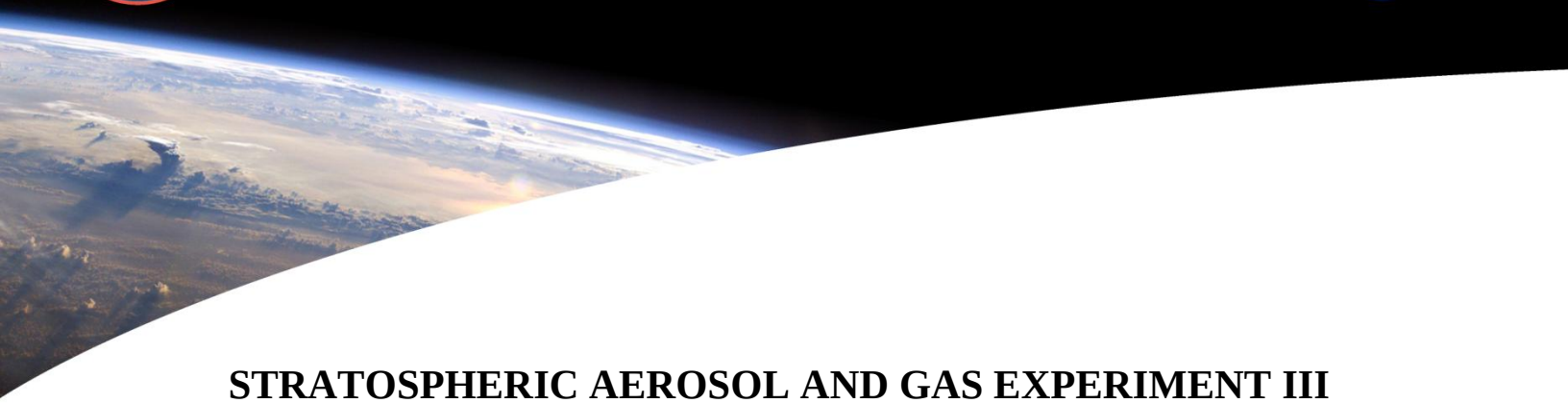
SAGE III on ISS

STRATOSPHERIC AEROSOL and GAS EXPERIMENT III



STRATOSPHERIC AEROSOL AND GAS EXPERIMENT III
SAGE III

TQCM & IMU PRODUCT ASSURANCE AND SAFETY REQUIREMENTS

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REVISION AND HISTORY PAGE

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1 PRODUCT ASSURANCE REQUIREMENTS

1.1 SCOPE

These Product Assurance Requirements shall apply to the Thermally Controlled Quartz Microbalance (TQCM) and Inertial Measuring Unit (IMU) flight hardware, for the SAGE III on ISS Project. The Contractor, together with the NASA SAGE III Project Office Mission Assurance Representative (MAR), will continually review and verify the proper implementation of this mission assurance plan.

2 QUALITY SYSTEM

The Contractor's quality management system shall be compliant to the current AS9100, ISO 9001 or AS9003 standard, Quality Management System Requirements, and the quality system shall remain compliant during the term of this contract. The Contractor shall implement this compliant quality system in addition to the other requirements in this document. The Contractor's quality system shall encompass all SAGE III flight hardware development. "Compliant" as used in this section means that the contractor has defined, documented, and will continually implement during the term of the contract management-approved methods of operation that generally conform to the requirements given in the above-cited International Standards.

2.1 QUALITY PLAN

The contractor shall provide a Quality Plan (deliverable) that describes the contractor's quality management system and how the system will be implemented on this contract. The Plan shall also include provisions for the following topics/functions:

- Quality Role in procured or sub-contracted work
- Fabrication and Assembly "traveler" process and associated quality assurance function
- Bonded Storage/control of parts and assemblies
- Workmanship standards, including Electro-Static Discharge (ESD)
- Contamination Control, including Foreign Object Debris Program
- Limited Life Items
- Metrology
- Control of Non-conforming Material
- Material Selection and Verification
- Software Assurance (see section 3.4)

2.2 WORKMANSHIP

The Contractor shall impose workmanship standards that will assure the products developed will perform as designed in the specified operating environment, and for the expected mission

lifetime. The Contractor shall identify all printed wiring boards used on flight hardware and propose a method, to be mutually agreed upon between the Contractor and the CO or designated representative, for testing printed wiring board coupons. Contractor standards and/or procedures shall be accessible to the Government for review. The Contractor shall comply with the following standards, unless a waiver is approved by the Government:

Conformal Coating and Staking: NASA-STD-8739.1, *Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies*.

Surface Mount Technology (SMT): NASA-STD-8739.2, *Workmanship Standard for Surface Mount Technology*. Note: SMT processes must be qualified to the mission profile and life expectancy of the mission.

Soldering of Electrical Connections: IPC J-STD-001ES, *Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001E, Requirements for Soldered Electrical and Electronic Assemblies* (Chapter 10 of IPC J-STD-001 ES does not apply).

Cabling, Harnessing, and Crimping: NASA Technical Standard NASA-STD-8739.4, *Crimping, Interconnecting Cables, Harnesses, and Wiring*.

Fiber Optics: NASA Technical Standard NASA-STD-8739.5, *Fiber Optics Terminations, Cable Assemblies, and Installation*.

ESD Control: ANSI/ESD S20-1999: *Standard for the development of an ESD Control Program for the protection of Electrical and Electronic Parts, Assemblies, and Equipment* (Excluding Electrically Initiated Explosive Devices

Printed Wiring Board Design: IPC-2221A and IPC-2222 are the basic specification requirements with MSFC-STD-3425, *Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies, Class 3*.

Printed Wiring Board Procurement: IPC 6011 and IPC 6012, Class 3 as the basic specification requirements with GSFC S-312-P-003B, *Procurement Specification for Rigid Printed Wiring Boards for Space Applications and other High Reliability Uses* as a supplement.

The Contractor shall provide personnel qualified and certified to perform the processes defined in the above workmanship standards. Note if a particular standard is not applicable due to the nature of the hardware in the quality plan deliverable (section 2.1).

2.3 SURVEILLANCE OF THE CONTRACTOR

The work activities and operations of the Contractor, subcontractors and suppliers are subject to survey, review, inspection and evaluation by the Government. The Government will have the inspections rights including comprehensive and specific in-plant responsibilities including, but not limited to, the following:

- Ensure the Contractor's compliance with the contract on a continuing basis.
- Conduct mandatory inspections.

The Contractor shall provide the Government with all documents, records, equipment, and working areas within its facilities required by the Government to perform overview and inspection activities.

If the Contractor's Quality personnel inspect a supplier for hardware used for this contract, the Contractor Quality personnel shall provide the NASA Mission Assurance Representative (MAR) and the supplier's in-plant SAGE III Delegated Government Quality Representative (if applicable), a list of the Contractor Quality personnel's authority and planned activities while at the supplier's facility. At no time shall government quality inspection be used in lieu of the Contractor's or supplier's quality inspection.

2.4 GOVERNMENT MANDATORY INSPECTION POINTS

Government Mandatory Inspection Points (GMIPs) shall be established and implemented to comply with NASA Policy Directive NPD 8730.5 which requires independent assurance of compliance of prescribed requirements through the quality assurance program. GMIPs shall be established by NASA early in the hardware planning phases and coordinated with the contractor for incorporation into the build and test planning of all hardware, including subcontractor hardware. The contractor/subcontractor shall provide the Government access to the build and planning processes and documentation for identification and inclusion of GMIPs. GMIPs shall be required to provide independent assurance by the Government of all workmanship requirements addressed in Workmanship Standards listed in 2.2 above and any subsequent revisions or future substitutions by NASA. The identification and notification of the required GMIPs to the Contractor will be coordinated with the Contractor. The Contractor shall provide a formal three (3) days advance notice prior to when each GMIP is scheduled. The Government, at its discretion will perform GMIPs on critical, before assembly (i.e., "pre-cap) stages of hardware build-up, workmanship inspection for soldering, conformal coating and staking of all flight boards, and crimp cable and harnessing work and witnessing of environment testing and the system acceptance test.

2.5 PRODUCT ASSURANCE REQUIREMENTS FOR CONTRACTOR ACQUISITIONS (PURCHASES)

2.5.1 Selection of Sources

When the Contractor acquires flight hardware or GSE, a Contractor PA representative shall be included in the selection process. Each potential procurement source shall be examined with respect to experience and capability in producing the required product with respect to the quality requirement contained herein.

2.5.2 Requirements on Subcontractors and suppliers

The Contractor shall ensure procurement documents impose applicable requirements of this document on subcontractors and suppliers and require subcontractors and suppliers to impose applicable requirements on their sources, subcontractors, and suppliers.

2.5.3 Review and Approval

Contractor PA personnel shall review and approve procurement documents prior to release to ensure applicable requirements of this document. The same requirement applies to documents for procurement from other divisions or subsidiaries of the Contractor.

2.6 NONCONFORMING ARTICLE AND MATERIAL CONTROL

The Contractor shall operate a closed-loop nonconformance control system for articles and materials that do not conform to applicable drawings, specifications, or other requirements. These articles and materials shall be identified as nonconforming, segregated to the extent practicable, and held for review action.

2.6.1 Documentation

Documentation of all non-conformances discovered by the Contractor, subcontractor, and supplier personnel and/or the designated Government quality representative shall be made available to the government for review.

2.6.2 Disposition

The contractor shall not use dispositions of use-as or repair unless specifically authorized by the government if the nonconformity results in a departure from the contract requirements.

Products dispositioned for scrap shall be conspicuously and permanently marked, or positively controlled until physically rendered unusable.

When the non-conforming product is corrected, it shall be subject to re-verification to demonstrate conformity to the requirements.

2.7 FAILURE REPORTING

The Contractor shall perform a failure analysis on all parts/components that fail after the final assembly of the boards.

The Contractor shall begin reporting failures to the CO or designated representative beginning with the first power application at the board level. The Contractor shall continue reporting through formal acceptance of the hardware. Notification to the Government shall occur within 24 hours of the failure.

Closeout of each failure shall require verification that remedial and preventative actions have been accomplished and verified in test, and that preventative actions has been established in other affected items.

2.8 QUALIFICATION AND ACCEPTANCE TESTING

The Contractor shall develop procedures, in accordance with the respective TQCM or IMU SOW for the functional and environmental testing requirements. The Contractor shall conduct tests according to documented procedures,.

2.9 QUALITY STATUS STAMP CONTROL

The Contractor shall establish and maintain a documented Quality Status Stamp (QSS) control system, including written procedures, which provide for the following:

- Stamps, decals, seals, torque wax, paints, and signatures that identify that articles and materials have undergone source and receiving inspection, in-process fabrication and inspection, end-item fabrication and inspection, end-item testing, storage, and shipment.
- Traceability to each individual responsible for their use.
- Differentiation between fabrication and inspection QSS's.
- Appropriate direct or indirect application procedures such that stamping does not compromise the article's quality.
- Allows for electronic signatures where required.

3 DESIGN ASSURANCE

3.1 EEE PARTS

The Contractor shall implement a parts selection process that will assure the mission design reliability and performance requirements are met. Parts selection and processing shall meet the requirements of NASA Parts Selection List (NPSL) and GSFC EEE-INST-002, *Instructions for EEE Parts Selection, Screening, Qualification and Derating*, as tailored and agreed upon in the SAGE III on ISS PAP and SAGE III-03-002 EEE Parts Plan. The EEE-INST and the NPSL are available at the following URLs: http://www.nepp.nasa.gov/index_nasa.cfm/725/ and http://nepp.nasa.gov/npsl respectively. The process shall identify the selection, application, evaluation, and acceptance of all parts. The Contractor shall have access to, and maintain knowledge of, parts problems as reported in the Government-Industry Data Exchange Program (GIDEP). All Electrical, Electronic, and Electro-mechanical (EEE) parts shall be de-rated in accordance with the guidelines specified in the SAGE III-03-002 EEE Parts Plan. All EEE parts shall be selected and design implemented to meet the maximum predicted mission ionizing radiation level requirements with adequate margin, to minimize the impact of Single Event Upsets (SEU), and to be immune to latch-up.

3.2 MATERIALS AND PROCESSES

The Contractor shall include the following in the build process:

- A method for selecting and accepting metallic material. This includes stock used in structural and mechanical assemblies, fasteners, mechanical devices, and springs, etc.
- A method to be utilized for identifying and controlling fabrication and assembly processes.
- Materials shall be selected to be consistent with contamination control requirements in the SOW (refers to SAGE III-02-005, Contamination Control Plan).
- The Contractor shall develop a single list that is all inclusive of the polymeric materials, inorganic materials, composites and lubricants.
- The Contractor shall maintain a list of materials, processes, and appropriate usage records prior to and during the hardware development. This as-built list shall be updated and

delivered with SAGE III as part of the End Item Data Package (EIDP) in accordance with the SOW.

3.3 RELIABILITY

As a guide, the Contractor can use NASA-STD-8729.1, Planning, Developing and Managing and Effective Reliability and Maintainability (R&M) Program. The Contractor shall plan and implement reliability activities that interact with other mission disciplines including systems engineering, hardware design, parts selection, and systems safety.

The Contractor shall complete a quantitative design reliability analysis concurrent with the design to evaluate against the desired design goal of 90% reliability (mean time to first failure) for SAGE III for 5 years. This analysis shall include part and failure rate information where available. The analysis shall be provided as a deliverable.

The contractor's reliability program shall additionally respond to the following objectives:

I. Design
   a. Design for graceful degradation.
   b. Reduce series complexity by eliminating unnecessary parts and components.
   c. Design such that failures allow continued successful, albeit degraded, operation.
   d. Design to promote failure workarounds that allow continued successful operation.
   e. Isolate failure impact so that effects do not propagate to other functions.
   f. Design such that failures of non-critical functions do not affect critical functions.
   g. Show that electrical stress applied to parts and devices meets de-rating requirements over the extremes of temperature range, voltage range, and current variations.
   h. Select parts to meet total dose and single event effects radiation requirements.

II. Manufacture
   a. An in-process inspection program that verifies hardware is assembled as designed.
   b. A verification program that assures specified manufacturing processes are followed.

III. Test

a. A test program that validates the finished product meets design specifications.

b. A test program that verifies the finished product functions as designed.

3.4 SOFTWARE ASSURANCE

No software development is required for the TQCM. Any required changes to the IMU software basic configuration (not changes in values in look up tables) will require company software quality assurance processes to be followed and shall be noted in the Quality Plan deliverable. In such cases, the government shall be allowed access to any pertinent software quality assurance

reports and metrics. Changes to software values shall be verified by the company's software engineering function.

4 TRANSPORTATION AND STORAGE

The Contractor shall insure the product will not be damaged during shipping and follow the shipping and handling requirements specified in section 5.25 of the SAGE III-03-002, EEE Parts Plan.

5 ACRONYMS

CO	Contracting Officer
EEE	Electrical, Electronic, and Electro-mechanical
ESD	Electro Static Discharge
GMIP	Government Mandatory Inspection Points
IMU	Inertial Measuring Unit
MAR	Mission Assurance Representative
PA	Product Assurance
QSS	Quality Status Stamp
R&M	Reliability and Maintainability
SAGE III	Stratospheric Aerosol and Gas Experiment III
SOW	Statement of Work
TQCM	Thermally Controlled Quartz Microbalance