.

#### **2.7.1 Satellite/Launch Vehicle I&T**

This element includes the resources required to perform integration of the satellite onto the launch vehicle.

#### **2.7.2 Flight Operations**

This element includes the resources required to flight operations support.

#### **2.7.3 Operations Training**

This element includes the resources required to perform training for flight operations.

#### **2.7.4 Simulator Maintenance**

This element includes the resources required to perform training for flight simulator support.

**2.8 Post Acceptance Support**

This element includes the resources required to perform sustaining engineering support of the satellite after acceptance by the government.

**2.9 Special Studies & Tasks**

This element includes the resources required to perform special studies and tasks as directed by the government.

**2.10 Education & Public Outreach**

This element includes the resources required to perform education and public outreach.

### **3.0 Spacecraft #3**

Once Option #1 is exercised, the Contractor will include within this WBS element at a minimum, all sub-elements to the level described in this document. This will assist the government in organizing, describing, and reporting the design, analysis, fabrication, assembly, integration, testing, and operation of the GOES-R satellite.

The Contractor will organize and report design and analysis separately from fabrication, assembly and test in separate WBS sub-elements.

The Contractor will organize and report non-recurring and recurring cost in separate WBS sub-elements.

### **4.0 Spacecraft #4**

Once Option #2 is exercised, the Contractor will include within this WBS element at a minimum, all sub-elements to the level described in this document. This will assist the government in organizing, describing, and reporting the design, analysis, fabrication, assembly, integration, testing, and operation of the GOES-R satellite.

The Contractor will organize and report design and analysis separately from fabrication, assembly and test in separate WBS sub-elements.

The Contractor will organize and report non-recurring and recurring cost in separate WBS sub-elements.

### **5.0 Spares**

The Contractor will include within this WBS element all spare parts and materials for Spacecraft #1 and Spacecraft #2. The Contractor will include within this WBS element all parts and materials for Spacecraft #3 and Spacecraft #4, when authorized to procure parts and material for those spacecraft. Upon exercising the Option #1 for Spacecraft #3, the parts and materials for required to build that spacecraft shall be moved, tracked, and reported in WBS element 3.0. Upon exercising the Option #2 for Spacecraft #4, the parts and materials for required to build that spacecraft shall be moved, tracked, and reported in WBS element 4.0. All resources for each spacecraft will be organized, tracked, and reported in separate WBS sub-elements.

#### **5.1 Spare Parts and Material**

This element includes spare parts and material including wire and connectors to support two spacecraft.

#### **5.2 Spare Assemblies/Subassemblies**

This element includes fabrication, assembly and testing of assemblies and subassemblies.

##### **5.2.1 Mechanical Spares**

This element includes fabrication, assembly and testing of Mechanical Subsystem spares.



**5.2.2 Thermal Spares**

This element includes fabrication, assembly and testing of Thermal Subsystem spares.

**5.2.3 GN&C Spares**

This element includes fabrication, assembly and testing of GN&C Subsystem spares.

**5.2.4 C&DH Spares**

This element includes fabrication, assembly and testing of C&DH Subsystem spares.

**5.2.5 COMM Spares**

This element includes fabrication, assembly and testing of COMM Subsystem spares.

**5.2.6 Power Spares**

This element includes fabrication, assembly and testing of Power Subsystem spares.

**5.2.7 Propulsion Spares**

This element includes fabrication, assembly and testing of Propulsion Subsystem spares.

**5.2.8 Magnetometer Spares**

This element includes fabrication, assembly and testing of Magnetometer Instrument spares.

**Effective Date:** (Date of last signature)

**417-R-SCWBS-0060**

**Version2.2**

**417-R-SCWBS-0060 DCR**

**CCR #:** 01111 Rev  
Contract # NNG0 - TBD  
CCB Status: **Approved**  
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Contract Mod#: **N/A**  
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**Title:** Baseline Spacecraft WBS  
GOES S/C: R Effectivity: SUVI Instrument  
Doc #: 417-R-SCWBS-0060  
Doc Section: All  
DOORS Version: SC WBS 2.0  
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**CCR #:** 01126 Rev  
Contract # NNG0 - TBD  
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**Title:** SC WBS Clarification of Spares & Materials  
GOES S/C: R Effectivity: SUVI Instrument  
Doc #: 417-R-SCWBS-0060  
Doc Section: 5.0  
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**Title:** Spacecraft WBS Changes for S/C RFP Release  
GOES S/C: R Effectivity: SUVI Instrument  
Doc #: 417-R-SCWBS-0060  
Doc Section: All  
DOORS Version: SC WBS 2.2  
DOORS ID #: N/A