CHANGE NOTICES ARE NOT CUMULATIVE AND SHALL BE RETAINED UNTIL SUCH TIME AS THE ENTIRE STANDARD IS REVISED.



MILITARY STANDARD

# FASTENER SYSTEMS FOR AEROSPACE APPLICATIONS

TO ALL HOLDERS OF MIL-STD-1515A:

1. THE FOLLOWING ITEMS OF MIL-STD-1515A HAVE BEEN REVISED AND SUPERSEDE THE ITEMS LISTED:

| NEW ITEM | DATE | SUPERSEDED ITEM | DATE | TYPE CHANGE |
|---|---|---|---|---|
| Page iii | 24 Sept 1979 | REPRINTED WITHOUT CHANGE | | |
| Page iv | 24 June 1983 | Page iv | 5 June 1981 | Minor |
| Page v | 24 June 1983 | Page v | 5 June 1981 | Minor |
| Page vi | 12 July 1978 | REPRINTED WITHOUT CHANGE | | |
| Page 3 | 24 June 1983 | Page 3 | 24 Sept 1979 | Typo |
| Page 4 | 24 June 1983 | Page 4 | 24 Sept 1979 | Minor |
| Page 103.7 | 24 Sept 1979 | REPRINTED WITHOUT CHANGE | | |
| Page 103.8 | 24 June 1983 | Page 103.8 | 24 Sept 1979 | Minor |
| Page 112.1 | 24 June 1983 | Page 112.1 | 24 Sept 1979 | Minor |
| Page 112.2 | 24 Sept 1979 | REPRINTED WITHOUT CHANGE | | |
| Req 120 | 24 June 1983 | INITIAL PUBLICATION | | |
| Req 201 | 24 June 1983 | INITIAL PUBLICATION | | |
| Req 202 | 24 June 1983 | INITIAL PUBLICATION | | |
| Page 204.3 | 24 Sept 1979 | REPRINTED WITHOUT CHANGE | | |
| Page 204.4 | 24 June 1983 | Page 204.4 | 24 Sept 1979 | Minor |
| Page 204.13 | 24 Sept 1979 | REPRINTED WITHOUT CHANGE | | |
| Page 204.14 | 24 June 1983 | Page 204.14 | 24 Sept 1979 | Typo |
| Req 206 | 24 June 1983 | Req 206 | 5 June 1981 | Major |
| Req 213 | 24 June 1983 | INITIAL PUBLICATION | | |

2. Change 2 renumbered Requirement 215 as Requirement 129 but inadvertently failed to delete Requirement 215. This change deletes Requirement 215. Remove Requirement 215 from the Standard.

3. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

4. Holders of MIL-STD-1515A will verify that page changes, deletions and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or cancelled.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Preparing Activity:
Air Force - 11

Project 53GP-0039

Review Activities:
Army - AR, MI
Navy -
Air Force - 10, 99
DLA - IS

FSC 53GP

TABLE 201-I. Non-locking screws and bolts - continued

| HEAD | DRIVE | MATERIAL | P/N | PROC SPEC | FINISH 1/ | OTHER INFO |
|---|---|---|---|---|---|---|
| **160 KSI FTU Tension - continued** | | | | | | |
| 100° Flush | Hi-Torque | Steel | NAS1221 | NAS498 | Cadmium | sizes .1120-40 |
| 100° Flush | Hi-Torque | A286 | NAS1221E | AMS7478/ AMS7479 | Passivated | Thru .1640-32, for larger sizes use NAS1580 |
| 100° Flush | Hi-Torque | Ti | NAS1221V | NAS621 | Bare | |
| 100° Flush | Hi-Torque-Torq-Set | Steel | NAS1580A | NAS498 | Cadmium | |
| 100° Flush | Hi-Torque-Torq-Set | A286 | NAS1580C | AMS7479 | Passivated/ Cadmium | |
| 100° Flush | Hi-Torque-Torq-Set | Ti | NAS1580V | NAS621 | Bare | |
| 100° Flush | Hi-Torque | Steel | NAS1219 | NAS498 | Cadmium/ Aluminum | Full Thread |
| 100° Flush | Hi-Torque | A286 | NAS1219E | AMS7479 | Passivated/ Cad/Alum | Full Thread |
| 100° Flush | Hi-Torque | Ti | NAS1219V | NAS621 | Bare/ Aluminum | Full Thread |
| 100° Flush | Torq-Set | Steel | NAS1102 | NAS498 | Cadmium | Full Thread |
| 100o Flash | Torq-Set | A286 | NAS1102V | AMS7478/ AMS7479 | Passivated | Full Thread |
| 100o Flush | Torq-Set | Ti | NAS1102V | NAS621 | | Full Thread |
| **180 KSI FTU Tension** | | | | | | |
| Protruding | 12 Spline | Steel | MS21134 | MIL-B-8831 | Cadmium | |
| Protruding | 12 Spline | Steel | MS14157 | MIL-B-8831 | Cadmium | Wheel Bolt |
| Protruding | Hex | Steel | NAS1953-1970 | NAS4002 | Cadmium | |
| Protruding | Hex | A286 | NAS1953C-1970C | NAS4003 | Passivated/ Aluminum | |
| Brazier | Torq-Set/ Hi-Torque | Steel | NAS1982-1990 | NAS4002 | Cadmium | No Fatigue Requirement |
| Brazier | Torq-Set/ Hi-Torque | A286 | NAS1982C-1900C | NAS4003 | Passivated | |

TABLE 201-I. Non-locking screws and bolts.

| HEAD | DRIVE | MATERIAL | P/N. | PROC SPEC | FINISH 1/ | OTHER INFO |
|---|---|---|---|---|---|---|
| 160 KSI FTU Tension | | | | | | |
| Protruding | Hex | Steel | NAS6603-6620 | NAS4002 | Cadmium | Long Thread |
| Protruding | Hex | A286 | NAS6703-6720 | NAS4003 | Passivated | Long Thread |
| Protruding | Hex | Ti | NAS6803-6820 | NAS4004 | Bare | Long Thread |
| Protruding | Hex | Steel | NAS6203-6220 | NAS4002 | Cadmium | Med. Thread |
| Protruding | Hex | A286 | NAS6303-6320 | NAS4003 | Passivated | Med. Thread |
| Protruding | Hex | Ti | NAS6403-6420 | NAS4004 | Bare | Med. Thread |
| Protruding | Hex | Steel | NAS563-572 | MIL-B-6812 | Cadmium | Full Thread |
| Protruding | Hex | A286 | NAS563-572C | MIL-B-6812 | Passivated | Full Thread |
| Pan | Hi-Torque | Steel | NAS1218 | NAS498 | Cadmium | Sizes-1120-40 thru .1640-32 for larger sizes use NAS1578 |
| Pan | Hi-Torque | A286 | NAS1218E | AMS7478/ AMS7479 | Passivated | |
| Pan | Hi-Torque | Ti | NAS1218V | NAS621 | Bare | |
| Pan | Torq-Set | Steel | NAS1578A | NAS498 | Cadmium | |
| Pan | & | A286 | NAS1578C | AMS7479 | Passivated | |
| Pan | Hi-Torque | Ti | NAS1578V | NAS621 | Bare | |
| Pan | Hi-Torque | Steel | NAS1216 | NAS498 | Cadmium | Full Thread |
| Pan | Hi-Torque | A286 | NAS1216E | AMS7479 | Passivated | Full Thread |
| Pan | Hi-Torque | Ti | NAS1216V | NAS621 | Bare | Full Thread |
| Pan | Torq-Set | Steel | NAS1101 | NAS498 | Cadmium | |
| Pan | Torq-Set | A286 | NAS1101E | AMS7478/ AMS7479 | Passivated | Drilled Head Only |
| Pan | Torq-Set | Ti | NAS1101V | NAS621 | Bare | Approved |

FOREWORD

The purpose of this document is to establish standardization in the selection, development, and use of aerospace fastening systems, including hole characteristics and inspection criteria. Existing fasteners cover a wide variety of configurations, sizes, materials, and finishes. Various aerospace fastener systems have common fastener needs but lack defined application exchangeability. This document provides contractual design requirements and guidelines for proper selection and application of approved fastening systems. The basic objectives of this standard can be summarized as:

> To document selection and application information for approved fastening systems and procedures so the designer can achieve an optimum balance of performance, reliability, and exchangeability with minimum cost, logistic inventory and maintenance.

Selections and procedures are limited to those listed herein.

CONTENTS

INTRODUCTORY SECTION



SECTION 100 - GENERAL DESIGN REQUIREMENTS



*Denotes change
Supersedes page iv of 5 June 1981

CONTENTS (Continued)

SECTION 200 - STRUCTURAL FASTENER REQUIREMENTS



* Denotes change.
Supersedes page v of 12 July 1978

3.1.11 Fastening system. An installed fastener, its component parts, the geometry of the hole where it affects the performance of the system, and installation and removal tooling and procedures.

3.1.12 Grip or grip accommodation. The allowable variation of material thickness in which a specific fastener can function.

3.1.13 Impedance locking. A resistance that impedes disengagement of mating fastener components.

3.1.14 Locking device. A part or mechanism designed to prevent loss of preload or disengagement of a fastener.

3.1.15 Permanent fastener. A fastener which does not require removal to service or maintain the aircraft and that normally requires the destruction of the fastener or one of its components during removal.

3.1.16 Plate nut. (See anchor nut)

3.1.17 Self locking. An attribute of a fastener or fastener assembly having an integral locking element to impede relative rotation of mating components.

* 3.1.18 Shank. The unthreaded portion of a fastener between the head and the threads, locking grooves, formed head, etcetera.

4. GENERAL STATEMENTS

4.1 Guidelines. A separate publication, "AMFRG Manual on Organization and Operations of the Aeromechanical Fastener Requirements Group for MIL-STD-1515", has been distributed to organizations participating in the preparation of MIL-STD-1515. This publication presents guidelines for the preparation and coordination of requirements for inclusion in this standard. These guidelines shall be followed for all requirement additions or changes and shall be revised as necessary by the preparing activity or his designee.

4.2 Application

a. The sections contained herein are intended to provide uniform requirements applicable to mechanical aerospace fasteners and shall be incorporated by reference in general and detail weapon systems and equipment specifications.

b. If a requirement contained herein conflicts with a requirement in the general or detail weapon system or equipment specification, the weapon system or equipment specification shall take precedence. If a requirement listed in the contents has not been published but is referenced herein, it is not applicable and the requirements of the general or detail weapon system or equipment specification shall apply.

* Denotes change.
Supersedes page dated 24 September 1979

c. Section 100 Requirements apply only to Section 200 Structural fastener requirements (excluding subsequent proposed sections such as nonstructural, propulsion, etcetera, not published or in preparation).

4.3 Descriptive factors and symbols. The descriptive factor symbols used in this standard shall be in accordance with MS17855.

5. NOTES

5.1 Availability of Documents. Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

6. INTENDED USE AND GUIDANCE CRITERIA

6.1 Information and guidance. Paragraph 6 in all applicable requirements in this document presents information and guidance for use of that requirement or parts listed therein. The paragraph is not contractual.

6.2 Implementation. This standard may not be applicable to programs in the experimental, developmental, exploration, prototype, demonstration, validation program phases where the advantages of the standard will not be realized.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Preparing Activity:
Air Force - 11

Reviewer Activities:
Army - AR, MI
Navy -
Air Force - 10, 99
DLA - IS

Project No. 5300-0039

* Denotes change.
Supersedes page dated 24 September 1979.

# RELEASE FOR USE OF NONAPPROVED FASTENERS

1. Purpose. Fastening systems, fasteners, and installation requirements identified and listed in the applicable requirements of this standard are approved and shall be given selection priority in new aerospace systems design. Those not listed as approved for use require a release for use by the procuring activity prior to incorporation into design, during development, or for use in assembly during production. This requirement establishes preparation and submission procedures for justification and engineering data necessary for the evaluation and use of fasteners not listed herein. It also establishes the point of contact for release requests.

2. Documents applicable to Requirement 112

| | |
|---|---|
| MIL-D-8706 | Data and Tests, Engineering, Contract Requirements for Aircraft Weapon Systems |
| MIL-STD-965 | Parts Control System |

3. Procedures for use. When a determination has been made that a fastening system or fasteners not listed herein should be used, a request for release for use, with the justification and engineering data specified herein, shall be submitted to the procuring activity in accordance with the procedures of MIL-D-8706 and MIL-STD-965. When contracts do not call out any of the above documented procedures, the requests shall be made to the contact points listed in table 112-1, through the procuring activity in accordance with procedure 1 of MIL-STD-965 and the data requirements of 3.1 of this requirement.

3.1 Engineering data required. When applicable, the following engineering data shall be furnished for each fastener not listed herein for which release for use is requested.

a. The reason an approved fastener would not be a satisfactory selection to perform the function required by the design problem or application.

b. The specific materials from which the fastener is manufactured.

c. The specific plating, coatings, surface treatments, and lubricants, as applicable. These shall be completely identified.

d. Values for the physical and mechanical properties, and available installation performance requirements, and available structural design load allowable data.

* e. An illustration of the fastener with the dimensions required to establish the geometrical material limits necessary for design selection and for determining exchangeability. This includes the geometrical material limits of installation formed fasteners after installation and clearances required for installation.

f. The maximum weight limit per one hundred of the fasteners.

g. The design and usage limitations to be applied.

h. The installation or process instruction for the part.

* Denotes change.

3.2 Contract data requirements. Contract data requirements shall include the data specified in 3.1.

TABLE 112-I. Request contact points

| Department | Submit to | Action Required |
|---|---|---|
| Air Force | Aeronautical Systems Division<br>ATTN: ENFEM<br>Wright-Patterson AFB, OH 45433<br>Telephone: 513-255-4158 | Disapprove or Release |
| Army | US Army Aviation R&D Command<br>ATTN: DRDAV-EKS<br>P. O. Box 209 - Main Station<br>St. Louis, MO 63166<br>Telephone: 314-268-5791 | Disapprove or Release |
| Navy | Naval Air Development Center<br>ATTN: 6013<br>Warminster, PA 18974<br>Telephone: 215-441-2833 | Review and Recommendation to NAVAIR |
| | Naval Air Systems Command<br>ATTN: AIR-5303<br>Washington, DC 20361 | Disapprove or Release |
| All Military Services DISC/MPCAG | Defense Industrial Supply Center<br>ATTN: DISC-EPM<br>Philadelphia, PA 19111<br>Telephone: 215-697-4395 | Information and Recommendation |

# DRIVE AND WRENCHING ELEMENTS

1. Purpose. This requirement provides for the selection of drive and wrenching elements established as approved for use in aerospace structure fastener systems. Selection may be further limited by other documents.

## 2. Documents applicable to Requirement 120

### 2.1 Government documents

Federal Specifications

| | |
|---|---|
| GGG-W-636 | Wrenches, (Box, Open End, and Combination) |
| GGG-W-660 | Socket, Socket Wrench and Attachments (For Power Driven Impact Wrenches) |
| GGG-W-1437 | Wrench, Socket and Box End (Thin Wall-High Strength) |

Military Specifications

| | |
|---|---|
| MIL-W-8982 | Wrenches, Splined, Socket and Box, Square Drive, High Strength, Thin Wall |
| MIL-B-9946 | Bits, Screwdriver, General Specification for |

Military Standards

| | |
|---|---|
| MS 9006 | Recesses-Cross, Low Torque Drive, Dimensions and Gage Dimensions for |
| MS 14191 | Recess, Ribbed-Torq-Set, Dimensions of Recess, Gage and Driver for |
| MS 21132 | Wrenching Element, External Hexagon, for Threaded Fasteners |
| MS 33750 | Recess, Hi-Torque; Dimensions of Recess, Gage, and Driver for |
| MS 33781 | Recess - Torq-Set, Dimensions of Recess, Gage, and Driver for |
| MS 33787 | Wrenching Element, External Spline, Dimensions for |

Other Government Documents

| | |
|---|---|
| TO-1-1A-8 | Structural Hardware Section III |

### 2.2 Non-Government documents

| | |
|---|---|
| ANSI B18.3 | Socket Cap, Shoulder and Set Screws - Inch Series (Including Dimensions of Hexagon and Spline Sockets and Keys to Match) |
| NAS 7100 | Recess, Phillips®, Dimensions of Recess and Gages |
| NAS 7101 | Bit, Screwdriver, Phillips®, Specification for |

## 3. Design and usage limitations

### 3.1 External wrenching elements (external or internal threaded)

3.1.1 The hexagon drive external wrenching element in accordance with MS 21132 shall be limited to use for fasteners up to 180,000 psi maximum ultimate tensile stress only.

3.1.2 All externally threaded fasteners heat treated to 180,000 psi minimum ultimate tensile stress and higher and all internally threaded fasteners rated at 180,000 psi minimum ultimate tensile stress and higher shall have the MS 33787 external wrenching element. Fasteners less than 180,000 psi may utilize the MS 33787 wrenching element.

3.2 Internal drive elements

3.2.1 The MS 9006 recess shall be limited to use in fasteners heat treated up to 150,000 psi maximum ultimate tensile stress.

3.2.2 The NAS 7100 recess may be used in fasteners heat treated up to 160,000 psi maximum ultimate tensile stress. (Note: Fasteners heat treated above 160,000 psi maximum ultimate tensile stress with MS 9006 or NAS 7100 recess may be used in secondary structure with acquisition activity approval.)

3.2.3 Recesses in accordance with MS 33750, MS 33781 and MS 14191 shall be used in fasteners heat treated to 160,000 psi minimum ultimate tensile stress and higher. These recesses may be used in fasteners below 160,000 psi in order to reduce the recess types used in each system.

3.2.4 Internal hexagon recess in accordance with ANSI B18.3 shall be limited to the threaded end of pins without head driving recess, set screws, and certain panel fasteners as specified in Requirement 129. Acquisition activity approval is required for use of socket head cap screws in airframe structures.

4. Design selection and approved callout

Drive and wrench elements identified by this requirement shall conform to the documents listed in section 2 and shall be selected from table 120-I.

5. Tooling

5.1 Bits for installing internal drive fasteners shall be in accordance with MIL-B-9946, MS 33781, MS 14191, MS 33750, ANSI B18.3, and NAS 710I, as applicable.

5.1.1 Refer to TO-1-1A-8, Section III for driver wear limits.

5.2 Wrenches for installing fasteners with spline or hexagon external wrenching elements shall be in accordance with MIL-W-8982, GGG-W-1437, GGG-W-636, as applicable. MIL-W-8982 wrenches are compatible with both the 12-spline and MS 21132 hexagon wrenching elements. Wrenches in accordance with GGG-W-636, GGG-W-660, and GGG-W-1437 are not compatible with the 12-spline wrenching element in accordance with MS 33787.

5.3 Recesses in accordance with MS 9006 and NAS 7100 and their related tools are fully interchangeable. Recesses in accordance with MS 14191 and MS 33781 and their related tooling are fully interchangeable.

5.4 Care shall be exercised to ensure that the correct size bit or wrench is used and particularly for internal drives that specified installation torque requirements are not exceeded.

6. Intended use and guidance criteria

6.1 Some "off-the-shelf" aerospace systems may contain fasteners with drive and wrenching systems not specified herein. Field replacement with preferred drive and wrenching elements shall be dependent upon availability of equivalent hardware meeting all other required features (configurations, material, performance, et cetera) of the original fasteners.

TABLE 120-I. Drive or wrench element selection.

| DRIVE OR WRENCH ELEMENT | DESIGN STANDARD | TOOLING | DESIGN STRENGTH AND USAGE LIMITATIONS |
|---|---|---|---|
| Hexagon (External)  | MS 21132 | GGG-W-1437<br>GGG-W-636<br>GGG-W-660 | Less than 180,000 psi tensile stress.<br>.190 inch nominal diameter and larger. |
| 12 Spline (External)  | MS 33787 | MIL-W-8982 | 180,000 psi minimum tensile stress. (Optional below this level) |
| Phillips (Internal)  | MS 9006 | MIL-B-9946 | 150,000 psi maximum tensile stress. |
| | NAS 7100 (Ribbed) | NAS 7101 | 160,000 psi maximum tensile stress. |
| Torq-Set (Internal)  | MS 14191 (Ribbed) | MIL-B-9946 | 160,000 psi minimum tensile stress. (Optional below this level) |
| | MS 33781 | | |
| Hi-Torque (Internal)  | MS 33750 | MIL-B-9946 | 160,000 psi minimum tensile stress. (Optional below this level) |
| Hexagon (Internal)  | ANSI B18.3 | ANSI B18.3 | See 3.2.4 for limitations. |

# BOLTS AND SCREWS, REGULAR AND SELF-LOCKING

1. Purpose. This requirement provides for the selection of bolts established as approved hardware for use in aerospace structural joining.

2. Documents applicable to Requirement 201

2.1 Government documents

Federal Specification

| | |
|---|---|
| GGG-W-1437 | Wrench, Socket and Box End (Thin Wall-High Strength) |

Military Specifications

| | |
|---|---|
| MIL-B-6812 | Bolts, Aircraft |
| MIL-B-7838 | Bolt, Internal Wrenching, 160 KSI Ftu |
| MIL-B-8831 | Bolt, 180 KSI Ftu and 108 KSI Fsu, 450°F Protruding and Flush Head; General Specifications for |
| MIL-B-8906 | Bolt, Tensile, Steel, 220 KSI Ftu, 450°F External Wrenching, Flanged Head |
| MIL-F-8906/2 | Bolts, Shear, Steel, 132 KSI Fsu, 450°F |
| MIL-B-8907 | Bolt, Tensile, Steel, 260 KSI Ftu, 450°F External Wrenching, Flanged Head |
| MIL-F-8961 | Fastener, Externally Threaded, 450°F and 1200°F, Self-Locking Elements for |
| MIL-W-8982 | Wrenches, Splined, Socket and Box, Square Drive, High Strength, Thin Wall |
| MIL-B-9946 | Bits, Screwdriver, General Specification for |
| MIL-F-18240 | Fastener, Externally Threaded, 250°F Self-Locking Element for |
| MIL-B-87114 | Bolts, Recess Drive, General Specification for |

Military Standards

| | |
|---|---|
| MS 14157 | Bolt, Wheel, Tension, Flanged Steel, 180 KSI Ftu, 450°F, External Spline Drive |
| MS 14163 | Bolt, Wheel, Tension, Flanged, Steel 220 KSI, Ftu, 450°F, External Wrenching, Spline, Drive |
| MS 14179 | Nut, Plate, Self-Locking, Floating, Two Lug, Reduced Rivet Spacing, Steel, (Vespel Insert) 500 Cycles Reuse, Replaceable Nut, 160 KSI Ftu, 450°F |
| MS 14181 | Bolt, Tension, Inconel, 220 KSI Ftu, 800°F, External Wrenching, Spline Drive, Flanged Head |
| MS 14191 | Recess, Ribbed-Torq-Set, Dimensions of Recess, Gage and Driver for |
| MS 21134 | Bolt, Tension, Steel, 180 KSI Ftu, 450°F, External Wrenching, Spline Drive, Flanged |
| MS 21296 | Bolt, Tension, Steel, 260 KSI, Ftu, 450°F, External Wrenching, Spline Drive, Flanged Head |
| MS 21297 | Bolt, Tension, Steel, 220 KSI, Ftu, 450°F, External Wrenching, Spline Drive, Flanged Head |
| MS 33750 | Recess, Hi-Torque; Dimensions of Recess, Gage and Driver For |
| MS 33781 | Recess-Torq-Set, Dimensions of Recess, Gage and Driver for |

Marshall Space Flight Center Documents

MSFC 10M90001 Requirements and Procedures for Contamination Control Due to Vacuum Outgassing

(Application for copies should be addressed to the Marshall Space Flight Center, Huntsville, AL 35812)

2.2 Non-Government documents

| | |
|---|---|
| NAS 498 | Bolts, Shear |
| NAS 563-572 | Bolt, Full Threaded, Fully Identified Head |
| NAS 621 | Fastener, Titanium Alloy, Procurement Specification |
| NAS 1101 | Screw, Machine, Flat Fillister Head, Full Thread, Torq-Set |
| NAS 1102 | Screw, Machine Flat 100 Deg Head, Full Thread, Torq-Set |
| NAS 1161-1168 | Screw, Self-Locking, Flat 100 Deg Head, Shear, Torq-Set |
| NAS 1189 | Screw, Self-Locking, Flat 100 Deg Head, Full Thread |
| NAS 1190 | Screw, Self-Locking, Pan Head, Full Thread |
| NAS 1216 | Bolt, Flat, Pan Head, Hi-Torque Recess, Full Thread |
| NAS 1218 | Bolt, Flat, Pan Head, Hi-Torque Recess, Long Thread |
| NAS 1219 | Bolt, 100° Flush Tension Head, Hi-Torque Recess, Full Thread |
| NAS 1221 | Bolt, 100° Flush Tension Head, Hi-Torque Recess, Long Thread |
| NAS 1578 | Bolt, Flat Pan Head |
| NAS 1580 | Bolt, 100 Deg Flush Tension Head |
| NAS 1581 | Bolt, 100 Deg Flush Shear Head |
| NAS 1767 | Bolt, Close Tolerance, 100 Deg Reduced Head, Hi-Torque, Recess |
| NAS 1953-1970 | Bolt, Shear, Hexagon Head, 180 KSI |
| NAS 1972-1980 | Bolt, Flat, 100° Head Torq-Set and Hi-Torque, 180 KSI |
| NAS 1982-1990 | Bolt, Brazier Head, Torq-Set and Hi-Torque, 180 KSI |
| NAS 1992-2000 | Bolt, Flat, 100° Reduced Head, Torq-Set and Hi-Torque 180 KSI Shear |
| NAS 4002 | Fasteners, Alloy Steel, Externally Threaded |
| NAS 4003 | Fasteners, A286 CRES, Externally Threaded |
| NAS 4004 | Fasteners, 6Al-4V Titanium Alloy, Externally Threaded |
| NAS 6203-6220 | Bolt, Hex Head, Close Tolerance, Alloy Steel, Long Thread, Self-Locking and Non-Locking |
| NAS 6303-6320 | Bolt, Hex Head, Close Tolerance, A286, Short Thread, Self-Locking and Non-Locking |
| NAS 6403-6420 | Bolt, Hex Head, Close Tolerance, GAL-4V Titanium Alloy, Short Thread, Self-Locking and Non-Locking |
| NAS 6604-6620 | Bolt, Hex Head, Close Tolerance, Alloy Steel, Long Thread, Self-Locking and Non-Locking |
| NAS 6704-6720 | Bolt, Hex Head, Close Tolerance, A286 CRES, Long Thread, Self-Locking and Non-Locking |
| NAS 6804-6820 | Bolt, Hex Head, Close Tolerance, GAL-4V Titanium Alloy, Long Thread, Self-Locking and Non-Locking |
| AMS 7478 | Bolts and Screws, Steel, Corrosion and Heat Resistant Heat Treated, Roll Threaded-1800°F (982.2°C) Solution and Precipitation Heat Treated |
| AMS 7479 | Bolts and Screws, Steel, Corrosion and Heat Resistant Heat Treated, Roll Threaded-1650°F (898.9°C) Solution and Precipitation Heat Treated |

3. Design and usage limitations

3.1 Bolts smaller than 0.2500 inch in diameter shall not be used in any single bolted structural connection, including primary flight control systems, or any application where failure would adversely affect safety of flight.

3.2 Aluminum alloy threaded bolts shall not be used in structural applications. (Does not apply to threaded pins. See Requirement 214.)

3.3 The smallest acceptable diameter for 100° reduced flush head bolts shall be 0.2500 inch, except 0.1900 inch dimater 100° reduced head bolts may be used in panels whose removal is not required for scheduled maintenance.

3.4 Silver plated or cadmium plated bolts shall not be used in contact with titanium structure.

3.5 Titanium alloy bolts shall not be used with silver plated self-locking nuts at temperatures above 600°F.

3.6 Titanium alloy bolts shall not be cadmium plated and shall not be used with cadmium plated nuts at temperatures above 200°F.

3.7 Cadmium plated bolts shall not be used in temperature probes, electrical or life support space vehicle components or systems, potable water supplies, or food processing equipment.

3.8 The self-locking element used in bolts shall be in accordance with MIL-F-8961 or MIL-F-18240. Self-locking bolts shall be used subject to the limitations stated herein.

a. Shall be selected and used in a manner that will permit functional and dimensional interchangeability with a part that has only the attributes described and defined by the applicable standard and drawings.

b. Shall be used only in applications that permit engagement with the complete internal threads over the minimum external thread as designated by X Minimum as shown on figure 201-1.

c. Bolts containing self-locking elements in accordance with MIL-F-18240 or an insert or part that is nonmetallic shall not be used in parts where the locking element will encounter keyways, slots, cross holes or other thread interruptions.

d. Shall not be used as stated herein:

(1) at joints in control systems, at single attachments or where the loss of the bolt would affect safety of flight

(2) as an axis of rotation for another part unless the fastener is held in a positive locking device that requires shearing or rupture of material before torsional loads would be applied to the bolt in such a manner as to relieve the internal stress of the assembly or turn the bolt loose.

Examples: bearings, bushings, clamp-up bushings, pulleys, cranks, levers, linkages, hinge pins, axles, shafts, spindle gears, cams, cam followers, sliding mechanisms and pivot points

(3) at any single bolted structural joint which serves as a primary load path, the failure of which would endanger the safety of personnel or would render the equipment inoperative or cause its destruction.

Examples: fixed joints, tie rods, struts (fixed length members) wing attachments of fuselage, stabilizer surface attachments, longeron joints

e. Shall not be used to attach access panels, doors, or to assemble any parts that are routinely disassembled at intervals less than 400 flight hours.

f. Shall not be used on jet engine aircraft in locations where a loose fastener could fall or be drawn into the engine intake.

g. Shall not be used if the locking device has been reworked or reprocessed.

h. Self-locking bolts containing self-locking elements classified as 250°F, 450°F or 1200°F are intended for use at ambient temperature conditions of -65°F to +250°F, 450°F or 1200°F respectively and are designed to function satisfactorily at temperatures through these ranges.

i. When used in applications requiring controlled torque, such as clamping molded gaskets in fuel cells, consideration must be given to the maximum and minimum locking torque permitted by the procurement document.

j. For the self-locking bolts that incorporate an insert or part that is nonmetallic, the entering end of the threaded holes used in conjunction with the self-locking externally threaded fastener shall be countersunk 90 to 120 degrees. This countersink shall have a minimum diameter .015 inch larger than the major thread diameter of the fastener. This is to prevent the first thread from cutting the self-locking element.

k. Unthreaded holes or portions of holes through which the locking element of the bolt must pass shall have a minimum diameter sufficient to clear the locking element.

l. Shall not be used with castellated nuts or self-locking nuts.

4. Design selection and callout. Bolts in the category established by this requirement shall conform to the documents specified in section 2 and shall be selected from and specified by part numbers listed on the documents in tables 201-I and 201-II.

5. Tools and installation procedures

a. Interference between the hole and the head to shank radius should be avoided. A countersink in the bolt hole or the washer are methods commonly used.

b. Bits for installing internal recess drive bolts shall be in accordance with MIL-B-9946, MS33750, MS33781 or MS14191, as applicable.

5.3 Wrenches for installing spline drive external wrenching bolts shall be in accordance with MIL-W-8982; hex head bolts shall be in accordance with MIL-W-8982 or GGG-W-1437.

5.4 Since the use of the improper wrench or bit will degrade installation, care shall be exercised to assure that specified size bit or wrench is available and used.

6. Intended use and guidance criteria

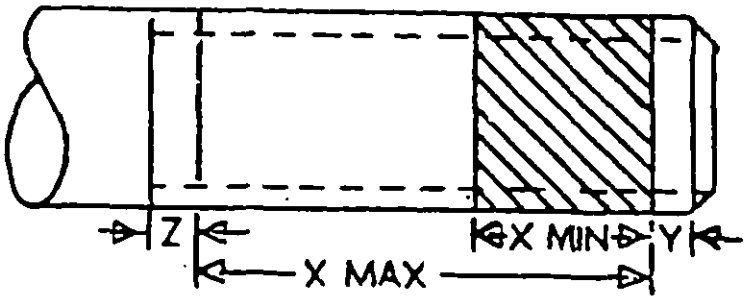
6.1 For the purposes of this requirement the terms bolt and screw are used interchangeably.

6.2 Where possible and practical, mating parts (except where flush head bolts or plate nuts are used) shall have similar external wrenching configurations.

6.3 When outgassing characteristics are a requirement, refer to Requirements 102 and 103 and to Marshall Space Flight Center Document 10M90001.

6.4 For the use of bolt threads in bearing refer to Requirement 121.

6.5 For the use of oversize bolts refer to Requirement 223.




| Thread Size | X Min. | Thread Size | X Min. | Thread Size | X Min. |
|---|---|---|---|---|---|
| 4-40 | .125 | 3/8-24 | .208 | 7/8-14 | .357 |
| 6-32 | .156 | 7/16-20 | .250 | 1-12 | .417 |
| 8-32 | | 1/2-20 | | 1-1/8-12 | |
| 10-32 | | 9/16-18 | .278 | 1-1/4-12 | |
| 1/4-28 | .178 | 5/8-18 | | | |
| 5/16-24 | .208 | 3/4-16 | .312 | | |

X, min represents the minimum length of external threads required for engagement with complete internal thread pitch. The locking element shall engage within this minimum length and meet requirements of the locking element or fastener specification or standard approved for use. X, min is equal to 5 thread pitches.

X, max equals the length of complete thread pitches between Y and Z.

Y, is for ease in starting, the locking element shall not be effective within the area of Y minimum.

Y, min equals one complete thread pitch; Y, max equals two complete thread pitches. This dimension shall not include thread pitches which have incomplete form or unthreaded portions of end, that is, chamfer and any extension beyond thread.

Z, equals one complete thread pitch plus thread runout. The locking element or any machine holes or grooves for the locking element shall not penetrate this area.

FIGURE 201-1. Effective locking area.

TABLE 201-I. Non-locking screws and bolts - continued

| HEAD | DRIVE | MATERIAL | P/N | PROC SPEC | FINISH 1/ | OTHER INFO |
|---|---|---|---|---|---|---|
| | | | 220 KSI FTU Tension | | | |
| Protruding | 12 Spline | Steel | MS14163 | MIL-B-8906 | VAC Cadmium | Wheel Bolt |
| Protruding | 12 Spline | Steel | MS21297 | MIL-B-8906 | VAC Cadmium | |
| Protruding | 12 Spline | INCO 718 | MS14181 | MIL-B-8906 | Bare | |
| | | | 260 KSI FTU Tension | | | |
| Protruding | 12 Spline | Steel | MS21296 | MIL-B-8907 | VAC Cadmium | |
| | | | 95 KSI FSU Shear | | | |
| 100° Flush Reduced | Hi-Torque | Steel | NAS1767 | NAS498 | Cadmium/ Aluminum | Crown Head |
| 100° Flush Reduced | Hi-Torque | A286 | NAS1767C | AMS7479 | Passivated/ Cad/Alum | Crown Head2/ |
| 100° Flush Reduced | Hi-Torque | Ti | NAS1767V | NAS621 | Bare/ Aluminum | Crown Head2/ |
| 100° Flush Reduced | Torq-Set | Steel | NAS1581A | NAS498 | Cadmium | Use Only2/ Torq-Set Recess |
| 100° Flush Reduced | Torq-Set | A286 | NAS1581C | AMS7479 | Passivated | Hi-Torque See NAS1767 |
| 100° Flush Reduced | Torq-Set | Ti | NAS1581V | NAS621 | Bare | |
| 100° Flush | Ribbed | Steel | MIL-B-87114/1 | MIL-B-87114 | Cadmium | Long Thread for use with MS14179 |
| 100° Flush Reduced | Torq-Set | Steel | MIL-B-87114/2 | MIL-B-87114 | Cadmium | |
| Pan | | Steel | MIL-B-87114/3 | MIL-B-87114 | Cadmium | |

TABLE 201-I. Non-locking screws and bolts - continued

| HEAD | DRIVE | MATERIAL | P/N | PROC SPEC | FINISH 1/ | OTHER INFO |
|---|---|---|---|---|---|---|
| | | | 108 KSI FSU | | | |
| 100° Flush Reduced | Hi-Torque/ Torq-Set | Steel | NAS1992-2000 | NAS4002 | Cadmium | 2/ |
| 100° Flush Reduced | Hi-Torque/ Torq-Set | A286 | NAS1992C-2000C | NAS4003 | Passivate/ Aluminum | 2/ |
| 100° | Hi-Torque Torq-Set | Steel | NAS1972-1980 | NAS4002 | Cadmium | No Fatigue Requirement |
| 100° Flush | Hi Torque/ Torq-Set | A286 | NAS1972C-1980C | NAS4003 | Passivated/ Aluminum | |
| | | | 132 KSI FSU | | | |
| Protruding | Spline | Steel | MIL-B-8906/2 | MIL-B-8906 | VAC Cadmium | |

1/ Only finish acceptable.
2/ See 3.3 for limitation on use of #10 and smaller.

TABLE 201-II. Self-locking bolts and screws.

| HEAD | DRIVE | MATERIAL | P/N | PROC SPEC 1/ | FINISH 2/ | TEMP °F | OTHER INFO |
|---|---|---|---|---|---|---|---|
| | | | 160 KSI FTU | | | | |
| Protruding | Hex | Steel | NAS6203L-6220L | NAS4002 | Cadmium | 250 | Medium Thread |
| Protruding | Hex | A286 | NAS6303L-6320L | NAS4003 | Passivated | 250 | Medium Thread |
| Protruding | Hex | Ti | NAS6403L-6420L | NAS4004 | Bare | 250 | Medium Thread |
| Protruding | Hex | Steel | NAS6603L-6620L | NAS4002 | Cadmium | 250 | 4/ |
| Protruding | Hex | A286 | NAS6703L-6720L | NAS4003 | Passivated/ Cad/Alum | 250 | 4/ |
| Protruding | Hex | Ti | NAS6803L-6820L | NAS4004 | Bare/ Aluminum | 250 | 4/ 5/ |
| | | | 95 KSI FSU | | | | |
| 100° Flush | Hi-Torque | Steel | NAS1221L | NAS498 | Cadmium | 250 | |
| 100° Flush | Hi-Torque | A286 | NAS1221EL | AMS7479 | Passivated | 250 | |
| 100° Flush | Hi-Torque | Ti | NAS1221VL | NAS621 | Bare | 250 | |
| 100° Flush | Torq-Set | Steel | NAS1161-1168 | NAS498 | Cadmium | 250 | |
| 100° Flush | Torq-Set | A286 | NAS1161E-1168E | AMS7478 | Passivated | 250 | |
| 100° Flush | Torq-Set | Ti | NAS1161V-1168V | NAS621 | Bare | 250 | |
| 100° Flush | Torq-Set | Steel | NAS1189 | NAS498 | Cadmium | 250 | Full Thread 3/ |
| 100° Flush | Torq-Set | A286 | NAS1189E | AMS7478 | Passivated | 250 | Full Thread 3/ |
| 100° Flush | Torq-Set | Ti | NAS1189V | NAS621 | Bare | 250 | Full Thread 3/ |
| 100° Flush | Hi-Torque | Steel | NAS1219L | NAS498 | Cadmium | 250 | Full Thread |
| 100° Flush | Hi-Torque | A286 | NAS1219EL | AMS7479 | Passivated | 250 | Full Thread |
| 100° Flush | Hi-Torque | Ti | NAS1219VL | NAS621 | Bare | 250 | Full Thread |

TABLE 201-II. Self-locking bolts and screws. - continued

| HEAD | DRIVE | MATERIAL | P/N | PROC SPEC 1/ | FINISH 2/ | TEMP °F | OTHER INFO |
|---|---|---|---|---|---|---|---|
| Pan | Hi-Torque | Steel | NAS1578AL | NAS496 | Cadmium | 250 | |
| Pan | Torq-Set | A286 | NAS1578CL | NAS496 | Passivated | 250 | |
| Pan | | Ti | NAS1578VL | NAS621 | Bare | 250 | |
| Pan | Hi-Torque | Steel | NAS1218L | NAS498 | Cadmium | 250 | Sizes .1120-40 |
| Pan | Hi-Torque | A286 | NAS1218EL | AMS7479 | Passivated | 250 | Thru .1640-32; |
| Pan | Hi-Torque | Ti | NAS1218VL | NAS621 | Bare | 250 | for .1900 and larger see NAS1578 |
| Pan | Torq-Set | Steel | NAS1190 | NAS498 | Cadmium | 250 | Full Thread 3/ |
| Pan | Torq-Set | A286 | NAS1190E | AMS7478 | Passivated | 250 | Full Thread 3/ |
| Pan | Torq-Set | Ti | NAS1190V | NAS621 | Bare | 250 | Full Thread 3/ |
| Pan | Hi-Torque | Steel | NAS1216L | NAS498 | Cadmium | 250 | Full Thread |
| Pan | Hi-Torque | A286 | NAS1216EL | AMS7479 | Passivated | 250 | Full Thread |
| Pan | Hi-Torque | Ti | NAS1216VL | NAS621 | Bare | 250 | Full Thread |

1/ Non-metallic locking feature in accordance with MIL-F-18240 or as specified on part standard.
2/ Only finish acceptable.
3/ Torq-Set recess only approved for use.
4/ See standard for exception to procurement specification.
5/ Cadmium plated bolt not approved.

# STUDS

1. Purpose. This requirement provides the engineering criteria, requirements and limitations for the selection and use of studs as aerospace mechanical fastening systems.

2. Documents applicable to Requirement 202

2.1 Government documents

Military Specifications

| | |
|---|---|
| MIL-S-45933 | Stud, Keyring Locked, 125 and 160 KSI, FTU: General Specifications for |
| MIL-S-45933/1 | Stud, Keyring Locked, 125 KSI, FTU, Single Step |
| MIL-S-45933/2 | Stud, Keyring Locked, 160 KSI, FTU, Multiple Step |
| MIL-S-45933/3 | Stud, Keyring Locked, Hole Dimensions for and Assembly of |

Military Standards

| | |
|---|---|
| MS 9827 | Stud - Stepped, 2 DIA, Engagement, Steel, .250-20 UNJS x .190-32 UNJF |
| MS 9828 | Stud - Stepped, 2 DIA, Engagement, Steel, .3125-18 UNJS x .250-28 UNJF |
| MS 9829 | Stud - Stepped, 2 DIA, Engagement, Steel, .375-16 UNJS x .3125-24 UNJF |
| MS 9830 | Stud - Stepped, 2 DIA, Engagement, Steel, .4375-14 UNJS x .375-24 UNJF |
| MS 9831 | Stud - Stepped, 2 DIA, Engagement, Steel, .500-13 UNJS x .4375-20 UNJF |
| MS 9832 | Stud - Stepped, 2 DIA, Engagement, Steel, .5625-12 UNJS x .500-20 UNJF |
| MS 9833 | Stud - Stepped, 2 DIA, Engagement, Steel, .625-11 UNJS x .5625-18 UNJF |
| MS 9834 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .250-20 UNJS x .190-32 UNJF |
| MS 9835 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .3125-18 UNJS x .250-28 UNJF |
| MS 9836 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .375-16 UNJS x .3125-24 UNJF |
| MS 9837 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .4375-14 UNJS x .375-24 UNJF |
| MS 9838 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .500-13 UNJS x .4375-20 UNJF |
| MS 9839 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .5625-12 UNJS x .500-20 UNJF |
| MS 9840 | Stud - Stepped, Drilled, 2 DIA, Engagement, Steel, .625-11 UNJS x .5625-18 UNJF |
| MS 17293 | Stud - Stepped, 1.5 DIA, Engagement, .250-20 x .190-32 (MIL-S-8879 Thread) |
| MS 17294 | Stud - Stepped, 1.5 DIA, Engagement, .3125-18 x .250-28 (MIL-S-8879 Thread) |

| | |
|---|---|
| MS 17295 | Stud - Stepped, 1.5 DIA, Engagement, .375-16 x .3125-24 (MIL-S-8879 Thread) |
| MS 17296 | Stud - Stepped, 1.5 DIA, Engagement, .4375-14 x .375-24 (MIL-S-8879 Thread) |
| MS 17297 | Stud - Stepped, Drilled, 1.5 DIA, Engagement, .3125-18 x .250-28 (MIL-S-8879 Thread) |
| MS 17298 | Stud - Stepped, Drilled, 1.5 DIA, Engagement, .375-16 x .3125-24 (MIL-S-8879 Thread) |
| MS 17299 | Stud - Straight, .190-24 x .190-32 (MIL-S-8879 Thread) |
| MS 17300 | Stud - Straight, .250-20 x .250-28 (MIL-S-8879 Thread) |
| MS 17301 | Stud - Straight, .3125-18 x .3125-24 (MIL-S-8879 Thread) |
| MS 17302 | Stud - Straight, Drilled, .250-20 x .250-28 (MIL-S-8879 Thread) |
| MS 17303 | Stud - Straight, Drilled, .3125-18 x .3125-24 (MIL-S-8879 Thread) |
| MS 51833 | Stud, Locked In-Key Locked, Lightweight |
| MS 51834 | Stud, Locked In-Key Locked, Heavy Duty |
| MS 51835 | Inserts and Studs, Locked In-Key Locked, Hole Dimensions for and Assembly of |
| MS 51989 | Stud, Locked In-Ring Locked, Serrated |
| MS 51990 | Ring, Lock, Serrated |
| MS 51992 | Stud, Locked In-Ring Locked, Serrated, High Strength |
| MS 51995 | Fasteners, Ring Locked Inserts and Studs, Installation of |
| MS 51997 | Ring, Lock, Serrated - High Strength |

Military Handbooks

| | |
|---|---|
| MIL-HDBK-5 | Metallic Materials and Elements for Aerospace Vehicle Structures |

2.2 Non-Government documents

| | |
|---|---|
| NAS1841 thru NAS1854 | Stud Assembly - Threaded Metal, Double Step |
| NAS1860 thru NAS1863 | Stud Assembly - Threaded Metal, Single Step |
| AS1229 | Insert, Screw Thread, Helical Coil, Stud Locking, Performance Standard for |
| AS3086 | Stud - Straight, Key Locked, Steel, .190-32 UNJF x .190-32 UNJF |
| AS3087 | Stud - Straight, Key Locked, Steel, .250-28 UNJF x .250-28 UNJF |
| AS3088 | Stud - Straight, Key Locked, Steel, .3125-24 UNJF x .3125-24 UNJF |
| AS3089 | Stud - Straight, Key Locked, Steel, .375-24 UNJF x .375-24 UNJF |
| AS3090 | Stud - Straight, Key Locked, CRES AMS5731, .190-32 UNJF x .190-32 UNJF |
| AS3091 | Stud - Straight, Key Locked, CRES AMS5731, .250-28 UNJF x .250-28 UNJF |
| AS3092 | Stud - Straight, Key Locked, CRES AMS5731, .3125-24 UNJF x .3125-24 UNJF |
| AS3093 | Stud - Straight, Key Locked, CRES AMS5731, .375-24 UNJF x .375-24 UNJF |
| AS3139 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .250-28 UNJF - 3A x .190-32 UNJF - 3A |
| AS3140 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .3125-24 UNJF - 3A x .250-28 UNJF - 3A |

| | |
|---|---|
| AS3141 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .375-24 UNJF - 3A x .3125-24 UNJF - 3A |
| AS3142 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .4375-20 UNJF - 3A x .375-24 UNJF - 3A |
| AS3143 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .500-20 UNJF - 3A x .4375-20 UNFJ - 3A |
| AS3144 | Stud, Stepped - 2.5 DIA. Engagement, PD Shank, AMS5731, .5625-18 UNJF - 3A x .580-20 UNJF - 3A |
| AS3319 | Stud - Straight, Ring Locked, CRES AMS5731, .190-24 UNJC x .190-32 UNJF |
| AS3320 | Stud - Straight, Ring Locked, CRES AMS5731, .250-20 UNJC x .190-32 UNJF |
| AS3321 | Stud - Straight, Ring Locked, CRES AMS5731, .3125-18 UNJC x .3125-24 UNJF |
| AS3322 | Stud - Straight, Ring Locked, CRES AMS5731, .375-16 UNJC x .375-24 UNJF |

3. Design and usage limitations. Studs for tapped holes shall be subject to the limitations and usages stated herein:

a. Studs shall be installed as specified in their particular design/usage standard to eliminate the possibility of their rotational displacement when installing or removing the mating unit.

b. Install MS 51833 and MS 51834 studs in accordance with MS 51835.

c. Install MIL-S-45933/1 and MIL-S-45933/2 studs in accordance with MIL-S-45933/3.

d. Install MS 51989 and MS 51992 studs in accordance with MS 51995.

e. Install MS 9827 thru MS9840 and MS 17293 thru MS 17303 studs in threaded holes tapped to National Form NC-3 tolerances or Unified National Form UNC-3B tolerances to the required depth. The studs shall be installed to the torque limit specified in table 202-I (for MS 17299 thru MS 17303) and table 202-II (for MS 9827 thru MS 9840 and MS 17293 thru MS 17298). In order to meet the required installation torque limits given in tables 202-I and 202-II, a standard or a +.003 oversize pitch diameter stud may be selected.

f. Install AS3086 thru AS3093 studs in accordance with the manufacturer's instrutions. Refer to standards AS3086 thru AS3093 for manufacturer's name and address.

g. Install AS3139 thru AS3144 studs into stud-locking helical coil threaded inserts (per AS1229) designed to proved an installation torque within the values specified in table 202-III.

h. Nut end threads of studs under.250 nominal diameter shall not be drilled for cotter pins or lock wire.

4. Design, selection and approved call-out. Fasteners in the category established by this requirement shall be selected and called-out from table 202-IV.

5. Tooling. Studs shall be installed by using tools that conform to acceptable aerospace practices for the type of stud being installed.

6. Intended use and guidance criteria. This section is intended to provide guidance to designers for the application and selection of studs.

a. Stepped studs may be used to provide higher strength capablities in relatively low strength structural (parent) materials with a shorter length of engagement than required for straight studs (both ends same diameter).

b. In the design selection of studs for structural applications, it is necessary that the proper degree of consideration be given to the axial load carrying capabilities of the installed stud in the specific parent materials at the maximum operating temperature of the assembly.

c. The axial load capability of an installed stud is determined by either the minimum tensile strength of the nut end or by the resistance to pullout from the parent material whichever is the lower.

(1) Resistance to pullout of the installed stud is the product of the shear engagement area of the stud end thread and the allowable shear stress of the parent material at the maximum operating temperature. It does not represent a dimension of either of the members in an unassembled condition.

(2) The allowable shear stress (Fs) for most metallic materials is listed in MIL-HDBK-5.

(3) The shear engagement areas of the stud end threads may be obtained from the design/usage standard for the particular stud.

d. Most studs are intended to be loaded primarily in tension. Joints carrying shear loads should be designed to preclude subjecting the studs to shear loads or use only those studs whose features allow their use under shear loading.

TABLE 202-I. Straight interference fit studs.

| Thread size (Drive end) | Torque, lb - in. | |
|---|---|---|
| | Minimum | Maximum |
| .250 -20 | 40 | 105 |
| .3125 -18 | 85 | 230 |

TABLE 202-II. Stepped interference fit studs.

| Thread size (nut end) | Torque, lb - in. | |
|---|---|---|
| | Minimum | Maximum |
| .190 -32 | 15 | 50 |
| .250 -28 | 40 | 125 |
| .3125 -24 | 85 | 260 |
| .375 -24 | 160 | 500 |
| .4375 -20 | 200 | 800 |
| .500 -20 | 250 | 1300 |
| .5625 -18 | 425 | 1800 |

TABLE 202-III. Stepped studs (AS3139 to AS3144) in stud-locking helical coil inserts per AS1229.

| Thread size (nut end) | Torque, lb - in. 1/ | |
|---|---|---|
| | Minimum | Maximum |
| .190 -32 | 23 | 45 |
| .250 -28 | 52 | 90 |
| .3125 -24 | 105 | 180 |
| .375 -24 | 140 | 240 |
| .4375 -20 | 175 | 300 |
| .500 -20 | 260 | 450 |

1/ A lubricant or coating may be applied to the stud end threads so as not to exceed the maximum torque values.

TABLE 202-IV. Studs.

| Part Number | Procurement Specification | Material | Other |
|---|---|---|---|
| Stud - Stepped 1.5 Dia Engagement | | | |
| MS 17293 | None | Steel | .250-20 x .190-32 |
| MS 17294 | None | Steel | .3125-18 x .20-28 |
| MS 17295 | None | Steel | .375-16 x .3125-24 |
| MS 17296 | None | Steel | .4375-14 x .375-24 |
| MS 17297 | None | Steel | .3125-18 x .250-28 |
| MS 17298 | None | Steel | .375-16 x .3125-24 |
| Stud - Stepped 2.0 Dia Engagement | | | |
| MS 9827 | AMS 7456 | Steel | .250-20 x .190-32 |
| MS 9828 | AMS 7456 | Steel | .3125-18 x 250-28 |
| MS 9829 | AMS 7456 | Steel | .375-16 x .3125-24 |
| MS 9830 | AMS 7456 | Steel | .4375-14 x .375-24 |
| MS 9831 | AMS 7456 | Steel | .500-13 x .4375-20 |
| MS 9832 | AMS 7456 | Steel | .5625-12 x .50-20 |
| MS 9833 | AMS 7456 | Steel | .625-11 x .5625-18 |
| MS 9834 | AMS 7456 | Steel | .250-20 x .190-32 |
| MS 9835 | AMS 7456 | Steel | .3125-18 x .250-28 |
| MS 9836 | AMS 7456 | Steel | .375-16 x .3125-24 |
| MS 9837 | AMS 7456 | Steel | .4375-14 x .375-24 |
| MS 9838 | AMS 7456 | Steel | .500-13 x .4375-20 |
| MS 9839 | AMS 7456 | Steel | .5625-12 x .500-20 |
| MS 9840 | AMS 7456 | Steel | .625-11 x .5625-18 |

TABLE 202-IV. Studs. - Continued

| Part Number | Procurement Specification | Material | Other |
|---|---|---|---|
| Stud - Stepped 2.5 Dia Engagement | | | |
| AS 3139 | AMS 7477 | CRES (AMS 5731) | .250-28 x .190-32 |
| AS 3140 | AMS 7477 | CRES (AMS 5731) | .3125-24 x .250-28 |
| AS 3141 | AMS 7477 | CRES (AMS 5731) | .375-24 x .3125-24 |
| AS 3142 | AMS 7477 | CRES (AMS 5731) | .4375-20 x .375-24 |
| AS 3143 | AMS 7477 | CRES (AMS 5731) | .500-20 x .4375-20 |
| AS 3144 | AMS 7477 | CRES (AMS 5731) | .5625-18 x .580-20 |
| Stud - Straight | | | |
| MS 17299 | None | Steel | .190-24 x .190-32 |
| MS 17300 | None | Steel | .250-20 x .250-28 |
| MS 17301 | None | Steel | .3125-18 x .3125-24 |
| MS 17302 | None | Steel | .250-20 x .250-28 |
| MS 17303 | None | Steel | .3125-18 x .3125-24 |
| AS 3086 | AMS 7452 | Steel | .190-32 x .190-32 |
| AS 3087 | AMS 7452 | Steel | .250-28 x .250-28 |
| AS 3088 | AMS 7452 | Steel | .3125-24 x .3125-24 |
| AS 3089 | AMS 7452 | Steel | .375-24 x .375-24 |
| AS 3090 | AMS 7477 | CRES (AMS 5731) | .190-32 x .190-32 |
| AS 3091 | AMS 7477 | CRES (AMS 5731) | .250-28 x .250-28 |
| AS 3092 | AMS 7477 | CRES (AMS 5731) | .3125-24 x .3125-24 |
| AS 3093 | AMS 7477 | CRES (AMS 5731) | .375-24 x .375-24 |
| AS 3319 | AMS 7482 | CRES (AMS 5731) | .190-24 x .190-32 |
| AS 3320 | AMS 7482 | CRES (AMS 5731) | .250-20 x .250-28 |
| AS 3321 | AMS 7482 | CRES (AMS 5731) | .3125-18 x .3125-24 |
| AS 3322 | AMS 7482 | CRES (AMS 5731) | .375-16 x .375-24 |

TABLE 202-IV. Studs. - Continued

| Part Number | Procurement Specification | Material | Other |
|---|---|---|---|
| Stud - Keyring Locked | | | |
| M 45933/1 | MIL-S-45933 | Steel (4130, 4140, A 286) | 125 ksi FTU |
| M 45933/2 | MIL-S-45933 | Steel (4130, 4140, A 286) | 160 ksi FTU |
| MS 51833 | MIL-S-45915 | Steel (4140, A 286, 303) | Lightweight |
| MS 51834 | MIL-S-45915 | Steel (4140, A 286, 303) | Heavy Duty |
| MS 51989 | MIL-S-45909 | Steel (4130, A 286) | |
| MS 51992 | MIL-S-45909 | Steel (8740, A 286)<br>Nickel (AMS 5662D-79)<br>Titanium (6Al-4V) | High Strength |
| Ring, Locked, Serrated | | | |
| MS 51990 | MIL-I-45910 | Steel (C1117, A 286) | |
| MS 51997 | MIL-I-45910 | Steel (C1117, A 286) | |
| Stud Assembly | | | |
| NAS 1841 thru NAS 1854 | None | Steel (4130, 303, A 286) | Double Step |
| NAS 1860 thru NAS 1863 | None | Steel (4130, 303, A 286) | Single Step |

# SOLID RIVETS

1. Purpose. This requirement provides the engineering criteria, requirements, and design and usage limitations for the selection and use of solid rivets in aerospace mechanical fastening systems.

## 2. Documents applicable to Requirement 206

### 2.1 Government documents

Military Standards

| | |
|---|---|
| MS 9403 | Rivet, Solid-Universal Head, AMS5737 |
| MS 9460 | Rivet, Solid - 100° Flush Head, AMS7235 |
| * MS 14218 | Rivet, Solid, 120° Flush Interference Shear Head |
| MS 20426 | Rivet, Solid, Countersunk 100°, Precision Head, Aluminum and Aluminum Alloy |
| MS 20427 | Rivet, Solid 100° Countersunk Head, Carbon Steel Corrosion-Resistant Steel, Monel and Copper |
| MS 20470 | Rivet, Solid-Universal Head, Aluminum and Aluminum Alloy |
| MS 20613 | Rivet, Solid-Universal Head, Steel, Carbon and Steel, Corrosion-Resistant |
| MS 20615 | Rivet, Solid-Universal Head, Brass, Copper and Nickel-Copper Alloy |

Air Force - Navy Aeronautical Standards

| | |
|---|---|
| AN123151 thru AN123300 | Rivet, Solid, Universal Head, AMS7229 |
| AN123301 thru AN123450 | Rivet, Solid, Universal Head, AMS7232 |
| AN123451 thru AN123600 | Rivet, Solid, 100° Flush Head, AMS7229 |
| AN123601 thru AN123750 | Rivet, Solid, 100° Flush Head, AMS7232 |

### 2.2 Non-Government documents

| | |
|---|---|
| * NAS1097 | Rivet, Solid, 100° Flush Shear Head, Aluminum Alloy, Titanium Columbium Alloy |
| NAS1198 | Rivet - Solid Universal Head, A286 Corrosion Resistant Steel |
| NAS1199 | Rivet - Solid - 100° Flush Head A286 Corrosion Resistant Steel |
| NAS1200 | Rivet, Solid, 100° Flush Shear Head A286 Corrosion Resistant Steel and Monel |

3. Design and usage limitations. Solid rivets in this requirement shall be * subject to the design and usage limitations stated herein.

a. Do not use cadmium-plated rivets where temperatures may exceed 450°F. Cadmium-plated monel rivets may not be used in applications where temperatures exceed 400°F.

b. Do not use cadmium-plated or silver-plated rivets in titanium.

* c. The primary loading of rivets shall be shear.

d. Head configuration shall be in accordance with Requirement 106. Where an angle other than 100° is needed, contact the procuring activity for approval of the specific application.

* e. Edge distance (center of hole to edge of sheet) for the location of rivets in sheets shall be a minimum of 2D (D = rivet diameter).

4. Design, selection and approved call-out. Fasteners in the category established by this requirement shall be selected from and called out by part numbers specified on standards listed in section 2.

5. Tooling. Rivets shall be driven utilizing tools that conform to acceptable aerospace practices for the rivet size and material being upset.

* 6. Intended use and guidance criteria. This section is intended to provide guidance to designers for the application and selection of solid rivets.

6.1 Aluminum alloy 2024 ("Type DD") rivets should be driven immediately after quenching or refrigeration. These require special care when driving to avoid or minimize upset cracking. See figure 206-1 for allowances.

6.2 When using rivet material harder than the material to be joined, particular care should be taken to avoid distortion during riveting. Special care is recommended when selecting rivet types and materials for installation through nonmetallic structures. Soft materials may be riveted by using washers under the rivet upset trail.

6.3 To minimize galvanic corrosion in the joint, rivets should not be anodic to the most anodic material in the joint.

6.4 Spotfacing should be used to provide a flat surface under upset heads when:

6.4.1 The surface slope is greater than 8° under the upset head of rivets. (Because of fatigue considerations, tapered shims may be used to avoid counterbores.)

6.4.2 A curved surface has a radius less than three times the rivet shank diameter.

6.4.3 The roughness of the facing surface under the heads is greater than 500 RHR.

6.5 Do not use solid rivets where forces required to upset the solid rivet can be detrimental to the structure.

6.6 Minimum spacing for riveted joints should be 4D between fasteners in the same adjacent rows or in staggered patterns except in fuel tight areas where the minimum spacing should be 3D (D = rivet diameter).

6.7 Tables 206-I and 206-II are presented as an aid in the selection of solid rivets.

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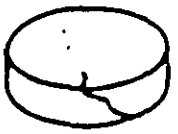

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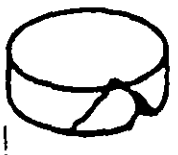

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REQUIREMENT 206
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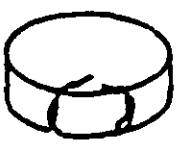

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FIGURE 206-1. Formed head inspectio

TABLE 206-I. Rivet, solid, flush head.

| PART NUMBER | MATERIAL | FINISH | ROOM TEMPERATURE ULTIMATE SHEAR STRENGTH, AS RECEIVED, PSI | MAXIMUM * TEMPERATURE |
|---|---|---|---|---|
| 100° COUNTERSUNK | | | | |
| AN123451 thru AN123600 | CRES, 300 Series | None | 48,000 (MIN) | 600°F |
| AN123601 thru AN123750 | Ni Alloy | None | 51,000 (MIN) | 1800°F |
| MS9460-( ) | CRES, A-286 | None | 80,000 to 95,000 | 1200°F |
| *MS14218 | Al Alloy | Anodized or Chemically Surface Treated | 24,000 to 38,000 | 250°F |
| MS20426A( )-( ) | Al, 1100-F | None | No Shear Test Required | 250°F |
| MS20426B( )-( ) | Al, 5056-1132 | Anodized or Chemically Surface Treated | 24,000 (MIN) | 250°F |
| MS20426AD( )-( ) | Al, 2117-T4 | Anodized or Chemically Surface Treated | 26,000 (MIN) | 250°F |
| MS20426DD( )-( ) | Al, 2024-T4 | Anodized | 37,000 (MIN) | 250°F |
| MS20427-( )C( ) | Steel, C1010-C1015 | Cd Plated | 32,000 to 38,000 | 450°F |

* Denotes change.

TABLE 206-I. Rivet, solid, flush head. - Continued

| PART NUMBER | MATERIAL | FINISH | ROOM TEMPERATURE ULTIMATE SHEAR STRENGTH, AS RECEIVED, PSI | MAXIMUM * TEMPERATURE |
|---|---|---|---|---|
| MS20427F( )-( ) | CRES, 300 Series | None | 65,000 to 85,000 | 600°F |
| MS20427M( )-( ) | Monel | None | 49,000 to 59,000 | 800°F |
| MS20427M( )C( ) | Monel | Cd Plated | 49,000 to 59,000 | 400°F |
| MS20427C( )-( ) | Copper, Annealed | None | 23,000 to 27,000 | 300°F |
| NAS1199-( )-( ) | CRES, A-286 | Passivated | 85,000 to 95,000 | 1200°F |
| 100° SHEAR HEAD<br>NAS1097B( )-( ) | Al, 5056-1132 | Anodized or Chemically Surface Treated | 24,000 (MIN) | 250°F |
| NAS1097AD( )-( ) | Al, 2117-T4 | Anodized or Chemically Surface Treated | 26,000 (MIN) | 250°F |
| NAS1097D( )-( ) | Al, 2017-T4 | Anodized or Chemically Surface Treated | 33,000 (MIN) | 250°F |
| NAS1097DD( )-( ) | Al, 2024-T4 | Anodized | 37,000 (MIN) | 250°F |
| AS1200-( )-( ) | CRES, A-286 | Passivated | 85,000 to 95,000 | 1200°F |
| NAS1200M( )-( ) | Monel | None | 49,000 to 59,000 | 800°F |
| NAS1200M( )-( )P | Monel | Cd Plated | 49,000 to 59,000 | 400°F |

Maximum temperature column is for information/guidance only. Some rivets may sustain strength for only a few seconds at these temperatures. Consequently, it is recommended that consideration be given to the time-at-temperature characteristics of each material specified in table 206-I to avoid severe degrading of rivets at maximum temperature exposure.

TABLE 206-II. Rivet, solid, universal head.

| PART NUMBER | MATERIAL | FINISH | ROOM TEMPERATURE ULTIMATE SHEAR STRENGTH, AS RECEIVED, PSI | MAXIMUM * TEMPERATURE |
|---|---|---|---|---|
| AN123151 thru AN123300 | CRES, 300 Series | None | 48,000 (MIN) | 600°F |
| AN123301 thru AN123450 | Ni Alloy | None | 51,000 (MIN) | 1800°F |
| MS9403-( ) | CRES, A-286 | None | 80,000 to 95,000 | 1200°F |
| MS20470A( )-( ) | Al, 1100-F | None | No Shear Test Required | 250°F |
| MS20470B( )-( ) | Al, 5056-1132 | Anodized or Chemically Surface Treated | 24,000 (MIN) | 250°F |
| MS20470AD( )-( ) | Al, 2117-T4 | Anodized or Chemically Surface Treated | 33,000 (MIN) | 250°F |
| MS20470D( )-( ) | Al, 2017-T4 | Anodized or Chemically Surface Treated | 33,000 (MIN) | 250°F |
| *MS20470DD( )-( ) | Al, 2024-T4 | Anodized | 37,000 (MIN) | 250°F |
| MS20613-( )P( ) | Steel, C1005-C1015 | Cd Plated | 25,000 to 42,000 | 450°F |
| MS20613-( )C( ) | CRES, 300 Series | Passivated | 65,000 to 85,000 | 600°F |
| MS20615-( )B( ) | Brass, 1/8 Hard | None | 35,000 | 300°F |
| MS20615-( )Cu( ) | Copper, Annealed | None | 17,000 to 30,000 | 300°F |

* Denotes change.

TABLE 206-II. Rivet, solid, universal head. - continued

| PART NUMBER | MATERIAL | FINISH | ROOM TEMPERATURE ULTIMATE SHEAR STRENGTH, AS RECEIVED, PSI | MAXIMUM * TEMPERATURE |
|---|---|---|---|---|
| MS20615-( )M( ) | Monel | None | 49,000 to 59,000 | 800°F |
| MS20615-( )MP( ) | Monel | Cd Plated | 49,000 to 59,000 | 400°F |
| NAS1198-( )-( ) | CRES, A-286 | Passivated | 85,000 to 95,000 | 1200°F |

Maximum temperature column is for information/guidance only. Some rivets may sustain strength for only a few seconds at these temperatures. Consequently, it is recommended that consideration be given to the time-at-temperature characteristics of each material specified in table 206-II to avoid severe degrading of rivets at maximum temperature exposure.

* Denotes change.

# BLIND FASTENERS

1. Purpose. This requirement provides the engineering criteria, requirements, and design and usage limitations for the selection and use of blind fasteners in aerospace structure.

2. Documents applicable to Requirement 213

2.1 Government documents

Military Specifications

| | |
|---|---|
| MIL-R-007885(AS) | Rivets; Blind, Structural, Locked and Friction Retained Spindle, General Specification For |
| MIL-R-007885/2 | Rivets, Blind, Structural, Universal Protruding Head, 5056 Al Alloy Sleeve, Positive Locked, 8740 Alloy Steel Spindle (Type I, Style A, Class 1) |
| MIL-R-007885/3 | Rivets, Blind, Structural, 100° Flush Head, 5056 Al Alloy Sleeve, Positive Locked, 8740 Alloy Steel Spindle (Type I, Style A, Class 2) |
| MIL-R-007885/4 | Rivets, Blind, Structural, Universal Protruding Head, Monel Sleeve, Positive Locked 15-7PH CRES Spindle (Type I, Style A, Class 1) |
| MIL-R-007885/5 | Rivets, Blind, Structural, 100° Flush Head, Monel Sleeve, Positive Locked 15-7PH CRES Spindle (Type I, Style A, Class 2) |
| MIL-R-007885/6 | Rivets, Blind, Structural, Universal Protruding Head, 5056 Al Alloy Sleeve, Positive Locked, 8740 Alloy Steel Spindle, Oversize Diameter (Type I, Style B, Class 1) |
| MIL-R-007885/7 | Rivets, Blind, Structural, 100° Flush Head, 5056 Al Alloy Sleeve, Positive Locked, 8740 Alloy Steel Spindle, Oversize Diameter (Type I, Style B, Class 2) |
| MIL-R-007885/8 | Rivets, Blind, Structural, Universal Protruding Head, Monel Sleeve, Positive Locked, 15-7PH CRES Spindle, Oversize Diameter (Type I, Style B, Class 1) |
| MIL-R-007885/9 | Rivets, Blind, Structural, 100° Flush Head, Monel Sleeve, Positive Locked, 15-7 PH CRES Spindle, Oversize Diameter (Type I, Style B, Class 2) |
| MIL-F-8975 | Fasteners, Blind, High Strength, Installation Formed, Corrosion Resistant Steel, Heat Resistant Steel and Titanium, General Specification For |
| MIL-F-8975/2 | Fasteners, Blind, High Strength, Corrosion Resistant Steel, Flush Head, Type II, Class 1 |
| MIL-F-8975/3 | Fasteners, Blind, Titanium, Flush Head, Type II, Class 2 |
| MIL-F-8975/4 | Fasteners, Blind, High Strength, Corrosion Resistant and Heat Resistant Steel, Protruding Head, Type II, Class 1 |
| MIL-F-8975/5 | Fasteners, Blind, Titanium, Protruding Head, Type II, Class 2 |
| MIL-F-81177 | Fasteners, Blind, High Strength, Installation Formed, Alloy Steel, General Specification For |
| MIL-F-81177/2 | Fasteners, Blind, High Strength, Installation Formed, Threaded, Self-Locking, 100° Flush Head, 450°F, Alloy Steel, 112 KSI Fsu |

| | |
|---|---|
| MIL-F-81177/3 | Fasteners, Blind, High Strength, Installation Formed, Threaded, Self-Locking, Protruding Head, 450°F, Alloy Steel, 112 KSI Fsu |
| MIL-R-85188(AS) | Riveter, Power, Pneumatic-Hydraulic or Pneumatic Blind Rivet Installation |

Military Standards

| | |
|---|---|
| MS 20426 | Rivet, Solid, Countersink 100°, Precision Head, Aluminum and Aluminum Alloy |
| MS 20470 | Rivet, Solid-Universal Head, Aluminum and Aluminum Alloy |
| MS 21140 | Fastener, Blind, High Strength, Pull Type, Positive Mechanical Lock, 100° Flush Head, Corrosion Resisting Steel, 95 KSI Fsu |
| MS 21141 | Fastener, Blind, High Strength, Pull Type, Positive Mechanical Lock Protruding Head, Corrosion Resisting Steel, 95 KSI Fsu |
| MS 24694 | Screw, Machine, Flat Countersunk Head, 100°, Structural, Cross Recessed, UNC-3A and UNF-3A |
| MS 90353 | Fastener, Blind, High Strength, Pull Type, Positive Mechanical Lock, 100° Flush Head, Alloy Steel, 112 KSI Fsu |
| MS 90354 | Fastener, Blind, High Strength, Pull Type, Positive Mechanical Lock, Protruding Head, Alloy Steel, 112 KSI Fsu |

2.2 Non-Government documents

| | |
|---|---|
| NAS 1097 | Rivet, Solid, 100° Flush Shear Head, Aluminum Alloy, Titanium Columbium Alloy |
| NAS 1398 | Rivet-Blind, Protruding Head, Locked Spindle |
| NAS 1399 | Rivet-Blind, 100° Flush Head, Locked Spindle |
| NAS 1400 | Rivet-Blind, Self-Plugging, Mechanically Locked Spindle |
| NAS 1669 | Fastener-Blind, Internally Threaded, External Sleeve, General Purpose, Protruding Head, Self-Locking |
| NAS 1670 | Fastener-Blind, Internally Threaded, External Sleeve, General Purpose, Flush Head, Slef-Locking |
| NAS 1671 | Fastener-Blind, Internally Threaded, External Sleeve, High Temperature, Protruding Head, Self-Locking |
| NAS 1672 | Fastener-Blind, Internally Threaded, External Sleeve, High Temperature, Flush Head, Self-Locking |
| NAS 1673 | Fastener-Blind, Internally Threaded, External Sleeve, Lightweight, Protruding Head, Slef-Locking |
| NAS 1674 | Fastener-Blind, Internally Threaded, External Sleeve, Lightweight, Millable Head, Self-Locking |
| NAS 1675 | Fastener-Blind, Internally Threaded, External Sleeve, Self-Locking |
| NAS 1738 | Rivet-Blind, Protruding Head, Mechanically Locked Spindle, Bulbed |
| NAS 1739 | Rivet-Blind, 100° Flush, Mechanically Locked, Spindle, Bulbed |
| NAS 1740 | Rivet-Blind, Self-Plugging, Mechanically Locked Spindle, Bulbed |
| NAS 1768 | Rivet-Blind, Protruding Head, Mechanically Locked Spindle, Bulbed |
| NAS 1769 | Rivet-Blind, 100° Flush Head, Mechanically Locked Spindle, Bulbed |

| | |
|---|---|
| NAS 1900 | Rivet, Blind-General Purpose, Bulbed, Self-Plugging, Mechanically-Locked-Spindle |
| NAS 1919 | Rivet, Blind-General Purpose, Bulbed, Protruding Head, Mechanically-Locked-Spindle |
| NAS 1921 | Rivet, Blind-General Purpose, Bulbed, 100° Flush Head, Mechanically-Locked-Spindle |

3. Design and usage limitations

3.1 Blind fastener general design and usage limitation are as stated herein.

3.1.2 Blind fasteners are primarily intended for applications where inaccessibility precludes the use of conventional fasteners.

3.1.3 Cadmium plated blind fasteners shall not be used where the temperature is above 450°F.

3.1.4 Cadmium plated blind fasteners shall not be used in space vehicle components or systems due to the instability of cadmium in a vacuum environment. Blind fasteners that are lubricated with dry film lubricants may be used in space applications provided the lubricant has been approved as meeting the outgasing requirements.

3.1.5 Cadmium plated blind fasteners may be used in titanium up to 200°F. CAUTION - Embrittlement of titanium from cadmium is directly related to temperature and structural bearing stresses normally encountered in end grain situations.

3.1.6 Blind fasteners shall be used in structural joints only where shear loads are the primary dsign load consideration.

3.1.7 Blind fasteners shall not be used in liquid tight areas without acquisition activity engineering approval.

3.1.8 Flush head styles may be used in conjunction with either machine countersinking or machine sub-countersinking where the sheet next to the head is dimpled. Flush head styles shall not be used where the blind side sheet is dimpled.

3.1.9 Blind fasteners shall not be used in applications where they are subject to removal during routine servicing and overhaul.

3.1.10 Blind fasteners head configuration shall conform to requirements in existing documents which specify appropriate parameters.

3.1.11 All blind fasteners shall be capable of obtaining functional characteristics when installed in hole sizes specified in their appropriate design and usage limitation standards and procurement specifications.

3.1.12 The grip increments for blind fasteners shall conform to requirements in existing documents which specify appropriate parameters.

3.1.13 Blind fasteners shall conform to shear strengths specified on their applicable specification or standard.

3.1.14 Unprotected areas of the blind fastener manufactured head shall receive a protective coating as necessary to comply with the aerospace vehicle finish requirements.

3.2 Blind rivet general design and usage limitations are as follows:

3.2.1 Blind rivets shall not be used on control surface hinges, hinge brackets, flight control actuating systems attachment, wing attach fittings, landing gear fittings or similar applications.

3.2.2 Mechanically locked spindle blind rivets may be used in engine inlet areas. Friction locked spindle blind rivets (no locking ring or collar) shall not be used in engine inlet areas.

3.2.3 Blind rivet holes for dimpled assembly shall be drilled to size after dimpling.

3.3 Blind bolt design and usage limitations are as stated herein.

3.3.1 Mechanically locked spindle blind bolts may be used in engine inlet areas. Friction locked spindle blind bolts (no locking ring or collar) shall not be used in engine inlet areas.

4. Design, selection and approved call out. Fasteners in the category established by this requirement shall be selected from and called-out by part numbers specified on standards or specifications slash sheets listed in table 213-I.

5. Tooling. Blind fasteners shall be installed by utilizing tools that are recommended by the fastener manufacturer. It is recommended that newly developed blind rivets be installed with MIL-R-85188 type tooling.

6. Intended use and guidance criteria. This section is intended to provide guidance for the application and selection of blind fasteners.

6.1 The head configuration of newly developed blind fasteners shall be protruding head or countersunk head. The countersunk head configuration shall be of the 100° included angle design in accordance with dimensions shown on MS 20426, MS 24694, or NAS 1097. The protruding head configuration shall be in accordance with dimensions shown on MS 20470, MS 90354 or NAS 1669.

6.2 All newly developed blind fasteners shall be capable of obtaining functional characteristics as required by applicable specifications or standards when installed in hole sizes for respective diameter dash numbers and types as listed in table 213-II.

TABLE 213-I. Blind fasteners.

| Part Number | Procurement Specification | Material | Other |
|---|---|---|---|
| Protruding Head | | | |
| MS 21141 | MIL-F-8975 | A 286 | 95 ksi FSU |
| MS 90354 | MIL-F-81177 | Alloy Steel | 112 ksi FSU |
| NAS 1398 | NAS 1400 | Al (5056, 2017)<br>Monel, A 286 | |
| NAS 1669 | NAS 1675 | Alloy Steel (Nut & Screw)<br>CRES (Sleeve) | |
| NAS 1671 | NAS 1675 | A 286 | 1200°F (max) |
| NAS 1673 | NAS 1675 | Al (7075) (Nut)<br>Alloy Steel (Screw)<br>CRES (Sleeve) | 250°F |
| NAS 1738 | NAS 1740 | Al (2219, 5056)<br>Inconel 600 (Sleeve)<br>Monel | |
| | | Inconel 600<br>Alloy Steel (Spindle)<br>A 286 | |
| | | Monel<br>Inconel (Lock Ring) | |
| NAS 1768 | NAS 1740 | Al (2017-T4)<br>Monel (Sleeve) | |
| | | Al (2017-T4)<br>Monel (Lock Ring) | |
| | | Al (7075-T6)<br>Monel (Stem) | |
| NAS 1919 | NAS 1900 | Al (5056)<br>A 286 (Sleeve)<br>Monel | |
| | | Al (2024)<br>A 286 (Spindle) | |
| | | Al (5056)<br>A 286 (Lock Ring) | |

TABLE 213-I. Blind fasteners. - Continued

| Part Number | Procurement Specification | Material | Other |
|---|---|---|---|
| Flush (100°) Head | | | |
| MS 21140 | MIL-F-8975 | A 286 | 95 ksi FSU |
| MS 90353 | MIL-F-81177 | Alloy Steel | 112 ksi FSU |
| NAS 1399 | NAS 1400 | Al (5056, 2017)<br>Monel, A 286 | |
| NAS 1670 | NAS 1675 | Alloy Steel (Nut & Screw)<br>CRES (Sleeve) | |
| NAS 1672 | NAS 1675 | A 286 | 1200°F (max) |
| NAS 1674 | NAS 1675 | Al (7075) (Nut)<br>Alloy Steel (Screw)<br>CRES (Sleeve) | 250°F |
| NAS 1739 | NAS 1740 | Al (2219, 5056)<br>Inconel 600 (Sleeve)<br>Monel | |
| | | Inconel 600<br>Alloy Steel (Spindle)<br>A 286 | |
| | | Monel<br>Inconel (Lock Ring) | |
| NAS 1769 | NAS 1740 | Al (2017-T4)<br>Monel (Sleeve) | |
| | | Al (2017-T4)<br>Monel (Lock Ring) | |
| | | Al (7075-T6)<br>Monel (Stem) | |
| NAS 1921 | NAS 1900 | Al (5056)<br>A 286 (Sleeve)<br>Monel | |
| | | Al (2024)<br>A 286 (Spindle) | |
| | | Al (5056)<br>A 286 (Lock Ring) | |

TABLE 213-II. Blind rivets/bolts hole sizes.

| Diameter Dash No. | Hole Sizes For Blind Rivets | Hole Sizes For Blind Bolts |
|---|---|---|
| -3 | .097 - .101 | |
| -4 | .129 - .132 | |
| -5 | .160 - .164 | .1645 - .1675 |
| -6 | .192 - .196 | .199 - .202 |
| -8 | .256 - .261 | .260 - .263 |
| -10 | | .312 - .315 |
| -12 | | .375 - .378 |
| -14 | | .437 - .441 |
| -16 | | .500 - .504 |

6.3 The grip increments for newly developed blind fasteners should be as listed in table 213-III.

TABLE 213-III. Grip increments.

| Material Thickness to be joined (Grip) | Grip Dash Numbers |
|---|---|
| 1/To - .062 | -1 |
| .063 - .125 | -2 |
| .126 - .187 | -3 |
| .188 - .250 | -4 |

1/ See individual standards pages for minimum grip.

NOTE: Longer grip lengths are available as documented on the applicable standards page.

6.4 Newly developed blind fasteners should be designed to be rated at one of the following shear strengths in pounds per square inch (psi):

| | |
|---|---|
| 30,000 | 75,000 |
| 34,000 | 95,000 |
| 38,000 | 112,000 |
| 46,000 | 125,000 |
| 50,000 | 132,000 |
| 55,000 | |

6.5 When using NAS 1398 and NAS 1399 fasteners, the minimum blind side sheet thickness should be as shown in table 213-IV.

TABLE 213-IV. Recommended minimum blind sheet thickness (in inches) for NAS 1398/1399.

| Dia Dash No. | Rivet Shank Material | Blind Sheet Material | | | |
|---|---|---|---|---|---|
| | | Aluminum | | | Titanium Ti-6Al-4V |
| | | 6061-T6 | 2024-T3 | 7075-T6 | Annealed |
| -4 | 5056-F | .032 | .032 | .032 | .016 |
| -5 | Aluminum | .032 | .032 | .032 | .016 |
| -6 | | .040 | .040 | .032 | .016 |
| -8 | | .050 | .050 | .032 | .020 |
| -4 | 2017-T4 | .040 | .032 | .032 | .016 |
| -5 | Aluminum | .040 | .032 | .032 | .016 |
| -6 | | .040 | .040 | .032 | .016 |
| -8 | | .040 | .040 | .032 | .020 |
| -4 | Monel | .025 | .025 | .025 | .016 |
| -5 | | .032 | .032 | .032 | .016 |
| -6 | | .050 | .050 | .050 | .016 |
| -8 | | .063 | .063 | .063 | .020 |
| -4 | A-286 | .032 | .025 | .025 | .016 |
| -5 | | .032 | .032 | .032 | .016 |
| -6 | | .040 | .040 | .040 | .025 |
| -8 | | .050 | .050 | .050 | .032 |

NOTE: The minimum thickness in a column may be used for other sheet materials having an equal or higher bearing ultimate strength (Fbru) value. Use of these fasteners in a thickness less than shown and in non-metallic materials shall be substantiated by test.

6.6 By definition, an oversize/repair fastener is one specifically designed for replacement purposes. Its shank diameter limits are greater than the fastener of the same family that is intended for selection in original design. The repair fastener shank diameter provides for larger diameter holes that are due to the removal of corrosive effects, the sizing of the hole, wear, etc. The fact that a fastener's shank is different (larger) than what is normally construed to the "nominal" diameter does not require that fastener to be identified as oversize.

CONTENTS (Continued)

SECTION 200 - STRUCTURAL FASTENER REQUIREMENTS



* Denotes change.
Supersedes page v of 12 July 1978

3.1.11 Fastening system. An installed fastener, its component parts, the geometry of the hole where it affects the performance of the system, and installation and removal tooling and procedures.

3.1.12 Grip or grip accommodation. The allowable variation of material thickness in which a specific fastener can function.

3.1.13 Impedance locking. A resistance that impedes disengagement of mating fastener components.

3.1.14 Locking device. A part or mechanism designed to prevent loss of preload or disengagement of a fastener.

3.1.15 Permanent fastener. A fastener which does not require removal to service or maintain the aircraft and that normally requires the destruction of the fastener or one of its components during removal.

3.1.16 Plate nut. (See anchor nut)

3.1.17 Self locking. An attribute of a fastener or fastener assembly having an integral locking element to impede relative rotation of mating components.

* 3.1.18 Shank. The unthreaded portion of a fastener between the head and the threads, locking grooves, formed head, etcetera.

4. GENERAL STATEMENTS

4.1 Guidelines. A separate publication, "AMFRG Manual on Organization and Operations of the Aeromechanical Fastener Requirements Group for MIL-STD-1515", has been distributed to organizations participating in the preparation of MIL-STD-1515. This publication presents guidelines for the preparation and coordination of requirements for inclusion in this standard. These guidelines shall be followed for all requirement additions or changes and shall be revised as necessary by the preparing activity or his designee.

4.2 Application

a. The sections contained herein are intended to provide uniform requirements applicable to mechanical aerospace fasteners and shall be incorporated by reference in general and detail weapon systems and equipment specifications.

b. If a requirement contained herein conflicts with a requirement in the general or detail weapon system or equipment specification, the weapon system or equipment specification shall take precedence. If a requirement listed in the contents has not been published but is referenced herein, it is not applicable and the requirements of the general or detail weapon system or equipment specification shall apply.

* Denotes change.
Supersedes page dated 24 September 1979

c. Section 100 Requirements apply only to Section 200 Structural fastener requirements (excluding subsequent proposed sections such as nonstructural, propulsion, etcetera, not published or in preparation).

4.3 Descriptive factors and symbols. The descriptive factor symbols used in this standard shall be in accordance with MS17855.

5. NOTES

5.1 Availability of Documents. Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

6. INTENDED USE AND GUIDANCE CRITERIA

6.1 Information and guidance. Paragraph 6 in all applicable requirements in this document presents information and guidance for use of that requirement or parts listed therein. The paragraph is not contractual.

6.2 Implementation. This standard may not be applicable to programs in the experimental, developmental, exploration, prototype, demonstration, validation program phases where the advantages of the standard will not be realized.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Preparing Activity:
Air Force - 11

Reviewer Activities:
Army - AR, MI
Navy -
Air Force - 10, 99
DLA - IS

Project No. 5300-0039

* Denotes change.
Supersedes page dated 24 September 1979.

# RELEASE FOR USE OF NONAPPROVED FASTENERS

1. Purpose. Fastening systems, fasteners, and installation requirements identified and listed in the applicable requirements of this standard are approved and shall be given selection priority in new aerospace systems design. Those not listed as approved for use require a release for use by the procuring activity prior to incorporation into design, during development, or for use in assembly during production. This requirement establishes preparation and submission procedures for justification and engineering data necessary for the evaluation and use of fasteners not listed herein. It also establishes the point of contact for release requests.

2. Documents applicable to Requirement 112

| | |
|---|---|
| MIL-D-8706 | Data and Tests, Engineering, Contract Requirements for Aircraft Weapon Systems |
| MIL-STD-965 | Parts Control System |

3. Procedures for use. When a determination has been made that a fastening system or fasteners not listed herein should be used, a request for release for use, with the justification and engineering data specified herein, shall be submitted to the procuring activity in accordance with the procedures of MIL-D-8706 and MIL-STD-965. When contracts do not call out any of the above documented procedures, the requests shall be made to the contact points listed in table 112-1, through the procuring activity in accordance with procedure 1 of MIL-STD-965 and the data requirements of 3.1 of this requirement.

3.1 Engineering data required. When applicable, the following engineering data shall be furnished for each fastener not listed herein for which release for use is requested.

a. The reason an approved fastener would not be a satisfactory selection to perform the function required by the design problem or application.

b. The specific materials from which the fastener is manufactured.

c. The specific plating, coatings, surface treatments, and lubricants, as applicable. These shall be completely identified.

d. Values for the physical and mechanical properties, and available installation performance requirements, and available structural design load allowable data.

* e. An illustration of the fastener with the dimensions required to establish the geometrical material limits necessary for design selection and for determining exchangeability. This includes the geometrical material limits of installation formed fasteners after installation and clearances required for installation.

f. The maximum weight limit per one hundred of the fasteners.

g. The design and usage limitations to be applied.

h. The installation or process instruction for the part.

* Denotes change.

3.2 Contract data requirements. Contract data requirements shall include the data specified in 3.1.

TABLE 112-I. Request contact points

| Department | Submit to | Action Required |
|---|---|---|
| Air Force | Aeronautical Systems Division<br>ATTN: ENFEM<br>Wright-Patterson AFB, OH 45433<br>Telephone: 513-255-4158 | Disapprove or Release |
| Army | US Army Aviation R&D Command<br>ATTN: DRDAV-EKS<br>P. O. Box 209 - Main Station<br>St. Louis, MO 63166<br>Telephone: 314-268-5791 | Disapprove or Release |
| Navy | Naval Air Development Center<br>ATTN: 6013<br>Warminster, PA 18974<br>Telephone: 215-441-2833 | Review and Recommendation to NAVAIR |
| | Naval Air Systems Command<br>ATTN: AIR-5303<br>Washington, DC 20361 | Disapprove or Release |
| All Military Services DISC/MPCAG | Defense Industrial Supply Center<br>ATTN: DISC-EPM<br>Philadelphia, PA 19111<br>Telephone: 215-697-4395 | Information and Recommendation |