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MSFC FASTENER MANAGEMENT AND CONTROL PRACTICES

PREPARED BY:

Wayne R. Gamwell	EH23 Organization	4/1/97 Date

APPROVED BY:

Biliyar N. Bhat	EH23 Organization	6/3/97 Date
Paul M. Munafo	EH21 Organization	6/9/97 Date
William R. Humphries	ED01 Organization	6-9-97 Date
Ann F. Whitaker	EH01 Organization	6-4-97 Date
Amanda O. Harris	CR01 Organization	6/11/97 Date
Grady S. Jobe Director Science and Engineering Directorate		6/13/97 Date

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MSFC FASTENER MANAGEMENT AND CONTROL PRACTICES

This plan has been approved by the George C. Marshall Space Flight Center (MSFC) and is available for use by MSFC and associated contractors.

1. SCOPE

1.1 Purpose

To establish Marshall Space Flight Center (MSFC) fastener management and control policy, responsibilities, and practices for fasteners that are procured, received, tested, inventoried or installed by MSFC or its contractors for space flight. This standard meets the intent of NMI 5320.7.

1.2 Applicability to MSFC Contractors

MSFC Major Subcontractors shall meet the intent of this document and the requirements of Appendix A. The definitions in section 3.0 also apply to appendix A.

1.3 Applicability to Other Centers and Agencies

Other NASA centers, NASA partners, and other independent hardware organizations who produce hardware which is integrated by the MSFC Program and Project Offices into a MSFC mission, payload, or element shall be advised of a JSC Safety Panel requirement to procure fasteners according to an approved plan, and shall meet the requirements of Appendix B. The definitions in section 3.0 also apply to appendix B., except that the definition of quality-sensitive fastener does *not* extend to fasteners performing a function related to mission success.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the latest revision unless otherwise specified, form a part of this standard to the extent specified herein.

SPECIFICATIONS/STANDARDS

Military

MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, Specification for

National Aeronautics and Space Administration

NASA-STD-5003	Fracture Control Requirements for Payloads Using the Space Shuttle
NSTS 1700.7	STS Payloads, Safety Policy and Requirements
NHB 5300.4(1C)	Inspection System Provisions for Aeronautical and Space System Materials, Parts, Components and Services
NMI 5320.7	Basic Policy for Mechanical Parts Control

George C. Marshall Space Flight Center

MMI 5300.12	Part and Material Traceability
MMI 5310.1	Reliability and Quality Assurance (R&QA) Surveys

MM 8040.12	Standard Contractor Configuration Management Requirements, MSFC Programs
MM 5330.10	MSFC Nonconformance (Discrepancy) Reporting System
MM 4000.1	Property Management Manual
MMI 5150.2	Procurement and Acceptance of Quality Sensitive Hardware
MSFC Form 847	Deviation/Waiver Approval Request
MSFC-HDBK-2071	Preferred Space Flight Structural Fasteners
EG11.2	Acceptance Reporting Procedure
CQ 5330.6	MSFC Policy for Delegation of QA Functions to government Agencies and the Related Receiving Inspection Efforts at MSFC
CQ5150.1	Integration of Quality and Reliability Requirements in MSFC Procurements
EH-PROC-14	Storeroom Operating Procedure

OTHER PUBLICATIONS

American National Standards Institute

ANSI/ASQC Q10011-1-1994 Guidelines for Auditing Quality Systems - Auditing

Requests for copies can be addressed to:
American Society for Quality Control; 310 West Wisconsin Avenue; Milwaukee, WI 53203

3. DEFINITIONS

a. Acceptance Data Package (ADP): Documentation required for each lot of fasteners for acceptance by QA Receiving Inspection.

b. Accredited Laboratory: A laboratory that has been recognized by national and/or international standards setting organizations to competently carry out specific tests according to established quality, management, administrative and test method accreditation criteria.

c. Catastrophic Hazard: A hazard which can result in the potential for: a disabling or fatal personnel injury; or loss of the Orbiter, ground facilities or STS equipment. (Reference NSTS 1700.7)

d. Certificate of Compliance (COC): A document signed by an authorized party affirming that the supplier of a product or service has met the requirements of the relevant specifications, contract, or regulation (e.g., affirms that the fasteners are of the quality specified and conform in all respects with the contract requirements, including specifications, drawings, preservation, packaging, packing, marking requirements, and physical item identification part number), and are in the quantity shown on the acceptance document.

e. Certification Validation Test (CVT): Receiving inspection test(s) to assure conformance to the procurement specification requirements. For fasteners, this is an elemental analysis and mechanical property testing.

f. Contained fastener: A fastener that meets the criterion specified in NASA-STD-5003, paragraph 4.2.2.2.

g. Distributor: A supplier of fasteners who buys and resells fasteners.

h. Fail-Safe fastener: A fastener that meets the criterion specified in NASA-STD-5003, paragraph 4.2.2.3.

i. Fracture-critical fastener: A fastener with a classification that assumes that fracture or failure of the fastener resulting from the occurrence of a crack will result in a catastrophic hazard as defined in NSTS 1700.7.

j. Lot: A collection of units or items manufactured from a homogeneous batch of material of the same continuous, uninterrupted production.

k. Low-released-mass fastener: A fastener that meets the criterion specified in NASA-STD-5003, paragraph 4.2.2.1.

l. Low-risk fracture fastener: A fastener that meets the criterion specified in NASA-STD-5003, paragraph 4.2.2.4.

m. Material Review Board (MRB): The formal board established for the purpose of reviewing, evaluating, and disposing of specific nonconforming supplies or services, and for insuring the implementation and accomplishment of corrective action to preclude recurrence.

n. MSFC Approved Fastener Manufacturers List (AFML): A list of suppliers approved to provide required fasteners for MSFC programs/ projects.

o. MTR: Fastener Manufacturer's Test Report

p. Project Fastener Inventory List: The Project maintained list of fastener numbers purchased by the Project.

q. Quality-sensitive Fastener: Any fastener or group of fasteners whose failure could result in a catastrophic hazard, or affect the success of an MSFC mission. This includes fail-safe, fracture critical, and low-risk fracture fasteners, fasteners whose failure would affect a must-work safety function, and fasteners performing a function related to mission success. (Note: Low-mass and contained/restrained fasteners are classified as non-quality sensitive).

r. PSRP: The NSTS Payload Safety Review Panel

s. Supplier: Either a manufacturer or a distributor

t. Threaded Fastener Selection List (TFSL): A list of threaded fasteners previously used and proven effective in NASA programs/projects. (ref. MSFC-HDBK-2071)

u. Traceability: For the purposes of this document, documentation that demonstrates a solid chain of possession from fastener manufacturer *through all intermediate distributors* to the buyer. Normally, traceability is demonstrated by a string of purchase orders from manufacturer and each distributor that link the sale of a particular lot of fasteners identified with a unique manufacturer's lot number.

4. REQUIREMENTS

All quality sensitive fasteners used in space flight hardware shall be controlled from fastener manufacture, through procurement, MSFC receiving inspection, storage, testing, and final assembly.

4.1 General Requirements

4.1.1 MSFC fastener management and control practices for space flight hardware shall be in accordance with this document.

4.1.2 Quality-sensitive fasteners shall be procured from audited and approved manufacturers and distributors. Fail-safe fasteners may be purchased from non-audited distributors or manufacturers if MSFC CVT testing is performed.

4.1.3 Quality-sensitive fasteners shall be purchased as single lots of fasteners that have been tested (to a statistically significant level at the time of their manufacture) to verify that the lots meet the part number or its noted procurement specification requirements (e.g., chemical composition, minimum load carrying capability, fatigue, macro/micro, etc.). The purchase of commingled lots is acceptable when traceability for each lot within a commingled lot is provided.

4.1.4 Quality-sensitive fasteners shall have traceability from the manufacturer into controlled storage and be controlled into the build. Fasteners for which traceability has been compromised shall be dispositioned as nonconforming hardware. They may be used when they are "dispositioned-for-use" as specified in paragraph 4.7.

4.1.5 MTRs shall be procured for all quality sensitive fasteners.

4.1.6 Certificates of Compliance shall be obtained for all quality sensitive and non-quality sensitive flight fasteners.

4.1.7 The acceptability of fasteners shall be determined by conducting receiving inspections, and reviewing acceptance data packages on the fasteners. Traceability records shall be maintained on all quality-sensitive fasteners. Separate lots of fasteners shall be identified by part number and lot number on the packaging containing the fasteners.

4.1.8 Fasteners shall be maintained in storage until they are issued for use. Commingling of lots of stored fasteners is prohibited, except for those purchased in that condition.

4.2 Fastener Selection

Fasteners shall be controlled by specifications which include engineering, design, performance and quality assurance requirements. Specifications for fasteners shall be under the configuration control of one of the following: National Aerospace Standards Committee, Society of Automotive Engineers Committee E-25, manufacturers specifications, NASA, other Federal Agencies and/or standards organizations or the flight hardware contractor. When practical, the responsible design organization should select fasteners from the TFSL. The TFSL shall be maintained by S & E. Use of fasteners on the list is encouraged to reduce the proliferation of fastener parts.

4.3 Supplier Selection

4.3.1 Quality sensitive fasteners shall be procured from suppliers listed in the MSFC Approved Fastener Manufacturers List (AFML). The AFML shall be maintained by EH23.

4.3.1.1 Manufacturers and distributors shall be placed on the MSFC Approved Fastener Manufacturers List by MSFC EH23 after verification by MSFC S&MA that they have been audited and approved by an MSFC Prime Contractor, an MSFC Major Subcontractor, MSFC personnel, or an MSFC delegated agency. MSFC S&MA personnel shall verify that Prime

and Major Subcontractors have auditing systems (e.g., NHB 5300.4(1C) etc.) that meet the requirements of 4.5.1.

4.3.1.2 Maintenance of the MSFC Approved Fastener Manufacturers List - will be done by performing periodic audits and/or by evaluating the manufacturers performance. Periodic re-audits will be performed in accordance with paragraph 4.5.

4.3.1.3 Removal from the MSFC Approved Fastener Manufacturers List - may be required if the supplier's performance deteriorates to an unacceptable level (e.g., consistent failure to provide acceptable products, to adhere to requirements imposed by purchase orders, or to maintain a QA plan that includes, as a minimum, the quality audit attributes specified in paragraph 4.5.1 as determined by re-audit).

4.4 Data Requirements

MMI 5150.2 and CQ 5150.1 provide policies and responsibilities for the incorporation within procurement requests of all requirements for documentation, and for all special requirements for delivery, storage, or testing of procured items, including the items requiring receiving inspections as specified by the requesting organization.

4.4.1 Acceptance Data Package (ADP) requirements:

A record of compliance to all of the ADP items listed shall be submitted to MSFC NASA QA receiving inspection simultaneously with the fasteners. The data package, as applicable, shall include but not be limited to the following:

QUALITY SENSITIVE FASTENERS (Fracture Critical, Fail-Safe, Low Risk Fracture)

a. An ADP index

b. A Certificate of Compliance (COC) noting each lot of fasteners shipped. The lot number will be listed on each end item packing list and shipping document. The Certificate of Compliance (COC) shall state-"The fasteners have been manufactured according to the requirements of the applicable standards and specifications, have been inspected and tested by an accredited laboratory and/or within the manufacturer's facility or laboratory, and an original laboratory testing report is on file with the manufacturer or under such custody that they are available for inspection."

c. Identification of manufacturer and manufacturer's lot number (and any subsequent modifying manufacturer and lot number).

d. Part number and procurement specification.

e. Quantity delivered.

f. Compliance to fastener procurement specification technical requirements shall be provided in the form of quantitative physical, chemical or mechanical test results and inspection reports (raw data). As a minimum, the manufacturer's test reports (MTRs) shall contain the following information:

1. All applicable specification numbers and revisions.

2. The name of the company which performed the tests.

3. The manufacturer's lot number of the fastener tested.

4. The sample size and the methods employed for sample size selection for each test.

5. Clear identification of test results, including individual fastener failures, for acceptable lots.

6. Documented notification of all nonconformances occurring at the manufacturers facility relative to the fasteners lot being tested.

g. Traceability requirements:

1. The original manufacturer will have lot traceability back through the manufacturing process to the raw material test certifications.

2. Any subsequent modifying manufacturer will have lot traceability to the manufacturing processes performed and back to the original manufacturer.

Any subsequent supplier shall lot traceability back to the original manufacturer.

NON-QUALITY-SENSITIVE FASTENERS (Low-mass, Contained/Restrained)

(a) A COC from the supplier.

4.4.2 Records Retention:

Purchase orders shall specify that manufacturers retain all records associated with the procurement, manufacture, inspection and test of each lot of fasteners for a period of five years after final lot acceptance. These records shall be made available to MSFC personnel upon request.

4.4.3 Traceability:

Traceability requirements for flight hardware programs/projects shall be in accordance with MMI 5300.12.

4.5 Quality Assurance Requirements

4.5.1 Quality Audits and Re-Audits of Fastener Manufacturers:

All prospective fastener manufacturers will be audited by either MSFC NASA personnel or their representative agencies to the requirements of MMI 5310.1 or by MSFC prime and/or major subcontractors. Quality audit teams will consist of QA representatives and appropriate technical personnel (e.g., Materials Engineers, Fastener Engineers etc.), as necessary.

Quality audits shall verify that manufacturers implement acceptable QA systems, and perform test and analyses in accordance with procurement specification requirements. Quality audit nonconformances and/or issues shall be resolved prior to procurement. Audits

shall be performed using the ANSI/ASQC Q10011-1-1994 guidelines. To verify implementation, quality audit attributes shall include as a minimum, but not be limited to:

a. Government source inspection provisions.
b. Document controls.
c. Procurement controls.
d. Raw material controls.
e. Metrology controls.
f. Process controls.
g. Sampling inspection plans.
h. Inspection and test controls.
i. Records of inspections and tests.
j. Nonconforming article and material controls.
k. Handling, packaging and storage controls.
l. Shipping and receiving controls.

Distributors shall be audited to verify that they implement acceptable quality control relative to paragraph 4.5.1 b, c, i, k, and l above.

4.5.2 Source Inspection Requirements

Source inspections will be conducted at the manufacturer's facility by MSFC NASA QA or their representative agencies, when required. Policy for delegation of source inspections is specified in CQ 5330.6. Frequency of source inspections will be based on contract performance. Source inspections shall satisfy the following:

a. The dimensional integrity and overall acceptability of each lot of fasteners will be verified through a combination of dimensional inspections, witness of manufacturer inspection, surveillance of processes, and/or manufacturer data review.

b. Lots not in full compliance with specification requirements will be documented in accordance with paragraph 4.7, or be withdrawn by the fastener manufacturer from source release consideration.

4.5.3 Receiving inspection requirements:

Fastener lots will be inspected by MSFC NASA QA Receiving Inspection to verify compliance with the fastener specifications, ADP requirements, and to determine if any fasteners lots were procured from manufacturers or distributors not on the MSFC AFML including all intermediate distributors between the final distributor and manufacturer. External type fasteners lots received from suppliers not on the MSFC AFML, may be used for redundant fastener applications provided they are CVT tested by the Materials and Processes Laboratory. Type and number of CVT tests are specified in table 1. Any lot of fasteners not meeting the fastener procurement and part number specification requirements shall be dispositioned in accordance with paragraph 4.7. Contact the project/program materials representative for all other fastener type testing requirements.

Table 1: CVT Testing Requirements
Minimum Sample Sizes Per Lot Size

Lot Size	Dimensional - System 22	Tensile Test	Macro/Micro Examination	Chemistry
1-100	5	2	2	1
101-500	10	3	3	2
501 and Over	15	5	5	3

4.6 Inventory Control

Once accepted , fasteners shall be placed in controlled limited access storage with strict lot separations (e.g., no commingling of lots allowed) and precise issuance and inventory controls maintained. Fasteners awaiting CVT results shall be held in controlled storage that will not allow their use until their final acceptability is determined. Records shall be maintained to insure the control and traceability of stored fasteners. These records shall indicate whether fastener is suitable for quality sensitive applications and also indicate any other attributes that limit use (like no MTR , or if supplier was not audited). Storeroom operating procedures are specified in EH-PROC-14.

4.7 Nonconformances

Hardware found to be nonconforming at the manufacturer's facility (by the manufacturer) shall be documented on the manufacturers' nonconformance form. Nonconforming material submitted to MSFC for acceptance shall be documented on MSFC Form 847 (DAR) per MSFC Form 847-3 processing instruction requirements. Deviation approval request requirements shall be per MM 8040.12. Hardware found to be nonconforming at receiving inspection will be processed to the requirements of EG11.2 and MM4000.1. Nonconforming hardware contractually accepted at receiving inspection shall be handled in accordance with MM 5330.10, and shall be placed in an MRB crib until dispositioned.

Hardware implicated as being nonconforming or potentially nonconforming as indicated by GIDEP Alert, NASA Preliminary Alert, Office of the Inspector General Alert, etc. shall be handled in accordance with MM 5330.10.

Fasteners received without MTRs that have a COC stating MTRs are either on file or are available for inspection (4.4.1.b), and that have lot traceability to the manufacturer (4.4.1.g) may be "used as is" for fail-safe applications if accepted by MRB in accordance with MM 5330.10.

Fasteners received without lot traceability to the manufacturer that have a general COC from the supplier which states that the fasteners meet the part number requirements may be "dispositioned-for-use" for fail-safe applications using an engineering analysis (e.g., redundancy, high margins, de-rated mechanical properties, etc.), if accepted by MRB in accordance with MM5330.10.

4.8 Database Requirements

4.8.1 A list of purchased fasteners will be maintained at the project level.

4.8.2 A list of preferred threaded fasteners will be maintained in the TFSL (reference MSFC-STD-2071).

4.8.3 A list of approved fastener manufacturers will be maintained in the MSFC Approved Fastener Manufacturers List.

4.9 Responsibilities for Requirements

4.9.1 The Safety and Mission Assurance Office will:

a. Identify and disposition fastener nonconformances.
b. Provide QA and ADP requirements for purchase orders and contracts.
c. Coordinate and conduct/participate in source inspections and quality audits for all fastener manufacturers and distributors who will subsequently be placed on the MSFC approved fasteners list.
d. Provide audit data and certifications and maintain audit files for all fastener manufacturers audited by Marshall.
e. Conduct receiving inspection operations for fasteners.

4.9.2 The Science & Engineering Directorate will:

a. Participate in source inspections and audits of fastener manufacturers and distributors as necessary.
b. Support MRB activities as required with expertise and testing.
c. Provide fastener technical requirements on design drawings and specifications as necessary.
d. Develop and maintain the following data:
   1. TFSL
   2. MSFC Approved Fastener Manufacturers List
e. Maintain fastener inventory control.
f. Provide sources for fasteners (e.g., bolts, nuts, nutplates, inserts, etc.) on procurement requests.
g. Perform CVT testing on fasteners as appropriate and necessary.

4.9.3 MSFC Program/Project Managers will:

a. Implement this standard on all programs, projects, and experiments.
b. Approve and maintain records of all waivers to this plan and submit a summary of waivers and MRBs to PSRP (if hardware is a NSTS payload)..
c. Assure contractor implemented fastener plans meet the intent of this plan.
d. Review independent organization information submittals and coordinate response to the PSRP (if hardware is a payload).

5. NOTES

5.1 Modifications or Changes

Recommendations for modifications or changes to the requirements specified herein shall be submitted in writing to the Materials and Processes Laboratory (EH) at MSFC for consideration.

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

CUSTODIAN:

Wayne R. Gamwell/EH23
NASA-George C. Marshall Space Flight Center

APPENDIX A

CONTRACTOR SUPPLIED FASTENER MANAGEMENT AND CONTROL REQUIREMENTS

CONTRACTOR SUPPLIED FASTENER MANAGEMENT AND CONTROL REQUIREMENTS

1. MSFC Contractors, as required, shall establish fastener management and control policy, responsibilities, and practices for space flight fasteners in the form of a fastener control plan that is reviewed and approved by the Marshall Space Flight Center. The plan shall address fasteners supplied by subcontractors.

2. Quality-sensitive fasteners used in space flight hardware shall be controlled from manufacture, through procurement, receiving inspection, storage, testing, fabrication, and final assembly.

3. Quality-sensitive fasteners shall be procured from audited manufacturers and distributors. Intermediate distributors must be audited as well. Audits may be performed by the independent organization, MSFC, another NASA center, major aerospace corporations, or any independent auditing organization provided the guidelines and attributes in section 4.5.1 are utilized during the site audit. Quality sensitive fasteners that are used in applications that produce redundant load paths fasteners may be purchased from non-audited distributors or manufacturers if CVT testing is performed.

4. Quality-sensitive fasteners shall be statistically tested at the time of their manufacture to verify that the lot meets the part number and/or procurement specification requirements. Commingled lots are acceptable when complete traceability and MTRs for each homogeneous lot within a commingled lot are provided.

5. Quality-sensitive fasteners fabricated by the user out of certified raw material stock do not require testing if no modification to the material is made that could reasonably affect mechanical properties, such as heat treating or forging.

6. Quality-sensitive fasteners shall have traceability from the manufacturer into controlled storage. The flight hardware build process shall be controlled to ensure that only proper fasteners are installed. Fasteners received without lot traceability to the manufacturer that have a COC from the supplier which states that the fasteners meet the part number requirements may be "dispositioned-for-use" for fail-safe applications using an engineering analysis (e.g., redundancy, high margins, de-rated mechanical properties, etc.), if accepted by Marshall MRB.

7. MTRs shall be obtained for all quality-sensitive fasteners.

8. Certificates of Compliance shall be obtained for all flight fasteners.

9. The acceptability of fasteners shall be determined by conducting receiving inspections, reviewing acceptance data packages on the fasteners, and, when required, performing CVT testing on fasteners.

10. Quality sensitive fasteners shall be maintained in controlled storage until they are issued for use. Commingling of lots of stored fasteners is prohibited, except for those received in that condition.

11. Traceability records shall be maintained on all quality-sensitive fasteners.

APPENDIX B

INDEPENDANT ORGANIZATION FASTENER MANAGEMENT AND CONTROL REQUIREMENTS

INDEPENDANT ORGANIZATION SUPPLIED FASTENER MANAGEMENT AND CONTROL REQUIREMENTS

1. Independent organizations, as required, shall submit their space flight fastener management and control policy, responsibilities, and practices for review by the Marshall Space Flight Center. This submittal shall also address fasteners supplied by their subcontractors.

2. Quality-sensitive fasteners used in space flight hardware shall be controlled from procurement, through fabrication, receiving inspection, storage, testing, and final assembly.

3. Quality-sensitive fasteners shall be procured from audited manufacturers and distributors. Intermediate distributors must be audited as well. Audits may be performed by the independent organization, MSFC, another NASA center, major aerospace corporations, or any independent auditing organization provided the guidelines and attributes in section 4.5.1 are utilized during the site audit. Quality sensitive fasteners that are used in applications that provide redundant load paths may be purchased from non-audited distributors or manufacturers if CVT testing is performed.

4. Quality-sensitive fasteners shall be statistically tested at the time of their manufacture to verify that the lot meets the part number and/or procurement specification requirements. Commingled lots are acceptable when complete traceability and MTRs (when required) for each homogeneous lot within a commingled lot are provided.

5. Quality-sensitive fasteners fabricated by the user out of certified raw material stock do not require testing if no modification to the material is made that could reasonably affect mechanical properties, such as heat treating or forging.

6. All quality-sensitive fasteners shall have traceability from the manufacturer into controlled storage. The flight hardware build process shall be controlled to ensure that only proper fasteners are installed.

7. MTR's and COC's shall be obtained for all quality sensitive fasteners.