



## NASA Fracture Panel 2004: Fasteners

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### Materials Science Research Rack (MSRR)

- Background

- MSRR had fracture critical fasteners delivered from a supplier not on the approved vendor list for MSFC
- Some of the fracture critical fasteners failed independent lot testing
  - Unacceptable thread laps & microstructure grain flow
- Fatigue tests were begun in an attempt to demonstrate that fasteners had favorable fatigue capability
  - Fasteners failed 2/3 allowable procedures in NAS-4003
- Safety & Mission Assurance organization recommended disapproval of fracture critical fasteners not from approved vendor list
  - Baseline approach in MSFC-STD-2594, MSFC Fastener Management & Control Practices



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### Fracture control requirements (NASA-STD-5003)

- Fracture critical fasteners 4.2.3.4
  - Be the highest quality aerospace fasteners fabricated from A286 steel, Inconel 718, MP35N alloy, or similarly tough and environmentally friendly alloys.
- Low risk fasteners 4.2.2.4.3
  - Be high-quality military standard, national aerospace standard, or equivalent commercial fasteners or pins that are fabricated and inspected in accordance with aerospace-type specifications.
- Fail-safe fasteners
  - Adequate quality control is implemented to ensure that generic or process defects are not present so that the remaining structure may be considered unflawed.
- How is this implemented?
  - MSFC-STD-2594 is used for quality control of mass produced, off-the-shelf type fasteners. Specific language exists for fracture critical fasteners
  - Any fastener with a margin of safety computed or essential for mission success should be considered a quality sensitive fastener per 2594.



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## MSFC-STD-2594

- Fracture critical fasteners must come from audited and approved vendors.
- All other quality sensitive fasteners may come from unapproved vendors, but must have separate CVT testing

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

3.18 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 term includes structural fasteners, fracture critical fasteners, low-risk fracture fasteners, safety critical fasteners, and fasteners performing a function related to mission success.

## 4. GENERAL REQUIREMENTS

This section covers general requirements for fasteners governed by this standard.

4.1 Product Control. All fasteners used in space flight hardware shall be controlled from fastener manufacture through procurement, receiving inspection, storage, testing, and final assembly. MSFC fastener management and control practices for space flight hardware shall be in accordance with this document.

4.2 Vendors. Quality-sensitive fasteners shall be procured from audited and approved manufacturers and distributors. Quality-sensitive fasteners may be purchased from non-audited distributors or manufacturers if CVT testing (excluding fracture critical fasteners) is performed at MSFC.

4.3 Lot Testing. 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, in order 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 is provided for each lot within a commingled lot.

4.4 Traceability. Quality-sensitive fasteners shall have traceability from the manufacturer to controlled storage and shall 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 5.6, "Nonconformances."

4.5 Manufacturer's Test Report. MTR's shall be procured for all quality-sensitive fasteners.

4.6 Certificate of Compliance. COC's shall be obtained for all flight fasteners.

4.7 Inspections & Reviews. The acceptability of fasteners shall be determined by conducting receiving inspections and reviewing ADP's 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.



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- What level, if any, of fatigue testing is expected with various fracture control classifications?
  - Fracture critical, low risk, fail-safe
    - Most analysts use the parent material fatigue data for analysis
  - NAS-4003 ?
  - Demonstration of capability for application?
- Modified fasteners (slots or holes thru threads)
  - Fatigue application?
  - Fracture critical application ?
- Fastener quality control should be standard across centers
  - E.g.... MSFC S&MA may not recognize JSC approved vendor list