Fastener Control Plan

Fluids and Combustion Facility

Preliminary
September 20, 2000

AUTHORIZED by CM when under FORMAL Configuration Control	
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PREFACE

The National Aeronautics and Space Administration (NASA) is developing a modular, multi-user experimentation facility for conducting fluid physics and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of three test platforms: the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Shared Accommodations Rack (SAR). This document establishes the requirements necessary to test and the quality assurance provisions to ensure the integrity of Safety Critical Fasteners in the FCF for all three integrated racks; FIR, CIR, and SAR.

FASTENER CONTROL PLAN
FOR THE
FLUIDS AND COMBUSTION FACILITY

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REVISION PAGE
FASTENER CONTROL PLAN

Revision	Date	Description of Change or ECO's Incorporated	Verification and Date
Preliminary	9/20/00	Initial	10/20/00

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1.0 INTRODUCTION

1.1 Scope.

The procedures presented in this publication apply to all Safety Critical Fasteners for both Flight and Ground Support Equipment (GSE) applications used in the FCF for all three integrated racks; FIR, CIR, and SAR. The procedures covered within this document are applicable for procuring the Safety Critical Fasteners and their traceability while in bonded storage.

The proposed FCF design for all Safety Critical Fastener Interfaces will consist of an externally threaded fastener mated with either a nut or threaded insert/Keensert of approximately equal material strength. These joint interfaces will insure that the externally threaded fastener is the weakest link thus preventing any overtorqueing of either the nut or threaded insert in the fastener system as referenced in Appendix A of MSFC-STD-486B. Safety Critical Interfaces will also include shear pins where deemed applicable.

Helicoil inserts, nutplates, rivets, and setscrews will not to be used at Safety Critical Fastener Interfaces. Rivets, which are used in non Safety Critical applications, shall be selected in accordance to NAS 523.

This document is not applicable for providing fastener traceability with respect to their installation locations within specific Space Flight or GSE hardware. This document will not define the specific applications or installation for these Safety Critical Fasteners with respect to torques, use of lubricants, or providing positive locking/backout prevention.

The tensile test requirements presented in this document apply to threaded fasteners and do not apply to nuts, nutplates, set screws, sheet metal screws, guide pins, nonmetallic fasteners, and helicoil wire and other inserts.

1.2 Purpose.

This document establishes the minimum requirements necessary to ensure the integrity of Safety Critical Fasteners, both Flight and GSE, prior to their use in the FCF on all three integrated racks; FIR, CIR, and SAR. This document will outline the Safety Critical fastener traceability, material requirements, Certifications of Compliance (CoC), and quality assurance provisions.

The methodology for assurance of fastener integrity satisfies the required supporting technical data submittal in Paragraph 7.1.1 of NSTS 13830 for the structural portion of the Phase I Safety Review. The methodology used in this plan was obtained from Johnson Space Center (JSC) publication JSC23642D, "JSC Fastener Integrity Testing Program" and modeled after a previously approved fastener control plan, PCS-DOC-015.

2.0 DOCUMENTS

This section lists specifications, models, standards, guidelines, handbooks, and other special publications. These documents have been grouped into two categories: applicable documents and reference documents.

2.1 Order of precedence for documents.

In the event of a conflict between this document and other documents referenced herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. All documents used, applicable or referenced, are to be the issues defined in the Configuration Management (CM) contract baseline. All document changes, issued after baseline establishment, shall be reviewed for impact on scope of work. If a change to an applicable document is determined to be effective, and contractually approved for implementation, the revision status will be updated in the CM contract baseline. The contract revision status of all applicable documents is available by accessing the CM database. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 Applicable documents.

The documents in these paragraphs of the latest revision or issue are applicable to the FCF Project to the extent specified herein.

NSTS/ISS 13830 Rev. C, 7/13/98	Payload Safety Review and Data Submittal Requirements
MSFC-STD-486B November 1992	Standard, Threaded Fasteners, Torque Limits For
MSFC-HDBK-527 JSC 09604 September 30, 1988	Materials Selection List for Space Hardware Systems
FF-S-86 Rev. E, 1/16/91	Federal Specifications Screw, Cap, Socket Head
ASTM-F606-98 ASTM-F606M-98 (Metric) December 10, 1998	Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets.

2.3 Reference documents.

The documents in this paragraph are provided only as reference material for background information and are not imposed as requirements.

JSC 23642 Rev. D, 1/26/00	JSC Fastener Integrity Testing Program
NAS 523 Revision 28, February 8, 1993	National Aerospace Standards Committee Fastener Code
S-313-100 Rev. B, 2/13/98	Goddard Space Flight Center Fastener Integrity Document
AMS 5731 Rev. J, 8/15/90	Aerospace Material Specification Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006 B - 0.30 V Consumable Electrode Melted, 1800 F (982 C) Solution Heat Treated
AMS 5737 Rev. M, 8/15/90	Aerospace Material Specification Steel Bars, Wire, Forgings, and Tubing, Corrosion and Heat Resistant 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006 B - 0.30 V Consumable Electrode Melted, 1650 F (899 C) Solution and Precipitation Heat Treated
PCS-DOC-015 Baseline, 5/5/99	Physics of Colloids in Space (PCS) Flight Project, PCS Flight Fastener Control Plan and Report for the Avionics Section and the Test Section

3.0 MATERIALS

Safety Critical Fastener Materials will be selected having an “A” rating for Stress Corrosion Cracking (SCC) per MSFC-HDBK-527 and JSC 09604. Safety Critical Fasteners preferably made of heat and corrosion resistant steel manufactured from A286 iron base superalloy (UNS S66286) in accordance with AMS 5731 or AMS 5737 per FF-S-86 will meet this SCC requirement.

3.1 Material Test Reports

Material Certification Reports, both chemical and physical properties, shall be obtained for all Safety Critical Fasteners. This applies to the threaded fasteners, nuts, threaded inserts/Keenserts, and shear pins.

At a minimum, Certifications of Compliance shall be obtained for all fasteners that are not Safety Critical.

Rivets, which are used in non Safety Critical applications, shall be selected in accordance to NAS 523.

4.0 TRACEABILITY

Shipment and storage of fasteners shall be controlled to assure traceability. The traceability of all Fasteners shall be maintained for each lot. Lot traceability shall include vendor, manufacturer, lot number, certification of compliance, and the material certification reports.

5.0 QUALITY ASSURANCE

Safety Critical Fasteners procured through Goddard Space Flight Center's (GSFC) Preferred Flight Fastener Inventory follow the Quality Assurance Criteria of S-313-100, "GSFC Fastener Integrity Document."

The following sections specifically outline the sampling, testing, and lot acceptance criteria for the Safety Critical Fasteners procured by vendors outside of GSFC's Preferred Flight Fasteners Inventory. These sections summarize the requirements presented in JSC 23642D.

5.1 Sampling

The Safety Critical Fastener sample size and acceptance criteria are summarized in the following Table;

TABLE I. Minimum Sample Sizes Per Lot Size

Lot Size	Samples	Acceptance Criteria
1 to 100	2	0 Defective
101 to 500	3	0 Defective
501 and over	5	0 Defective

5.2 Fastener Testing

All Safety Critical Fasteners, sizes #8 or greater (M4 or greater), procured by vendors outside of the GSFC Preferred Flight Fastener Inventory and used for Flight or GSE Hardware must undergo a chemical analysis, an ultimate tensile test, and/or a hardness test. Each tested lot shall have its samples examined for lot homogeneity.

5.3 Test Procedures

5.3.1 Tensile Testing

Applies to threaded fasteners.

Ultimate tensile tests shall be performed on the test lot samples per ASTM-F606.

The ultimate tensile test may be waived for fasteners of length insufficient for testing. These fasteners will require hardness tests in lieu of the ultimate tensile test.

Any test result not meeting or exceeding the required tensile properties shall be dispositioned as specified below.

5.3.2 Chemical Analysis

Applies to Safety Critical threaded fasteners, nuts, threaded insert/Keenserts, and shear pins.

Chemical analysis by an independent testing laboratory, completely separate of the fastener manufacturer, shall be performed on the sampled fastener lot. The chemical analysis shall verify that the chemical composition of the tested sample is within the tolerances allowed by the applicable material specification. Any sample not meeting the chemical property requirements shall be dispositioned as specified below.

5.3.3 Hardness Testing

Applies to threaded fasteners.

Hardness tests shall be applied to all fastener lots sampled that are nominally 1/4 inch in diameter and larger (M6 diameter and larger). A hardness test is required for fasteners on which

the tensile test cannot be performed because of their insufficient length. Any sample not meeting the hardness property requirements shall be dispositioned as specified below.

This test may be waived by obtaining material compliance data from the supplier or vendor.

5.3.4 Lot Homogeneity

The results of testing for each fastener shall be compared to the results of other fasteners within the lot sample. Test data suggesting that more than one lot of fasteners is present shall be dispositioned as specified below.

6.0 DISPOSITION OF TEST LOT SAMPLES

Test lot samples that fail to meet the required tensile strength, chemical analysis, hardness testing, or lot homogeneity shall be documented in a Non-Conformance Report to be dispositioned by the Project Engineering Team.

7.0 TEST RESULTS ANALYSIS

All sampled test data (i.e., ultimate tensile strengths, chemical analyses, and hardness values) will be reported and evaluated against the requirements of the fastener specification. The submitted report will identify any sample not meeting the required material specification.

ACRONYMS AND ABBREVIATIONS

A.1 Scope.

This appendix lists the acronyms and abbreviations used in this document.

A.2 List of acronyms and abbreviations.

CIR	Combustion Integrated Rack
CoC	Certification of Compliance
FCF	Fluids and Combustion Facility
FIR	Fluids Integrated Rack
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ISS	International Space Station
JSC	Johnson Space Center
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
SAR	Shared Accommodations Rack
SCC	Stress Corrosion Cracking

APPENDIX B DEFINITIONS

B.1 Scope.

This appendix defines special terminology used in this document.

B.2 List of definitions.

Externally threaded fastener. Any screw, bolt, or stud having external threads.

Lot. A quantity of fasteners or one part number fabricated by the same production process from the same coil or heat number of metal, provided by the metal manufacturer, and submitted for inspection and testing at one time.

Safety Critical Fastener. Fasteners whose failure can result in injury to personnel, damage to flight hardware, and/or damage to facilities.

Structural fastener. A fastener used in either the primary or secondary load path of a structure.