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James Webb Space Telescope Project

Statement of Work

for

James Webb Space Telescope Project
Micro-Shutter Assembly
Launch Lock Actuator

July 24, 2006

JWST GSFC CMO

July 24, 2006

RELEASED

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

CM FOREWORD

This document is a James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Subsystem Configuration Management (CM)-controlled document. Changes to this document require prior approval of the Subsystem CCB Chairperson or designee. Proposed changes shall be submitted to the JWST CM Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

WAIVERS AND DEVIATIONS

Waivers and deviations against this document can be found in the NGIN library https://ngin.jwst.nasa.gov/ under this document record.

Questions or comments concerning this document should be addressed to:

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JAMES WEBB SPACE TELESCOPE PROJECT

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1.0 INTRODUCTION

1.1 GENERAL INFORMATION

The National Aeronautics and Space Administration (NASA) has the stated mission to design, develop, integrate, launch, and operate the James Webb Space Telescope (JWST) Project.

The JWST is a large infrared-optimized space telescope. JWST is designed to study the earliest galaxies and some of the first stars formed. JWST is scheduled to launch in 2013 into a Lissajous orbit (L2) with a mission life of 5 to 10 years.

One of the three instruments on board JWST is the Near-Infrared Spectrograph (NIRSpec). The NIRSpec utilizes a micro-electromechanical system (MEMS) to provide dynamic aperture shutter masks that will enable users to observe hundreds of different objects in a single field of view. A magnet swept across the array of shutter masks provides for actuation of the shutters. This mechanism is referred to as the Micro-Shutter Assembly (MSA). A launch lock is required to prevent damage to the mechanism during launch. Opening and closing the launch lock is of paramount importance for the mission and requires high reliability in design and function.

This document defines the work to be performed for Contractor design, development, fabrication, and delivery of the MSA Launch Lock Actuator hardware as specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638). There are two configurations of the MSA Actuator Unit:

a. Ambient Temperature Actuator (ATA)

b. Helium Cryogenic Actuator (HCA)

The ATA units are to be used for laboratory testing at room temperature and are to be lubricated with wet lube like typical commercial units. Moreover, ATA units are to be built using the same processes as a typical commercial unit.

The HCA units are to be operated down to LHe cryogenic temperatures, so are required to be lubricated with dry lubricant. HCA units should be built in the same manner as a typical Flight Unit, though these HCA units will be used for cryogenic operation and environmental testing of Engineering Test Unit (ETU) MSAs. Rigorous control of processes and documentation are essential in order to ensure that life tests results are valid for future Flight Unit (FU) builds.

1.2 GENERAL REQUIREMENTS

The Contractor, or Contractor's supplier, *hereafter referred to as Contractor*, shall provide the facilities, personnel, and materials necessary to deliver a total of four (4) Actuators Units as follows:

a. One (1) ATA unit
b. Three (3) HCA units
c. Documentation and Deliverable Data per contract
    1. Certificate of Compliance
    2. Final inspection records
    3. Test reports from acceptance tests
    4. Material list, parts list, and processes used
    5. Assembly drawings
    6. Interface control drawings, including details of the shaft interface
    7. All Class I MRB activity and associated waiver requests
    8. Log of total operating time and conditions
    9. Parts Inspection Reports
    10. As-Built Assembly Procedures

2.0 MANAGEMENT, REPORTING, DOCUMENTATION AND REVIEWS

2.1 MANAGEMENT AND REPORTING

The Contractor shall designate a single individual who shall be given full responsibility and authority to manage and administer all phases of the work specified by the contract and to ensure that all objectives are accomplished within schedule and cost constraints. The Contractor shall designate and identify by name a single individual who shall serve as a point of contact with the Micro-Shutter Subsystem (MSS) Program Representative, *hereafter referred to as the MSS Project*, for all technical aspects of the Actuator contract.

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 MSS Project status reports as noted in Section 6 of this document.

The Program may assign one or more MSS program representatives.

2.2 DOCUMENTATION

The Contractor shall ensure the generation and delivery of all documentation as called for in the Contract.

In addition to that documentation specifically called for in the Contract, upon request by the MSS Project, the Contractor shall make available a copy of any document or data generated during this contract performance for review either at the Contractor's facility or via e-mail correspondence. This includes, but is not limited to, technical reports and memorandums, drawings, schematics, studies, analyses, parts and materials data, test data, alerts, etc.

2.3 REVIEWS AND MEETINGS

2.3.1 Design Conformance Review

The Contractor is not required to present a Design Conformance Review. A Design Conformance Review typically covers programmatic, technical, test and verification, and quality assurance topics. Its purpose is to demonstrate overall conformance of the specified requirements. In lieu of such a review, the Contractor shall provide a Certificate of Conformance that certifies that the actuator units conform to the requirements as specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) and this SOW.

2.3.2 Pre-Environmental Review

The Contractor is not responsible for Pre-Environmental Review (PER) activities. Environmental testing will not occur until after integration with the mechanism, which is after delivery by the Contractor of the Actuator Units.

2.3.3 Pre-Ship Review

The Contractor is not required to hold a Pre-Ship Review (PSR).

2.4 APPLICABLE DOCUMENTS

541-PG-8072.1.2	GSFC Fastener Integrity Requirements
ANSI/ASQ 9001-2000	Model for Quality Assurance Design, Development, Production, Installation, and Servicing
ANSI/ESD S20.20 -1999	Electrostatic Discharge Control
ASTM E-595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
GEVS-SE	General Environmental Verification Requirements
IPC-2222	Sectional Design Standard for Rigid Organic Printed Boards
IPC-2223	Sectional Design Standard for Flexible Printed Boards
JWST-SPEC-006638	Performance Specification for James Webb Space Telescope Project Micro-Shutter Assembly (MSA) Launch Lock Actuator
MIL-HBK-217	Reliability Modeling and Prediction
MIL-STD-1629	Procedures for Performing an FMEA
MSFC-STD-3029	Multiprogram/Project Common-Use Document Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments Materials, Processes, and Manufacturing Department Metallic Materials and Processes Group
NASA-STD-6001	Flammability, Odor, Off-Gassing and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion
NASA-STD-8739.3	Requirements for Soldered Electrical Connections
NASA-STD-8739.4	Requirements for Crimping Inter-connecting Cables, Harnesses, and Wiring
NASA-STD-8739.7	Electrostatic Discharge Control
RADC-TR-85-229	Reliability Prediction for Spacecraft
S-311-M-70	Destructive Physical Analysis Equivalent

3.0 ENGINEERING

3.1 GENERAL REQUIREMENTS

The Contractor shall perform analyses, as necessary, of the technical and environmental requirements specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) to ensure compliance of the hardware fabrication and to assemble the documentation necessary to ensure its usability by the Government.

3.2 ENGINEERING DOCUMENTATION

The system engineering analyses of the detailed design and subsequent fabrication and assembly, test, and inspection of the Actuator Units shall result, as a minimum, in the following technical documentation, as required in the Contract. Contractor format is suitable for this documentation.

3.2.1 Interface Control Document

A unique Actuator Unit assembly interface control document shall be prepared by the vendor and submitted to the Government for approval. The Interface Control Document (ICD) shall define, in detail, all performance, functional, mechanical and environmental specifications and all electrical and mechanical interfaces for an Actuator Unit.

A Preliminary ICD that defines the mechanical interface and envelope, as well as the electrical interface, shall be submitted with the proposal. An ICD that fully defines the mechanical interface and envelope of the Actuator Unit, as well as the electrical interface, shall be delivered to the MSS Project.

Though detailed part level fabrication drawings are not required for submittal, these detailed fabrication drawings shall be available for review by GSFC at the Contractor's facilities.

3.2.2 Documentation and Data Delivery Package

The Documentation and Data Delivery Package shall 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 listing that is in Section 6.1.8 of this document.

3.2.3 Additional Technical Information required

The Contractor shall provide to the Government the technical details of all bearings to be provided as part of the actuator. This information shall include:

- Detailed drawings cross section of the actuator
- General description (angular contact, duplex set, deep groove, etc.)
- Manufacturer and part number
- Rated load capacity (radial, thrust, moment)
- Contact angle
- Preload at assembly

- Predicted preload at operating temperature
- Spring rate of preload springs (if applicable)
- Lubricant
- Intended film thickness
- Number of balls
- Amount of press fits / sliding fits
- Detailed dimensions of bearings, including:
  - Overall size (Outer diameter, inner diameter, thickness)
  - Ball pitch circle diameter
  - Inner ring curvature
  - Outer ring curvature
  - All shoulder heights
  - Inner and outer ring thicknesses
- Inner shaft diameter of all shafts

3.2.4 Certification Log

Each actuator shall have an associated fabrication/assembly certification log that documents all operations, parts and procedures. In addition, the components' actual inspected dimensions shall be recorded in the certification log.

A fabrication and assembly log shall be maintained for each deliverable unit. The log shall at a minimum describe each step in the assembly process; including the name of the assembler and the date such assembly was completed. All data regarding torques shall be recorded in the log. The log must also include a connector log and an actuation log that records data for each actuation and connector attachment.

3.3 THERMAL ANALYSIS

Thermal analyses will be performed as required as determined by the Contractor so that the Contractor has assurance that the actuator units conform to the requirements as specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) and this SOW. Meeting this prerequisite is necessary so that the Contractor may provide the required Certificate of Conformance.

3.4 STRUCTURAL ANALYSIS

Structural analyses will be performed as required as determined by the Contractor so that the Contractor has assurance that the actuator units conform to the requirements as specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) and this SOW. Meeting this prerequisite is necessary so that the Contractor may provide the required Certificate of Conformance.

4.0 HARDWARE MANUFACTURE

4.1 ACTUATOR UNITS

The Contractor shall manufacture one (1) ATA unit and three (3) HCA units to meet the requirements of the MSA Launch Lock Actuator Specification (JWST-SPEC-006638). The Contractor shall use the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) for definition and test requirement differences between these different units.

4.2 GROUND SUPPORT EQUIPMENT

The Actuator Unit mechanical and electrical Ground Support Equipment (GSE) that directly interfaces with Actuator Unit deliverable items shall be assembled and maintained to the same standards as the deliverable Actuator Unit items, especially calibration control and configuration management. This information shall be documented. Parts and materials selection and reporting requirements are exempted as long as deliverable Actuator Unit contamination requirements are not compromised.

5.0 LIFE TEST

The Contractor is not required to perform a Life Test. The Life Test will occur after delivery by the Contractor. However, final acceptance by the government of the delivered actuators will be pending a successful life test and subsequent performance verification of the delivered units.

6.0 QUALITY ASSURANCE

6.1 GENERAL REQUIREMENTS

6.1.1 Schedule to Ensure Timely Delivery

The Contractor shall submit to the MSS Project at NASA Goddard Space Flight Center (GSFC) a complete detailed manufacturing/fabrication schedule structured to ensure delivery requirements are adhered to as agreed upon by the MSS Project and the Contractor. This Project schedule and all updates to that schedule shall be submitted as follows for review and comments by the MSS Project:

a. Initial submittal of Project Schedule shall occur two weeks after receipt of the order (ARO).

b. For the first two months ARO, the schedule shall be submitted once per month to the MSS Project for review and concurrence.

c. For the next two months, the schedule shall be submitted on a bi-weekly basis to the MSS Project for review and concurrence.

d. For the remainder of the project, the schedule shall be submitted weekly until the product is received and subsequently delivered to the MSS Project.

e. Overall Status Reports shall be submitted to the MSS Project on a monthly basis.

If at any time the schedule delivery dates are in jeopardy of not being met, the Contractor has the responsibility to notify the MSS Project immediately, formally and in writing. Within 5 days of notification, the Contractor shall submit a complete plan outlining the steps that will be taken to recover the schedule issues associated with the delay in order to keep the agreed upon deliveries on schedule.

6.1.2 Quality Management System

The Contractor shall implement a Quality Management System that meets the intent of the requirements of American National Standards Institute (ANSI)/ISO/ American Society for Quality (ASQ) Q9001 (1994 or 2000 version) or equivalent. GSFC shall be notified of any changes to the Quality Assurance (QA) program.

6.1.3 Quality Assurance Inspection/Test Plan

The Contractor shall submit to MSS Quality Assurance at NASA/GSFC, a detailed Quality Assurance Inspection/Test Plan prior to the commencement of manufacturing/fabrication. The purpose of this plan is to ensure product Quality from receipt of the Purchase Order (PO) through shipment of the product to NASA/GSFC.

6.1.4 Acceptance Test Procedure

The Contractor shall submit to MSS Quality Assurance the “Acceptance Test Procedure,” prior to the performance of any specified testing. The Contractor will include a minimum of 2 weeks

in the schedule in order for this document to be submitted, discussed, reviewed, and comments returned, leading to approval from the MSS Project. No testing will begin until approval has been received from the MSS Project.

6.1.5 Certificate of Compliance

Upon delivery of the product, the Contractor shall supply to MSS Quality Assurance, a "Certificate of Compliance" (C of C), stating that the product being supplied meets all aspects of the requirements as specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) and this SOW.

6.1.6 Review and Inspection

All products are subject to review, inspection, and/or test witness at the buyer's expense, by MSS personnel, or as required through proper delegation of responsibility. These activities will be carried out at reasonable times and places, including during manufacturing/fabrication at the Contractor's facilities. Resources, documentation, and measuring and test equipment shall be made available to the Contractor for such reviews and inspections by MSS personnel at no charge to the buyer.

6.1.6.1 Right of Access

The MSS Project shall be assured Right of Access to the Contractors facility for the purpose of performing on-site audits of the Contractor's Quality Assurance Program as well as to perform product inspections and/or witness testing as necessary. Inspection and test witness shall not be interpreted as product acceptance and shall not relieve the Contractor of providing product and/or services in strict compliance with the specified requirements as contained in the purchase order and its accompanying documents, nor shall it preclude rejection by the MSS Project at a later stage of Program Processing/Testing. The MSS Project will notify the Contractor at least 2 days in advance of any visits to these facilities.

6.1.6.2 Inspection and/or Test Witness Hold Points

If agreed upon by the MSS Project and the Contractor that inspection and/or test witness Hold Points are required, and the Contractor fails to notify the MSS Project of that Hold Point in the process, the MSS Project may request that the inspection or test be repeated at the expense of the Contractor.

6.1.7 Configuration Management

The Contractor's Configuration Management (CM) system (to be made available for review on request) shall control the design and hardware/software by means of drawings, specifications, and other documents and shall ensure all applicable changes are reviewed in a systematic manner to determine the validity and impact on performance, schedule, and cost. The Contractor's Configuration Management system shall have a change classification and impact assessment process that ensures Class I changes are forwarded to the MSS Project for approval prior to release/incorporation. Class I changes are defined as changes that affect form, fit, function, external interfaces, or requirements as stated within this document and item specification.

All other changes are considered to be Class II changes and shall be controlled and dispositioned by the Contractor. NASA/GSFC reserves the right to review all Class II changes for technical content to ensure the proper classification has been assigned. Any item that is found to be non-compliant with the quality, workmanship and performance requirements of the contract shall be dispositioned via a waiver or Material Review Board (MRB), unless the affected item is reworked to restore compliance or is replaced with a fully compliant item. The Contractor shall submit Waivers and MRBs to MSS Quality Assurance for final approval.

6.1.8 Documentation and Data Delivery Package

Engineering and manufacturing documents shall be compiled and forwarded with the product when shipped to NASA/GSFC. The documents shall be marked to the attention of MSS Quality Assurance. Documentation at a minimum shall include:

a. Certificate of Compliance
b. Final inspection records
c. Test reports from acceptance tests
d. Material list, parts list, and processes used
e. Assembly drawings
f. Interface control drawings, including details of the shaft interface
g. All Class I MRB activity and associated waiver requests
h. Log of total operating time and conditions

6.1.9 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. Stored and stocked items shall be controlled in accordance with documented procedures and be subject to quality surveillance.

Contractor is responsible for providing an acceptable shipping container that protects the hardware appropriately.

While in a shipping container, the item shall be wrapped in a non-electrostatic discharge (ESD)-generating vapor barrier with redundant maximum humidity indicators. In addition, the packaging materials shall not shed, transfer, or outgas contaminants on to the hardware. The shipping container shall also be capable of prolonged shipping conditions.

By executing the act of product shipment, the supplier certifies that the product complies with all contract requirements. Prior to shipping, quality assurance personnel shall ensure that:

1. Fabrication, inspection, and test operations have been completed and accepted.
2. All products are identified and marked in accordance with requirements.

3. The accompanying documentation (developer's shipping and property accountable form) has been reviewed for completeness, identification, and quality approvals.
4. Evidence exists that preservation and packaging are in compliance with requirements.
5. Packaging and marking of products, as a minimum comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identification at their destinations.
6. The loading and transporting methods are in compliance with those designated in the shipping documents.
7. Integrity seals are on shipping containers and externally observable shock and humidity monitors do not show excessive environmental exposure.
8. In the event of unscheduled removal of a product from its container, the extent of re-inspection and retest shall be as authorized by NASA or its representative.
9. Special handling instructions for receiving activities, including observation and recording requirements for shipping-environment monitors are provided where appropriate.
10. Nitrogen purged environment for shipping and shock sensors in each of 3 axes set to 10 g's.

The Contractor's quality assurance organization shall verify prior to shipment that the above requirements have been met and shall sign off appropriate shipping documents to provide evidence of this verification. The Contractor has the responsibility for any damage incurred during shipment.

6.2 DESIGN VERIFICATION REQUIREMENTS

6.2.1 Verification Requirements

The Contractor shall implement a program to verify all requirements specified in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638).

The Contractor shall provide a verification matrix defining the method of verification for each specific requirement of the MSA Launch Lock Actuator Specification (JWST-SPEC-006638) and this SOW. Verification methods shall include:

1. Inspection: Designated as (I) and represents inspection of the physical hardware by a customer appointed qualified inspector for compliance.
2. Analysis: Designated as (A) and represents documentation of performance or function through detailed analysis using all applicable tools and techniques.
3. Test: Designated as (T) and represents a detailed test of performance and/or functionality throughout a properly configured test setup where all critical data taken during the test period is captured for review.
4. Heritage: Designated as (H) and represents heritage of previous successful applications of similar actuator units required to meet similar or more stringent requirements.

In-process production evaluation tests, and environmental stress screening tests shall also be considered to be verification tests.

6.3 WORKMANSHIP STANDARDS AND PROCESSES

6.3.1 Workmanship: Use of Alternate Workmanship Standards

GSFC recognizes that the Contractor may have an established workmanship program equivalent to the specific standards cited herein. In these instances, the Contractor may use existing standards upon review and approval by the MSS Project. It must be established that the developer's workmanship program fully encompasses the specific requirements of this chapter. It is the Contractor's responsibility to list all deltas from the baseline workmanship standards and to provide data supporting their position/rationale (delta information shall be submitted with Quality Assurance Plan/Manual).

6.3.2 Training and Certification of Contractor Personnel

All personnel performing work on HCA hardware requiring a prerequisite set of skills and competency shall be certified as having completed the required training, appropriate to their involvement.

6.3.3 Hardware Handling, Cleaning and Packaging

The handling of HCA hardware shall be performed by qualified personnel in accordance with approved procedures that address cleaning, handling, packaging, tent enclosures, shipping containers, bagging, and purging. Compatible packaging shall be selected so that hardware is not contaminated or otherwise degraded during shipping or storage. All personnel working on HCA hardware shall be certified as having completed the required training and competency certifications prior to handling any HCA hardware. This includes, but is not limited to, workmanship, clean room and ESD awareness courses.

6.3.4 Electrostatic Discharge Control Requirements

The Contractor shall document and implement an ESD Control Program suitable to protect the most ESD-sensitive instrument components at all levels of assembly and integration in accordance with the requirements of ANSI/ESD S20.20 or NASA-STD-8739.7.

All personnel who manufacture, inspect, test or otherwise process electronic hardware or who require unescorted access into ESD protected areas shall be certified as having completed the required training, appropriate to their involvement prior to handling any electronic hardware.

6.4 MATERIALS, PROCESSES AND LUBRICATION REQUIREMENTS

6.4.1 Materials Selection Requirements

To qualify material for HCA use, the material must have a satisfactory flight heritage relevant to JWST requirements or meet the following applicable selection criteria as defined herein for:

- Vacuum outgassing
- Stress corrosion cracking
- Lubrication requirements
- Manufacturing process selection
- Fastener integrity

The Contractor shall create and maintain a Materials and Processes Identification List (M&P) and shall review proposed materials and processes with the MSS Project.

Pure Tin, Zinc, and Cadmium are not acceptable for flight use.

6.4.2 Vacuum Outgassing of Polymeric Materials

Only materials that have a total mass loss (TML) less than 1.00% and a collected volatile condensable mass (CVCM) less than 0.10% shall be approved for use in a vacuum environment. Material vacuum outgassing shall be determined in accordance with ASTM E-595. If a material exceeds these maximum limits, the Contractor shall be required to either replace with a compliant material or bring it into compliance via a vacuum bakeout, or to submit a Materials Usage Agreement (MUA) for its usage.

6.4.3 Stress Corrosion Cracking of Inorganic Materials

Materials used in structural applications shall be highly resistant to stress corrosion cracking (SCC) as specified in MSFC-STD-3029. A Material Usage Agreement (MUA) and an SCC evaluation form shall be submitted, Contractor format acceptable, for each material usage that does not comply with the MSFC-STD-3029 SCC requirements.

6.4.4 Lubrication Systems

The Contractor's material list shall include lubrication usage. Lubricants shall be selected for use with materials on the basis of flight heritage and valid test results that confirm the suitability of the composition and the performance characteristics for each specific application, including compatibility with the anticipated environment and contamination concerns.

6.4.5 Process Selection Requirements

Materials and manufacturing process information shall be provided on the material list.

6.4.6 Fasteners

The Contractor shall comply with the procurement and test requirements for flight hardware and critical ground support equipment fasteners contained in 541-PG-8072.1.2, Goddard Space Flight Center Fastener Integrity Requirements. Traceability shall be maintained for every fastener lot.

6.4.7 Materials Procurement Requirements

Raw materials purchased by the Contractor and its developers shall be accompanied by a Certificate of Compliance and, where applicable, the results of nondestructive, chemical and physical tests. When requested, this information shall be made available to the NASA GSFC MSS Project for review.

6.4.8 Dissimilar Metals

To avoid electrolytic corrosion, dissimilar metals should not be used in direct contact unless protection against corrosion has been provided in accordance with MIL-STD-889. Variances from this policy shall be submitted to the government for approval.

6.4.9 Magnetic Materials

Magnetic materials shall be used only where necessary for equipment operation. Other materials, which are not necessary for operation, shall have minimum permanent, induced and transient magnetic fields.

6.4.10 Radiation Hardness

All HCA parts shall be selected to meet their intended application in the on-orbit JWST radiation environment as defined in the MSA Launch Lock Actuator Specification (JWST-SPEC-006638). The radiation environment consists of two separate effects: total ionizing dose (TID) and single-event effects (SEE).

Appendix A. Abbreviations and Acronyms

Abbreviation/ Acronym	DEFINITION
ANSI	American National Standards Institute
ARO	After Receipt of the Order
ASQ	American Society for Quality
ASTM	American Society of Testing and Materials
ATA	Ambient Temperature Actuator
CM	Configuration Management
C of C	Certificate of Compliance
CVCM	Collected Volatile Condensable Mass
ESD	Electro-Static Discharge
ETU	Engineering Test Unit
FU	Flight Unit
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HCA	Helium Cryogenic Actuator
ICD	Interface Control Document
JWST	James Webb Space Telescope
M&P	Materials and Processes
MEMS	Micro-Electromechanical System
MRB	Material Review Board
MUA	Materials Usage Agreement
MSA	Microshutter Assembly
MSS	Microshutter Subsystem
NASA	National Aeronautics and Space Administration
NIRSpec	Near-Infrared Spectrograph
PER	Pre-Environmental Review
PO	Purchase Order
PSR	Pre-Ship Review
QA	Quality Assurance
SCC	Stress Corrosion Cracking
SEE	Single Event Effects
SOW	Statement of Work
TID	Total Ionizing Dose