



National Aeronautics and  
Space Administration

**INCH-POUND**

MSFC-STD-557  
REVISION: A  
EFFECTIVE DATE:2/1/2005

---

**George C. Marshall Space Flight Center**  
Marshall Space Flight Center, Alabama 35812

EM30

# THREADED FASTENERS, 6Al-4V TITANIUM ALLOY, USAGE CRITERIA FOR SPACECRAFT APPLICATIONS

**Approved for Public Release; Distribution Unlimited**

CHECK THE MASTER LIST—  
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE  
MSFC - Form 454 (Rev. October 1992)

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 2 of 9

### DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
-	-		Baseline Release
Revision	Revision		Update doc. Per MSFC rules review. Update applicable documents section. Change paragraph 4.9.1.2.2 to reflect new thread inspection documents.

CHECK THE MASTER LIST VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

<b>Multiprogram/Project Common-Use Document or Program/Project Name</b>		
<b>OPR Org Code: EM30</b>		
<b>Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications</b>	<b>Document No.: MSFC-STD-557</b>	<b>Revision: A</b>
	<b>Effective Date:</b>	<b>Page 3 of 9</b>

## FOREWORD

1. This standard specifies criteria for use of 6Al-4V titanium alloy fasteners systems for spacecraft and associated equipment.
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the custodian: Wayne R. Gamwell/EM30, Materials and Processes Laboratory, NASA/George C. Marshall Space Flight Center, Huntsville, AL 35812.

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 4 of 9

## CONTENTS

<u>PARAGRAPH</u>	<u>PAGE</u>
<u>DOCUMENT HISTORY LOG</u> .....	2
<u>FOREWORD</u> .....	3
1. <u>SCOPE</u> .....	5
2. <u>APPLICABLE DOCUMENTS</u> .....	5
3. <u>DEFINITIONS</u> .....	7
4. <u>GENERAL REQUIREMENTS</u> .....	7
5. <u>NOTES</u> .....	9

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 5 of 9

## 1. SCOPE

1.1 Scope. This standard establishes criteria for use of 6Al-4V titanium alloy threaded fastener systems for spacecraft and associated equipment. These criteria are applicable to items designed and fabricated by MSFC and its prime contractors for use on MFSC programs.

## 2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal **shall** apply.

### SPECIFICATIONS

#### Military

MIL-PRF-46010 Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting

#### Johnson Space Center

SP-R-0022 General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

### STANDARDS

#### Military

MIL-STD-889 Dissimilar Metals

### PUBLICATIONS

DOT/FAA/AR-MMPDS-01 Metallic Materials Properties Development and Standardization (MMPDS)

(Copies of Specifications and Standards required by contractors in connection with specified procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 6 of 9

2.2 Other publications- The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for bids or request for proposal, **shall** apply.

#### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ANSI/ASME-B1.2 Gages and Gaging for Unified Inch Screw Threads

ASME-B1.3M Screw Thread Gaging System for Dimensional Acceptability -Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)

(Applications for copies should be addressed to ASME International, Three Park Avenue, New York, N.Y. 10016-5990)

#### NATIONAL AEROSPACE STANDARDS

NAS4004 Fasteners, 6A1-4V Titanium Alloy, Externally Threaded

NASM25027 Nut, Self-Locking , 250° F, 450° F, and 800° F

(Applications for copies should be addressed to the Aerospace Industries Association of America, Inc., 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3901)

#### SOCIETY OF AUTOMOTIVE ENGINEERING

SAE-AS8879 Screw Threads -UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter

#### SAE AEROSPACE MATERIAL SPECIFICATION

SAE-AMS5525 Steel, Corrosion and Heat Resistant, Sheet, Strip, and Plate 15Cr-25.5Ni-1.2Mo-2.1Ti-0.006B-0.30V, 1800 Degrees F (982 Degrees C) Solution Heat Treated

SAE-AMS5732 Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings 15Cr-25.5Ni-1.2Mo-0.006B-0.30V Consumable Electrode Melted 1800MDF (982MDC) Solution and Precipitation Heat Treated

SAE-AMS5737 Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, and Tubing 15Cr-25.5Ni-1.2Mo-2.1Ti-0.006B-0.30V Consumable Electrode Melted 1650 Degrees F(899 Degrees C) Solution and Precipitation Heat Treated

SAE-AMS5758 Alloy Bars, Corrosion Resistant, 20Cr-35Ni-35Co-10Mo, Vacuum

CHECK THE MASTER LIST VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 7 of 9

Induction Plus consumable Electrode Vacuum Melted, Solution Heat Treated For Work Strengthening

(Application for copies should be addressed to the SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

3. DEFINITIONS: None

#### 4. GENERAL REQUIREMENTS

4.1 All 6Al-4V titanium alloy bolts **shall** comply with the requirements of NAS4004 and the applicable bolt design drawing, but the size **shall** be limited to #10 through 0.750 inch diameter. Any bolt size greater than 0.750 inch diameter **shall** be submitted to MSFC for review.

4.2 All nuts **shall** be self-locking, lubricated and **shall** be made from material conforming to SAE-AMS5525, SAE-AMS5732, SAE-AMS5737, SAE-AMS5758, or a MSFC approved corrosion resistant alloy and **shall** comply with the applicable sections or NASM25027.

4.3 All washers **shall** be made from a material which is capable of accepting the peak fastener load without deformation. Use countersunk washers under protruding head bolts for clearance of the bolt head-to-shank fillet, and use flat washers under the nut. Provide clearance in the hole for the head-to-shank fillet on flush head bolts.

4.4 The fastener system (bolt, washer and nut with coating) **shall** be designed to prevent corrosion in accordance with the guidelines given in MIL-STD-889. The use of cadmium or silver on any fastener system component is specifically prohibited.

4.5 Lubricants for nuts **shall** be selected in accordance with the requirements of MIL-PRF-46010 and NASM25027 and **shall** pass the requirements of SP-R-0022 for use in spacecraft applications. Lubricants not contained in these documents **shall** be submitted to MSFC for review.

4.6 Hole preparation and installation of threaded fasteners **shall** be in accordance with the best practices for spacecraft application

4.7 Titanium fastener systems are prohibited from being used in any tensile or shear application or design where the bolt or nut is considered a single point for failure.

#### 4.8 ALLOWABLE BOLT LOADS

4.8.1 The maximum allowable ultimate tensile load for 6Al-4V titanium bolts **shall** be no greater than sixty per cent (60%) of the ultimate tensile load for the bolt material as published in

CHECK THE MASTER LIST VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 8 of 9

DOT/FAS/AR-MMPDS-01. All shear strength values may be used as published in DOT/FAA/AR-MMPDS-01.

4.8.1.1 For threaded titanium fastener bolt sizes not listed in DOT/FAA/AR-MMPDS-01, the stress area for tension **shall** be based on the basic minor diameter of the thread.

4.8.2 The total applied tensile load **shall** include the additive influences of installation preloading and service loading.

#### 4.9 REUSE OF 6A1-4V TITANIUM ALLOY THREADED FASTENER SYSTEMS

4.9.1 Reuse of 6A1-4V titanium alloy bolts **shall** be limited to fifteen times, subject to the following requirements for inspection.

4.9.1.1 After removal of the components from the structure, the fastener components **shall** be visually inspected under an illumination level of at least 5X for damage at the fastener surface. The following conditions **shall** be cause for rejection.

4.9.1.1.1 Visible corrosion or corrosion products.

4.9.1.1.2 Galling, stripping, scoring or scratching of threads or plating.

4.9.1.1.3 Deformation of any part of the bolt.

4.9.1.1.4 Foreign material in threads (not easily removed with a nonmetallic bristle brush and using an approved solvent).

4.9.1.2 After visual inspection, the fastener system components **shall** be inspected for reuse as follows:

4.9.1.2.1 Bolt threads **shall** be protected from damage during any handling operation.

4.9.1.2.2 Bolt threads **shall** be inspected in accordance with the methods of measuring the characteristics of thread forms presented in ASME B1.3M. At a minimum, System 22 shall be used to inspect thread characteristics. Gages shall meet the requirements of ANSI/ASME B1.2.

4.9.1.2.3 Bolt surfaces **shall** be inspected for cracks and discontinuities. If bolt cracks and discontinuities exceed the specified limits of NAS4004, they shall be rejected.

#### 4.10 REUSE OF NUTS INSTALLED ON 6A1-4V TITANIUM ALLOY BOLTS



Multiprogram/Project Common-Use Document or Program/Project Name OPR Org Code: EM30		
Title: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for SpaceCraft Applications	Document No.: MSFC-STD-557	Revision: A
	Effective Date:	Page 9 of 9

4.10.1 Nuts **shall** not be reused and **shall** be discarded if removed after application of the initial design fastener preload.

4.10.2 Anchor nuts can be reused for five times provided they pass the inspection criteria limits of paragraphs 4.9.1.1.1, 4.9.1.1.2. and 4.9.1.1.4 above, and the nut prevailing torque is within the limits specified in NASM25027.

5. NOTES - When Government specifications, drawings 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 specifications, drawings or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person, corporation or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

CUSTODIAN:

PREPARING ACTIVITY:

NASA – George C. Marshall  
Space Flight Center

Materials and Processes Laboratory  
Metals Engineering Branch

FILE NO. MSFC-STD-557

202 ~

DR060PR0

PACKAGE NO. 10443R

DOCUMENTATION RELEASE LIST  
GEORGE C. MARSHALL SPACE FLIGHT CENTERMSFC CODE IDENT 14981/339B2  
ISSUE DATE FEB 22 2007

PAGE 1

C H	DOCUMENT NUMBER	DRL DRL DSH REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
* MSFC-STD-557		202 -	STANDARD THREADED FASTENERS, TITANIUM ALLOY, USAGE CRITERIA	000-00-0000	0000000	ZA	NONE
CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION	
			C. WOOD	EH44	03/09/94	BASELINE RELEASE	
* 1	DCN000		EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.	

CHECKER

N/A  
02/15/07

(FINAL)

PACKAGE NO: 10443R

PROGRAM/PROJECT: MULTI

LAST UPDATED: 02/22/07

NOMENCLATURE: MSFC-STD- GOING TO NONE EFFECTIVITY

ECR NO:	PCN:	CCBD NO:	DATE PREPARED:
EO03-0000	0000000	000-00-0000 SB3-00-0000	02/22/07

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
			MSFC-RQMT-1282		202	-			
			MSFC-SPEC-1198		202	-			
			MSFC-SPEC-1238		202	-			
			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
			MSFC-SPEC-1870		202	-			
			MSFC-SPEC-1918		203	-			
			MSFC-SPEC-1919		206	-			
			MSFC-SPEC-2083		202	-			
			MSFC-SPEC-2223		202	-			
			MSFC-SPEC-2489		206	-			
			MSFC-SPEC-2490		205	-			
			MSFC-SPEC-2491		203	-			
			MSFC-SPEC-2492		203	-			
			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
			MSFC-SPEC-445		202	-			
			MSFC-SPEC-504		202	-			
			MSFC-SPEC-521		202	-			
			MSFC-SPEC-548		202	-			
			MSFC-SPEC-560		202	-			
			MSFC-SPEC-626		202	-			
			MSFC-SPEC-684		202	-			
			MSFC-SPEC-708		202	-			
			MSFC-SPEC-766		202	-			
			MSFC-STD-1249		202	-			
			MSFC-STD-1800		202	-			
			MSFC-STD-246		202	-			
			MSFC-STD-2594		203	-			

## DOCUMENTATION PACKAGE/ROUTING REPORT

02/22/07 DR120PR0 PAGE 2

PACKAGE NO: 10443R

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES	ACTION
EO03		X		X		EO03

PREPARED BY:  
EUGENA GOGGANS  
12/19/06

SUBMITTED BY:

CONCURRENCE:

TRANSMITTAL DATES  
TO RELEASE DESK 02/22/07 10:00  
TO MSFC DOC REP 02/22/07 00:00

REMARKS:

2007 FEB 22 AM 11:22

## DOCUMENT INPUT RECORD - MSFC DOCUMENTATION REPOSITORY

## I. GENERAL INFORMATION

1. APPROVED PROJECT:	2. DOCUMENT/ DRAWING NUMBER: MSFC-STD-557A	3. CONTROL NUMBER:	4. RELEASE DATE: 2/14/05	5. SUBMITTAL DATE: 02/01/2005
6. DOCUMENT/DRAWING TITLE: Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for Spacecraft Applications			7. REPORT TYPE: Standard	
8. CONTRACT NUMBER / PERFORMING ACTIVITY:	9. DRD NUMBER:	10. DPD / DRL / IDRD NUMBER:		
11. DISPOSITION AUTHORITY (Check One): <input checked="" type="checkbox"/> Official Record - NRRS 8/12/A <input checked="" type="checkbox"/> Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)	12. SUBMITTAL AUTHORITY:	13. RELEASING AUTHORITY:		
14. SPECIAL INSTRUCTIONS:				
15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER:		16. ORIGINATING NASA CENTER: Marshall Space Flight Center		
		17. OFFICE OF PRIMARY RESPONSIBILITY: Metals Engineering Branch (EM30) Materials and Processes Laboratory Marshall Space Flight Center		
18. PROJECT CODE: 794-40-4L			19. NUMBER OF PAGES: 9	

## II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:

## III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION: A	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
30. ISSUE:	31. ANNEX:	32. SCN:	33. DCN:	34. AMENDMENT:	
35. APPENDIX:	36. ADDENDUM:	37. CCBD:	38. CODE ID:	39. IRN:	

## IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- Privacy Act (see MWI 1382.1)
  EAR (see MPR 2220.1, MPD 2190.1)
- Proprietary (see MPD 2210.1, MPR 7120.3)
  Other ACI (see MPR 1600.1)
- Patent (see MPR 2220.1)
- ITAR (see MPR 2220.1, MPD 2190.1)
  No statutory or institutional restrictions applicable -- material may be electronically distributed to user in the NASA domain

## V. DOCUMENTATION SUBMITTER (NASA OR CONTRACTOR)

40. ORG. CODE: EM30	41. PHONE NUMBER: (000) 544-2592	42. NAME: Wayne R. Gamwell	43. SIGNATURE/DATE: Wayne R. Gamwell 2/1/05
------------------------	-------------------------------------	-------------------------------	--

## VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY: Kim Miller	45. DATE RECEIVED: 2/14/05	46. WORK ORDER: 03-0048-5
--------------------------------	-------------------------------	------------------------------

M.F.  
Per  
customer