

Approved: 2020-06-02

Measurement System Identification:



NASA TECHNICAL STANDARD

National Aeronautics and Space Administration

NASA-STD-8739.14

Approved: 2020-06-02
Superseding NASA-STD-6008

NASA FASTENER PROCUREMENT, RECEIVING INSPECTION, AND STORAGE PRACTICES FOR NASA MISSION HARDWARE

MEASUREMENT SYSTEM IDENTIFICATION:

METRIC/SI (ENGLISH)

DOCUMENT HISTORY LOG

Status	Document Revision	Approval Date	Description
Baseline		2020-06-02	Initial Release (Supersedes NASA Fastener Standard NASA-STD-6008).

FOREWORD

This standard is published by the National Aeronautics and Space Administration (NASA) to provide uniform technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA programs and projects.

Fastener control consists of practices related to the procurement, receiving inspection, quality data control, and storage of fasteners.

This standard defines fastener control requirements for NASA mission hardware and is applicable when invoked by higher level requirements documents, such as by NASA Center quality management system documents, by Program safety and mission assurance plans, by Project mission assurance plans, or in procurements such as purchase orders and contracts. NPR 8735.2, Management of Government Quality Assurance Functions for NASA Contracts, establish that the requirements herein are part of the Agency's quality requirements baseline. See NPR 8735.2 for applicability statements.

Requests for information, corrections, or additions to this standard should be submitted to the OSMA by email to Agency-SMA-Policy-Feedback@mail.nasa.gov or via the "Email Feedback" link at <https://standards.nasa.gov>.

6/2/2020

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1. SCOPE

1.1 Purpose

1.1.1 This document establishes minimum requirements for supply chain risk management, procurement, receiving inspection, testing, traceability management, and storage practices for fasteners used in NASA mission hardware. This document does not contain fastener requirements pertaining to design or design analysis; design and design analysis requirements are contained in NASA-STD-5020, Requirements for Threaded Fastening Systems in Spaceflight Hardware.

1.1.2 For the purpose of this document, “fastener” includes all metallic fastening system hardware that joins or retains components or structural elements, including but not limited to bolts, screws, nuts, nut plates, threaded inserts, rivets, shear pins, set screws, washers, safety wire, and cotter pins.

1.2 Applicability

1.2.1 The requirements described within this document are intended for fasteners used in NASA mission hardware and fasteners used to transfer load across flight hardware-to-Ground Support Equipment (GSE), for:

- a. Programs or projects managed per NPR 7120.5, NASA Space Flight Program and Project Management Requirements.
- b. Custom-built aircraft modifications for projects managed per NPR 7120.8, NASA Research and Technology Program and Project Management Requirements, and that are subject to the requirements in NPR 7900.3, Aircraft Operations Management.

1.2.2 For NASA Centers where projects are likely to flow down this standard for in-house procurement, parts and materials handling, or production, processes that support compliance with the requirements herein shall be addressed in the NASA Center’s QMS.

1.2.3 NASA Centers, programs and projects not meeting the applicability statement in 1.2.1 may choose to invoke this standard for in-house production or in procurements. This standard is applicable to NASA Headquarters and NASA Centers, including Component Facilities and Technical and Service Support Centers. This language applies to the Jet Propulsion Laboratory (JPL), other contractors, recipients of grants, cooperative agreements, or other agreements only to the extent specified or referenced in the applicable contracts, grants, or agreements.

1.2.4 Alternative means shall be used by programs and projects for establishing the quality of fasteners used in mission-critical applications when the requirements herein cannot be flowed to the supplier including for:

- c. Fasteners installed in commercial off-the-shelf (COTS) hardware by the COTS manufacturer.
- d. When using international partner suppliers who are not subject to federal acquisition regulations.
- e. When inheriting spare units from another project that may have had different quality requirements.

1.2.5 The requirements of this standard are applicable to fasteners installed as part of a modification/substitution in COTS hardware.

1.2.6 In this standard, all mandatory actions (i.e., requirements) are denoted by statements containing the term “shall.” The terms “may” denotes a discretionary privilege or permission, “can” denotes statements of possibility or capability, “should” denotes a good practice and is recommended, but not required, “will” denotes expected outcome, and “are/is” denotes descriptive material.

1.2.7 The requirements enumerated in this document are applicable to all new programs and projects managed in accordance with NPR 7120.5 or NPR 7900.3 that are in Formulation Phase as of or after the effective date of this document. (See NPR 7120.5 for definitions of program phases.)

1.2.8 The requirements enumerated in this document shall be addressed within NASA Center quality management systems within a year of the publication of this standard.

1.2.9 Within this standard, guidance text is included to assist the reader with understanding the requirements and to assist with their implementation. This text is indicated through the use of italics.

1.3 Requirements Management and Flow Down

1.3.1 Programs and projects are responsible for levying the requirements of this document on internal organizations and external suppliers, and for providing for flow-down to sub-tier suppliers.

1.3.2 It is recommended that a compliance matrix is used to show traceability between the fastener requirements that are flowed down by the program, project or procuring activity to the hardware developer, to the method of implementation for each requirement (the hardware developer is the user of the fastener - see definition of hardware developer).

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The applicable documents are accessible via the NASA Technical Standards System at <https://standards.nasa.gov> or may be obtained directly from the Standards Developing Organizations or other document distributors.

2.1.1 Government Documents

NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7120.8	NASA Research and Technology Program and Project Management Requirements
NPR 7900.3	Aircraft Operations Management
NASA-STD-5019	Fracture Control Requirements for Spaceflight Hardware

2.1.2 Non-Government Documents

ASME B1.3–2007	Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)
ASTM F606/F606M–16	Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
NAM 1312-108	Fastener Test Methods, Metric, Method 108, Tensile Strength – Rev 1
NASM 1312-8	Fastener Test Methods, Method 8, Tensile Strength – Rev 2
AS9003A	Inspection and Test Quality Systems Requirements for Aviation, Space, and Defense Organizations
AS9100D	Quality Management Systems – Requirements for Aviation, Space and Defense Organizations
AS9120B	Quality Management Systems – Requirements for Aviation, Space, and Defense Distributors
ISO 9001:2015	Quality Management Systems – Requirements

2.2 Reference Documents

The reference documents listed in this section are not incorporated by reference within this standard, but may provide further clarification and guidance.

2.2.1 Government Documents

NPD 8730.2	NASA Parts Policy
NPR 8735.1	Exchange of Problem Data Using NASA Advisories and the Government-Industry Data Exchange Program (GIDEP)
NPR 8735.2	Management of Government Quality Assurance Functions for NASA Contracts
NASA-STD-5020	Requirements for Threaded Fastening Systems in Spaceflight Hardware

2.2.2 Non-Government Documents

ASTM F1470–19	Standard Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories

2.3 Order of Precedence

2.3.1 This document establishes requirements for fastener procurement, receiving inspection, and storage practices but does not supersede nor waive established Agency requirements found in other documentation.

2.3.2 Conflicts between this standard and other requirements documents shall be resolved by the responsible Technical Authority.

3. ACRONYMS AND DEFINITIONS

3.1 Acronyms

AIA	Aerospace Industries Association
AS	Aerospace Standard
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials

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CoC	Certificate of Conformance
CoA	Certificate of Analysis
COTS	Commercial Off-the-Shelf
DLA	Defense Logistics Agency
EDS	Energy Dispersive Spectroscopy
GIDEP	Government-Industry Data Exchange Program
GSE	Ground Support Equipment
ISO	International Organization for Standardization
JPL	Jet Propulsion Laboratory
MTR	Manufacturer's Test Report
NAS	National Aerospace Standard
NASA	National Aeronautics and Space Administration
NASM	National Aerospace Standard Military
NFC	Non-Fracture Critical
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
OES	Optical Emission Spectroscopy
QSL	Qualified Suppliers List
QMS	Quality Management System
SAE	Society of Automotive Engineers
STD	Standard
XRF	X-ray Fluorescence

3.2 Definitions

The definitions listed below are in addition to those listed in NASA-HDBK-8709.22, Safety and Mission Assurance Acronyms, Abbreviations, and Definitions.

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Catastrophic Hazard: A hazard, condition or event that could result in a mishap causing fatal injury to personnel and/or loss of spacecraft (payload), launch vehicle, or ground facility.

Certificate of Conformance (CoC): A document signed by the supplier to affirm the product has met the requirements of the relevant specification(s), contract(s), and any other applicable regulations.

Commingling: A storage state where hardware (e.g., fasteners, inserts, etc.) from two or more different lots are co-located or stored in the same bin or other holding container resulting in loss of traceability to the quality data, certification documentation, and records.

Critical Hazard: A hazard, condition or event that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.

Distributor: An enterprise that stocks the products of various manufacturers for resale and does not engage in manufacturing activity.

Hardware Developer: Organization directly responsible for the design, manufacture, analysis, test, and safety compliance documentation of the hardware (Reference NASA-STD-5020, Requirements for Threaded Fastening Systems in Spaceflight Hardware).

Hazard: A state or a set of conditions, internal or external to a system that has the potential to cause harm.

Lot: A collection of units or items which are of the same configuration, fabricated from the same mill heat of material, formed, machined, heat treated, and finished at the same time, using the same processes.

Manufacturer: An enterprise that manufactures fasteners from raw materials.

Manufacturer's Test Report (MTR): A document that is produced by the manufacturer to report information required by the applicable technical and procurement specification.

The information typically includes lot number, manufacturing date, lot quantity, raw material heat number, chemical composition, mechanical properties as determined by testing, and metallurgical test results. An MTR may also be referred to as a Certificate of Analysis (CoA).

Second-Party Audit: An external audit performed on a supplier by a customer or by a contracted organization on behalf of a customer.

Specification: A document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior or other characteristics of a system or component, and, often the procedures for determining whether these procedures have been satisfied.

Supplier: Generic term for distributors and manufacturers.

Third-Party Audit: An external audit performed by an audit organization independent of the customer-supplier relationship; typically associated with independent certification or accreditation bodies.

4. REQUIREMENTS

Note: The requirements set forth in this document are the baseline fastener management and control requirements. Fastener management and control pertains to supplier qualifications, procurement, inspection, testing, storage, and handling of fasteners. Specific requirements for fastener control are contained in this section and summarized in Table 1.

4.1 Fastener Specification

4.1.1 All fasteners shall be defined by a government/military, aerospace industry consensus technical specification, or company specific technical specification.

4.1.2 When company specific fastener technical specifications are used, the hardware developer shall ensure design, manufacturing and performance criteria are sufficient to meet system performance requirements and provide sufficient detail for evaluating product conformance.

4.2 Fastener Quality Control Level

4.2.1 The supplier qualification, procurement documentation, receiving inspection, and testing requirements are defined for three fastener criticality categories (herein referred to as control levels).

4.2.2 The following criteria shall be used to identify the applicable quality control requirements found herein:

4.2.2.1 **Control Level I** (hereafter referred to as Level I): Fasteners whose failure would result in a catastrophic hazard or when classified per NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware, as Fracture Critical or Non-Fracture Critical (NFC)-Low Risk.

4.2.2.2 **Control Level II** (hereafter referred to as Level II): Fasteners whose failure would result in a critical hazard or when classified per NASA-STD-5019 as NFC-Fail Safe.

4.2.2.3 **Control Level III** (hereafter referred to as Level III): Fasteners whose failure would not result in a critical or catastrophic hazard or when classified per NASA-STD-5019, as NFC-Contained or NFC-Low Released Mass.

4.3 Counterfeit Avoidance

4.3.1 Fasteners shall be addressed in the hardware developer's counterfeit control program. See NPD 8730.2, NASA Parts Policy and NPR 8735.2 for programs' and projects' responsibilities for flowing down counterfeit avoidance and reporting requirements to hardware developers.

4.4 Procurement Provisions

4.4.1 Supplier Qualification

4.4.1.1 Level I fasteners shall be procured through qualified suppliers. Level II and III fasteners may be procured through nonqualified suppliers.

Note: Additional testing may be required during receiving inspection for Level II fasteners procured through nonqualified suppliers. See Table 1.

4.4.1.2 Suppliers are qualified by complying with one or more of the following criteria:

- a. The supplier meets the requirements of AS9100D, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations, or ISO 9001:2015, Quality Management System – Requirements, for manufacturers, or AS9120B, Quality Management Systems – Requirements for Aviation, Space, and Defense Distributors for distributors, as certified by a third party audit.
- b. The supplier meets the requirements of one of the standards in 4.4.1.2.a above or AS9003A, Inspection and Test Quality Systems Requirements for Aviation, Space, and Defense Organizations, as evidenced by second-party or third-party audit results.
- c. The supplier is listed in the Defense Logistics Agency (DLA) Qualified Suppliers List (QSL). (<https://www.dla.mil/TroopSupport/IndustrialHardware/Engineering-and-Technical-services/Qualified-Suppliers-List/>)
- d. The supplier is qualified through a second party audit process, defined in the hardware developer's QMS, and has an expiration period of no more than 3 years.

4.4.1.3 The objective evidence that serves as a basis for supplier qualification shall be maintained by the hardware developer.

4.4.2 Traceability

4.4.2.1 Level I fasteners shall have complete traceability in accordance with section 4.4.2.4. Incomplete traceability is acceptable for level II and III fasteners.

Note: Additional testing may be required during receiving inspection for Level II fasteners with incomplete traceability. See Table 1.

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4.4.2.2 Fasteners shall be procured in homogeneous lots.

4.4.2.3 Commingling of lots shall not occur in order to ensure lot traceability.

4.4.2.4 The criteria for complete traceability of each fastener lot shall include all of the following:

- a. Documentation showing all transfers of custody from the original raw material manufacturer through the original part manufacturer, including unique lot/heat numbers.
- b. Documentation for all transfers of custody from the original part manufacturer to any intermediate manufacturers and distributors and the final supplier.

Note: Traceability documentation that does not meet all of the criteria for complete traceability is considered incomplete traceability.

4.4.2.5 Traceability documentation shall be maintained by the hardware developer.

Note: Bolts are often marked with identifying characteristics including the material symbol, manufacturer's symbol, and lot number as space allows to facilitate traceability.

4.4.3 Certificate of Conformance (CoC)

4.4.3.1 Level I, II and III fasteners shall be procured with a Certificate of Conformance (CoC) that references the applicable technical specifications and the supplier.

4.4.4 Manufacturer's Test Report (MTR)

4.4.4.1 Level I and II fasteners shall be procured with a Manufacturer's Test Report (MTR). The MTR is optional for level III fasteners

4.5 Receiving Inspection

4.5.1 Fastener lots shall have receiving inspection and testing performed by an entity whose quality management system is in compliance with, or registered to, an appropriate ISO or equivalent standard (e.g., ISO 17025:2017, General Requirements for the Competence of Testing and Calibration Laboratories, ISO 9001:2015, AS9100D, etc.).

4.5.2 Fastener lots shall be verified by inspection and tests as required in this section and summarized in Table 1. When these inspections and tests are performed on a sampling basis, the required sampling size (A, B, or C) is identified in Table 1 and the corresponding sampling quantity is called out in Table 2.

Note: These inspections/tests are performed upon receipt of the fasteners and is in addition to those performed by the fastener manufacturer. Their purpose is to verify the quality of the fastener lot and the integrity of the delivered documentation.

4.5.3 Fastener lot acceptance criteria for inspections and tests shall be zero failures.

4.5.4 Dimensional Inspection

4.5.4.1 All Level I threaded fasteners shall be inspected in accordance with the System 22 criteria of ASME B1.3–2007, Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ).

4.5.4.2 Level II and III threaded fasteners shall have dimensional inspection performed on a sampling basis in accordance with the System 21 or 22 criteria of ASME B1.3-2007.

4.5.5 Visual Inspection for Finish

4.5.5.1 Visual inspection for finish (e.g. dry film lubricant, plating) shall be performed on a sampling basis on level I, II, and III fasteners in accordance with the applicable specification. The applicable finish specification will include inspection requirements such as magnification, environment and inspection criteria.

4.5.6 Visual Inspection for Lot Uniformity

Visual inspection shall be performed on all level I, II, and III fasteners at 1X magnification, verifying the fasteners are uniform in appearance, and free from rust, scale, seams, bursts, voids, nicks, gouges, and burrs.

4.5.7 Chemical Analysis

4.5.7.1 Chemical analysis shall be performed on a sampling basis for level II fasteners that have been procured from a nonqualified supplier or have incomplete traceability.

4.5.7.2 For the case of level II fasteners that are procured through a nonqualified supplier and do not have complete traceability, chemical analysis shall be performed using a quantitative technique that allows comparison to the composition ranges specified in the controlling material specification. (reference Table 1, footnote 3)

Note: Chemical analysis is used to verify the integrity of the fastener lot and delivered documentation when procuring through a nonqualified supplier or to provide material identification when the traceability paperwork is incomplete. Level I fasteners require qualified suppliers and complete traceability, additional chemical analysis is not required. Chemical analysis is not required for level III fasteners.

Note: Optical Emission Spectroscopy (OES) is the preferred test method for quantitative elemental analysis. Semi-quantitative methods include X-ray Fluorescence (XRF) and

Energy Dispersive Spectroscopy (EDS), and may be used to verify the correct alloy but do not provide a sufficient level of accuracy to satisfy this requirement.

4.5.8 Tensile Testing

4.5.8.1 Tensile testing shall be performed on a sampling basis for level II threaded fasteners such as bolts, screws, nuts, and nut plates that have been procured from a nonqualified suppliers or have incomplete traceability.

4.5.8.2 Tensile testing shall be performed in accordance with one of the following standards:

- a. NASM1312-8, Fastener Test Methods, Method 8, Tensile Strength – Rev 2
- b. NAM1312-108, Fastener Test Methods, Metric, Method 108, Tensile Strength – Rev 1
- c. ASTM F606/F606M-16, Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

4.5.8.3 Tensile test reports shall identify the location of the tensile break, the ultimate load/strength, and the specification minimum and maximum values.

Note: Load extension curves are not required. Level II fasteners that are smaller than #10 or shorter than 2 times their diameter may need to be procured through a qualified supplier with complete traceability, since tensile testing at receiving inspection may not be possible.

4.6 Handling, Packaging, and Storage

4.6.1 Fasteners shall be handled, packaged, and stored in a manner designed to prevent damage. This will include environmental controls for temperature, humidity, and contamination.

4.6.2 Fasteners shall be handled, packaged, and stored in a manner designed to prevent commingling of lots.

4.6.3 Fasteners shall be stored in a controlled access area until issued for use.

4.6.4 Fastener documentation shall be controlled.

Note: it is recommended that external packaging marking includes part number, lot number, and supplier name.

Table 1: Fastener Quality Control Requirements and Sampling Level

Quality Controls		Quality Control Level					
		Level I	Level II				Level III
Procurement Provisions	Supplier Qualification	Qualified	Qualified		Nonqualified		Qualified or Nonqualified
	Traceability Level	Complete	Complete	Incomplete	Complete	Incomplete	Complete or Incomplete
	CoC	Required	Required		Required		Required
	MTR	Required	Required		Required		Optional
Receiving Inspection	Dimensional Inspection ¹	System 22 100%	System 21 ² Sample Size C	System 21 ² Sample Size B	System 21 ² Sample Size B	System 21 ² Sample Size A	System 21 ² Sample Size B
	Visual Inspection for Finish	Sample Size B	Sample Size C	Sample Size B	Sample Size B	Sample Size A	Sample Size B
	Visual Inspection for Uniformity	100%	100%		100%		100%
	Chemical Analysis	Optional	Optional	Sample Size C	Sample Size B	Sample Size A ³	Optional
	Tensile Testing ^{4,5}	Optional	Optional	Sample Size C	Sample Size B	Sample Size A	Optional
<p>1: Dimensional inspection is only applicable to threaded fasteners. 2: System 22 may be performed as a substitute for System 21 per ASME B1.3-2007, using the same sample size. 3: Chemical analysis must be performed using a quantitative method (Section 4.5.6.2) 4: Tensile testing is only applicable to threaded bolts, screws, nuts, and nutplates 5: Fasteners smaller than #10 or shorter than 2 times the diameter may not be capable of meeting this requirement.</p>							

Table 2: Sampling Size and Acceptance Criteria

Lot Size	Sample Size			Acceptance Criteria
	A	B	C	
1-2	2	1	1	0 failures
3-15	3	2	2	0 failures
16-25	4	3	2	0 failures
26-50	5	4	2	0 failures
51-90	6	5	2	0 failures
91-150	7	6	2	0 failures
151-280	10	7	2	0 failures
281-500	11	9	3	0 failures
501-1200	15	11	3	0 failures
1201-3200	18	13	3	0 failures
3201-10,000	22	15	4	0 failures
10,001-35,000	29	15	4	0 failures
35,001-150,000	29	15	5	0 failures
150,001-500,000	29	15	6	0 failures
500,001+	29	15	7	0 failures

Note: Receiving inspection sample size and acceptance criteria are designed to meet/exceed ASTM F1470–19, Standard Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection.