

# **Restore Mission**

## **Statement of Work for the Vision Sensor Subsystem Camera**



**Goddard Space Flight Center  
Greenbelt, Maryland**

## CM FOREWORD

This document is a RESTORE Project controlled document. Changes to this document require prior approval of the RESTORE Project CCB Chairperson. Proposed changes shall be submitted to the RESTORE Project Configuration Management Office (CMO), along with supportive material justifying the proposed change.

Questions or comments concerning this document should be addressed to:

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Statement of Work for the VSS Camera for the Restore

**DOCUMENT CHANGE RECORD**

REV/ VER LEVEL	DESCRIPTION OF CHANGE	APPROVED BY	DATE APPROVED
-	Baseline Release of Document		

**Statement of Work for RESTORE Project  
VSS Camera**

**RECORD OF WAIVERS**

APPLICABLE SECTION	DESCRIPTION OF WAIVER

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# **1 Introduction**

## ***1.1 General Information***

The Satellite Servicing Capabilities Office (SSCO) was established in 2009 to continue NASA's 40-year legacy of satellite servicing and repair. Among its various pursuits, SSCO has conducted a detailed engineering study of a notional mission: a free flying satellite with advanced robotics to perform refueling and other servicing. Restore is the internal name for this design reference mission.

The Restore mission is a free-flying mission to be launched in 2018 conducted with a U.S. industry partner to initiate on-orbit satellite servicing to operational legacy Government and commercial satellites. Notional operational locations include, Geosynchronous Orbit (GEO), Low Earth Orbit (LEO) and interplanetary environments (2 AU).

This document defines the work to be performed for Contractor design, development, fabrication, and delivery of the Restore Vision Sensor Subsystem (VSS) Camera, from here on referred to as the VSS Camera.

The SSCO staff is comprised of federal and contractor staff, any of whom may interface with the Contractor's team.

## ***1.2 General Requirements***

The Contractor shall provide the facilities, personnel, services, tools, equipment, and materials necessary to deliver VSS Camera for Restore.

The Contractor shall fabricate, test and deliver the following units of hardware/software:

- Minimum order quantity of one (1) protoflight model, as defined in the accompanying camera specification document (RESTORE-SPEC-001394), herein referred to as the Specification. All sections of the Specification document shall apply to this unit.
- Minimum order quantity of two (2) Engineering Model (EM) units, as defined in the accompanying Specification document. The EM camera shall be of the same fit, form and function as a space-capable unit. It shall have the same size, weight and power (SWAP) footprint as the space-capable version. The EM model may use commercial electrical parts throughout its design under the assumption that the commercial parts can be swapped one-for-one with a space-suitable component with no changes required to the camera design. GSFC will wave all environmental testing for the EM units. As such, Section 5.5 of the Specification, with the exception of subsection 5.5.1 and 5.5.2, does not apply.

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- Minimum order quantity of two (2) sets of Electrical Ground Support Equipment (EGSE) that will allow a user to power, command, view images/video from and save images/video from, a VSS camera.
- Complete set of software deliverables per the Specification.
- Contractor provides 10 hours of post-delivery technical support via phone and email regarding the VSS Camera.

## **2 Management, Reporting, Documentation and Reviews**

### ***2.1 Applicable Documents***

All applicable and reference documentation identified in this document shall apply in the situations where they are specifically referenced. In the event of a conflict between the SOW and the Specification, the SOW shall take precedence. See Appendix C for referenced documents.

### ***2.2 Management and Reporting***

The Contractor shall designate a single individual who will be given full responsibility and authority to manage and administer all phases of the work specified by the contract, and ensure that all objectives are accomplished within schedule and cost constraints.

The Contractor shall provide for managing all resources, controlling schedules, managing all engineering, manufacturing and procurement activities, configuration management, Quality Assurance, documentation control, and distribution.

The Contractor shall prepare and present to the NASA/GSFC Technical Representative monthly status via telecon and a written report. The report shall be a summary presentation of the period's progress, problem areas, and activities on-going and planned. The Contractor shall generate a list of significant milestones that will enable NASA/GSFC to ascertain program progress. The designated Contractor point of contact to GSFC will be responsible for scheduling the monthly status telecons with the NASA/GSFC Technical Representative.

### ***2.3 Reviews and Meetings***

In addition to the listed reviews and meetings below, NASA/GSFC requests that the Contractor provide advance notice for all functional and environmental testing. NASA/GSFC reserves the right for Technical Representative and Quality Assurance staff to be present during testing activities at the Contractor's facility.

### **2.3.1 Kick-Off Meeting (KO)**

The Contractor shall organize and present a Kick-Off Meeting to a NASA/GSFC Review Team at the Contractor's facility on a date defined in the contract. The Contractor shall expect to host 3-5 GSFC engineers for the duration of the meeting. This review shall demonstrate overall conformance of the requirements specified in the Specification and this Statement of Work. This review shall cover programmatic, technical, schedule, test and verification, and quality assurance topics. During this review, the contractor will also be required to present their preliminary design of the VSS camera.

The Contractor shall provide to GSFC the Kick-Off Presentation Package and all other required deliverable data within one week of the formal Kick-Off meeting.

Review minutes shall be prepared and, as a minimum, shall include attendance, action items, action item accomplishment responsibility and agreements. All items shall be in sufficient detail to be self-explanatory.

### **2.3.2 Critical Design Review**

The Contractor shall organize and conduct a Critical Design Review at the Contractor's facility before the fabrication program begins. This review shall demonstrate overall conformance of the requirements specified in the Specification and this Statement of Work for this phase of the procurement. Additionally, this review will be used to discuss plans for environmental and functional testing. NASA/GSFC requests that the Contractor provide as-designed parts list, for the protoflight unit at the Critical Design Review.

### **2.3.3 Pre-Ship Review (PSR)**

The Contractor shall hold a Pre-Ship Review (PSR) at the Contractor's facility at the completion of verification tests and prior to shipment of the hardware to NASA/GSFC. A PSR shall be held prior to the delivery of the hardware items. A Data Delivery Package shall be presented for review at the PSR. The PSR will be used to discuss results of the functional and environmental testing, details regarding the conclusion of the contract and the delivery of the hardware to NASA/GSFC:

### **2.3.4 Technical Interchange Meeting (TIM) Path to Flight**

The Contractor shall plan for an informal, face-to-face technical interchange meeting to be held at the Contractor's facility. This Technical Interchange Meeting (TIM) shall serve as a forum to discuss the Contractor's path forward in potentially manufacturing 20 – 25 additional flight cameras for NASA/GSFC. This TIM is NOT to be construed as a commitment by the Government to enter into a contractual agreement for these additional flight units. NASA/GSFC is specifically interested in how economies of scale may be realized in the event that a second contract for flight units is announced.

## **2.4 Notification to NASA/GSFC**

The Contractor shall notify the NASA/GSFC Technical Representative at least five (5) calendar days in advance of all mandatory hardware inspections, test activities, and deliveries at either the Contractor's or a sub-Contractor's facility to allow timely participation by the NASA/GSFC Quality Assurance activities.

## **3 Engineering**

### **3.1 General Requirements**

The Contractor shall perform analyses of the technical and environmental requirements specified in the Specification document to ensure compliance of the hardware fabrication and to assemble the documentation necessary to ensure its usability by NASA/GSFC users.

### **3.2 Engineering Documentation**

The system engineering analyses of the detailed design and subsequent fabrication and assembly, test, and inspection of the VSS Camera shall result, as a minimum, in the technical documentation, as required in this SOW and Specification document. Contractor format is suitable for this documentation.

#### **3.2.1 Mechanical and Electrical Hardware Documentation**

In addition to any documentation called for in a final contract, NASA/GSFC specifically requires the following documentation in support of the VSS camera hardware build:

- **Mechanical:**
  - High Fidelity mechanical CAD model for the VSS camera for the as-designed unit with updates provided for the as-built units.
  - A top-level mechanical Interface Control Document (ICD) that details the mechanical properties of the as-built VSS camera.
  - Mechanical assembly drawings showing how the VSS camera is assembled from subassembly and component parts.
  - Mechanical drawings of all subassemblies and individual mechanical components that make up the final as-built VSS camera.
- **Electrical:**
  - As-designed parts lists for the VSS camera. The list shall include the original equipment manufacturer (OEM) of each part, its corresponding OEM part number, serial number, lot number or any other relevant traceability information.
  - An electrical ICD detailing the electrical interface of the VSS camera. This document shall contain detailed specifications regarding the pin outs of any input / output connectors, the format and structuring of any command / data interfaces, as well as any other pertinent information that GSFC will need to

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power, control and command the camera. Details on the structure and any status / telemetry packets is also required.

- The OEM manufacturer's specification document for the Focal Plane Array (FPA) used in the VSS camera.
- Documentation regarding the camera's demosaicing algorithm (if applicable per the Specifications document).

If not included in the above details, the Contractor shall provide a document or documents that define, in detail, all performance, functional, environmental specifications, and all command, data, electrical, and mechanical interfaces.

If not included in the above details, the Contractor shall provide a drawing package that includes, but is not limited to;

- ELECTRICAL: assembly and interface drawings
- MECHANICAL: assembly and interface drawings

### 3.2.2 Kick-Off Presentation Package

The Contractor shall provide a Kick-Off Presentation Package to NASA/GSFC. The Kick-Off Presentation Package shall address all program management, design, analysis, manufacturing, test, and quality assurance activities outlined in this SOW and Specification in sufficient detail to ensure that the proposed product conforms to all requirements. At a minimum, the design package should cover the following areas:

- Program Management
- Quality Assurance
- Reliability Data (including assessment and predictions)
- Electrical, Mechanical, and Environmental specifications
- Preliminary design of the VSS camera
- Parts List, including stress analysis and radiation hardness assessment
- Detailed architectural block diagrams for the different deliverable units
- Manufacturing flow with inspection points
- Facilities
- Verification test plan (Including Performance Test Description)
- Materials and Processes
- Thermal analyses
- Mechanical/Structural analyses
- Electrical Worst-Case analyses
- Failure Modes Effects Analysis
- Flight Heritage
- SOW Compliance Matrix
- Specification Compliance Matrix
- Contamination Control Plan
- Environmental Qualifications
- Technical Issues Report

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The Contractor shall generate a SOW Compliance Matrix listing each section in this Statement of Work reflecting either compliance or non-compliance. The Contractor shall generate a Specification Compliance Matrix listing each section in the Specification reflecting either compliance or non-compliance. Areas of non-compliance need to be addressed by the Contractor showing how they would meet the requirement(s) for flight units or why it will remain non-compliant for a future flight model of the units.

### 3.2.3 Data Delivery Package

The Data Delivery Package shall be made available for review during mandatory inspections and pre-ship reviews for each of the different hardware deliverables. This package shall also be delivered with each end item with the level of detail required of that item. The package should be comprised of, but not limited to, the following data:

#### All Items:

- As-Built vs. As Designed Parts List, (includes serialization/revisions)
- Final Drawing Package (including rework instructions, if any)
- Critical Parameters Trend Data
- Problem/anomaly reporting (complete copies of report)
- Deviations/Waivers/open items/nonconformances and their dispositions
- Class I MRBs (complete copies of reports)
- List of Materials and Processes used
- Log of total operating time
- List and status of all identified Life-Limited Items
- SOW and Specification verification matrix, test data and reports
- Flight connector mate/demate log (Flight Unit only)
- Photograph Documentation (Pre-Closure and Closed)
- Certificate of Conformance
- Open Items with proposed closure dates
- As-run test procedures and results for all functional performance tests
- As-run test procedures and results for all electrical tests
- As-run test procedures and results for all environmental tests
- Final versions of the mechanical and electrical ICDs

Minor deviations in the Data Delivery Package may be approved on a case-by-case basis by the NASA/GSFC Technical Representative.

In addition to the items listed above, NASA/GSFC requires that the Data Delivery Package include a cost per unit for any future VSS flight cameras that may be required from the Contractor. The contractor must note the per unit cost savings that may be realized if minimum order quantities are increased to 20 – 25 flight units. The Contractor must specify how any Non-Reoccurring Engineering (NRE) costs that are part of this initial contract will benefit NASA/GSFC in terms of cost savings for future flight units.

### **3.2.4 Verification**

The Contractor shall conduct a verification program that demonstrates the hardware design is qualified and meets all requirements contained in the Specification document.

## **4 Hardware Manufacture**

### ***4.1 General Requirement***

The Contractor shall manufacture and test hardware to meet the requirements of the Specification document.

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

The VSS Camera GSE required to operate the VSS Camera shall be provided to NASA/GSFC for integration and testing of the VSS Camera.

## **5 Firmware/Software**

### ***5.1 Contractor Responsibilities***

Contractor will write, manage, and verify software for the EGSE that is required to operate the VSS Camera.

### ***5.2 Functional and Performance Modifications***

The Contractor shall provide software modifications as necessary to ensure functionality and performance of the VSS camera throughout the entirety contract phase.

## **6 Quality Assurance**

### ***6.1 General Requirements***

The Contractor shall manufacture and test hardware to meet the quality assurance requirements of the Specification document.

## **7 Contamination Control**

The Contractor shall establish the specific cleanliness requirements to minimize performance degradation and delineate the approaches to meet the Restore Project requirements.

### **7.1 Contamination Control Plan**

The Contractor shall submit their CCP, as currently used in their manufacturing facility, to NASA/GSFC for review. Review of the CCP will assist NASA/GSFC evaluation of Contractor facility capabilities for possible future flight unit manufacture.

If data is available, ideally the CCP will:

- Establish the implementation and describe the methods and procedures that will be used to measure and maintain the levels of cleanliness required during each of the various phases of the item's lifetime.
- Describe the contamination potential of material and equipment used in cleaning, handling, packaging, tent enclosures, shipping containers, bagging (e.g., anti-static film materials), and purging in detail at each phase of assembly, integration, and test.
- Define the use of protective covers and purges, vent locations and paths, and environmental constraints.

## **8 Handling, Storage, Packaging, Preservation, and Delivery**

Products shall be stored, preserved, marked, labeled, packaged, and packed to prevent loss of marking, deterioration, contamination, excessive condensation and moisture, or damage during all phases of the program.

Contractor is responsible for providing an acceptable shipping container that protects the hardware appropriately, such as a pelican case or similar container. While in a shipping container, the VSS Camera shall be wrapped in a non-ESD-generating vapor barrier with redundant maximum humidity indicators.

The shipping container shall also include shock and humidity indicators and shall be capable of prolonged shipping conditions. The Contractor shall document what action NASA/GSFC is to take if the sensors are tripped when hardware arrives at the NASA/GSFC receiving area. A copy of this document shall be included with shipping documentation.

The Contractor shall ship Freight On Board (F.O.B.) Greenbelt, Maryland. The Contractor has responsibility for any damage incurred during shipment.

## 9 Schedule

The Contractor shall furnish and deliver the supplies/documentation and perform the services required by this Statement of Work in accordance with the schedule set forth below:

<b>Item</b>	<b>On or Before</b>
Contractor shall conduct Monthly Status Meeting/Reports.	Beginning one (1) month from ARO and continuing until delivery of unit
Contractor supplies NASA/GSFC with a Kick-Off Presentation Package.	Within one week of Kick-Off Meeting
Contractor hosts a Kickoff Meeting.	Within two (2) months of ARO
Contractor hosts a Critical Design Review.	Two (2) weeks prior to Manufacturing of protoflight hardware
Contractor provides an as-designed parts list, for the protoflight unit.	At the Critical Design Review
Contractor supplies NASA/GSFC with an electrical Interface Control Document.	Two (2) weeks prior to Pre-Ship Review
Contractor supplies NASA/GSFC with a Drawing Package.	Two (2) weeks prior to Pre-Ship Review
Contractor hosts a Pre-Ship Review.	Two (2) weeks prior to hardware delivery to NASA/GSFC
Contractor delivers minimum order quantity of two (2) Engineering Model (EM) and a single protoflight unit of the VSS Camera and associated hardware & software deliverables to NASA/GSFC.	No later than October 2015, if possible
Contractor supplies NASA/GSFC with a Data Delivery Package.	To accompany hardware unit delivery
Complete set of software to accompany each hardware unit.	To accompany hardware unit delivery
Complete set of GSE to accompany each hardware unit.	To accompany hardware unit delivery
Contractor provides 10 hours of post-delivery technical support via phone and email regarding the VSS Camera.	Post-delivery of hardware until completion of Subsystem I&T
Contractor hosts a Technical Interchange Meeting to discuss VSS Camera Path to Flight.	Prior to close of contract

## **10 Instructions to Respondents**

NASA appreciates responses from all capable and qualified sources including, but not limited to, NASA Centers, universities, university affiliated research centers, federally funded research and development centers, private or public companies, and government research laboratories.

Respondents shall address the following programmatic items in their RFP response:

- Name of corporate point of contact, telephone number, full mailing address, and e-mail address.
- Corporate competencies and past performance experience with regard to the development and production of similar camera systems.
- Respondent's previous experiences in building flight hardware for NASA, DoD, or private firms.
- Respondent's ability to conduct functional acceptance testing of camera units prior to delivery, and ability to provide relevant test plans, procedures, and the results of these tests at the time of the camera units delivery. This includes both functional performance testing and environmental qualification tests such as thermal vacuum and vibration testing. Such activities would be required under any future award call.
- Respondent's ability to provide relevant camera system specification documents including, but not limited to, system drawings, parts lists, electrical, optical, and software Interface Control Documents (ICDs).
- Delivery lead times for the various camera hardware deliverables (EM & protoflight units) from the date of any potential ARO.
- Cost breakdown between the protoflight unit and Engineering Model units for the assumed minimum order quantities stated in Section 1.2 of this document. Respondents are also encourage to note per unit cost savings that may be realized if minimum order quantities are increased.

## 11 APPENDIX A: Abbreviations and Acronyms

ABBREVIATION/ ACRONYM	DEFINITION
ANSI	American National Standards Institute
ATP	Acceptance Test Procedure
BBU	Breadboard Unit
BSP	Board Support Package
C&DH	Command and Data Handling
CCP	Configuration Control Plan
CDR	Critical Design Review
CM	Configuration Management
CO	Contracting Officer
TECHNICAL REPRESENTATIVE	Contracting Officer Technical Representative
CVCM	Collected Volatile Condensable Mass
DPA	Destructive Physical Analysis
ESD	Electrostatic-Discharge
FMEA	Failure Modes and Effects Analysis
FRB	Failure Review Board
GEO	Geosynchronous Orbit
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
LEO	Low Earth Orbit
MIP	Mandatory Inspection Point
MRB	Material Review Board
MUA	Materials Usage Agreement
PEMs	Plastic Encapsulated Microcircuits
PER	Pre-Environmental Review
PIL	Parts Identification List
PIND	Particle Impact Noise Detection
PSR	Pre-Ship Review
PWB	Printed Wiring Board
QA	Quality Assurance
QCM	Quartz Crystal Microbalance
ROM	Read-Only Memory
SCC	Stress Corrosion Cracking
SCM	Software Configuration Management
S/C	Spacecraft
SEE	Single-Event Effects
SOW	Statement of Work
SUROM	Startup Read-Only Memory
TML	Total Mass Loss
TID	Total Ionizing Dose
TIM	Technical Interchange Meeting
TPL	Trended Parameters List
TQCM	Thermal Quartz Crystal Microbalance
VSS	Vision Sensor Subsystem
WVR	Waiver

## 12 APPENDIX B: Restore Material Usage Agreement Form

<b>MATERIAL USAGE AGREEMENT (MUA)</b>			<b>USAGE AGREEMENT NO.:</b>			<b>PAGE OF</b>			
<b>PROJECT:</b>		:		<b>ORIGINATOR:</b>			<b>ORGANIZATION:</b>		
<b>DETAIL DRAWING</b>		<b>NOMENCLATURE</b>			<b>USING ASSEMBLY</b>			<b>NOMENCLATURE</b>	
<b>MATERIAL &amp; SPECIFICATION</b>					<b>MANUFACTURER &amp; TRADE NAME</b>				
<b>USAGE</b>	<b>THICKNESS</b>	<b>WEIGHT</b>	<b>EXPOSED AREA</b>	<b>ENVIRONMENT</b>					
				<b>PRESSURE</b>	<b>TEMPERATURE</b>	<b>MEDIA</b>			
<b>APPLICATION:</b>									
<b>RATIONALE:</b>									
<b>ORIGINATOR:</b>				<b>PROJECT MANAGER:</b>				<b>DATE:</b>	

### 13 APPENDIX C: List of Referenced Documents

All referenced documentation identified in the SOW shall apply in the situations where they are specifically referenced.

DOCUMENT NUMBER	TITLE	Revision/Date
RESTORE-SPEC-001394	Performance Specification: Restore VSS Camera	10/22/14
541-PG-8072.1.2	GSFC Fastener Integrity Requirements	03/05/01
ANSI/ASQ9001-2000	Model for Quality Assurance Design, Development, Production, Installation, and Servicing	8/91
NASA-STD-8739.7	Electrostatic Discharge Control	12/15/97
NASA-STD-8739.3	Requirements for Soldered Electrical Connections	12/15/97
NASA-STD-8739.4	Requirements for Crimping Interconnecting Cables, Harnesses, and Wiring	02/09/98
NASA-STD-8739.2	Workmanship Standard for Surface Mount Technology	08/31/99
NASA-STD-8739.1	Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies	08/06/99
S312-P-003	Procurement Specification for Rigid Printed Boards for Space Flight Applications and Other High Reliability Uses	07/16/97 Revision B
EEE-INST-002	Instructions for EEE Parts Selection, Screening, Qualification, and Derating	05/01/03
IPC-D-275	Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies	09/30/91
IPC-2223	Sectional Design Standard for Flexible Printed Boards	11/01/98
IPC-2222	Sectional Design Standard for Rigid Organic Printed Boards	02/01/98

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IPC-2221	Generic Standard on Printed Board Design	05/01/03 Revision A
IPC-A-600	Acceptability of Printed Boards	11/01/99 Revision F
IPC-6011	Generic Performance Specification for Printed Boards	07/01/96
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards	07/01/00 Revision A
IPC-6013	Qualification and Performance Specification for Flexible Printed Boards	11/01/98
S-311-M-70	Destructive Physical Analysis. Equivalent	01/07/91
NASA-STD-6001	Flammability, odor, off-gassing and compatibility requirements & test procedures for materials in environments that support combustion	02/09/98
MIL-STD-1629	Procedures for Performing an FMEA	Revision A
MSFC-STD-3029	Multiprogram/project common-use document guidelines for the selection of metallic materials for stress corrosion cracking resistance in sodium chloride environments	05/22/00
ASTM E-595	Standard test method for total mass loss and collected volatile condensable materials from outgassing in a vacuum environment	10/01/03
NASA Reference Publication 1124	Outgassing Data for Selecting Spacecraft Materials	09/01/03
MIL-HDBK-217	Reliability Modeling and Prediction	Revision F