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# Metallic Materials Properties Development and Standardization (MMPDS)

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Scientific Report

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16. Abstract

The Metallic Material Properties Development and Standardization (MMPDS) Handbook is the replacement document for MIL-HDBK-5. It is recognized internationally as a reliable source of aircraft materials data for aerospace materials selection and analysis. Consistent and reliable methods are used to collect, analyze, and present statistically based material and fastener allowable properties. The Handbook is the only publicly available source in the U.S. for material allowables that the Federal Avaiation Administration generally accepts for compliance with Federal Aviation Regulations (FAR) for material strength properties and design values for aircraft certification and continued airworthiness. Moreover, it is the only publicly available source worldwide for fastener joint allowables that comply with the FARs.

This edition, MMPDS-01, incorporates the additions and changes to aircraft metallic material design properties and analysis guidelines approved at the 1st and 2nd MMPDS government/industry coordination meetings.

This year, 2003, marks the first year of publication of the MMPDS Handbook and the final year of publication of MIL-HDBK-5. For this year only, MMPDS-01 and MIL-HDBK-5J will be technically equivalent. In the spring of 2004, when the 1st Change Notice of MMPDS-01 is published, MIL-HDBK-5 will be designated noncurrent and MMPDS will become the only government-recognized source in the U.S. of published design allowable properties for metallic commercial and military aircraft structures and mechanically fastened joints. In this way, the 65-year legacy of MIL-HDBK-5, and its predecessor ANC-5, will be maintained.

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# *FOREWORD*

This handbook is approved for use by the Federal Aviation Administration (FAA) and all Departments and Agencies of the Department of Defense. MMPDS-01 is equivalent to MIL-HDBK-5J, the last edition of the Metallic Materials and Elements for Aerospace Vehicle Structures Handbook that was maintained by the U.S. Air Force. The FAA plans to publish annual updates and revisions to the MMPDS. MIL-HDBK-5J is scheduled to be reclassified as noncurrent in the Spring of 2004.

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Chairman, MMPDS Coordination Activity (609-485-4784 voice or 609-485-4004 fax), AAR-450, Materials and Structures Branch, FAA William J. Hughes Technical Center, Atlantic City International Airport, Atlantic City, NJ 08405.

This document contains design information on the strength properties of metallic materials and elements for aerospace vehicle structures. All information and data contained in this Handbook have been coordinated with the FAA, the Air Force, the Army, the Navy, and industry prior to publication and are being maintained as a joint effort of the FAA and the Department of Defense.

The electronic copy of the Handbook is technically consistent with the paper copy Handbook; however, minor differences exist in format, i.e., table or figure position. Depending on monitor size and resolution setting, more data may be viewed without on-screen magnification. The figures were converted to electronic format using one of several methods. For example, digitization or recomputation methods were used on most of the engineering figures like typical stress-strain and effect of temperature, etc. Scanning was used to capture informational figures such as those found in Chapters 1 and 9. These electronic figures were also used to generate the paper copy figures to maintain equivalency between the paper copy and electronic copy. In all cases, the electronic figures have been compared to the paper copy figures to ensure the electronic figure was technically equivalent. Appendix E provides a detailed list of all the figures in the Handbook, along with a description of each figure's format.

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# *EXPLANATION OF NUMERICAL CODE*

For chapters containing materials properties, a deci-numeric system is used to identify sections of text, tables, and illustrations. This system is explained in the examples shown below. Variations of this deci-numerical system are also used in Chapters 1, 8, and 9.

Example A 2.4.2.1.1

General material category (in this case, steel) . . . . .

A logical breakdown of the base material by family characteristics (in this case, intermediate alloy steels); or for element properties . . . . .

Particular alloy to which all data are pertinent. If zero, section contains comments on the family characteristics . . . . .

If zero, section contains comments specific to the alloy; if it is an integer, the number identifies a specific temper or condition (heat treatment) . . . . .

Type of graphical data presented on a given figure (see following description) . . . . .

Example B 3.2.3.1.X

Aluminum . . . . .

2000 Series Wrought Alloy . . . . .

2024 Alloy . . . . .

T3, T351, T3510, T3511, T4, and T42 Tempers . . . . .

Specific Property as Follows . . . . .

Tensile properties (ultimate and yield strength) . . . . . 1

Compressive yield and shear ultimate strengths . . . . . 2

Bearing properties (ultimate and yield strength) . . . . . 3

Modulus of elasticity, shear modulus . . . . . 4

Elongation, total strain at failure, and reduction of area . . . . . 5

Stress-strain curves, tangent-modulus curves . . . . . 6

Creep . . . . . 7

Fatigue . . . . . 8

Fatigue-Crack Propagation . . . . . 9

Fracture Toughness . . . . . 10

# *CONTENTS*



NOTE: Information and data for alloys deleted from MMPDS may be obtained through the Chairman, MMPDS Coordination Activity.

## *CONTENTS (Continued)*



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## *CONTENTS (Continued)*



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# CHAPTER 8

## STRUCTURAL JOINTS

This chapter, while comprising three major sections, primarily is concerned with joint allowables. Section 8.1 is concerned with mechanically fastened joints; Section 8.2, with metallurgical joints (various welding and brazing processes). Section 8.3 contains information for structural component data; it is concerned with bearings, pulleys, and cables.

With particular reference to Section 8.1, the introductory section (8.1.1) contains fastener indexes that can be used as a quick reference to locate a specific table of joint allowables. Following this introductory section are five sections comprising the five major fastener categories, as shown in Table 8.0.1.

**Table 8.0.1. Structural Joints Index (Fastener Type)**

| Section | Fastener Type |
|---|---|
| 8.1.2 | Solid Rivets |
| 8.1.2.1 | Protruding head |
| 8.1.2.2 | Flush head |
| 8.1.3 | Blind fasteners |
| 8.1.3.1 | Protruding head |
| 8.1.3.2 | Flush head |
| 8.1.4 | Swaged collar fasteners |
| 8.1.4.1 | Protruding head |
| 8.1.4.2 | Flush head |
| 8.1.5 | Threaded fasteners |
| 8.1.5.1 | Protruding head |
| 8.1.5.2 | Flush head |
| 8.1.6 | Special fasteners |
| 8.1.6.1 | Fastener sleeves |

In each of the five major sections, there are subsections that describe the factors to be considered in determining the strength of fasteners and joints. After each major section, pertinent tables are presented.

Similarly, Section 8.2 has an introductory section (8.2.1), followed by two major sections comprising different metallurgical joints as shown in Table 8.0.2.

**Table 8.0.2. Structural Joints Index (Joining Methods)**

| Section | Joining Methods |
|---|---|
| 8.2.2 | Welded joints |
| 8.2.2.1 | Fusion |
| 8.2.2.2 | Flush and pressure |
| 8.2.2.3 | Spot and seam |
| 8.2.3 | Brazing |
| 8.2.3.1 | Copper |
| 8.2.3.2 | Silver |

Following each 4-digit section, applicable tables and figures for the particular section are presented.

## 8.1 MECHANICALLY FASTENED JOINTS

To determine the strength of mechanically fastened joints, it is necessary to know the strength of the individual fasteners (both by itself, and when installed in various thicknesses of the various materials). In most cases, failures in such joints occur by tensile failure of the fasteners, shearing of the fasteners and by bearing and/or tearing of the sheet or plate.

**8.1.1 INTRODUCTION AND FASTENER INDEXES** — Five categories of mechanical fasteners are presently contained in this Handbook, generically defined as follows:

*Solid Rivets* — Solid rivets are defined as one piece fasteners installed by mechanically upsetting one end.

*Blind Fasteners* — Blind fasteners are usually multiple piece devices that can be installed in a joint which is accessible from one side only. When a blind fastener is being installed, a self-contained mechanical, chemical, or other feature forms an upset on its inaccessible or blind side. These fasteners must be destroyed to be removed. This fastener category includes such fasteners as blind rivets, blind bolts, etc.

*Swaged Collar Fasteners* — Swaged collar fasteners are multiple piece fasteners, usually consisting of a solid pin and a malleable collar which is swaged or formed onto the pin to clamp the joint. This fastener usually is permanently installed. This fastener class includes such fasteners as "Hi-Shear" rivets, "Lockbolts", and "Cherrybucks".

*Threaded Fasteners* — Fasteners in this category are considered to be any threaded part (or parts) that after assembly in a joint can be easily removed without damage to the fastener or to the material being joined. This classification includes bolts, screws, and a wide assortment of proprietary fasteners.

*Special Fasteners* — As the name implies, this category of fastener is less commonly used in primary aircraft structure than the four categories listed above. Examples of such fastening systems are sleeves, inserts, panel fasteners, etc.

In the following 3-digit sections, descriptive information is presented relative to the establishment of design allowables in joints containing these four categories of fasteners. Following each such section are the various tables of joint allowables or associated information for computing joint allowables as described.

Tables 8.1.1(a) through (e) are fastener indexes that list the joint allowables tables for each fastener category. These indexes are provided to make it easier to locate the allowables table for a given fastener and sheet material combination. Each of the indexes generally is similarly structured in the following manner. The left-hand column describes the fastener by referring to the NASM part number or to a vendor part number when the fastener is not covered by either series. The second column contains the table number for the allowables table for each fastener. The fastener column has been so arranged that when protruding head and countersunk head fasteners are included in a given fastener index table, the protruding head tables appear first in the second column. The third column identifies generally the base material of the fastener. Generic terms usually are used, such as steel, aluminum, titanium, etc. The fourth column identifies the specific sheet or plate material.

It is recommended that Section 9.7 be reviewed in its entirety since it contains detailed information on the generation and analysis of joint data that results in the joint allowables tables contained in this section.

**8.1.1.1** ***Data Sources*** — The data shown in subsequent tables are provided by one or more manufacturers as listed in the table. There may be more than one producer of a fastener type, but data support is provided by only the footnoted source. **Warning: Caution should be exercised to ensure that use of static joint strength data is applicable only for the data producer(s) indicated by the footnote on each table.**

**8.1.1.2** ***Fastener Shear Strengths*** — Fastener shear strengths accepted and documented by the aerospace industry and government agencies are listed in Table 8.1.1.1. Some existing tables in MMPDS may reflect other values; however, new fastener proposals will be classified in accordance with the above-noted table.

**8.1.1.3** ***Edge Distance Requirements*** — The joint allowables in MMPDS are based on joint tests having edge distances of twice the nominal hole diameter, 2D. Therefore, the allowables are applicable only to joints having 2D edge distance.

**Table 8.1.1(a). Fastener Index for Solid Rivets**

| Fastener Identification[a] | Table Number | Rivet Material | Sheet Material | Page No. |
|---|---|---|---|---|
| Rivet Hole Size | 8.1.2(a) | ... | ... | 8-12 |
| Shear Strength of Solid Rivets | 8.1.2(b) | ... | ... | 8-13 |
| Unit Bearing Strength | 8.1.2.1(a) | ... | ... | 8-14 |
| Shear Strength Corection Factors | 8.1.2.1(b) | Aluminum | ... | 8-15 |
| NAS1198 (MC)[b] | 8.1.2.1(c) | A-286 | A-286 | 8-16 |
| MS20427M (MC) | 8.1.2.2(a) | Monel | AISI 301/302 | 8-17 |
| MS20427M (D)[b] | 8.1.2.2(b) | Monel | AISI 301/302 | 8-18 |
| MS20426AD (D) | 8.1.2.2(c) | Aluminum | Aluminum | 8-19 |
| MS20426D (D) | 8.1.2.2(d) | Aluminum | Aluminum | 8-20 |
| MS20426DD (D) | 8.1.2.2(e) | Aluminum | Aluminum | 8-21 |
| MS20426 (MC) | 8.1.2.2(f) | Aluminum | Clad 2024-T42 | 8-22 |
| MS20426B (MC) | 8.1.2.2(g) | Aluminum | AZ31B-H24 | 8-23 |
| MS20427M (MC) | 8.1.2.2(h) | Monel | Com Pure Titanium | 8-24 |
| BRFS-D (MC) | 8.1.2.2(i) | Aluminum | Clad 2024-T3 | 8-25 |
| BRFS-AD (MC) | 8.1.2.2(j) | Aluminum | Clad 2024-T3 | 8-26 |
| BRFS-DD (MC) | 8.1.2.2(k) | Aluminum | Clad 2024-T3 | 8-27 |
| BRFS-T (MC) | 8.1.2.2(l) | Ti-45Cb | Clad 7075-T6/Ti-6Al-4V | 8-28 |
| MS14218E (MC) | 8.1.2.2(m) | Aluminum | Clad 2024-T3 | 8-29 |
| NAS1097E (MC) | 8.1.2.2(n) | Aluminum | Clad 2024-T3/7075-T6 | 8-30 |
| MS14218AD (MC) | 8.1.2.2(o) | Aluminum | Clad 2024-T3 | 8-31 |
| MS14219E (MC) | 8.1.2.2(p) | Aluminum | Clad 2024-T3 | 8-32 |
| MS14219E (MC) | 8.1.2.2(q) | Aluminum | Clad 7075-T6 | 8-33 |
| MS20426E (MC) | 8.1.2.2(r) | Aluminum | Clad 2024-T3 | 8-34 |
| MS20426E (MC) | 8.1.2.2(s) | Aluminum | Clad 7075-T6 | 8-35 |
| AL905KE (MC) | 8.1.2.2(t) | Aluminum | Clad 2024-T3 | 8-36 |

a In some cases, entries in this table identify the subject matter in certain tables.
b MC, machine countersunk holes; D, dimpled holes.

**Table 8.1.1(b). Fastener Index for Blind Fasteners**

| Fastener Identification | Table Number | Fastener Sleeve Material | Sheet or Plate Material | Page No. |
|---|---|---|---|---|
| Protruding-head, Friction-Lock Blind Rivets | | | | |
| CR 6636 | 8.1.3.1.1(a) | A-286 | Various | 8-38 |
| MS20600M | 8.1.3.1.1(b) | Monel | AISI 301 | 8-39 |
| MS20600M | 8.1.3.1.1(c) | Monel | Clad 2024-T3/7075-T6 | 8-40 |
| MS20600AD and MS20602AD | 8.1.3.1.1(d) | Aluminum | Clad 2024-T3 | 8-41 |
| MS20600B | 8.1.3.1.1(e) | Aluminum | AZ31B-H24 | 8-42 |
| Protruding-head, Mechanical-Lock Blind Rivets | | | | |
| NAS1398C | 8.1.3.1.2(a) | A-286 | Alloy Steel | 8-43 |
| CR 2643 | 8.1.3.1.2(a) | A-286 | Alloy Steel | 8-43 |
| NAS1398 MS or MW | 8.1.3.1.2(b) | Monel | AISI 301-½ Hard | 8-44 |
| NAS1398 MS or MW | 8.1.3.1.2(c) | Monel | Clad 7075-T6 | 8-45 |
| NAS1398B | 8.1.3.1.2($d_1$) | Aluminum | Clad 2024-T3 | 8-46 |
| NAS1398D | 8.1.3.1.2($d_1$) | Aluminum | Clad 2024-T3 | 8-46 |
| NAS1738B and NAS1738E | 8.1.3.1.2($d_2$) | Aluminum | Clad 2024-T3 | 8-47 |
| NAS1398B | 8.1.3.1.2(e) | Aluminum | AZ31B-H24 | 8-48 |
| NAS1738B and NAS1738E | 8.1.3.1.2(e) | Aluminum | AZ31B-H24 | 8-48 |
| CR 2A63 | 8.1.3.1.2(f) | Aluminum | Clad 2024-T81 | 8-49 |
| CR 4623 | 8.1.3.1.2(g) | A-286 | Clad 7075-T6 | 8-50 |
| CR 4523 | 8.1.3.1.2(h) | Monel | Clad 7075-T6 | 8-51 |
| NAS1720KE and NAS1720KE ( ) L | 8.1.3.1.2(i) | Aluminum | Clad 7075-T6 | 8-52 |
| NAS1720C and NAS1720C ( ) L | 8.1.3.1.2(j) | A-286 | Clad 2024-T3 | 8-53 |
| AF3243 | 8.1.3.1.2(k) | Aluminum | Clad 2024-T3 | 8-54 |
| HC3213 | 8.1.3.1.2(l) | Aluminum | Clad 2024-T3 | 8-55 |
| HC6223 | 8.1.3.1.2(m) | Aluminum | Clad 2024-T3 | 8-56 |
| HC6253 | 8.1.3.1.2(n) | Aluminum | Clad 2024-T3 | 8-57 |
| AF3213 | 8.1.3.1.2(o) | Aluminum | Clad 2024-T3 | 8-58 |
| CR3213 | 8.1.3.1.2(p) | Aluminum | Clad 2024-T3 | 8-59 |
| CR3243 | 8.1.3.1.2(q) | Aluminum | Clad 2024-T3 | 8-60 |
| HC3243 | 8.1.3.1.2(r) | Aluminum | Clad 2024-T3 | 8-61 |
| AF3223 | 8.1.3.1.2(s) | Aluminum | Clad 2024-T3 | 8-62 |
| CR3223 | 8.1.3.1.2(t) | Aluminum | Clad 2024-T3 | 8-63 |

**Table 8.1.1(b). Fastener Index for Blind Fasteners (Continued)**

| Fastener Identification | Table Number | Fastener Sleeve Material | Sheet or Plate Material | Page No. |
|---|---|---|---|---|
| Flush-head, Friction-Lock Blind Rivets | | | | |
| CR 6626 (MC)[a] | 8.1.3.2.1(a) | A-286 | Various | 8-64 |
| MS20601M (MC) | 8.1.3.2.1(b) | Monel | 17-7PH (TH1050) | 8-65 |
| MS20601M (D)[a] | 8.1.3.2.1(c) | Monel | AISI 301 | 8-66 |
| MS20601M (MC) | 8.1.3.2.1($d_1$) | Monel | AISI 301-Ann | 8-67 |
| MS20601M (MC) | 8.1.3.2.1($d_2$) | Monel | AISI 301-¼ Hard | 8-68 |
| MS20601M (MC) | 8.1.3.2.1($d_3$) | Monel | AISI 301-½ Hard | 8-69 |
| MS20601M (MC) | 8.1.3.2.1(e) | Monel | 7075-T6 | 8-70 |
| MS20601AD and MS20603AD (MC) | 8.1.3.2.1(f) | Aluminum | Clad 2024-T3 | 8-71 |
| MS20601B (MC) | 8.1.3.2.1(g) | Aluminum | AZ31B-H24 | 8-72 |
| Flush-head, Mechanical-Lock Spindle Blind Rivets | | | | |
| NAS1399C (MC) | 8.1.3.2.2(a) | A-286 | Alloy Steel | 8-73 |
| CR 2642 (MC) | 8.1.3.2.2(a) | A-286 | Alloy Steel | 8-73 |
| NAS1399 MS or MW (MC) | 8.1.3.2.2(b) | Monel | AISI 301-½ Hard | 8-74 |
| NAS1921C (MC) | 8.1.3.2.2(c) | A-286 | Clad 7075-T6 | 8-75 |
| NAS1399 MS or MW (MC) | 8.1.3.2.2(d) | Monel | Clad 7075-T6 | 8-76 |
| NAS1921M (MC) | 8.1.3.2.2(e) | Monel | Clad 7075-T6 | 8-77 |
| CR 2A62 (MC) | 8.1.3.2.2(f) | Aluminum | Clad 2024-T81 | 8-78 |
| NAS1921B (MC) | 8.1.3.2.2(g) | Aluminum | Clad 7075-T6 | 8-79 |
| NAS1399B (MC) | 8.1.3.2.2(h) | Aluminum | Clad 2024-T3 | 8-80 |
| NAS1399D (MC) | 8.1.3.2.2(h) | Aluminum | Clad 2024-T3 | 8-80 |
| NAS1739B and NAS1379E (MC) | 8.1.3.2.2(i) | Aluminum | Clad 2024-T3 | 8-81 |
| NAS1739B and NAS1739E (D) | 8.1.3.2.2(i) | Aluminum | Clad 2024-T3 | 8-81 |
| NAS1399B (MC) | 8.1.3.2.2(j) | Aluminum | AZ31B-H24 | 8-82 |
| NAS1739B and NAS1739E (MC) | 8.1.3.2.2(j) | Aluminum | AZ31B-H24 | 8-82 |
| CR 4622 (MC) | 8.1.3.2.2(k) | A-286 | Clad 7075-T6 | 8-83 |
| CR 4522 (MC) | 8.1.3.2.2(l) | Monel | Clad 7075-T6/T651 | 8-84 |
| NAS1721KE and NAS1721KE ( )L (MC) | 8.1.3.2.2(m) | Aluminum | Clad 2024-T3 | 8-85 |
| NAS1721C and NAS1721C ( ) L (MC) | 8.1.3.2.2(n) | A-286 | Clad 7075-T6 | 8-86 |
| HC3212 (MC) | 8.1.3.2.2(o) | Aluminum | Clad 2024-T3 | 8-87 |
| MBC 4807 and MBC 4907 (MC) | 8.1.3.2.2(p) | Aluminum | Clad 2024-T3 | 8-88 |
| MBC 4801 and MBC 4901 | 8.1.3.2.2(q) | Aluminum | Clad 2024-T3 | 8-89 |
| HC6222 (MC) | 8.1.3.2.2(r) | Aluminum | Clad 2024-T3 | 8-90 |
| HC6252 (MC) | 8.1.3.2.2(s) | Aluminum | Clad 2024-T3 | 8-91 |
| HC6224 (MC) (A-286 pin) | 8.1.3.2.2($t_1$) | 5056 Al | Clad 2024-T3 | 8-92 |
| HC3214 (MC) (8740 pin) | 8.1.3.2.2($t_2$) | 5056 Al | Clad 2024-T3 | 8-93 |
| AF3212 (MC) | 8.1.3.2.2(u) | Aluminum | Clad 2024-T3 | 8-94 |
| CR3212 (MC) | 8.1.3.2.2(v) | Aluminum | Clad 2024-T3 | 8-95 |
| AF3242 (MC) | 8.1.3.2.2(w) | Aluminum | Clad 2024-T3 | 8-96 |
| CR3242 (MC) | 8.1.3.2.2(x) | Aluminum | Clad 2024-T3 | 8-97 |
| HC3242 (MC) | 8.1.3.2.2(y) | Aluminum | Clad 2024-T3 | 8-98 |
| AF3222 (MC) | 8.1.3.2.2(z) | Aluminum | Clad 2024-T3 | 8-99 |
| CR3222 (MC) | 8.1.3.2.2(aa) | Aluminum | Clad 2024-T3 | 8-100 |

a MC, machine countersunk holes; D, dimpled holes.

**Table 8.1.1(b). Fastener Index for Blind Fasteners (Continued)**

| Fastener Identification | Table Number | Fastener Sleeve Material | Sheet or Plate Material | Page No. |
|---|---|---|---|---|
| | Flush-head Blind Bolts | | | |
| MS21140 (MC) | 8.1.3.2.3(a) | A-286 | Clad 7075-T6/T651 | 8-101 |
| MS90353 (MC) | 8.1.3.2.3($b_1$) | Alloy Steel | Clad 2024-T3/T351 | 8-102 |
| MS90353 (MC) | 8.1.3.2.3($b_2$) | Alloy Steel | Clad or Bare 7075-T6 or T651 | 8-103 |
| FF-200, FF-260 and FF-312 (MC) | 8.1.3.2.3(c) | Alloy Steel | Clad 2024-T42/ 7075-T6 | 8-104 |
| NS 100 (MC) | 8.1.3.2.3(d) | Alloy Steel | Clad 7075-T6 | 8-105 |
| SSHFA-200 and SSHFA-260(MC) | 8.1.3.2.3(e) | Aluminum | Clad 2024-T42/ 7075-T6 | 8-106 |
| PLT-150 (MC) | 8.1.3.2.3(f) | Alloy Steel | Clad 7075-T6/T651 | 8-107 |
| NAS1670-L (MC) | 8.1.3.2.3(g) | Alloy Steel | Clad 7075-T6/T651 | 8-108 |
| NAS1674-L (MC) | 8.1.3.2.3(h) | Aluminum | Clad 7075-T6 | 8-109 |

a MC, machine countersunk holes; D, dimpled holes.

**Table 8.1.1(c). Fastener Index for Swaged-Collar/Upset-Pin Fasteners**

| Fastener Identification | Table Number | Fastener Pin Material | Sheet or Plate Material | Page No. |
|---|---|---|---|---|
| Ultimate Single-Shear and Tensile Strengths | 8.1.4 | Alloy Steel and Alum. | ... | 8-112 |
| CSR 925 | 8.1.4.1(a) | Titanium | Clad 7075-T6 | 8-113 |
| CSR 925 | 8.1.4.1(b) | Titanium | Clad 2024-T3 | 8-114 |
| NAS1436-NAS1442 (MC)[a] | 8.1.4.2(a) | Alloy Steel | Clad 7075-T6/T651 | 8-115 |
| NAS7024-NAS7032 (MC) | 8.1.4.2(b) | Alloy Steel | Clad 7075-T6/T651 | 8-116 |
| CSR 924 (MC) | 8.1.4.2(c) | Titanium | Clad 7075-T6 | 8-117 |
| CSR 924 (MC) | 8.1.4.2(d) | Titanium | Clad 2024-T3 | 8-118 |
| HSR 201 (MC) | 8.1.4.2(e) | A-286 | Clad 7075-T6 | 8-119 |
| HSR 101 (MC) | 8.1.4.2(f) | Titanium | Clad 7075-T6 | 8-120 |
| GPL 3SC-V (MC) | 8.1.4.2(g) | Titanium | Clad 7075-T6 | 8-121 |
| GPL 3SC-V (MC) | 8.1.4.2(h) | Titanium | Clad 2024-T3 | 8-122 |
| LGPL 2SC-V (MC) | 8.1.4.2(i) | Titanium | Clad 7075-T6 | 8-123 |
| LGPL 2SC-V (MC) | 8.1.4.2(j) | Titanium | Clad 2024-T3 | 8-124 |

a MC, machine countersunk holes.

**Table 8.1.1(d). Fastener Index for Threaded Fasteners**

| Fastener Identification[a] | Table Number | Fastener Sleeve Material | Sheet | Page No. |
|---|---|---|---|---|
| Single Shear Strength | 8.1.5(a) | Steel | ... | 8-127 |
| Tensile Strength | 8.1.5($b_1$) | Steel | ... | 8-128 |
| Tensile Strength | 8.1.5($b_2$) | ... | ... | 8-129 |
| Unit Bearing Strength | 8.1.5.1 | Alloy Steel | ... | 8-130 |
| AN 509 Screws (MC)[b] | 8.1.5.2($a_1$) | Alloy Steel | Clad 2024-T3 | 8-131 |
| AN 509 Screws (MC) | 8.1.5.2($a_2$) | CRES | Clad 7075-T6 | 8-132 |
| PBF 11 (MC) | 8.1.5.2(b) | Alloy Steel | Ti-6Al-4V | 8-133 |
| TL 100 (MC) | 8.1.5.2(c) | | Clad 7075-T6 | 8-134 |
| TLV 10 (MC) | 8.1.5.2(d) | Titanium | Clad 7075-T6 | 8-135 |
| HPB-V (MC) | 8.1.5.2(e) | Titanium | Clad 7075-T6 | 8-136 |
| KLBHV with KFN 600 (MC) | 8.1.5.2(f) | Titanium | Clad 7075-T6 | 8-137 |
| HL-61-70 (MC) | 8.1.5.2(g) | CRES | Clad 7075-T6 | 8-138 |
| HL-719-79 (MC) | 8.1.5.2(h) | Alloy Steel | Clad 7075-T6 | 8-139 |
| HL-11 (MC) | 8.1.5.2(i) | Titanium | Clad 7075-T6 | 8-140 |
| HL-911 (MC) | 8.1.5.2(j) | Titanium | Clad 7075-T6 | 8-141 |
| NAS4452S and KS 100-FV with NAS4445DD (MC) | 8.1.5.2(k) | Alloy Steel or Titanium | Clad 7075-T6 | 8-142 |
| HPG-V (MC) | 8.1.5.2(l) | Titanium | Clad 7075-T6 | 8-143 |
| NAS4452V with NAS4445 DD (MC) | 8.1.5.2(m) | Titanium | Clad 7075-T6 | 8-144 |
| HL18Pin, HL70 Collar (MC) | 8.1.5.2(n) | Alloy Steel | Clad 7075-T6 | 8-145 |
| HL19 Pin, HL70 Collar (MC) | 8.1.5.2(o) | Alloy Steel | Clad 7075-T6 | 8-146 |

a In some cases entries in this table identify the subject matter in certain tables.
b MC, machine countersunk holes; D, dimpled holes.

**Table 8.1.1(e). Fastener Index for Special Fasteners**

| Fastener Identification | Table Number | Fastener Pin Material | Sheet or Plate Material | Page No. |
|---|---|---|---|---|
| ACRES Sleeves | ... | A-286 | Clad 7075-T6 | 8-147 |
| MIL-B-8831/4 (MC)[a] | 8.1.6.2(a) | Steel Pin, Aluminum Sleeve | Clad 7075-T6 | 8-148 |
| MIL-B-8831/4 (MC) | 8.1.6.2(b) | Steel Pin, Aluminum Sleeve | Clad 2024-T3 | 8-149 |

a MC, machine countersunk holes.

**Table 8.1.1.1. Fastener Shear Strengths**

| $F_{su}$, ksi | Examples of Current Alloys Which Meet Level[a] | Current Usage | | |
|---|---|---|---|---|
| | | Driven Rivets | Blind Fasteners | Solid Shank Fasteners |
| 28 | 5056 | X | X | |
| 30 | 2117 | X | X | |
| 34 | 2017 | X | X | |
| 36 | 2219 | X | X | |
| 38 | 2017 | X | X | |
| 41 | 2024 and 7050-T73 | X | | |
| 43 | 7050-T731 | X | X | X |
| 46 | 7075 | | X | |
| 49 | Monel | Undriven | | |
| 50 | Ti/Cb | X | | |
| 55 | Monel | | X | |
| 75 | Alloy Steel and CRES | | X | X |
| 78 | A-286 | | | X |
| 90 | A-286 | Undriven | | |
| 95 | Alloy Steel, A-286, Ti-6Al-4V | X | X | X |
| 108 | Alloy Steel and Ti-6Al-2Sn | | | X |
| 110 | A-286 | | | X |
| 112 | Alloy Steel | | X | X |
| 125 | Alloy Steel and CRES | | | X |
| 132 | Alloy Steel | | | X |
| 145 | MP35N | | | X |
| 156 | Alloy Steel | | | X |
| 180 | Alloy Steel | | | X |

a Different tempers and thermal treatments are used to obtain desired fastener shear strengths.

**8.1.2 SOLID RIVETS** — The recommended diameter dimensions of the upset tail on solid rivets shall be at least 1.5 times the nominal shank diameter except for 2024-T4 rivets which shall be at least 1.4 times the nominal shank diameter. Tail heights shall be a minimum of 0.3 diameter. Shear strengths for driven rivets may be based on areas corresponding to the nominal hole diameter provided that the nominal hole diameter is not larger than the values listed in Table 8.1.2(a). If the nominal hole diameter is larger than the listed value, the listed value shall be used. Shear strength values for solid rivets of a number of rivet materials are given in Table 8.1.2(b).

**8.1.2.1 *Protruding-Head Solid Rivet Joints*** — The unit load at which shear or bearing type of failure occurs is calculated separately and the lower of the two governs the design.

The design bearing stress for various materials at both room and elevated temperatures is given in the strength properties stated for each alloy or group of alloys and is applicable to riveted joints wherein cylindrical holes are used and where t/D is greater than or equal to 0.18; where t/D is less than 0.18, tests to substantiate yield and ultimate bearing strengths must be performed. These bearing stresses are applicable only for the design of rigid joints where there is no possibility of relative motion of the parts joined without deformation of such parts. Design bearing stresses at low temperatures will be higher than those specified for room temperature; however, no quantitative data are available.

For convenience, "unit" sheet bearing strengths for rivets, based on a bearing stress of 100 ksi and nominal hole diameters, are given in Table 8.1.2.1(a).

In computing protruding-head rivet design shear strengths, the shear strength values obtained from Table 8.1.2(b) should be multiplied by the correction factors given in Table 8.1.2.1(b). This compensates for the reduction in rivet shear strength resulting from high bearing stresses on the rivet at t/D ratios less than 0.33 for single-shear joints and 0.67 for double-shear joints.

For those rivet material sheet material combinations where test data shows the above to be unconservative or for rivet materials other than those shown in Table 8.1.2(b), joint allowables should be established by test in accordance with Section 9.7. From such tests tabular presentation of ultimate load and yield load allowables are made.

Unless otherwise specified, yield load is defined in Section 9.7.1.1 as the load which results in a joint permanent set equal to 0.04D, where D is the decimal equivalent of the hole diameter defined in Table 9.7.1.1(a).

Table 8.1.2.1(c) provides ultimate and yield strength data on protruding-head A-286 solid rivets in aged A-286 sheet, for a variety of conditions of exposure.

**8.1.2.2 *Flush-Head Solid Rivet Joints*** — Tables 8.1.2.2(a) through (t) contain joint allowables for various flush-head solid rivet/sheet material combinations. Prior to 2003 the allowable ultimate loads were established from test data using the average ultimate test load divided by a factor of 1.15. (See Section 9.7 for current statistical procedures and possible variations.) Shear strength cutoff values may be either the procurement specification shear strength (S value) of the fastener, or if no specification exists, a statistical value determined from test results as described in Section 9.7.

Yield load allowables are established from test data. Unless otherwise specified, the yield load is defined as the load which results in a joint permanent set equal to 0.04D, where D is the decimal equivalent of the hole diameter defined in Table 9.7.1.1.

For machine countersunk joints, the sheet gage specified in the tables is that of the countersunk sheet. When the noncountersunk sheet is thinner than the countersunk sheet, the bearing allowable for the noncountersunk sheet-fastener combination should be computed, compared to the table value, and the lower of the two values selected. Increased attention should be paid to detail design in cases where t/D < 0.25 because of possibly greater incidence of difficulty in service life.

**Table 8.1.2(a). Standard Rivet-Hole Drill Sizes and Nominal Hole Diameters**

| Rivet Size, in. | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
|---|---|---|---|---|---|---|---|---|
| Drill No. . . . . | 51 | 41 | 30 | 21 | 11 | F | P | W |
| Nominal Hole Diameter, in. | 0.067 | 0.096 | 0.1285 | 0.159 | 0.191 | 0.257 | 0.323 | 0.386 |

**Table 8.1.2(b). Single Shear Strength of Solid Rivets[a]**

| Undriven | | | Driven | | Rivet Designation | Rivet Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rivet Material | $F_{su}$ (ksi) Min | $F_{su}$ (ksi) Max | Rivet Material | $F_{su}$[b] (ksi) | | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
| | | | | | | Driven Single Shear Strength, lbs[c] | | | | | | | |
| 5056-H32 | 24 | n/a | 5056-H321[d] | 28[e] | B[f] | 99 | 203 | 363 | 556 | 802 | 1450 | 2290 | 3275 |
| 2117-T4 | 26 | n/a | 2117-T3 | 30[e] | AD | 106 | 217 | 389 | 596 | 860 | 1555 | 2455 | 3510 |
| 2017-T4 | 35 | 42 | 2017-T3 | 38[e] | D | 134 | 275 | 493 | 755 | 1085 | 1970 | 3115 | 4445 |
| 2024-T4 | 37 | n/a | 2024-T31 | 41[g] | DD | 145 | 297 | 532 | 814 | 1175 | 2125 | 3360 | 4795 |
| 7050-T73 | 41 | 46 | 7050-T731[d] | 43[e] | E[h] | 152 | 311 | 558 | 854 | 1230 | 2230 | 3520 | 5030 |
| Monel | 49 | 59 | Monel | 52[e] | M | 183 | 376 | 674 | 1030 | 1490 | 2695 | 4260 | 6085 |
| Ti-45Cb | 50 | 59 | Ti-45Cb | 53[e] | T | 187 | 384 | 687 | 1050 | 1515 | 2745 | 4340 | 6200 |
| A-286 | 85 | 95 | A-286 | 90[e] | - | 317 | 651 | 1165 | 1785 | 2575 | 4665 | 7375 | 10500 |

a All rivets must be sufficiently driven to fill the rivet hole at the shear plane. Driving changes the rivet strength from the undriven to the driven condition and thus provides the above driven shear strengths.
b Shear stresses are for the as driven condition on B-basis probability.
c Based on nominal hole diameter specified in Table 8.1.2(a).
d The temper designations last digit (1), indicates recognition of strengthening derived from driving.
e The bucktail's minimum diameter is 1.5 times the nominal hole diameter in Table 8.1.2(a).
f Should not be exposed to temperatures over 150°F.
g Driven in the W (fresh or ice box) condition to minimum 1.4D bucktail diameter.
h E (or KE, as per NAS documents).

**Table 8.1.2.1(a). Unit Bearing Strength of Sheet on Rivets, $F_{br}$ = 100 ksi**

| Sheet thickness, in. | Unit Bearing Strength for Indicated Rivet Diameter, lbs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
| 0.012 . . . . . | 80 | ... | ... | ... | ... | ... | ... | ... |
| 0.016 . . . . . | 107 | ... | ... | ... | ... | ... | ... | ... |
| 0.018 . . . . . | 121 | 173 | ... | ... | ... | ... | ... | ... |
| 0.020 . . . . . | 134 | 192 | ... | ... | ... | ... | ... | ... |
| 0.025 . . . . . | 168 | 240 | 321 | ... | ... | ... | ... | ... |
| 0.032 . . . . . | 214 | 307 | 411 | 509 | ... | ... | ... | ... |
| 0.036 . . . . . | 241 | 346 | 462 | 572 | 688 | ... | ... | ... |
| 0.040 . . . . . | 268 | 384 | 514 | 636 | 764 | ... | ... | ... |
| 0.045 . . . . . | 302 | 432 | 578 | 716 | 860 | ... | ... | ... |
| 0.050 . . . . . | 335 | 480 | 642 | 795 | 955 | 1285 | ... | ... |
| 0.063 . . . . . | 422 | 605 | 810 | 1002 | 1203 | 1619 | 2035 | ... |
| 0.071 . . . . . | 476 | 682 | 912 | 1129 | 1356 | 1825 | 2293 | 2741 |
| 0.080 . . . . . | 536 | 768 | 1028 | 1272 | 1528 | 2056 | 2584 | 3088 |
| 0.090 . . . . . | 603 | 864 | 1156 | 1431 | 1719 | 2313 | 2907 | 3474 |
| 0.100 . . . . . | 670 | 960 | 1285 | 1590 | 1910 | 2570 | 3230 | 3860 |
| 0.125 . . . . . | 838 | 1200 | 1606 | 1988 | 2388 | 3212 | 4038 | 4825 |
| 0.160 . . . . . | 1072 | 1536 | 2056 | 2544 | 3056 | 4112 | 5168 | 6176 |
| 0.190 . . . . . | 1273 | 1824 | 2442 | 3021 | 3629 | 4883 | 6137 | 7334 |
| 0.250 . . . . . | 1670 | 2400 | 3210 | 3975 | 4775 | 6425 | 8075 | 9650 |

**Table 8.1.2.1(b). Shear Strength Correction Factors for Solid Protruding Head Rivets[a]**

| Rivet Diameter, in. | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
|---|---|---|---|---|---|---|---|---|
| | Single-Shear Rivet Strength Factors | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.016 . . . . . | 0.964 | ... | ... | ... | ... | ... | ... | ... |
| 0.018 . . . . . | 0.981 | 0.912 | ... | ... | ... | ... | ... | ... |
| 0.020 . . . . . | 0.995 | 0.933 | ... | ... | ... | ... | ... | ... |
| 0.025 . . . . . | 1.000 | 0.970 | 0.920 | ... | ... | ... | ... | ... |
| 0.032 . . . . . | ... | 1.000 | 0.964 | 0.925 | ... | ... | ... | ... |
| 0.036 . . . . . | ... | ... | 0.981 | 0.946 | 0.912 | ... | ... | ... |
| 0.040 . . . . . | ... | ... | 0.995 | 0.964 | 0.933 | ... | ... | ... |
| 0.045 . . . . . | ... | ... | 1.000 | 0.981 | 0.953 | ... | ... | ... |
| 0.050 . . . . . | ... | ... | ... | 0.995 | 0.970 | 0.920 | ... | ... |
| 0.063 . . . . . | ... | ... | ... | 1.000 | 1.000 | 0.961 | 0.922 | ... |
| 0.071 . . . . . | ... | ... | ... | ... | ... | 0.979 | 0.944 | 0.909 |
| 0.080 . . . . . | ... | ... | ... | ... | ... | 0.995 | 0.964 | 0.933 |
| 0.090 . . . . . | ... | ... | ... | ... | ... | 1.000 | 0.981 | 0.953 |
| 0.100 . . . . . | ... | ... | ... | ... | ... | ... | 0.995 | 0.972 |
| 0.125 . . . . . | ... | ... | ... | ... | ... | ... | 1.000 | 1.000 |
| | Double-Shear Rivet Strength Factors | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.016 . . . . . | 0.687 | ... | ... | ... | ... | ... | ... | ... |
| 0.018 . . . . . | 0.744 | 0.518 | ... | ... | ... | ... | ... | ... |
| 0.020 . . . . . | 0.789 | 0.585 | ... | ... | ... | ... | ... | ... |
| 0.025 . . . . . | 0.870 | 0.708 | 0.545 | ... | ... | ... | ... | ... |
| 0.032 . . . . . | 0.941 | 0.814 | 0.687 | 0.560 | ... | ... | ... | ... |
| 0.036 . . . . . | 0.969 | 0.857 | 0.744 | 0.630 | 0.518 | ... | ... | ... |
| 0.040 . . . . . | 0.992 | 0.891 | 0.789 | 0.687 | 0.585 | ... | ... | ... |
| 0.045 . . . . . | 1.000 | 0.924 | 0.834 | 0.744 | 0.653 | ... | ... | ... |
| 0.050 . . . . . | ... | 0.951 | 0.870 | 0.789 | 0.708 | 0.545 | ... | ... |
| 0.063 . . . . . | ... | 1.000 | 0.937 | 0.872 | 0.808 | 0.679 | 0.550 | ... |
| 0.071 . . . . . | ... | ... | 0.966 | 0.909 | 0.852 | 0.737 | 0.622 | 0.508 |
| 0.080 . . . . . | ... | ... | 0.992 | 0.941 | 0.891 | 0.789 | 0.687 | 0.585 |
| 0.090 . . . . . | ... | ... | 1.000 | 0.969 | 0.924 | 0.834 | 0.744 | 0.653 |
| 0.100 . . . . . | ... | ... | ... | 0.992 | 0.951 | 0.870 | 0.789 | 0.708 |
| 0.125 . . . . . | ... | ... | ... | 1.000 | 1.000 | 0.935 | 0.870 | 0.805 |
| 0.160 . . . . . | ... | ... | ... | ... | ... | 0.992 | 0.941 | 0.891 |
| 0.190 . . . . . | ... | ... | ... | ... | ... | 1.000 | 0.981 | 0.939 |
| 0.250 . . . . . | ... | ... | ... | ... | ... | ... | 1.000 | 1.000 |

a Sheet thickness is that of the thinnest sheet in single-shear joints and the middle sheet in double-shear joints. Values based on tests of aluminum rivets, Reference 8.1.

**Table 8.1.2.1(c). Static Joint Strength of Protruding Head A-286 Solid Rivets in A-286 Alloy Sheet at Various Temperatures**

| Rivet Type | NAS1198 ($F_{su}$ = 90 ksi) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | A-286, solution treated and aged, $F_{tu}$ = 140 ksi | | | | | | | | |
| Temperature | Room Temperature | | | 1200°F, Stabilized 15 Minutes | | | 1200°F, Rapid Heating in 20 Seconds, Tested in 15 Seconds | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) |
| Sheet thickness, in.: | Ultimate Strength[a], lbs. | | | | | | | | |
| 0.020 | 478 | ... | ... | 331 | ... | ... | 470[b] | ... | ... |
| 0.025 | 590 | 740 | ... | 426 | 626 | ... | 587[b] | 726[b] | ... |
| 0.032 | 745 | 932 | 1132 | 560 | 801 | 962 | 752[b] | 930[b] | 1117[b] |
| 0.040 | 923 | 1152 | 1397 | 682 | 1002 | 1204 | 783 | 1164[b] | 1397[b] |
| 0.050 | 1023 | 1428 | 1677 | ... | 1044 | 1505 | ... | 1198 | 1729[b] |
| 0.063 | 1131 | 1578 | 1821 | ... | ... | 1507 | ... | ... | ... |
| 0.071 | 1170 | 1660 | 1909 | ... | ... | ... | ... | ... | ... |
| 0.080 | ... | 1752 | 2008 | ... | ... | ... | ... | ... | ... |
| 0.090 | ... | 1790 | 2118 | ... | ... | ... | ... | ... | ... |
| 0.100 | ... | ... | 2229 | ... | ... | ... | ... | ... | ... |
| 0.125 | ... | ... | 2504 | ... | ... | ... | ... | ... | ... |
| 0.160 | ... | ... | 2580 | ... | ... | ... | ... | ... | ... |
| Rivet shear strength[c] | 1170 | 1790 | 2580 | 682 | 1044 | 1507 | 783 | 1198 | 1729 |
| Sheet thickness, in.: | Yield Strength[a,d], lbs. | | | | | | | | |
| 0.020 | 447 | ... | ... | 300 | ... | ... | 300 | ... | ... |
| 0.025 | 590 | 695 | ... | 374 | 464 | ... | 374 | 464 | ... |
| 0.032 | 745 | 932 | 974 | 479 | 593 | 713 | 478 | 593 | 712 |
| 0.040 | 867 | 1152 | 1167 | 598 | 741 | 890 | 598 | 740 | 889 |
| 0.050 | 938 | 1331 | 1407 | ... | 925 | 1112 | ... | 924 | 1110 |
| 0.063 | 1031 | 1447 | 1649 | ... | ... | 1400 | ... | ... | ... |
| 0.071 | 1089 | 1518 | 1723 | ... | ... | ... | ... | ... | ... |
| 0.080 | ... | 1597 | 1806 | ... | ... | ... | ... | ... | ... |
| 0.090 | ... | 1686 | 1898 | ... | ... | ... | ... | ... | ... |
| 0.100 | ... | ... | 1990 | ... | ... | ... | ... | ... | ... |
| 0.125 | ... | ... | 2221 | ... | ... | ... | ... | ... | ... |
| 0.160 | ... | ... | 2543 | ... | ... | ... | ... | ... | ... |

a Test data from which the yield and ultimate strengths were derived can be found in Reference 8.1.2.1.
b Yield value is less than 2/3 of indicated ultimate.
c Rivet shear strength is documented in NAS1198 as 90 ksi.
d Permanent set at yield load: 0.005 inch.
Note: Because of difficulties encountered upsetting countersunk head rivets in thin A-286 sheet, such conditions should be avoided in design.

**Table 8.1.2.2(a). Static Joint Strength of 100° Flush Head Monel Solid Rivets in Machine-Countersunk Stainless Steel Sheet**

| Rivet Type | MS20427M ($F_{su}$ = 49 ksi) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | AISI 302-Annealed | | | AISI 301-¼ Hard | | | AISI 301-½ Hard AISI 301-Full Hard | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/8 | 5/32 | 3/16 | 3/32 | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.1285) | (0.159) | (0.191) | (0.1285) | (0.159) | (0.191) | (0.096) | (0.1285) | (0.159) | (0.191) |
| | Ultimate Strength, lbs | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | |
| 0.040 | 439[a,b] | ... | ... | 439[b] | ... | ... | 251[b] | 439[b] | ... | ... |
| 0.050 | 526[a] | 673[a,b] | ... | 468 | 673[b] | ... | 322 | 447 | 673[b] | ... |
| 0.063 | 635[a] | 820[a] | ... | 595 | 732 | ... | 355 | 538 | 688 | ... |
| 0.071 | ... | 915[a] | 1110[a,b] | 635 | 830 | 990[b] | ... | 615 | 741 | 984[b] |
| 0.080 | ... | 973[a] | 1246[a] | ... | 936 | 1118 | ... | 635 | 850 | 995 |
| 0.090 | ... | ... | 1380[a] | ... | 973 | 1255 | ... | ... | 973 | 1132 |
| 0.100 | ... | ... | 1400 | ... | ... | 1400 | ... | ... | ... | 1280 |
| 0.125 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1400 |
| Rivet shear strength[c] | 635 | 973 | 1400 | 635 | 973 | 1400 | 355 | 635 | 973 | 1400 |
| | Yield Strength[d], lbs | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | |
| 0.040 | 259 | ... | ... | 368 | ... | ... | 212 | 324 | ... | ... |
| 0.050 | 324 | 402 | ... | 442 | 570 | ... | 293 | 360 | 498 | ... |
| 0.063 | 408 | 506 | ... | 492 | 686 | ... | 355 | 480 | 557 | ... |
| 0.071 | ... | 570 | 685 | 561 | 714 | 958 | ... | 561 | 630 | 780 |
| 0.080 | ... | 643 | 771 | ... | 764 | 1012 | ... | 635 | 765 | 848 |
| 0.090 | ... | ... | 865 | ... | 893 | 1062 | ... | ... | 893 | 1000 |
| 0.100 | ... | ... | 965 | ... | ... | 1160 | ... | ... | ... | 1160 |
| 0.125 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1400 |
| Head height (ref.), in. | 0.048 | 0.061 | 0.077 | 0.048 | 0.061 | 0.077 | 0.042 | 0.048 | 0.061 | 0.077 |

a Yield value is less than 2/3 of the indicated ultimate strength value.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Rivet shear strength is documented in MS20427M.

d Permanent set at yield load: 0.005 inch.

**Table 8.1.2.2(b). Static Joint Strength of 100° Flush Head Monel Solid Rivets in Dimpled Stainless Steel Sheet**

| Rivet Type | MS20427M ($F_{su}$ = 49 ksi) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | AISI 302 - annealed | | | | AISI 301 - 1/4 hard | | | AISI 301 - 1/2 hard | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 | 1/8 | 5/32 | 3/16 | 3/32 | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.1285) | (0.159) | (0.191) | (0.257) | (0.1285) | (0.159) | (0.191) | (0.096) | (0.1285) | (0.159) | (0.191) |
| | Ultimate Strength, lbs. | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | |
| 0.020 | 348 | ... | ... | ... | 497 | ... | ... | 348 | 497 | ... | ... |
| 0.025 | 441 | 536 | ... | ... | 595 | 766 | ... | 355 | 595 | 766 | ... |
| 0.032 | 568 | 698 | 846 | ... | 635 | 931 | 1163 | ... | 635 | 931 | 1163 |
| 0.040 | 635 | 884 | 1046 | 1370 | ... | 973 | 1382 | ... | ... | 973 | 1382 |
| 0.050 | ... | 973 | 1320 | 1730 | ... | ... | 1405 | ... | ... | ... | 1405 |
| 0.063 | ... | ... | 1405 | 2240 | ... | ... | ... | ... | ... | ... | ... |
| 0.071 | ... | ... | ... | 2490 | ... | ... | ... | ... | ... | ... | ... |
| 0.080 | ... | ... | ... | 2540 | ... | ... | ... | ... | ... | ... | ... |
| Rivet shear strength[a] | 635 | 973 | 1405 | 2540 | 635 | 973 | 1405 | 355 | 635 | 973 | 1405 |
| | Yield Strength[b], lbs. | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | |
| 0.020 | 336 | ... | ... | ... | 449 | ... | ... | 329 | 449 | ... | ... |
| 0.025 | 427 | 518 | ... | ... | 533 | 681 | ... | 355 | 533 | 681 | ... |
| 0.032 | 550 | 679 | 801 | ... | 635 | 842 | 1049 | ... | 635 | 842 | 1049 |
| 0.040 | 635 | 856 | 1020 | 1326 | ... | 973 | 1252 | ... | ... | 973 | 1252 |
| 0.050 | ... | 973 | 1280 | 1678 | ... | ... | 1405 | ... | ... | ... | 1405 |
| 0.063 | ... | ... | 1405 | 2140 | ... | ... | ... | ... | ... | ... | ... |
| 0.071 | ... | ... | ... | 2420 | ... | ... | ... | ... | ... | ... | ... |
| 0.080 | ... | ... | ... | 2540 | ... | ... | ... | ... | ... | ... | ... |
| Head height (max.), in. | 0.048 | 0.061 | 0.077 | 0.103 | 0.048 | 0.061 | 0.077 | 0.042 | 0.048 | 0.061 | 0.077 |

a Rivet shear strength from Table 8.1.2(b).
b Permanent set at yield load: 0.005 inch.

**Table 8.1.2.2(c). Static Joint Strength of 100° Flush Head Aluminum Alloy (2117-T3) Solid Rivets in Dimpled Aluminum Alloy Sheet[a,b]**

| Rivet Type | MS20426AD ($F_{su}$ = 30 ksi) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | 2024-T3<br>2024-T42<br>2024-T62<br>2024-T81 | | 2024-T3<br>2024-T42 | | 2024-T62<br>2024-T81 | | 2024-T86<br>7075-T6 | | |
| Rivet Diameter, in. | 3/32 | 1/8 | 5/32 | 3/16 | 5/32 | 3/16 | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.096) | (0.1285) | (0.159) | (0.191) | (0.159) | (0.191) | (0.1285) | (0.159) | (0.191) |
| | Ultimate Strength, lbs. | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.016 | 177 | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.020 | 209 | 299 | ... | ... | ... | ... | 302 | ... | ... |
| 0.025 | 217 | 360 | 474 | ... | 462 | ... | 383 | 462 | ... |
| 0.032 | ... | 388 | 568 | 722 | 596 | 725 | 388 | 596 | 725 |
| 0.040 | ... | ... | 596 | 839 | ... | 862 | ... | ... | 862 |
| 0.050 | ... | ... | ... | 862 | ... | ... | ... | ... | ... |
| Rivet shear strength[c] | 217 | 388 | 596 | 862 | 596 | 862 | 388 | 596 | 862 |
| | Yield Strength[d], lbs. | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.016 | 154 | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.020 | 184 | 257 | ... | ... | ... | ... | 257 | ... | ... |
| 0.025 | 209 | 315 | 324 | ... | 324 | ... | 315 | 410 | ... |
| 0.032 | ... | 367 | 430 | 512 | 430 | 512 | 367 | 525 | 640 |
| 0.040 | ... | ... | 506 | 644 | ... | 644 | ... | ... | 782 |
| 0.050 | ... | ... | ... | 757 | ... | ... | ... | ... | ... |
| Head height (max.), in. | 0.036 | 0.042 | 0.055 | 0.070 | 0.055 | 0.070 | 0.042 | 0.055 | 0.070 |

a These allowables apply to double dimpled sheets and to the upper sheet dimpled into a machine-countersunk lower sheet. Sheet gage is that of the thinnest sheet for double dimpled joints and of the upper dimpled sheet for dimpled, machine-countersunk joints. The thickness of machine-countersunk sheet must be at least one tabulated gage thicker than the upper sheet. In no case shall allowables be obtained by extrapolation for gages other than those shown.

b Test data from which the yield strengths listed were derived and can be found in Reference 8.1.2.2.

c Rivet shear strength from Table 8.1.2(b).

d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.2.2(d). Static Joint Strength of 100° Flush Head Aluminum Alloy (2017-T3) Solid Rivets in Dimpled Aluminum Alloy Sheet[a,b]**

| Rivet Type | MS20426D ($F_{su}$ = 38 ksi) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | 2024-T3 and 2024-T42 | | | 2024-T86 and 7075-T6 | | | 2024-T62 and 2024-T81 | | |
| Rivet Diameter, in. | 5/32 | 3/16 | 1/4 | 5/32 | 3/16 | 1/4 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.159) | (0.191) | (0.257) | (0.159) | (0.191) | (0.257) | (0.159) | (0.191) | (0.257) |
| | Ultimate Strength, lbs. | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.025 | 419 | ... | ... | 530 | ... | ... | 419 | ... | ... |
| 0.032 | 600 | 681 | ... | 672 | 822 | ... | 600 | 681 | ... |
| 0.040 | 738 | 905 | 845 | 755 | 1000 | 1108 | 738 | 905 | 1108 |
| 0.050 | 755 | 1090 | 1332 | ... | 1090 | 1508 | 755 | 1090 | 1508 |
| 0.063 | ... | ... | 1695 | ... | ... | 1803 | ... | ... | 1803 |
| 0.071 | ... | ... | 1853 | ... | ... | 1930 | ... | ... | 1930 |
| 0.080 | ... | ... | 1970 | ... | ... | 1970 | ... | ... | 1970 |
| Rivet shear strength[c] | 755 | 1090 | 1970 | 755 | 1090 | 1970 | 755 | 1090 | 1970 |
| | Yield Strength[d], lbs. | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.025 | 336 | ... | ... | 450 | ... | ... | 336 | ... | ... |
| 0.032 | 483 | 546 | ... | 581 | ... | ... | 483 | 546 | ... |
| 0.040 | 589 | 730 | 845 | 675 | 705 | 978 | 589 | 730 | 845 |
| 0.050 | 681 | 888 | 1187 | ... | 867 | 1508 | 681 | 888 | 1187 |
| 0.063 | ... | ... | 1415 | ... | 1007 | 1803 | ... | ... | 1415 |
| 0.071 | ... | ... | 1656 | ... | ... | 1930 | ... | ... | 1656 |
| 0.080 | ... | ... | 1870 | ... | ... | 1970 | ... | ... | 1870 |
| Head height (max.), in. | 0.055 | 0.070 | 0.095 | 0.055 | 0.070 | 0.095 | 0.055 | 0.070 | 0.095 |

a These allowables apply to double dimpled sheets and to the upper sheet dimpled into a machine-countersunk lower sheet. Sheet gage is that of the thinnest sheet for double dimpled joints and of the upper dimpled sheet for dimpled, machine-countersunk joints. The thickness of machine-countersunk sheet must be at least one tabulated gage thicker than the upper sheet. In no case shall allowables be obtained by extrapolation for gages other than those shown.
b Test data from which the yield strengths listed were derived and can be found in Reference 8.1.2.2.
c Rivet shear strength from Table 8.1.2(b).
d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.2.2(e). Static Joint Strength of 100° Flush Head Aluminum Alloy (2024-T31) Solid Rivets in Dimpled Aluminum Alloy Sheet[a,b]**

| Rivet Type | MS20426DD ($F_{su}$ = 41 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet Material | 2024-T3 2024-T42 | | 2024-T62 2024-T81 | | 2024-T86 7075-T6 | |
| Rivet Diameter, in. | 3/16 | 1/4 | 3/16 | 1/4 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.191) | (0.257) | (0.191) | (0.257) | (0.191) | (0.257) |
| | Ultimate Strength, lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.032 | 744 | ... | 786 | ... | 786 | ... |
| 0.040 | 941 | 879 | 982 | 1300 | 982 | 1300 |
| 0.050 | 1110 | 1359 | 1152 | 1705 | 1152 | 1705 |
| 0.063 | 1175 | 1727 | 1175 | 2010 | 1175 | 2010 |
| 0.071 | ... | 1883 | ... | 2125 | ... | 2125 |
| 0.080 | ... | 2025 | ... | ... | ... | ... |
| 0.090 | ... | 2125 | ... | ... | ... | ... |
| Rivet shear strength[c] | 1175 | 2125 | 1175 | 2125 | 1175 | 2125 |
| | Yield Strength[d], lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.032 | 582 | ... | 649 | ... | 786 | ... |
| 0.040 | 666 | 879 | 816 | 962 | 982 | 978 |
| 0.050 | 738 | 1308 | 961 | 1308 | 1152 | 1543 |
| 0.063 | 925 | 1564 | 1068 | 1564 | 1175 | 1958 |
| 0.071 | ... | 1711 | ... | 1711 | ... | 2125 |
| 0.080 | ... | 1928 | ... | ... | ... | ... |
| 0.090 | ... | 2121 | ... | ... | ... | ... |
| Head height (max.), in. | 0.070 | 0.095 | 0.070 | 0.095 | 0.070 | 0.095 |

a These allowables apply to double dimpled sheets and to the upper sheet dimpled into a machine-countersunk lower sheet. Sheet gage is that of the thinnest sheet for double dimpled joints and of the upper dimpled sheet for dimpled, machine-countersunk joints. The thickness of machine-countersunk sheet must be at least one tabulated gage thicker than the upper sheet. In no case shall allowables be obtained by extrapolation for gages other than those shown.

b Test data from which the yield strengths listed were derived and can be found in Reference 8.1.2.2.

c Rivet shear strength from Table 8.1.2(b).

d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

## Table 8.1.2.2(f). Static Joint Strength of 100° Flush Head Aluminum Alloy Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet

| Rivet Type | MS20426AD (2117-T3) ($F_{su}$ = 30 ksi) | | | | MS20426D (2017-T3) ($F_{su}$ = 38 ksi) | | | MS20426DD (2024-T31) ($F_{su}$ = 41 ksi) | |
|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T42 | | | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 5/32 (0.159) | 3/16 (0.191) | 1/4 (0.257) | 3/16 (0.191) | 1/4 (0.257) |
| | Ultimate Strength[a], lbs | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.032 | 178[b] | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 193 | 309[b] | ... | ... | ... | ... | ... | ... | ... |
| 0.050 | 206 | 340 | 479[b] | ... | 580[b,c] | ... | ... | ... | ... |
| 0.063 | 216 | 363 | 523 | 705[b] | 657[c] | 859[b,c] | ... | 886 [b] | ... |
| 0.071 | ... | 373 | 542 | 739 | 690 | 917[c] | ... | 942 | ... |
| 0.080 | ... | ... | 560 | 769 | 720 | 969[c] | ... | 992 | ... |
| 0.090 | ... | ... | 575 | 795 | 746 | 1015 | 1552[b,c] | 1035 | 1647[b,c] |
| 0.100 | ... | ... | ... | 818 | ... | 1054 | 1640[c] | 1073 | 1738[c] |
| 0.125 | ... | ... | ... | 853 | ... | 1090 | 1773 | 1131 | 1877 |
| 0.160 | ... | ... | ... | ... | ... | ... | 1891 | ... | 2000 |
| 0.190 | ... | ... | ... | ... | ... | ... | 1970 | ... | 2084 |
| Rivet shear strength[d] | 217 | 388 | 596 | 862 | 755 | 1090 | 1970 | 1175 | 2125 |
| | Yield Strength[a,e], lbs | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | |
| 0.032 | 132 | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 153 | 231 | ... | ... | ... | ... | ... | ... | ... |
| 0.050 | 188 | 261 | 321 | ... | 345 | ... | ... | ... | ... |
| 0.063 | 213 | 321 | 402 | 471 | 401 | 515 | ... | 614 | ... |
| 0.071 | ... | 348 | 453 | 538 | 481 | 557 | ... | 669 | ... |
| 0.080 | ... | ... | 498 | 616 | 562 | 623 | ... | 761 | ... |
| 0.090 | ... | ... | 537 | 685 | 633 | 746 | 861 | 842 | 1053 |
| 0.100 | ... | ... | ... | 745 | ... | 854 | 1017 | 913 | 1115 |
| 0.125 | ... | ... | ... | 836 | ... | 1018 | 1313 | 1021 | 1357 |
| 0.160 | ... | ... | ... | ... | ... | ... | 1574 | ... | 1694 |
| 0.190 | ... | ... | ... | ... | ... | ... | 1753 | ... | 1925 |
| Head height (ref.), in. | 0.036 | 0.042 | 0.055 | 0.070 | 0.055 | 0.070 | 0.095 | 0.070 | 0.095 |

a Test data from which the yield and ultimate strength listed were derived can be found in Reference 8.1.2.2.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Yield value is less than 2/3 of the indicated ultimate strength value.

d Rivet shear strength is documented in MS20426.

e Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.2.2(g). Static Joint Strength of 100° Flush Head Aluminum Alloy (5056-H321) Solid Rivets in Machine-Countersunk Magnesium Alloy Sheet**

| Rivet Type | MS20426B ($F_{su}$ = 28 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet Material | AZ31B-H24 | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/4 (0.257) |
| | Ultimate Strength, lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.032 | 172[a,b] | ... | ... | ... | ... |
| 0.040 | 180 | 304[a,b] | ... | ... | ... |
| 0.050 | 190 | 318 | 467[a,b] | ... | ... |
| 0.063 | 203 | 337 | 490 | 679[a,b] | ... |
| 0.071 | ... | 348 | 503 | 697[a] | ... |
| 0.080 | ... | 360 | 519 | 715 | ... |
| 0.090 | ... | 363 | 536 | 737 | 1244[b] |
| 0.100 | ... | ... | 554 | 757 | 1271 |
| 0.125 | ... | ... | 556 | 802 | 1343 |
| 0.160 | ... | ... | ... | ... | 1440 |
| 0.190 | ... | ... | ... | ... | 1450 |
| Rivet shear strength[c] | 203 | 363 | 556 | 802 | 1450 |
| | Yield Strength[d], lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.032 | 104 | ... | ... | ... | ... |
| 0.040 | 127 | 172 | ... | ... | ... |
| 0.050 | 152 | 214 | 268 | ... | ... |
| 0.063 | 186 | 259 | 334 | 409 | ... |
| 0.071 | ... | 287 | 369 | 459 | ... |
| 0.080 | ... | 318 | 406 | 504 | ... |
| 0.090 | ... | 353 | 450 | 555 | 792 |
| 0.100 | ... | ... | 491 | 606 | 856 |
| 0.125 | ... | ... | 556 | 735 | 1030 |
| 0.160 | ... | ... | ... | ... | 1273 |
| 0.190 | ... | ... | ... | ... | 1450 |
| Head height (ref.), in. | 0.036 | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Rivet shear strength is documented in MS20426.

d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.2.2(h). Static Joint Strength of 100° Flush Head Monel Solid Rivets in Machine-Countersunk Titanium Alloy Sheet**

| Rivet Type | MS20427M ($F_{su}$ = 49 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Commercially Pure Titanium, $F_{tu}$ = 80 ksi | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.1285) | (0.159) | (0.191) | (0.257) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 531[a] | ... | ... | ... |
| 0.050 | 573 | 818[a] | ... | ... |
| 0.063 | 626 | 885 | ... | ... |
| 0.071 | 635 | 926 | 1242[a] | ... |
| 0.080 | ... | 973 | 1302 | ... |
| 0.090 | ... | ... | 1360 | ... |
| 0.100 | ... | ... | 1400 | 2260[a] |
| 0.125 | ... | ... | ... | 2460 |
| 0.160 | ... | ... | ... | 2540 |
| Rivet shear strength[b] | 635 | 973 | 1400 | 2540 |
| | Yield Strength[c], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 376 | ... | ... | ... |
| 0.050 | 472 | 582 | ... | ... |
| 0.063 | 598 | 736 | ... | ... |
| 0.071 | 635 | 835 | 933 | ... |
| 0.080 | ... | 945 | 1130 | ... |
| 0.090 | ... | ... | 1268 | ... |
| 0.100 | ... | ... | 1400 | 1860 |
| 0.125 | ... | ... | ... | 2340 |
| 0.160 | ... | ... | ... | 2540 |
| Head height (max.), in. | 0.048 | 0.061 | 0.077 | 0.103 |

a Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

b Rivet shear strength is documented in MS20427.

c Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.2.2(i). Static Joint Strength of 120° Flush Shear Head Aluminum Alloy (2017-T3) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | BRFS-D[a] ($F_{su}$ = 38 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/4 (0.257) |
| | Ultimate Strength, lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.020 | 139 | ... | ... | ... | ... |
| 0.025 | 176 | 233 | ... | ... | ... |
| 0.032 | 226 | 300 | 367 | ... | ... |
| 0.040 | 275 | 378 | 465 | 552 | ... |
| 0.050 | ... | 477 | 585 | 697 | 930 |
| 0.063 | ... | 494 | 741 | 886 | 1182 |
| 0.071 | ... | ... | 755 | 1005 | 1338 |
| 0.080 | ... | ... | ... | 1090 | 1513 |
| 0.090 | ... | ... | ... | ... | 1711 |
| 0.100 | ... | ... | ... | ... | 1902 |
| 0.125 | ... | ... | ... | ... | 1970 |
| Rivet shear strength[c] | 275 | 494 | 755 | 1090 | 1970 |
| | Yield Strength[d], lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.020 | 137 | ... | ... | ... | ... |
| 0.025 | 171 | 229 | ... | ... | ... |
| 0.032 | 207 | 294 | 359 | ... | ... |
| 0.040 | 231 | 357 | 453 | 547 | ... |
| 0.050 | ... | 398 | 550 | 680 | 918 |
| 0.063 | ... | 451 | 614 | 814 | 1149 |
| 0.071 | ... | ... | 655 | 857 | 1295 |
| 0.080 | ... | ... | ... | 914 | 1430 |
| 0.090 | ... | ... | ... | ... | 1513 |
| 0.100 | ... | ... | ... | ... | 1592 |
| 0.125 | ... | ... | ... | ... | 1790 |
| Head height (ref.), in. | 0.018 | 0.023 | 0.030 | 0.039 | 0.049 |

a Data supplied by Briles Rivet Corp.

b Fasteners installed in hole diameters of 0.0975, 0.1285, 0.1615, 0.1945, 0.257, +0.0005, -0.001, respectively.

c Shear strength based on Table 8.1.2(b) and $F_{su}$ = 38 ksi.

d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.2.2(j). Static Joint Strength of 120° Flush Shear Head Aluminum Alloy (2117-T3) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | BRFS-AD[a] ($F_{su}$ = 30 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/4 (0.257) |
| | Ultimate Strength, lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.020 | 119 | ... | ... | ... | ... |
| 0.025 | 144 | 201 | ... | ... | ... |
| 0.032 | 171 | 250 | 316 | ... | ... |
| 0.040 | 204 | 292 | 386 | 474 | ... |
| 0.050 | 217 | 343 | 451 | 571 | 806 |
| 0.063 | ... | 388 | 536 | 675 | 987 |
| 0.071 | ... | ... | 596 | 737 | 1073 |
| 0.080 | ... | ... | ... | 812 | 1169 |
| 0.090 | ... | ... | ... | 862 | 1278 |
| 0.100 | ... | ... | ... | ... | 1371 |
| 0.125 | ... | ... | ... | ... | 1550 |
| Rivet shear strength[c] | 217 | 388 | 596 | 862 | 1550 |
| | Yield Strength[d], lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.020 | 119 | ... | ... | ... | ... |
| 0.025 | 144 | 201 | ... | ... | ... |
| 0.032 | 171 | 250 | 316 | ... | ... |
| 0.040 | 204 | 292 | 386 | 474 | ... |
| 0.050 | 217 | 343 | 451 | 571 | 806 |
| 0.063 | ... | 388 | 536 | 675 | 987 |
| 0.071 | ... | ... | 596 | 737 | 1073 |
| 0.080 | ... | ... | ... | 812 | 1169 |
| 0.090 | ... | ... | ... | 862 | 1278 |
| 0.100 | ... | ... | ... | ... | 1371 |
| 0.125 | ... | ... | ... | ... | 1550 |
| Head height (ref.), in. | 0.018 | 0.023 | 0.030 | 0.039 | 0.049 |

a Data supplied by Briles Rivet Corp.

b Fasteners installed in hole diameters of 0.0975, 0.1285, 0.1615, 0.1945, 0.257, +0.0005, -0.001, respectively.

c Shear strength based on Table 8.1.2(b) and $F_{su}$ = 38 ksi.

d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.2.2(k). Static Joint Strength of 120° Flush Shear Head Aluminum Alloy (2024-T31) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | BRFS-DD[a] ($F_{su}$ = 41 ksi) | |
|---|---|---|
| Sheet Material | Clad 2024-T3 | |
| Rivet Diameter, in.<br>(Nominal Hole Diameter, in.)[b] | 3/16<br>(0.191) | 1/4<br>(0.257) |
| | Ultimate Strength, lbs | |
| Sheet thickness, in.: | | |
| 0.040 | 598 | ... |
| 0.050 | 772 | 1000 |
| 0.063 | 994 | 1300 |
| 0.071 | 1130 | 1480 |
| 0.080 | 1180 | 1690 |
| 0.090 | ... | 1920 |
| 0.100 | ... | 2120 |
| Rivet shear strength[c] | 1180 | 2120 |
| | Yield Strength[d], lbs | |
| Sheet thickness, in.: | | |
| 0.040 | 598 | ... |
| 0.050 | 772 | 1000 |
| 0.063 | 949 | 1300 |
| 0.071 | 1000 | 1480 |
| 0.080 | 1060 | 1680 |
| 0.090 | ... | 1760 |
| 0.100 | ... | 1850 |
| Head height (ref.), in. | 0.039 | 0.049 |

a Data supplied by Briles Rivet Corp.
b Fasteners installed in hole diameters of 0.1935 and 0.257, ±0.0005.
c Shear strength based on Table 8.1.2(b) and $F_{su}$ = 41 ksi.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.2.2(l). Static Joint Strength of 120° Flush Shear Head Ti-45 Cb Solid Rivets in Machine-Countersunk Aluminum Alloy and Titanium Sheet**

| Rivet Type | BRFS-T[a] ($F_{su}$ = 53 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | Annealed Ti-6Al-4V | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) |
| | Ultimate Strength, lbs | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.025 | 288 | ... | ... | 400 | ... | ... |
| 0.032 | 369 | 456 | ... | 513 | 635 | ... |
| 0.040 | 461 | 572 | 685 | 564 | 796 | 952 |
| 0.050 | 577 | 713 | 858 | 602 | 867 | 1190 |
| 0.063 | 610 | 891 | 1080 | 650 | 927 | 1270 |
| 0.071 | 628 | 914 | 1220 | 680 | 964 | 1310 |
| 0.080 | 649 | 939 | 1300 | 687 | 1005 | 1360 |
| 0.090 | 671 | 967 | 1330 | ... | 1050 | 1420 |
| 0.100 | 687 | 996 | 1370 | ... | ... | 1470 |
| 0.125 | ... | 1050 | 1450 | ... | ... | 1520 |
| 0.160 | ... | ... | 1520 | ... | ... | ... |
| Rivet shear strength[c] | 687 | 1050 | 1520 | 687 | 1050 | 1520 |
| | Yield Strength[d], lbs | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.025 | 288 | ... | ... | 400 | ... | ... |
| 0.032 | 369 | 456 | ... | 513 | 635 | ... |
| 0.040 | 461 | 572 | 685 | 564 | 796 | 952 |
| 0.050 | 577 | 713 | 858 | 602 | 867 | 1190 |
| 0.063 | 610 | 891 | 1080 | 650 | 927 | 1270 |
| 0.071 | 628 | 914 | 1220 | 680 | 964 | 1310 |
| 0.080 | 649 | 939 | 1300 | 687 | 1005 | 1360 |
| 0.090 | 671 | 967 | 1330 | ... | 1050 | 1420 |
| 0.100 | 687 | 996 | 1370 | ... | ... | 1470 |
| 0.125 | ... | 1050 | 1450 | ... | ... | 1520 |
| 0.160 | ... | ... | 1520 | ... | ... | ... |
| Head height (ref.), in. | 0.023 | 0.030 | 0.039 | 0.023 | 0.030 | 0.039 |

a Data supplied by Briles Rivet Corp.

b Allowables developed from tests with hole diameters noted, except 5/32 and 3/16 diameters were 0.161 and 0.1935 ±0.0005, respectively.

c Rivet shear strength based on Table 8.1.2(b) and $F_{su}$ = 53 ksi.

d Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.2.2(m). Static Joint Strength of 120° Flush Shear Head Aluminum Alloy (7050-T731) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS14218E[a] ($F_{su}$ = 43 ksi) | | | | | | |
|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 7/32 (0.228) | 1/4 (0.257) | 9/32 (0.290) | 5/16 (0.323) |
| | Ultimate Strength, lbs | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.025 | 215[c] | ... | ... | ... | ... | ... | ... |
| 0.032 | 307 | 346[c] | ... | ... | ... | ... | ... |
| 0.040 | 434 | 478 | 529[c] | ... | ... | ... | ... |
| 0.050 | 508 | 673 | 732 | 806 [c] | ... | ... | ... |
| 0.063 | 536 | 781 | 1045 | 1135 | 1200 | 1285[c] | ... |
| 0.071 | 554 | 803 | 1110 | 1365 | 1445 | 1530 | 1630[c] |
| 0.080 | 558 | 827 | 1140 | 1565 | 1735 | 1835 | 1930 |
| 0.090 | ... | 854 | 1175 | 1605 | 1990 | 2200 | 2320 |
| 0.100 | ... | ... | 1205 | 1645 | 2030 | 2525 | 2725 |
| 0.125 | ... | ... | 1230 | 1740 | 2140 | 2650 | 3205 |
| 0.160 | ... | ... | ... | 1755 | 2230 | 2820 | 3400 |
| 0.190 | ... | ... | ... | ... | ... | 2840 | 3525 |
| Rivet shear strength[d] | 558 | 854 | 1230 | 1755 | 2230 | 2840 | 3525 |
| | Yield Strength[e], lbs | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.025 | 215 | ... | ... | ... | ... | ... | ... |
| 0.032 | 307 | 346 | ... | ... | ... | ... | ... |
| 0.040 | 388 | 478 | 529 | ... | ... | ... | ... |
| 0.050 | 487 | 601 | 721 | 806 | ... | ... | ... |
| 0.063 | 536 | 760 | 912 | 1085 | 1200 | 1285 | ... |
| 0.071 | 552 | 803 | 1030 | 1225 | 1377 | 1530 | 1630 |
| 0.080 | 558 | 827 | 1140 | 1385 | 1554 | 1755 | 1930 |
| 0.090 | ... | 854 | 1175 | 1560 | 1750 | 1970 | 2200 |
| 0.100 | ... | ... | 1205 | 1645 | 1950 | 2200 | 2445 |
| 0.125 | ... | ... | 1230 | 1735 | 2140 | 2650 | 3060 |
| 0.160 | ... | ... | ... | 1755 | 2230 | 2810 | 3400 |
| 0.190 | ... | ... | ... | ... | ... | 2840 | 3525 |
| Head height (ref.), in. | 0.027 | 0.035 | 0.044 | 0.053 | 0.061 | 0.069 | 0.077 |

a Data supplied by Briles Rivet Corp.

b Allowables developed from tests with hole diameters noted, except 5/32, 3/16, and 5/16 diameters were 0.161, 0.1935, and 0.316, respectively. Hole tolerances were +0.0005, -0.001 inch.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Shear strength based on Table 8.1.2(b) and $F_{su}$ = 43 ksi.

e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.2.2(n). Static Joint Strength of 100° Flush Shear Head Aluminum Alloy (7050-T73) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1097-E[a] ($F_{su}$ = 41 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | Clad 7075-T6 | | | |
| Nominal Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.)[b] | (0.1285) | (0.159) | (0.191) | (0.257) | (0.1285) | (0.159) | (0.191) | (0.257) |
| | Ultimate Strength, lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.025 | 227[c] | ... | ... | ... | 278[c] | ... | ... | ... |
| 0.032 | 326 | 367[c] | ... | ... | 354 | 441[c] | ... | ... |
| 0.040 | 437 | 505 | 561[c] | ... | 439 | 547 | 661[c] | ... |
| 0.050 | 466 | 679 | 773 | 908[c] | 456 | 674 | 823 | 1120[c] |
| 0.063 | 485 | 717 | 1005 | 1275 | 477 | 700 | 980 | 1330 |
| 0.071 | 497 | 731 | 1025 | 1500 | 490 | 716 | 999 | 1570 |
| 0.080 | 507 | 747 | 1045 | 1750 | 505 | 734 | 1020 | 1760 |
| 0.090 | 521 | 765 | 1065 | 1840 | 520 | 754 | 1045 | 1790 |
| 0.100 | 531 | 781 | 1085 | 1870 | 531 | 774 | 1070 | 1825 |
| 0.125 | ... | 814 | 1135 | 1935 | ... | 814 | 1130 | 1905 |
| 0.160 | ... | ... | 1175 | 2030 | ... | ... | 1175 | 2020 |
| 0.190 | ... | ... | ... | 2110 | ... | ... | ... | 2115 |
| 0.250 | ... | ... | ... | 2125 | ... | ... | ... | 2125 |
| Rivet shear strength[d] | 531 | 814 | 1175 | 2125 | 531 | 814 | 1175 | 2125 |
| | Yield Strength[e], lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.025 | 192 | ... | ... | ... | 222 | ... | ... | ... |
| 0.032 | 283 | 311 | ... | ... | 307 | 356 | ... | ... |
| 0.040 | 349 | 439 | 479 | ... | 372 | 475 | 542 | ... |
| 0.050 | 398 | 538 | 674 | 767 | 398 | 572 | 724 | 894 |
| 0.063 | 462 | 617 | 799 | 1105 | 431 | 612 | 836 | 1205 |
| 0.071 | 497 | 665 | 857 | 1310 | 451 | 638 | 867 | 1400 |
| 0.080 | 507 | 720 | 921 | 1400 | 474 | 666 | 900 | 1490 |
| 0.090 | 521 | 765 | 995 | 1500 | 499 | 698 | 938 | 1540 |
| 0.100 | 531 | 781 | 1065 | 1595 | 525 | 729 | 976 | 1595 |
| 0.125 | ... | 814 | 1135 | 1835 | ... | 808 | 1070 | 1720 |
| 0.160 | ... | ... | 1175 | 2030 | ... | ... | 1175 | 1895 |
| 0.190 | ... | ... | ... | 2110 | ... | ... | ... | 2050 |
| 0.250 | ... | ... | ... | 2125 | ... | ... | ... | 2125 |
| Head height (ref.), in. | 0.029 | 0.037 | 0.046 | 0.060 | 0.029 | 0.037 | 0.046 | 0.060 |

a Data supplied by Lockheed-Georgia Company.

b Fasteners installed in hole diameters of 0.130, 0.158, 0.191, and 0.254 ± 0.003 inch, respectively.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Shear strength based on Table 8.1.2(b) and $F_{su}$ = 41 ksi.

e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.2.2(o). Static Joint Strength of 120° Flush Shear Head Aluminum Alloy (2117-T3) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS14218AD[a] ($F_{su}$ = 30 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 7/32 (0.228) | 1/4 (0.257) |
| | Ultimate Strength, lbs | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.020 | 125[c] | ... | ... | ... | ... | ... |
| 0.025 | 153 | 212[c] | ... | ... | ... | ... |
| 0.032 | 188 | 263 | 334[c] | ... | ... | ... |
| 0.040 | 216 | 322 | 408 | 498[c] | ... | ... |
| 0.050 | 217 | 380 | 498 | 609 | 740[c] | 849[c] |
| 0.063 | ... | 388 | 588 | 751 | 910 | 1040 |
| 0.071 | ... | ... | 596 | 817 | 1015 | 1155 |
| 0.080 | ... | ... | ... | 842 | 1125 | 1290 |
| 0.090 | ... | ... | ... | 862 | 1205 | 1425 |
| 0.100 | ... | ... | ... | ... | 1225 | 1520 |
| 0.125 | ... | ... | ... | ... | ... | 1555 |
| Rivet shear strength[d] | 217 | 388 | 596 | 862 | 1225 | 1555 |
| | Yield Strength[e], lbs | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.020 | 125 | ... | ... | ... | ... | ... |
| 0.025 | 153 | 212 | ... | ... | ... | ... |
| 0.032 | 188 | 263 | 334 | ... | ... | ... |
| 0.040 | 216 | 319 | 408 | 498 | ... | ... |
| 0.050 | 217 | 370 | 492 | 609 | 740 | 849 |
| 0.063 | ... | 388 | 574 | 733 | 910 | 1040 |
| 0.071 | ... | ... | 596 | 794 | 1005 | 1155 |
| 0.080 | ... | ... | ... | 842 | 1090 | 1275 |
| 0.090 | ... | ... | ... | 862 | 1180 | 1380 |
| 0.100 | ... | ... | ... | ... | 1225 | 1480 |
| 0.125 | ... | ... | ... | ... | ... | 1555 |
| Head height (ref.), in. | 0.022 | 0.027 | 0.035 | 0.044 | 0.053 | 0.061 |

a Data supplied by Briles Rivet Corp.

b Load allowables developed from tests with hole diameters noted, except 3/32, 5/32, and 3/16 diameters were 0.098, 0.161, and 0.1935, respectively. Hole tolerance was +0.0005, -0.001 inch.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Shear strength based on Table 8.1.2(b) and $F_{su}$ = 30 ksi.

e Permanent set at yield load: 4% of nominal hole diameter.

## Table 8.1.2.2(p). Static Joint Strength of 120° Flush Tension Type Head Aluminum Alloy (7050-T731) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet

| Rivet Type | MS14219 E[a] ($F_{su}$ = 43 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 7/32 (0.228) | 1/4 (0.257) | 9/32 (0.290) | 5/16 (0.523) |
| | Ultimate Strength, lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.032 | 210[c] | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 279 | 339[c] | ... | ... | ... | ... | ... | ... |
| 0.050 | 310 | 473 | 527[c] | ... | ... | ... | ... | ... |
| 0.063 | 311 | 538 | 743 | 819[c] | ... | ... | ... | ... |
| 0.071 | ... | 558 | 788 | 979 | 1065[c] | ... | ... | ... |
| 0.080 | ... | ... | 834 | 1105 | 1280 | ... | ... | ... |
| 0.090 | ... | ... | 854 | 1165 | 1520 | 1625[c] | ... | ... |
| 0.100 | ... | ... | ... | 1230 | 1605 | 1890 | 2020[c] | 2120[c] |
| 0.125 | ... | ... | ... | ... | 1755 | 2145 | 2580 | 2965 |
| 0.160 | ... | ... | ... | ... | ... | 2230 | 2840 | 3415 |
| 0.190 | ... | ... | ... | ... | ... | ... | ... | 3525 |
| Rivet shear strength[d] | 311 | 588 | 854 | 1230 | 1755 | 2230 | 2840 | 3525 |
| | Yield Strength[e], lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.032 | 210 | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 277 | 339 | ... | ... | ... | ... | ... | ... |
| 0.050 | 301 | 468 | 527 | ... | ... | ... | ... | ... |
| 0.063 | 309 | 538 | 728 | 819 | ... | ... | ... | ... |
| 0.071 | ... | 543 | 788 | 979 | 1065 | ... | ... | ... |
| 0.080 | ... | ... | 823 | 1100 | 1280 | ... | ... | ... |
| 0.090 | ... | ... | 833 | 1165 | 1490 | 1625 | ... | ... |
| 0.100 | ... | ... | ... | 1190 | 1605 | 1875 | 2020 | 2120 |
| 0.125 | ... | ... | ... | ... | 1705 | 2145 | 2580 | 2945 |
| 0.160 | ... | ... | ... | ... | ... | 2200 | 2765 | 3390 |
| 0.190 | ... | ... | ... | ... | ... | ... | ... | 3455 |
| Head height (ref.), in. | 0.034 | 0.041 | 0.053 | 0.068 | 0.077 | 0.090 | 0.100 | 0.104 |

a Data supplied by Briles Rivet Corp.
b Load allowables developed from tests with hole diameters noted, except 5/32, 3/16, and 5/16 diameter were 0.161, 0.1935, and 0.316, respectively. Hole tolerances were + 0.0005, -0.001 inch.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength based on Table 8.1.2(b) and $F_{su}$ = 43 ksi.
e Permanent set at yield load: 4% of nominal hole diameter.

## Table 8.1.2.2(q). Static Joint Strength of 120° Flush Tension Type Head Aluminum Alloy (7050-T731) Solid Rivets in Machine-Countersunk Aluminum Alloy Sheet

| Rivet Type | MS14219 E[a] ($F_{su}$ = 43 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 3/32 (0.096) | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 7/32 (0.228) | 1/4 (0.257) | 9/32 (0.290) | 5/16 (0.523) |
| | Ultimate Strength, lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.032 | 272[c] | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 297 | 455[c] | ... | ... | ... | ... | ... | ... |
| 0.050 | 311 | 522 | 704[c] | ... | ... | ... | ... | ... |
| 0.063 | ... | 558 | 803 | 1065[c] | ... | ... | ... | ... |
| 0.071 | ... | ... | 832 | 1140 | 1435[c] | ... | ... | ... |
| 0.080 | ... | ... | 854 | 1180 | 1600 | ... | ... | ... |
| 0.090 | ... | ... | ... | 1220 | 1650 | 2030[c] | ... | ... |
| 0.100 | ... | ... | ... | 1230 | 1700 | 2090 | 2565[c] | 2860[c] |
| 0.125 | ... | ... | ... | ... | 1755 | 2230 | 2740 | 3295 |
| 0.160 | ... | ... | ... | ... | ... | ... | 2840 | 3525 |
| Rivet shear strength[d] | 311 | 558 | 854 | 1230 | 1755 | 2230 | 2840 | 3525 |
| | Yield Strength[e], lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.032 | 272 | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 296 | 455 | ... | ... | ... | ... | ... | ... |
| 0.050 | 308 | 522 | 704 | ... | ... | ... | ... | ... |
| 0.063 | ... | 550 | 802 | 1065 | ... | ... | ... | ... |
| 0.071 | ... | ... | 823 | 1140 | 1435 | ... | ... | ... |
| 0.080 | ... | ... | 845 | 1170 | 1600 | ... | ... | ... |
| 0.090 | ... | ... | ... | 1205 | 1650 | 2030 | ... | ... |
| 0.100 | ... | ... | ... | 1220 | 1685 | 2090 | 2565 | 2860 |
| 0.125 | ... | ... | ... | ... | 1740 | 2195 | 2715 | 3295 |
| 0.160 | ... | ... | ... | ... | ... | ... | 2815 | 3480 |
| Head height (ref.), in. | 0.034 | 0.041 | 0.053 | 0.068 | 0.077 | 0.090 | 0.100 | 0.104 |

a Data supplied by Briles Rivet Corp.
b Allowables developed from tests with hole diameters noted, except 3/32, 5/32, 3/16, and 5/16 diameters were 0.098, 0.161, 0.1935, and 0.316, respectively. Hole tolerances were +0.0005, -0.001 inch.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength based on Table 8.1.2(b) and $F_{su}$ = 43 ksi.
e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.2.2(r). Static Joint Strength of Solid 100° Flush Head Aluminum Alloy (7050-T73) Solid Rivets in Machine Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS20426E ($F_{su}$ = 41 ksi)[a] | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.)[b] | (0.1285) | (0.159) | (0.191) | (0.257) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 386[c] | ... | ... | ... |
| 0.050 | 419 | 592[c] | ... | ... |
| 0.063 | 463 | 647 | 870[c] | ... |
| 0.071 | 491 | 680 | 910 | ... |
| 0.080 | 521 | 718 | 955 | ... |
| 0.090 | 531 | 760 | 1005 | 1610[c] |
| 0.100 | ... | 802 | 1055 | 1680 |
| 0.125 | ... | 814 | 1175 | 1845 |
| 0.160 | ... | ... | ... | 2085 |
| 0.190 | ... | ... | ... | 2125 |
| Rivet shear strength[d] | 531 | 814 | 1175 | 2125 |
| | Yield Strength[e], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 262 | ... | ... | ... |
| 0.050 | 327 | 404 | ... | ... |
| 0.063 | 412 | 510 | 612 | ... |
| 0.071 | 464 | 574 | 690 | ... |
| 0.080 | 517 | 647 | 777 | ... |
| 0.090 | 531 | 728 | 875 | 1175 |
| 0.100 | ... | 794 | 972 | 1310 |
| 0.125 | ... | 814 | 1160 | 1635 |
| 0.160 | ... | ... | ... | 2070 |
| 0.190 | ... | ... | ... | 2125 |
| Head Height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Data supplied by Lockheed Ga. Co. and Air Force Materials Laboratory.
b Load allowables developed from tests with hole diameters of 0.130, 0.158, 0.191, and 0.256 ± 0.003 inch.
c The values in the table above the horizontal line in each column are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires the specific approval of the procuring agency.
d Shear strength based on area computed from nominal hole diameters in Table 8.1.2(b) and $F_{su}$ = 41 ksi.
e Permanent set at yield load: 4% of the nominal hole diameter.

**Table 8.1.2.2 (s). Static Joint Strength of Solid 100° Flush Head Alumunim Alloy (7050-T73) Solid Rivets in Machine Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS20426E ($F_{su}$ = 41 ksi)[a] | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.)[b] | (0.1285) | (0.159) | (0.191) | (0.257) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 318[c] | ... | ... | ... |
| 0.050 | 393 | 492[c] | ... | ... |
| 0.063 | 440 | 606 | 745[c] | ... |
| 0.071 | 469 | 642 | 840 | ... |
| 0.080 | 502 | 683 | 898 | ... |
| 0.090 | 531 | 728 | 952 | 1430[c] |
| 0.100 | ... | 773 | 1005 | 1570 |
| 0.125 | ... | 814 | 1140 | 1755 |
| 0.160 | ... | ... | 1175 | 2010 |
| 0.190 | ... | ... | ... | 2125 |
| Rivet shear strength[d] | 531 | 814 | 1175 | 2125 |
| | Yield Strength[e], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 257 | ... | ... | ... |
| 0.050 | 330 | 399 | ... | ... |
| 0.063 | 423 | 515 | 607 | ... |
| 0.071 | 469 | 586 | 693 | ... |
| 0.080 | 502 | 666 | 789 | ... |
| 0.090 | 531 | 728 | 896 | 1175 |
| 0.100 | ... | 773 | 1005 | 1320 |
| 0.125 | ... | 814 | 1140 | 1680 |
| 0.160 | ... | ... | 1175 | 2010 |
| 0.190 | ... | ... | ... | 2125 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Data supplied by Lockheed Ga. Co., Air Force Materials Laboratory, Allfast, Cherry Fasteners, Douglas Aircraft Co., and Huck Mfg. Co.

b Load allowables developed from tests with hole diameters of 0.130, 0.158, 0.191, and 0.256 ± 0.003 inch.

c The values in the table above the horizontal line in each column are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires the specific approval of the procuring agency.

d Shear strength based on area computed from nominal hole diameters in Table 8.1.2(b) and $F_{su}$ = 41 ksi.

e Permanent set at yield load: 4% of the nominal hole diameter.

**Table 8.1.2.2(t). Static Joint Strength of 105 degree Flush Shear Head Aluminum Alloy (7050) Solid Rivet in 100 degree Machine-Countersunk Alloy Sheet**

| Rivet Type | AL 905 KE[a] ($F_{su}$ = 41 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.1285) | 5/32 (0.159) | 3/16 (0.191) | 1/4 (0.257) |
| | Ultimate Strength, lbs. | | | |
| Sheet thickness, in.: | | | | |
| 0.032 | 325[c] | --- | --- | --- |
| 0.040 | 396 | 502[c] | --- | --- |
| 0.050 | 452 | 612 | 750[c] | --- |
| 0.063 | 498 | 696 | 923 | 1280[c] |
| 0.071 | 526 | 731 | 980 | 1425 |
| 0.080 | 531 | 771 | 1030 | 1585 |
| 0.090 | --- | 814 | 1080 | 1735 |
| 0.125 | --- | --- | 1175 | 1985 |
| 0.160 | --- | --- | --- | 2125 |
| Rivet Shear Strength[d] | 531 | 814 | 1175 | 2125 |
| | Yield Strength, lbs[e] | | | |
| Sheet thickness, in.: | | | | |
| 0.032 | 268 | --- | --- | --- |
| 0.040 | 326 | 415 | --- | --- |
| 0.050 | 399 | 504 | 619 | --- |
| 0.063 | 493 | 620 | 759 | 1060 |
| 0.071 | 526 | 692 | 845 | 1175 |
| 0.080 | 531 | 771 | 942 | 1305 |
| 0.090 | --- | 814 | 1050 | 1450 |
| 0.125 | --- | --- | 1175 | 1955 |
| 0.160 | --- | --- | --- | 2125 |
| Head height [ref.],[f] in. | 0.029 | 0.037 | 0.046 | 0.060 |

a Data supplied by Ateliers De La Haute Garonne SARL.
b Loads developed from tests with hole diameters of 0.1285, 0.161, 0.193, and 0.257, +/- 0.001 inch.
c The values above the horizontal line in each column are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring activity.
d Rivet shear strength is based upon Table 8.1.2(b) and $F_{su}$ = 41 ksi.
e Permanent set at yield load: 4% of nominal diameter.
f Head height values reflect driven rivet configuration.

**8.1.3 BLIND FASTENERS** — The strengths shown in the following tables are applicable only for the grip lengths and hole tolerances recommended by the respective fastener manufacturers. For some fastener systems, permanent set at yield load may be increased if hole sizes greater than those listed in the applicable table are used. This condition may exist even though the test hole size lies within the manufacturer's recommended hole size range.

The strength values were established from test data and are applicable to "joints" with e/D ≥ 2.0. For joints with e/D ratios less than 2.0, tests to substantiate the use of yield and ultimate strength allowables must be made. Ultimate strength values of protruding- and flush-head blind fasteners were obtained as described in Section 9.7. The analyses prior to 2003 included dividing the average ultimate load from test data by 1.15. This factor was not applicable to shear strength cutoff values which represented either the procurement specification shear strength (S values) of the fastener, or if no specification existed, a statistical value determined from test results as described in Chapter 9.

Unless otherwise specified, prior to 2003 the yield load was defined as the load which resulted in a joint permanent set equal to 0.04D, where D is the decimal equivalent of the hole or fastener shank diameter, as defined in Table 9.7.1.1. Some tables are footnoted to show the previous criteria used for those particular tables.

For machine countersunk joints, the sheet gage specified in the tables is that of the countersunk sheet. When the noncountersunk sheet is thinner than the countersunk sheet, the bearing allowable for the noncountersunk sheet-fastener combination should be computed, compared to the table value, and the lower of the two values selected. Increased attention should be paid to detail design in cases where t/D < 0.25 because of the possibility of unsatisfactory service life.

Joint allowable strengths of blind fasteners in double-dimpled or dimpled into machine countersunk applications should be established on the basis of specific tests acceptable to the procuring or certifying agency.

Reference should be made to the requirements of the applicable procuring or certifying agency relative to the use of blind fasteners such as the limitations of usage in design standard MS33522.

#### 8.1.3.1 *Protruding-Head Blind Fasteners*

**8.1.3.1.1** *Friction-Lock Blind Rivets* — Tables 8.1.3.1.1(a) through 8.1.3.1.1(e) contain joint allowables for various protruding-head, friction-lock blind rivet/sheet material combinations.

**8.1.3.1.2** *Mechanical-Lock Spindle Blind Rivets* — Tables 8.1.3.1.2(a) through (t) contain joint allowables for various protruding-head, mechanical-lock spindle blind rivet/sheet material combinations.

#### 8.1.3.2 *Flush-Head Blind Fasteners*

**8.1.3.2.1** *Friction-Lock Blind Rivets* — Tables 8.1.3.2.1(a) through (g) contain joint allowables for various flush-head, friction-lock blind rivet/sheet material combinations.

**8.1.3.2.2** *Mechanical-Lock Spindle Blind Rivets* — Tables 8.1.3.2.2(a) through (aa) contain joint allowables for various flush-head, mechanical-lock spindle blind rivet/sheet material combinations.

**8.1.3.2.3** *Flush-Head Blind Bolts* — Tables 8.1.3.2.3(a) through (h) contain joint allowables for various flush-head blind bolt/sheet material combinations.

**Table 8.1.3.1.1(a). Static Joint Strength of Blind Protruding Head A-286 Rivets in Alloy Steels, Titanium Alloy and A-286 Alloy Sheet**

| Rivet Type | CR 6636[a] ($F_{su}$ = 75 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Alloy Steel, $F_{tu}$ = 125 ksi, Titanium Alloys, $F_{tu}$ = 120 ksi, and A-286 Alloy, $F_{tu}$ = 140 ksi | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength[b], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.008 | 169 | ... | ... | ... |
| 0.012 | 290 | 341 | ... | ... |
| 0.016 | 412 | 493 | 566 | ... |
| 0.020 | 532 | 645 | 748 | 924 |
| 0.025 | 688 | 816 | 967 | 1221 |
| 0.032 | 796 | 1050 | 1278 | 1650 |
| 0.040 | 879 | 1233 | 1570 | 2129 |
| 0.050 | 945 | 1354 | 1807 | 2673 |
| 0.063 | 970 | 1461 | 1980 | 3168 |
| 0.071 | ... | 1490 | 2062 | 3350 |
| 0.080 | ... | ... | 2150 | 3515 |
| 0.090 | ... | ... | ... | 3663 |
| 0.100 | ... | ... | ... | 3779 |
| 0.112 | ... | ... | ... | 3890 |
| Rivet shear strength[c] | 970 | 1490 | 2150 | 3890 |

a Data supplied by Cherry Fasteners.

b Yield strength is in excess of 80% of ultimate. This is based on a previous Navy "BuAer" definition that yield strength would not be considered to be critical if it exceeded 1.15 x 2.3 of design ultimate strength. There was no requirement for submission of the yield data for inclusion in ANC-5.

c Shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 75 ksi.

**Table 8.1.3.1.1(b). Static Joint Strength of Protruding Head Monel Rivets in Stainless Steel Sheet**

| Rivet Type | MS20600M ($F_{su}$ = 55 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | ANSI 301-Annealed | | | | AISI 301-½ Hard | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.154) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.010 | ... | ... | ... | ... | 195 | ... | ... | ... |
| 0.012 | ... | ... | ... | ... | 225 | 287 | ... | ... |
| 0.016 | ... | ... | ... | ... | 290 | 367 | 453 | ... |
| 0.020 | 332[a] | ... | ... | ... | 358 | 450 | 552 | 774 |
| 0.025 | 396[a] | 494[a] | ... | ... | 440 | 552 | 675 | 940 |
| 0.032 | 472[a] | 627[a] | 768[a] | ... | 522 | 690 | 1040 | 1163 |
| 0.040 | 526[a] | 729[a] | 942[a] | 1290[a] | 580 | 810 | 1200 | 1430 |
| 0.050 | 594[a] | 810[a] | 1070[a] | 1585[a] | 635 | 903 | 1325 | 1760 |
| 0.063 | 681[a] | 919[a] | 1280[a] | 1875[a] | 678 | 980 | 1385 | 2090 |
| 0.071 | 700[a] | 984[a] | 1370[a] | 1980[a] | 701 | 1013 | 1438 | 2220 |
| 0.080 | 713 | 1055[a] | 1470[a] | 2110[a] | 713 | 1050 | 1486 | 2340 |
| 0.090 | ... | 1080[a] | 1530[a] | 2240[a] | ... | 1081 | 1540 | 2450 |
| 0.100 | ... | 1090 | 1580 | 2380[a] | ... | 1090 | 1580 | 2540 |
| 0.125 | ... | ... | ... | 2700[a] | ... | ... | ... | 2710 |
| 0.160 | ... | ... | ... | 2855 | ... | ... | ... | 2855 |
| Rivet shear strength[b] | 713 | 1090 | 1580 | 2855 | 713 | 1090 | 1580 | 2855 |
| | Yield Strength[c], lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.010 | ... | ... | ... | ... | 195 | ... | ... | ... |
| 0.012 | ... | ... | ... | ... | 225 | 287 | ... | ... |
| 0.016 | ... | ... | ... | ... | 290 | 367 | 453 | ... |
| 0.020 | 128 | ... | ... | ... | 358 | 450 | 551 | 774 |
| 0.025 | 160 | 199 | ... | ... | 440 | 552 | 675 | 940 |
| 0.032 | 205 | 254 | 306 | ... | 522 | 690 | 836 | 1163 |
| 0.040 | 257 | 318 | 382 | 514 | 580 | 810 | 1040 | 1430 |
| 0.050 | 321 | 397 | 477 | 642 | 635 | 903 | 1200 | 1760 |
| 0.063 | 405 | 501 | 601 | 810 | 678 | 980 | 1325 | 2090 |
| 0.071 | 456 | 564 | 678 | 912 | 701 | 1013 | 1385 | 2220 |
| 0.080 | 514 | 635 | 764 | 1025 | 713 | 1050 | 1438 | 2340 |
| 0.090 | ... | 715 | 860 | 1155 | ... | 1081 | 1486 | 2450 |
| 0.100 | ... | 795 | 955 | 1285 | ... | 1090 | 1540 | 2540 |
| 0.125 | ... | ... | ... | 1605 | ... | ... | ... | 2710 |
| 0.160 | ... | ... | ... | 2055 | ... | ... | ... | 2855 |

a Yield value is less than 2/3 of the indicated ultimate strength value.
b Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi.
c Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.1.1(c). Static Joint Strength of Blind Protruding Head Monel Rivets in Aluminum Alloy Sheet**

| Rivet Type | MS20600M ($F_{su}$ = 55 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | 2024-T3 | | | | 7075-T6 | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.025 | 268 | ... | ... | ... | 297 | ... | ... | ... |
| 0.032 | 365 | 429 | ... | ... | 405 | 472 | ... | ... |
| 0.040 | 478 | 569 | 650 | ... | 485 | 631 | 720 | ... |
| 0.050 | 545 | 738 | 860 | 1070 | 545 | 747 | 955 | 1190 |
| 0.063 | 622 | 844 | 1110 | 1430 | 622 | 844 | 1110 | 1590 |
| 0.071 | 652 | 903 | 1180 | 1665 | 652 | 903 | 1180 | 1840 |
| 0.080 | 684 | 968 | 1255 | 1910 | 684 | 968 | 1255 | 1940 |
| 0.090 | 713 | 1010 | 1345 | 2060 | 713 | 1010 | 1345 | 2060 |
| 0.100 | ... | 1050 | 1415 | 2180 | ... | 1050 | 1415 | 2180 |
| 0.125 | ... | 1090 | 1545 | 2480 | ... | 1090 | 1545 | 2480 |
| 0.160 | ... | ... | 1580 | 2735 | ... | ... | 1580 | 2735 |
| 0.190 | ... | ... | ... | 2855 | ... | ... | ... | 2855 |
| Rivet shear strength[a] | 713 | 1090 | 1580 | 2855 | 713 | 1090 | 1580 | 2855 |
| | Yield Strength[b], lbs | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.025 | 234 | ... | ... | ... | 272 | ... | ... | ... |
| 0.032 | 297 | 370 | ... | ... | 343 | 430 | ... | ... |
| 0.040 | 368 | 460 | 556 | ... | 425 | 533 | 644 | ... |
| 0.050 | 458 | 570 | 688 | 936 | 492 | 657 | 797 | 1090 |
| 0.063 | 529 | 715 | 863 | 1170 | 529 | 759 | 996 | 1350 |
| 0.071 | 552 | 786 | 970 | 1315 | 552 | 786 | 1075 | 1520 |
| 0.080 | 577 | 818 | 1090 | 1470 | 577 | 818 | 1110 | 1700 |
| 0.090 | 605 | 853 | 1155 | 1650 | 605 | 853 | 1155 | 1915 |
| 0.100 | ... | 888 | 1200 | 1830 | ... | 888 | 1200 | 1970 |
| 0.125 | ... | 976 | 1300 | 2110 | ... | 976 | 1300 | 2110 |
| 0.160 | ... | ... | 1450 | 2310 | ... | ... | 1450 | 2310 |
| 0.190 | ... | ... | ... | 2480 | ... | ... | ... | 2480 |

a Shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi.
b Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.1.1(d). Static Joint Strength of Blind Protruding Head Alloy (2117-T3) Rivets in Aluminum Alloy Sheet**

| Rivet Type | MS20600AD and MS20602AD ($F_{su}$ = 30 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024 T3 | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.025 | 233 | ... | ... | ... |
| 0.032 | 277 | 368 | ... | ... |
| 0.040 | 321 | 425 | 544 | ... |
| 0.050 | 388 | 506 | 643 | 961 |
| 0.063 | ... | 596 | 753 | 1110 |
| 0.071 | ... | ... | 823 | 1200 |
| 0.080 | ... | ... | 862 | 1305 |
| 0.090 | ... | ... | ... | 1415 |
| 0.100 | ... | ... | ... | 1550 |
| Rivet shear strength[a] | 388 | 596 | 862 | 1550 |
| | Yield Strength[b], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.025 | 226 | ... | ... | ... |
| 0.032 | 264 | 356 | ... | ... |
| 0.040 | 304 | 406 | 523 | ... |
| 0.050 | 362 | 475 | 610 | 925 |
| 0.063 | 388 | 560 | 709 | 1058 |
| 0.071 | ... | 596 | 771 | 1135 |
| 0.080 | ... | ... | 862 | 1230 |
| 0.090 | ... | ... | ... | 1330 |
| 0.100 | ... | ... | ... | 1450 |

a Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 30 ksi.
b Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.1.1(e). Static Joint Strength of Blind Protruding Head Aluminum Alloy (5056) Rivets in Magnesium Alloy Sheet**

| Rivet Type | MS20600B ($F_{su}$ = 28 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | AZ31B-H24 | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength[a], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.025 | 178 | ... | ... | ... |
| 0.032 | 218 | 282 | ... | ... |
| 0.040 | 256 | 339 | 420 | ... |
| 0.050 | 290 | 392 | 502 | 714 |
| 0.063 | 330 | 449 | 584 | 870 |
| 0.071 | 352 | 481 | 627 | 942 |
| 0.080 | 363 | 512 | 667 | 1025 |
| 0.090 | ... | 550 | 714 | 1090 |
| 0.100 | ... | 556 | 757 | 1160 |
| 0.125 | ... | ... | 802 | 1315 |
| 0.160 | ... | ... | ... | 1450 |
| Rivet shear strength[b] | 363 | 556 | 802 | 1450 |

a Yield strength is in excess of 80% of ultimate. This is based on a previous Navy "Bureau of Aeronautics" definition that yield strength was not considered to be critical if it exceeded 1.15 x 2/3 of design ultimate strength. There was no requirement for submission of the yield data for inclusion in ANC-5.

b Shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 28 ksi.

**Table 8.1.3.1.2(a). Static Joint Strength of Blind Protruding Head Locked Spindle A-286 Rivets in Alloy Steel Sheet**

| Rivet Type | NAS1398C[a] and NAS1398C, Code A[b] ($F_{su}$ = 75 ksi) | | | CR 2643[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|---|---|---|
| Sheet Material | Alloy Steel $F_{tu}$ = 180 ksi | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength[c], lbs | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.025 | 697 | ... | ... | 697 | ... | ... |
| 0.032 | 785 | 1112 | ... | 807 | 1112 | ... |
| 0.040 | 860 | 1211 | 1628 | 911 | 1246 | 1639 |
| 0.050 | 956 | 1325 | 1772 | 1043 | 1406 | 1833 |
| 0.063 | 970 | 1480 | 1958 | 1215 | 1615 | 2090 |
| 0.071 | ... | 1490 | 2070 | 1230 | 1748 | 2240 |
| 0.080 | ... | ... | 2150 | ... | 1885 | 2420 |
| 0.090 | ... | ... | ... | ... | ... | 2610 |
| 0.100 | ... | ... | ... | ... | ... | 2720 |
| Rivet shear strength | 970[d] | 1490[d] | 2150[d] | 1230[e] | 1885[e] | 2720[e] |

a Data supplied by Cherry Fasteners.

b Confirmatory data supplied by Olympic Fastening Systems, Inc.

c Yield strength is in excess of 80% of ultimate. This is based on a previous Navy "Bureau of Aeronautics" definition that yield strength would not be considered to be critical if it exceeded 1.15 x 2/3 of design ultimate strength. There was no requirement for submission of the yield data for inclusion in ANC-5.

d Rivet shear strength is documented in NAS1400.

e Shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 95 ksi.

**Table 8.1.3.1.2(b). Static Joint Strength of Blind Protruding Head Locked Spindle Monel Rivets in Stainless Steel Sheet**

| Rivet Type | NAS1398 MS or MW[a] and NAS1398 MS or MW, Code A[b] ($F_{su}$ = 55 ksi) | | |
|---|---|---|---|
| Sheet Material | AISI 301-½ Hard | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.025 | 462 | ... | ... |
| 0.032 | 568 | 734 | ... |
| 0.040 | 594 | 870 | 1094 |
| 0.050 | 632 | 915 | 1270 |
| 0.063 | 678 | 971 | 1335 |
| 0.071 | 706 | 1009 | 1380 |
| 0.080 | 710 | 1048 | 1428 |
| 0.090 | ... | 1090 | 1532 |
| 0.100 | ... | ... | 1580 |
| Rivet shear strength[d] | 710 | 1090 | 1580 |

a Data supplied by Cherry Fasteners.

b Confirmatory data supplied by Olympic Fastening Systems, Inc.

c Yield strength is in excess of 80% of ultimate strength. This is based on a previous Navy "Bureau of Aeronautics" definition that yield strength was not considered to be critical if it exceeded 1.15 x 2/3 of design ultimate strength. There was no requirement for submission of the yield strength data for inclusion in ANC-5.

d Rivet shear strength is documented in NAS1400.

**Table 8.1.3.1.2(c). Static Joint Strength of Blind Protruding Head Locked Spindle Monel Rivets in Aluminum Alloy Sheet**

| Rivet Type | NAS1398 MS or MW[a] and NAS1398 MS or MW, Code A[b] ($F_{su}$ = 55 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.025 | 318 | ... | ... |
| 0.032 | 404 | 506 | ... |
| 0.040 | 466 | 624 | 774 |
| 0.050 | 546 | 720 | 922 |
| 0.063 | 647 | 845 | 1072 |
| 0.071 | 710 | 921 | 1168 |
| 0.080 | ... | 1009 | 1272 |
| 0.090 | ... | 1090 | 1387 |
| 0.100 | ... | ... | 1507 |
| 0.125 | ... | ... | 1580 |
| Rivet shear strength[d] | 710 | 1090 | 1580 |

a Data supplied by Cherry Fasteners.

b Confirmatory data supplied by Olympic Fastening Systems, Inc.

c Yield strength is in excess of 80% of ultimate. This is based on a previous Navy "Bureau of Aeronautics" definition that yield strength would not be considered to be critical if it exceeded 1.15 x 1/3 of design ultimate strength. There was no requirement for submission of the yield data for inclusion in ANC-5.

d Rivet shear strength is documented in NAS1400.

**Table 8.1.3.1.2($d_1$). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | NAS1398B[a] ($F_{su}$ = 30 ksi) | | | | NAS1398D[a] ($F_{su}$ = 38 ksi) | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs. | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.025 | 228 | ... | ... | ... | 228 | ... | ... | ... |
| 0.032 | 289 | 364 | 412 | ... | 304 | 364 | ... | ... |
| 0.040 | 337 | 448 | 553 | 670 | 355 | 470 | 553 | ... |
| 0.050 | 388 | 521 | 662 | 914 | 418 | 548 | 696 | 914 |
| 0.063 | ... | 596 | 781 | 1145 | 494 | 647 | 816 | 1205 |
| 0.071 | ... | ... | 854 | 1240 | ... | 710 | 894 | 1303 |
| 0.080 | ... | ... | 862 | 1350 | ... | 755 | 975 | 1420 |
| 0.090 | ... | ... | ... | 1475 | ... | ... | 1069 | 1545 |
| 0.100 | ... | ... | ... | 1550 | ... | ... | 1090 | 1670 |
| 0.125 | ... | ... | ... | ... | ... | ... | ... | 1970 |
| Rivet shear strength[b] | 388 | 596 | 862 | 1550 | 494 | 755 | 1090 | 1970 |

a Data supplied by Cherry Fasteners.
b Rivet shear strength documented in NAS1400.

**Table 8.1.3.1.2($d_2$). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | NAS1738B and NAS1738E[a] ($F_{su}$ = 34 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.025 | 267 | 305 | 330 |
| 0.032 | 368 | 428 | 473 |
| 0.040 | 427 | 567 | 636 |
| 0.050 | 480 | 650 | 815 |
| 0.063 | 547[b] | 735 | 912 |
| 0.071 | 554[b] | 785[b] | 976 |
| 0.080 | ... | 837[b] | 1042[b] |
| 0.090 | ... | ... | 1115[b] |
| 0.100 | ... | ... | 1128[b] |
| Rivet shear strength[c] | 554 | 837 | 1128 |
| | Yield Strength[d], lbs | | |
| Sheet thickness, in.: | | | |
| 0.020 | 185 | 213 | 228 |
| 0.025 | 242 | 285 | 317 |
| 0.032 | 298 | 386 | 433 |
| 0.040 | 321 | 453 | 568 |
| 0.050 | 336 | 489 | 625 |
| 0.063 | 336 | 508 | 680 |
| 0.071 | 336 | 508 | 684 |
| 0.080 | ... | 508 | 684 |
| 0.090 | ... | ... | 684 |
| 0.100 | ... | ... | 684 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate.
c Rivet shear strength was documented in NAS1740 prior to Revision (1), dated January 15, 1974.
d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.1.2(e). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Magnesium Alloy Sheet**

| Rivet Type | NAS1398B[a] ($F_{su}$ = 30 ksi) | | | | NAS1738B and NAS1738E[a] ($F_{su}$ = 34 ksi) | | |
|---|---|---|---|---|---|---|---|
| Sheet Material | AZ31B-H24 | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.025 | 163 | ... | ... | ... | 202 | ... | ... |
| 0.032 | 208 | 256 | 310 | ... | 261 | 321 | 372 |
| 0.040 | 255 | 324 | 388 | 519 | 325 | 401 | 465 |
| 0.050 | 298 | 394 | 485 | 654 | 372 | 501 | 579 |
| 0.063 | 352 | 461 | 588 | 822 | 425 | 570 | 708 |
| 0.071 | 385 | 501 | 639 | 924 | 458 | 609 | 756 |
| 0.080 | 388 | 550 | 695 | 1020 | 495 | 656 | 809 |
| 0.090 | ... | 596 | 755 | 1109 | 536[b] | 709 | 866 |
| 0.100 | ... | ... | 820 | 1191 | 554[b] | 759 | 925 |
| 0.125 | ... | ... | 862 | 1397 | ... | 837[b] | 1072[b] |
| 0.160 | ... | ... | ... | 1550 | ... | ... | 1128[b] |
| Rivet shear strength | 388[c] | 596[c] | 862[c] | 1550[c] | 554[d] | 837[d] | 1128[d] |
| | Yield Strength[e], lbs. | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.025 | ... | ... | ... | ... | 155 | ... | ... |
| 0.032 | ... | ... | ... | ... | 198 | 243 | 282 |
| 0.040 | ... | ... | ... | ... | 248 | 304 | 353 |
| 0.050 | ... | ... | ... | ... | 302 | 380 | 441 |
| 0.063 | ... | ... | ... | ... | 325 | 460 | 556 |
| 0.071 | ... | ... | ... | ... | 336 | 478 | 614 |
| 0.080 | ... | ... | ... | ... | 336 | 499 | 638 |
| 0.090 | ... | ... | ... | ... | 336 | 508 | 664 |
| 0.100 | ... | ... | ... | ... | 336 | 508 | 684 |
| 0.125 | ... | ... | ... | ... | ... | 508 | 684 |
| 0.160 | ... | ... | ... | ... | ... | ... | 684 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Rivet shear strength is documented in NAS1400.
d Rivet shear strength was documented in NAS1740 prior to Revision (1), dated January 15, 1974.
e Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.1.2(f). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy (2219) Rivets in Aluminum Alloy Sheet**

| Rivet Type | CR 2A63[a] ($F_{su}$ = 36 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T81 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in. | | | |
| 0.025 | 256 | ... | ... |
| 0.032 | 295 | 404 | ... |
| 0.040 | 340 | 458 | 592 |
| 0.050 | 395 | 527 | 675 |
| 0.063 | 467 | 617 | 783 |
| 0.071 | 478 | 672 | 848 |
| 0.080 | ... | 734 | 922 |
| 0.090 | ... | 741 | 1005 |
| 0.100 | ... | ... | 1063 |
| Rivet shear strength[b] | 478 | 741 | 1063 |
| | Yield Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.025 | 256 | ... | ... |
| 0.032 | 295 | 404 | ... |
| 0.040 | 336 | 458 | 592 |
| 0.050 | 383 | 521 | 675 |
| 0.063 | 440 | 598 | 770 |
| 0.071 | 445 | 646 | 827 |
| 0.080 | ... | 683 | 890 |
| 0.090 | ... | 690 | 963 |
| 0.100 | ... | ... | 984 |

a Data supplied by Cherry Fasteners.

b Shear strength values based on indicated nominal hole diameters and $F_{su}$ = 36 ksi.

c Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.1.2(g). Static Joint Strength of Blind Protruding Head Locked Spindle A-286 Rivets in Aluminum Alloy Sheet**

| Rivet Type | CR4623[a] ($F_{su}$ = 75 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.020 | 237 | ... | ... | ... |
| 0.025 | 298 | 367 | ... | ... |
| 0.032 | 385 | 478 | 566 | ... |
| 0.040 | 486 | 601 | 714 | 939 |
| 0.050 | 610 | 757 | 902 | 1185 |
| 0.063 | 772 | 958 | 1145 | 1505 |
| 0.071 | 856 | 1080 | 1290 | 1705 |
| 0.080 | 903 | 1220 | 1455 | 1925 |
| 0.090 | 956 | 1340 | 1645 | 2175 |
| 0.100 | 995 | 1405 | 1830 | 2425 |
| 0.125 | ... | 1545 | 2055 | 3035 |
| 0.160 | ... | ... | 2215 | 3570 |
| 0.190 | ... | ... | ... | 3885 |
| 0.250 | ... | ... | ... | 3920 |
| Rivet shear strength[c] | 995 | 1545 | 2215 | 3920 |
| Sheet thickness, in.: | Yield Strength[d], lbs. | | | |
| 0.020 | 237 | ... | ... | ... |
| 0.025 | 296 | 367 | ... | ... |
| 0.032 | 381 | 475 | 565 | ... |
| 0.040 | 478 | 594 | 709 | 938 |
| 0.050 | 596 | 745 | 890 | 1180 |
| 0.063 | 690 | 932 | 1125 | 1490 |
| 0.071 | 747 | 1005 | 1270 | 1680 |
| 0.080 | 812 | 1085 | 1385 | 1895 |
| 0.090 | 857 | 1175 | 1495 | 2140 |
| 0.100 | 879 | 1265 | 1600 | 2360 |
| 0.125 | ... | 1365 | 1870 | 2715 |
| 0.160 | ... | ... | 1995 | 3215 |
| 0.190 | ... | ... | ... | 3425 |
| 0.250 | ... | ... | ... | 3690 |

a Data supplied by Cherry Fasteners.
b Allowable loads developed from test with hole diameters as listed.
c Fastener shear strength based on nominal hole diameters and $F_{su}$ = 75 ksi from data analysis.
d Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.1.2(h). Static Joint Strength of Blind Protruding Head Locked Spindle Monel Rivets in Aluminum Alloy Sheet**

| Rivet Type | CR 4523[a] ($F_{su}$ = 65 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter, in<br>(Nominal Hole Diameter, in.)[b] | 1/8<br>(0.130) | 5/32<br>(0.162) | 3/16<br>(0.194) | 1/4<br>(0.258) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.020 | 221 | ... | ... | ... |
| 0.025 | 284 | 344 | ... | ... |
| 0.032 | 373 | 456 | 533 | ... |
| 0.040 | 475 | 582 | 684 | 878 |
| 0.050 | 602 | 740 | 875 | 1130 |
| 0.063 | 701 | 945 | 1120 | 1455 |
| 0.071 | 729 | 1055 | 1270 | 1655 |
| 0.080 | 760 | 1095 | 1440 | 1885 |
| 0.090 | 796 | 1140 | 1540 | 2135 |
| 0.100 | 831 | 1180 | 1590 | 2390 |
| 0.125 | 863 | 1290 | 1725 | 2760 |
| 0.160 | ... | 1340 | 1905 | 3005 |
| 0.190 | ... | ... | 1920 | 3215 |
| 0.250 | ... | ... | ... | 3400 |
| Rivet shear strength[c] | 863 | 1340 | 1920 | 3400 |
| Sheet thickness, in.: | Yield Strength[d], lbs. | | | |
| 0.020 | 221 | ... | ... | ... |
| 0.025 | 279 | 344 | ... | ... |
| 0.032 | 360 | 447 | 530 | ... |
| 0.040 | 453 | 561 | 667 | 878 |
| 0.050 | 569 | 706 | 841 | 1110 |
| 0.063 | 659 | 893 | 1065 | 1405 |
| 0.071 | 707 | 965 | 1205 | 1590 |
| 0.080 | 729 | 1035 | 1340 | 1795 |
| 0.090 | 752 | 1105 | 1430 | 2030 |
| 0.100 | 776 | 1135 | 1520 | 2260 |
| 0.125 | 834 | 1205 | 1645 | 2590 |
| 0.160 | ... | 1305 | 1765 | 2880 |
| 0.190 | ... | ... | 1870 | 3015 |
| 0.250 | ... | ... | ... | 3290 |

a Data supplied by Cherry Fasteners.
b Allowable loads developed from test with hole diameters as listed.
c Fastener shear strength based on nominal hole diameters and $F_{su}$ = 65 ksi from data analysis.
d Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.1.2(i). *Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy (7050) Rivets in Aluminum Alloy Sheet***

| Rivet Type | NAS 1720KE and NAS 1720KE( )L[a,b] ($F_{su}$ = 33 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[c] | (0.130) | (0.162) | (0.194) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | |
| 0.020 | 174 | ... | ... |
| 0.025 | 219 | 272 | ... |
| 0.032 | 282 | 350 | 417 |
| 0.040 | 354 | 440 | 525 |
| 0.050 | 376 | 552 | 659 |
| 0.063 | 392 | 585 | 816 |
| 0.071 | 402 | 597 | 831 |
| 0.080 | 413 | 611 | 847 |
| 0.090 | 425 | 626 | 866 |
| 0.100 | 437 | 641 | 884 |
| 0.125 | 450 | 680 | 929 |
| 0.160 | ... | 700 | 950 |
| Rivet shear strength[d] | 450 | 700 | 950 |
| Sheet thickness, in.: | Yield Strength[e], lbs. | | |
| 0.020 | 174 | ... | ... |
| 0.025 | 215 | 272 | ... |
| 0.032 | 261 | 340 | 417 |
| 0.040 | 314 | 406 | 504 |
| 0.050 | 366 | 489 | 603 |
| 0.063 | 382 | 570 | 732 |
| 0.071 | 391 | 582 | 809 |
| 0.080 | 402 | 595 | 825 |
| 0.090 | 414 | 610 | 843 |
| 0.100 | 426 | 625 | 861 |
| 0.125 | 450 | 662 | 905 |
| 0.160 | ... | 700 | 950 |

a Data supplied by Avdel Corp.
b Fasteners should not be used for structural applications where the t/D is less than 0.15.
c Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +0.0005, -0.0000 inch.
d Rivet shear strength is documented in NAS 1722.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(j). Static Joint Strength of Blind Protruding Head Locked Spindle A-286 Rivets in Aluminum Alloy Sheet**

| Rivet Type | NAS1720C and NAS1720C( )L[a,b] ($F_{su}$ = 75 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[c] | (0.130) | (0.162) | (0.194) |
| Sheet thickness, in: | Ultimate Strength, lbs. | | |
| 0.025 | 329 | ... | ... |
| 0.032 | 399 | 528 | ... |
| 0.040 | 499 | 621 | 799 |
| 0.050 | 625 | 778 | 930 |
| 0.063 | 789 | 982 | 1170 |
| 0.071 | 847 | 1105 | 1320 |
| 0.080 | 870 | 1245 | 1490 |
| 0.090 | 896 | 1320 | 1680 |
| 0.100 | 921 | 1350 | 1865 |
| 0.125 | 985 | 1430 | 1955 |
| 0.160 | 1000 | 1500 | 2090 |
| 0.190 | ... | ... | 2200 |
| Rivet shear strength[d] | 1000 | 1500 | 2200 |
| Sheet thickness, in.: | Yield Strength[e], lbs. | | |
| 0.025 | 329 | ... | ... |
| 0.032 | 390 | 386 | ... |
| 0.040 | 453 | 607 | 779 |
| 0.050 | 531 | 704 | 895 |
| 0.063 | 632 | 831 | 1045 |
| 0.071 | 687 | 909 | 1140 |
| 0.080 | 701 | 996 | 1245 |
| 0.090 | 717 | 1070 | 1360 |
| 0.100 | 733 | 1090 | 1475 |
| 0.125 | 773 | 1140 | 1575 |
| 0.160 | 829 | 1210 | 1655 |
| 0.190 | ... | ... | 1730 |

a Data supplied by Avdel Corp.
b Fasteners should not be used for structural applications where the t/D is less than 0.15.
c Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, ±.0001 inch.
d Rivet shear strength is documented in NAS1722.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(k). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | AF3243 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in.<br>(Nominal Hole Diameter, in.)[b] | 1/8<br>(0.144) | 5/32<br>(0.178) | 3/16<br>(0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 242 | --- | --- |
| 0.032 | 302 | 382 | 453 |
| 0.040 | 371 | 467 | 551 |
| 0.050 | 456 | 572 | 674 |
| 0.063 | 538 | 710 | 834 |
| 0.071 | 556 | 795 | 932 |
| 0.080 | 577 | 828 | 1040 |
| 0.090 | 600 | 856 | 1110 |
| 0.100 | 622 | 885 | 1140 |
| 0.125 | 679 | 955 | 1225 |
| 0.160 | 759 | --- | 1335 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

| Rivet shear strength[c] | 814 | 1245 | 1685 |
|---|---|---|---|
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.025 | 242 | --- | --- |
| 0.032 | 302 | 382 | 453 |
| 0.040 | 371 | 467 | 551 |
| 0.050 | 456 | 572 | 674 |
| 0.063 | 538 | 710 | 834 |
| 0.071 | 556 | 795 | 932 |
| 0.080 | 577 | 828 | 1040 |
| 0.090 | 600 | 856 | 1110 |
| 0.100 | 622 | 885 | 1140 |
| 0.125 | 679 | 955 | 1225 |
| 0.160 | 759 | --- | 1335 |

a Data supplied by Allfast Fastening Systems Inc.
b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.
c Rivet shear strength is documented on AF3243 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(l). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | HC3213 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.020 | 225 | --- | --- |
| 0.025 | 265 | 351 | --- |
| 0.032 | 320 | 419 | 527 |
| 0.040 | 383 | 498 | 621 |
| 0.050 | 461 | 596 | 738 |
| 0.063 | 538 | 723 | 891 |
| 0.071 | 558 | 801 | 985 |
| 0.080 | 581 | 840 | 1090 |
| 0.090 | 607 | 872 | 1180 |
| 0.100 | 632 | 904 | 1220 |
| 0.125 | 664 | 983 | 1315 |
| 0.160 | --- | 1030 | 1445 |
| 0.190 | --- | --- | 1480 |
| Rivet shear strength[c] | 664 | 1030 | 1480 |
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.020 | 182 | --- | --- |
| 0.025 | 222 | 284 | --- |
| 0.032 | 278 | 354 | 431 |
| 0.040 | 343 | 434 | 527 |
| 0.050 | 423 | 534 | 647 |
| 0.063 | 436 | 658 | 803 |
| 0.071 | 444 | 668 | 898 |
| 0.080 | 453 | 679 | 951 |
| 0.090 | 463 | 691 | 965 |
| 0.100 | 473 | 704 | 980 |
| 0.125 | 497 | 734 | 1015 |
| 0.160 | --- | 777 | 1065 |
| 0.190 | --- | --- | 1110 |

a Data supplied by Huck International Inc.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c Rivet shear strength is documented on HC3213 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(m). Static Joint Strength of Protruding Head Locked Spindle Aluminum Alloy Blind Rivets in Aluminum Alloy Sheet**

| Rivet Type | HC6223[a] ($F_{su}$ = 50 ksi) Nominal | | |
|---|---|---|---|
| Sheet and Plate Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.016 | ... | ... | ... |
| 0.020 | ... | ... | ... |
| 0.025 | 272 | ... | ... |
| 0.032 | 367 | 437 | ... |
| 0.040 | 427 | 573 | 661 |
| 0.050 | 476 | 664 | 864 |
| 0.063 | 539 | 743 | 975 |
| 0.071 | 578 | 792 | 1033 |
| 0.080 | 622 | 846 | 1099 |
| 0.090 | 664 | 907 | 1171 |
| 0.100 | ... | 967 | 1244 |
| 0.125 | ... | 1030 | 1425 |
| 0.160 | ... | ... | 1480 |
| 0.190 | ... | ... | ... |
| Rivet shear strength[b] | 664 | 1030 | 1480 |
| | Yield Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.016 | ... | ... | ... |
| 0.020 | ... | ... | ... |
| 0.025 | 255 | ... | ... |
| 0.032 | 320 | 406 | ... |
| 0.040 | 394 | 498 | 605 |
| 0.050 | 417 | 613 | 743 |
| 0.063 | 437 | 648 | 901 |
| 0.071 | 449 | 664 | 920 |
| 0.080 | 463 | 681 | 940 |
| 0.090 | 478 | 700 | 963 |
| 0.100 | ... | 720 | 986 |
| 0.125 | ... | 768 | 1044 |
| 0.160 | ... | ... | 1125 |
| 0.190 | ... | ... | ... |

a Data supplied by Huck International, Inc.
b Rivet shear strength is documented in MIL-R-7885D.
c Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.1.2(n). Static Joint Strength of Protruding Head Locked Spindle Aluminum Alloy Blind Rivets in Aluminum Alloy Sheet**

| Rivet Type | HC6253[a] ($F_{su}$ = 50 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.144) | (0.178) | (0.207) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.016 | ... | ... | ... |
| 0.020 | ... | ... | ... |
| 0.025 | ... | ... | ... |
| 0.032 | 344 | 419 | ... |
| 0.040 | 436 | 532 | 613 |
| 0.050 | 513 | 674 | 777 |
| 0.063 | 559 | 789 | 992 |
| 0.071 | 588 | 824 | 1055 |
| 0.080 | 620 | 864 | 1101 |
| 0.090 | 656 | 908 | 1152 |
| 0.100 | 691 | 952 | 1204 |
| 0.125 | 781 | 1063 | 1332 |
| 0.160 | 814 | 1217 | 1512 |
| 0.190 | ... | 1245 | 1666 |
| 0.250 | ... | ... | 1685 |
| Rivet shear strength[b] | 814 | 1245 | 1685 |
| | Yield Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.016 | ... | ... | ... |
| 0.020 | ... | ... | ... |
| 0.025 | ... | ... | ... |
| 0.032 | 344[d] | 419[d] | ... |
| 0.040 | 403 | 532[d] | 613[d] |
| 0.050 | 462 | 619 | 731 |
| 0.063 | 523 | 715 | 879 |
| 0.071 | 541 | 774 | 948 |
| 0.080 | 560 | 805 | 1025 |
| 0.090 | 583 | 832 | 1079 |
| 0.100 | 605 | 859 | 1110 |
| 0.125 | 660 | 928 | 1190 |
| 0.160 | 738 | 1024 | 1302 |
| 0.190 | ... | 1245 | 1397 |
| 0.250 | ... | ... | 1588 |

a Data supplied by Huck International, Inc.
b Rivet shear strength is documented in MIL-R-7885D.
c Permanent set at yield load: 4% of nominal hole diameter.
d Calculated yield reduced to match ultimate strength.

**Table 8.1.3.1.2(o). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | AF3213 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.020 | 223 | --- | --- |
| 0.025 | 262 | 347 | --- |
| 0.032 | 317 | 416 | 522 |
| 0.040 | 380 | 494 | 616 |
| 0.050 | 411 | 592 | 733 |
| 0.063 | 441 | 640 | 875 |
| 0.071 | 459 | 663 | 902 |
| 0.080 | 480 | 689 | 933 |
| 0.090 | 503 | 717 | 968 |
| 0.100 | 526 | 746 | 1000 |
| 0.125 | 583 | 818 | 1085 |
| 0.160 | --- | 918 | 1205 |
| 0.190 | --- | --- | 1310 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

| Rivet shear strength[c] | 664 | 1030 | 1480 |
|---|---|---|---|
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.020 | 223 | --- | --- |
| 0.025 | 262 | 347 | --- |
| 0.032 | 317 | 416 | 522 |
| 0.040 | 362 | 494 | 616 |
| 0.050 | 378 | 562 | 733 |
| 0.063 | 398 | 588 | 814 |
| 0.071 | 411 | 604 | 833 |
| 0.080 | 425 | 622 | 854 |
| 0.090 | 441 | 641 | 878 |
| 0.100 | 457 | 661 | 901 |
| 0.125 | 496 | 710 | 960 |
| 0.160 | --- | 779 | 1040 |
| 0.190 | --- | --- | 1110 |

a Data supplied by Allfast Fastening Systems Inc.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c Rivet shear strength is documented on AF3213 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(p). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | CR3213 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.020 | 250 | --- | --- |
| 0.025 | 280 | 389 | --- |
| 0.032 | 322 | 441 | 576 |
| 0.040 | 370 | 501 | 648 |
| 0.050 | 430 | 576 | 737 |
| 0.063 | 492 | 673 | 853 |
| 0.071 | 513 | 733 | 925 |
| 0.080 | 536 | 769 | 1005 |
| 0.090 | 562 | 801 | 1080 |
| 0.100 | 587 | 833 | 1115 |
| 0.125 | 652 | 913 | 1215 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

| Rivet shear strength[c] | 664 | 1030 | 1480 |
|---|---|---|---|
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.020 | 214 | --- | --- |
| 0.025 | 238 | 332 | --- |
| 0.032 | 272 | 375 | 491 |
| 0.040 | 298 | 424 | 550 |
| 0.050 | 315 | 463 | 623 |
| 0.063 | 338 | 491 | 672 |
| 0.071 | 351 | 508 | 692 |
| 0.080 | 367 | 527 | 716 |
| 0.090 | 384 | 549 | 741 |
| 0.100 | 401 | 570 | 767 |
| 0.125 | 445 | 624 | 831 |

a Data supplied by Textron Aerospace Fasteners.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c Rivet shear strength is documented on CR3213 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(q). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | CR3243 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 317 | --- | --- |
| 0.032 | 366 | 494 | 617 |
| 0.040 | 421 | 562 | 696 |
| 0.050 | 489 | 647 | 795 |
| 0.063 | 579 | 758 | 924 |
| 0.071 | 623 | 826 | 1000 |
| 0.080 | 640 | 902 | 1090 |
| 0.090 | 660 | 957 | 1190 |
| 0.100 | 679 | 981 | 1280 |
| 0.125 | 728 | 1040 | 1350 |
| **THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.** | | | |
| Rivet shear strength[c] | 814 | 1245 | 1685 |
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.025 | 272 | --- | --- |
| 0.032 | 317 | 425 | 527 |
| 0.040 | 368 | 488 | 600 |
| 0.050 | 432 | 567 | 692 |
| 0.063 | 451 | 664 | 811 |
| 0.071 | 462 | 677 | 884 |
| 0.080 | 475 | 693 | 911 |
| 0.090 | 489 | 710 | 931 |
| 0.100 | 503 | 728 | 951 |
| 0.125 | 538 | 771 | 1000 |

a Data supplied by Textron Aerospace Fasteners.
b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.
c Rivet shear strength is documented on CR3243 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(r). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | HC3243 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 252 | --- | --- |
| 0.032 | 312 | 397 | 473 |
| 0.040 | 380 | 481 | 571 |
| 0.050 | 465 | 586 | 693 |
| 0.063 | 546 | 723 | 852 |
| 0.071 | 576 | 803 | 950 |
| 0.080 | 610 | 844 | 1060 |
| 0.090 | 647 | 891 | 1125 |
| 0.100 | 685 | 937 | 1175 |
| 0.125 | 779 | 1050 | 1310 |
| 0.160 | 814 | 1215 | 1500 |
| 0.190 | --- | 1245 | 1665 |
| 0.250 | --- | --- | 1685 |
| Rivet shear strength[c] | 814 | 1245 | 1685 |
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.025 | 252 | --- | --- |
| 0.032 | 312 | 397 | 473 |
| 0.040 | 371 | 481 | 571 |
| 0.050 | 401 | 569 | 693 |
| 0.063 | 440 | 617 | 790 |
| 0.071 | 464 | 646 | 824 |
| 0.080 | 491 | 680 | 863 |
| 0.090 | 521 | 717 | 906 |
| 0.100 | 551 | 754 | 949 |
| 0.125 | 626 | 846 | 1055 |
| 0.160 | 730 | 976 | 1205 |
| 0.190 | --- | 1085 | 1335 |
| 0.250 | --- | --- | 1595 |

a Data supplied by Huck International Inc.
b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.
c Rivet shear strength is documented on HC3243 standards drawing.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(s). Static Joint Strength of Blind Protruding Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | AF3223 ($F_{su}$ = 50 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 272 | ... | ... |
| 0.032 | 331 | 431 | ... |
| 0.040 | 390 | 516 | 640 |
| 0.050 | 421 | 606 | 767 |
| 0.063 | 461 | 656 | 883 |
| 0.071 | 486 | 687 | 920 |
| 0.080 | 514 | 722 | 962 |
| 0.090 | 545 | 760 | 1005 |
| 0.100 | 576 | 799 | 1050 |
| 0.125 | 653 | 896 | 1170 |
| 0.160 | 664 | 1030 | 1330 |
| 0.190 | ... | ... | 1460 |
| Rivet shear strength[c] | 664 | 1030 | 1460 |
| | Yield Strength[d], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 243 | ... | ... |
| 0.032 | 312 | 387 | ... |
| 0.040 | 390 | 485 | 580 |
| 0.050 | 421 | 606 | 727 |
| 0.063 | 448 | 656 | 883 |
| 0.071 | 463 | 678 | 920 |
| 0.080 | 481 | 700 | 958 |
| 0.090 | 500 | 723 | 987 |
| 0.100 | 519 | 747 | 1015 |
| 0.125 | 566 | 806 | 1085 |
| 0.160 | 633 | 889 | 1185 |
| 0.190 | ... | ... | 1270 |

a Data supplied by Allfast Fastening Systems Inc.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c Rivet shear strength as documented in Allfast Fastening Systems Inc P-127.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.1.2(t). Static Joint Strength of Protruding Head 5056 Aluminum Alloy Rivets in Clad Aluminum Alloy Sheet**

| Rivet Type | CR3223 ($F_{su}$ = 50 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 257 | ... | ... |
| 0.032 | 316 | 408 | ... |
| 0.040 | 383 | 492 | 606 |
| 0.050 | 450 | 596 | 731 |
| 0.063 | 486 | 701 | 894 |
| 0.071 | 509 | 729 | 987 |
| 0.080 | 534 | 760 | 1025 |
| 0.090 | 562 | 795 | 1065 |
| 0.100 | 590 | 830 | 1105 |
| 0.125 | 659[c] | 917 | 1210 |
| 0.160 | 664[c] | 1030[c] | 1355[c] |
| 0.190 | ... | ... | 1480[c] |
| Rivet shear strength[d] | 664 | 1030 | 1480 |
| | Yield Strength[e], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 221 | ... | ... |
| 0.032 | 279 | 351 | ... |
| 0.040 | 321 | 434 | 525 |
| 0.050 | 333 | 498 | 649 |
| 0.063 | 350 | 519 | 720 |
| 0.071 | 360 | 531 | 736 |
| 0.080 | 371 | 545 | 752 |
| 0.090 | 384 | 561 | 771 |
| 0.100 | 396 | 577 | 790 |
| 0.125 | 428 | 616 | 837 |
| 0.160 | 472 | 671 | 903 |
| 0.190 | ... | ... | 959 |

a Data supplied by Textron Aerospace Fasteners.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.0005 inch.
c Yield value is less than 2/3 of indicated ultimate strength value.
d Rivet shear strength as documented in Textron Aerospace Fasteners PS-CMR-3000.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.1(a). Static Joint Strength of Blind 100° Flush Head A-286 Rivets in Machine-Countersunk Alloy Steel, Titanium Alloy, and A-286 Alloy Sheet**

| Rivet Type | CR 6626[a] ($F_{su}$ = 75 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Alloy Steel, $F_{tu}$ = 125 ksi, Titanium Alloy, $F_{tu}$ = 120 ksi, and A-286 Alloy, $F_{tu}$ = 140 ksi | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 582[b,c] | ... | ... | ... |
| 0.050 | 693 | 898[b,c] | ... | ... |
| 0.063 | 842 | 1082 | 1351[b,c] | ... |
| 0.071 | 891 | 1189 | 1478 | ... |
| 0.080 | 949 | 1303 | 1633 | ... |
| 0.090 | 970 | 1379 | 1798 | 2558[b,c] |
| 0.100 | ... | 1461 | 1916 | 2772 |
| 0.112 | ... | 1490 | 2026 | 3036 |
| 0.125 | ... | ... | 2150 | 3333 |
| 0.140 | ... | ... | ... | 3531 |
| 0.160 | ... | ... | ... | 3795 |
| 0.190 | ... | ... | ... | 3890 |
| Rivet shear strength[d] | 970 | 1490 | 2150 | 3890 |
| | Yield Strength[e], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 355 | ... | ... | ... |
| 0.050 | 499 | 557 | ... | ... |
| 0.063 | 681 | 784 | 858 | ... |
| 0.071 | 771 | 923 | 1031 | ... |
| 0.080 | 858 | 1082 | 1223 | ... |
| 0.090 | 920 | 1202 | 1424 | 1700 |
| 0.100 | ... | 1297 | 1643 | 1997 |
| 0.112 | ... | 1417 | 1779 | 2327 |
| 0.125 | ... | ... | 1925 | 2690 |
| 0.140 | ... | ... | ... | 3053 |
| 0.160 | ... | ... | ... | 3432 |
| 0.190 | ... | ... | ... | 3845 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Data supplied by Cherry Fasteners.

b Yield value is less than 2/3 of the indicated ultimate strength value.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 75 ksi.

e Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

## Table 8.1.3.2.1(b). Static Joint Strength of Blind 100° Flush Head Monel Rivets in Machine-Countersunk Stainless Steel

| Rivet Type | MS20601M (R.T. $F_{su}$ = 55 ksi) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | 17-7PH, TH 1050 | | | | | | | | | | | |
| Temperature | Room | | | | 500°F | | | | 700°F | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 | 1/8 | 5/32 | 3/16 | 1/4 | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) | (0.130) | (0.162) | (0.194) | (0.258) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength, lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 373[a,b] | ... | ... | ... | 373[a,b] | ... | ... | ... | 373[a,b] | ... | ... | ... |
| 0.050 | 429 | 574[a,b] | ... | ... | 429 | 574[a,b] | ... | ... | 429 | 574[a,b] | ... | ... |
| 0.063 | 495 | 664 | 866[a,b] | ... | 495 | 664 | 866[a,b] | ... | 495 | 664 | 866[a,b] | ... |
| 0.071 | 535 | 714 | 924 | ... | 535 | 714 | 924 | ... | 535 | 714 | 924 | ... |
| 0.080 | 579 | 771 | 991 | ... | 579 | 771 | 991 | ... | 574 | 771 | 991 | ... |
| 0.090 | 630 | 833 | 1065 | 1615[a,b] | 625 | 833 | 1065 | 1615[a,b] | 590 | 833 | 1065 | 1615[a,b] |
| 0.100 | ... | 896 | 1140 | 1720 | ... | 896 | 1140 | 1720 | ... | 884 | 1140 | 1720 |
| 0.125 | ... | ... | 1325 | 1970 | ... | ... | 1325 | 1970 | ... | 904 | 1290 | 1970 |
| 0.160 | ... | ... | ... | 2320 | ... | ... | ... | 2320 | ... | ... | 1305 | 2300 |
| 0.180 | ... | ... | ... | 2520 | ... | ... | ... | 2500 | ... | ... | ... | 2360 |
| Rivet shear strength[c] | 713 | 1090 | 1580 | 2855 | 648 | 993 | 1430 | 2590 | 590 | 904 | 1305 | 2360 |
| | Yield Strength[d], lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 213 | ... | ... | ... | 213 | ... | ... | ... | 213 | ... | ... | ... |
| 0.050 | 303 | 332 | ... | ... | 303 | 332 | ... | ... | 303 | 332 | ... | ... |
| 0.063 | 439 | 476 | 518 | ... | 439 | 476 | 518 | ... | 439 | 476 | 518 | ... |
| 0.071 | 528 | 569 | 621 | ... | 528 | 569 | 621 | ... | 528 | 569 | 621 | ... |
| 0.080 | 579 | 696 | 741 | ... | 579 | 696 | 741 | ... | 574 | 696 | 741 | ... |
| 0.090 | 630 | 833 | 910 | 1030 | 625 | 833 | 910 | 1030 | 590 | 833 | 910 | 1030 |
| 0.100 | ... | 896 | 1075 | 1212 | ... | 896 | 1075 | 1212 | ... | 884 | 1075 | 1212 |
| 0.125 | ... | ... | 1325 | 1731 | ... | ... | 1325 | 1731 | ... | 904 | 1290 | 1731 |
| 0.160 | ... | ... | ... | 2320 | ... | ... | ... | 2320 | ... | ... | 1305 | 2300 |
| 0.180 | ... | ... | ... | 2520 | ... | ... | ... | 2500 | ... | ... | ... | 2360 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ values at 55 ksi, 50 ksi, and 45 ksi at room temperature, 500°F and 700°F, respectively.

d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1(c). Static Joint Strength of Blind 100° Flush Head Monel Rivets in Dimpled Stainless Steel Sheet**

| Rivet Type | MS20601M ($F_{su}$ = 55 ksi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sheet Material | AISI 301-Annealed | | | | AISI 301-1/4 Hard | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs. | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.010 | 224 | ... | ... | ... | 277 | 377 | ... | ... |
| 0.012 | 254 | 338 | ... | ... | 302 | 428 | 560 | ... |
| 0.016 | 313 | 412 | 519 | ... | 358 | 485 | 632 | ... |
| 0.020 | 375 | 486 | 610 | ... | 415 | 542 | 705 | 1135 |
| 0.025 | 447 | 576 | 722 | 1045 | 482 | 642 | 808 | 1230 |
| 0.032 | 516 | 705 | 876 | 1255 | 543 | 750 | 963 | 1400 |
| 0.040 | 536 | 793 | 1055 | 1490 | 585 | 833 | 1110 | 1660 |
| 0.050 | 565 | 825 | 1150[a] | 1790 | 628 | 910 | 1240 | 1930 |
| 0.063 | ... | 868 | 1200[a] | 2065 | ... | 964 | 1330 | 2175 |
| 0.071 | ... | ... | ... | 2100 | ... | 973 | 1375 | 2275 |
| 0.080 | ... | ... | ... | 2150 | ... | ... | 1405 | 2340 |
| 0.090 | ... | ... | ... | 2200 | ... | ... | ... | 2440 |
| 0.100 | ... | ... | ... | ... | ... | ... | ... | 2510 |
| Rivet shear strength[a] | 635 | 973 | 1405 | 2540 | 635 | 973 | 1405 | 2540 |
| | Yield Strength[b], lbs. | | | | | | | |
| Sheet thickness, in.: | | | | | | | | |
| 0.010 | 188 | ... | ... | ... | 244 | 291 | ... | ... |
| 0.012 | 214 | 281 | ... | ... | 259 | 335 | 423 | ... |
| 0.016 | 270 | 352 | 438 | ... | 333 | 428 | 535 | ... |
| 0.020 | 328 | 422 | 518 | ... | 398 | 528 | 639 | 896 |
| 0.025 | 397 | 506 | 627 | 873 | 443 | 612 | 774 | 1080 |
| 0.032 | 498 | 627 | 770 | 1070 | 505 | 689 | 912 | 1330 |
| 0.040 | 536 | 772 | 939 | 1310 | 576 | 779 | 1015 | 1590 |
| 0.050 | 565 | 825 | 1150 | 1590 | 619 | 883 | 1145 | 1770 |
| 0.063 | ... | 868 | 1200 | 1970 | ... | 954 | 1305 | 2000 |
| 0.071 | ... | ... | ... | 2100 | ... | 973 | 1350 | 2140 |
| 0.080 | ... | ... | ... | 2150 | ... | ... | 1400 | 2305 |
| 0.090 | ... | ... | ... | 2200 | ... | ... | ... | 2395 |
| 0.100 | ... | ... | ... | ... | ... | ... | ... | 2475 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 |

a Rivet shear strength from Table 8.1.2(b).
b Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1($d_1$). Static Joint Strength of Blind 100° Flush Head Monel Rivets in Machine-Countersunk Stainless Steel Sheet**

| Rivet Type | MS20601M ($F_{su}$ = 55 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | AISI 301-Annealed | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 469[a,b] | ... | ... | ... |
| 0.050 | 555[a] | 721[a,b] | ... | ... |
| 0.063 | ... | 864[a] | 1075[a,b] | ... |
| 0.071 | ... | ... | 1187[a] | ... |
| 0.080 | ... | ... | ... | ... |
| 0.090 | ... | ... | ... | 2040[b] |
| Rivet shear strength[c] | 713 | 1090 | 1580 | 2855 |
| | Yield Strength[d], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 231 | ... | ... | ... |
| 0.050 | 321 | 359 | ... | ... |
| 0.063 | ... | 500 | 566 | ... |
| 0.071 | ... | ... | 678 | ... |
| 0.080 | ... | ... | ... | ... |
| 0.090 | ... | ... | ... | 1135 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi.

d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

## Table 8.1.3.2.1($d_2$). Static Joint Strength of Blind 100° Flush Head Monel Rivets in Machine-Countersunk Stainless Steel Sheet

| Rivet Type | MS20601M (R.T. $F_{su}$ = 55 ksi) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | AISI 301-¼ Hard | | | | | | | | | | | |
| Temperature | Room | | | | 500°F | | | | 700°F | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 373[a,b] | ... | ... | ... | 373[a,b] | ... | ... | ... | 373[a,b] | ... | ... | ... |
| 0.050 | 450 | 574[a,b] | ... | ... | 450[a] | 574[a,b] | ... | ... | 450[a] | 574[a,b] | ... | ... |
| 0.063 | 538 | 704 | 866[a,b] | ... | 538 | 704[a] | 866[a,b] | ... | 538 | 704[a] | 866[a,b] | ... |
| 0.071 | 584 | 773 | 960 | ... | 584 | 773 | 960[a] | ... | 584 | 773 | 960[a] | ... |
| 0.080 | 637 | 838 | 1065 | ... | 637 | 838 | 1065[a] | ... | 590 | 838 | 1065[a] | ... |
| 0.090 | 695 | 910 | 1155 | 1645[b] | 648 | 910 | 1155 | 1645[a,b] | ... | 904 | 1155 | 1645[a,b] |
| 0.100 | 713 | 984 | 1240 | 1800 | ... | 984 | 1240 | 1800[a] | ... | ... | 1240 | 1800[a] |
| 0.125 | ... | 1090 | 1460 | 2135 | ... | 993 | 1430 | 2135 | ... | ... | 1305 | 2135 |
| 0.160 | ... | ... | 1580 | 2550 | ... | ... | ... | 2550 | ... | ... | ... | 2360 |
| 0.180 | ... | ... | ... | 2780 | ... | ... | ... | 2590 | ... | ... | ... | ... |
| Rivet shear strength[c] | 713 | 1090 | 1580 | 2855 | 648 | 993 | 1430 | 2590 | 590 | 904 | 1305 | 2360 |
| | Yield Strength[d], lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 231 | ... | ... | ... | 192 | ... | ... | ... | 192 | ... | ... | ... |
| 0.050 | 336 | 359 | ... | ... | 279 | 298 | ... | ... | 279 | 298 | ... | ... |
| 0.063 | 459 | 531 | 566 | ... | 425 | 440 | 471 | ... | 425 | 440 | 471 | ... |
| 0.071 | 530 | 625 | 698 | ... | 525 | 546 | 576 | ... | 525 | 546 | 576 | ... |
| 0.080 | 607 | 725 | 835 | ... | 607 | 683 | 690 | ... | 590 | 683 | 690 | ... |
| 0.090 | 693 | 832 | 966 | 1135 | 648 | 832 | 872 | 945 | ... | 832 | 872 | 945 |
| 0.100 | 713 | 943 | 1095 | 1345 | ... | 943 | 1060 | 1115 | ... | ... | 1060 | 1115 |
| 0.125 | ... | 1090 | 1420 | 1815 | ... | 993 | 1420 | 1670 | ... | ... | 1305 | 1670 |
| 0.160 | ... | ... | 1580 | 2430 | ... | ... | ... | 2430 | ... | ... | ... | 2360 |
| 0.180 | ... | ... | ... | 2775 | ... | ... | ... | 2590 | ... | ... | ... | ... |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.
b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
c Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi at R.T., $F_{tu}$ = 50 ksi at 500°F, and $F_{su}$ = 45 ksi at 700°F.
d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1($d_3$). Static Joint Strength of Blind 100° Flush Head Monel Rivets in Machine-Countersunk Stainless Steel Sheet**

| Rivet Type | MS20601M (R.T. $F_{su}$ = 55 ksi) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheet Material | AISI 301-½ Hard | | | | | | | | | | | |
| Temperature | Room | | | | 500°F | | | | 700°F | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 350[a,b] | ... | ... | ... | 350[a,b] | ... | ... | ... | 350[a,b] | ... | ... | ... |
| 0.050 | 444 | 540[a,b] | ... | ... | 444 | 540[a,b] | ... | ... | 444 | 540[a,b] | ... | ... |
| 0.063 | 538 | 694 | 821[b] | ... | 538 | 694 | 821[b] | ... | 538 | 694 | 821[b] | ... |
| 0.071 | 584 | 773 | 935 | ... | 584 | 773 | 935 | ... | 575 | 773 | 935 | ... |
| 0.080 | 637 | 838 | 1065 | ... | 624 | 838 | 1065 | ... | 586 | 838 | 1065 | ... |
| 0.090 | 695 | 910 | 1155 | 1585[b] | 648 | 910 | 1155 | 1585[b] | 590 | 886 | 1155 | 1585[b] |
| 0.100 | 713 | 984 | 1240 | 1780 | ... | 962 | 1240 | 1780 | ... | 904 | 1240 | 1780 |
| 0.125 | ... | 1090 | 1460 | 2135 | ... | 993 | 1410 | 2135 | ... | ... | 1305 | 2135 |
| 0.160 | ... | ... | 1580 | 2550 | ... | ... | 1430 | 2500 | ... | ... | ... | 2345 |
| 0.180 | ... | ... | ... | 2780 | ... | ... | ... | 2590 | ... | ... | ... | 2360 |
| Rivet shear strength[c] | 713 | 1090 | 1580 | 2855 | 648 | 993 | 1430 | 2590 | 590 | 904 | 1305 | 2360 |
| | Yield Strength[d], lbs | | | | | | | | | | | |
| Sheet thickness, in.: | | | | | | | | | | | | |
| 0.040 | 231 | ... | ... | ... | 231 | ... | ... | ... | 231 | ... | ... | ... |
| 0.050 | 336 | 359 | ... | ... | 336 | 359 | ... | ... | 336 | 359 | ... | ... |
| 0.063 | 459 | 531 | 566 | ... | 459 | 531 | 566 | ... | 459 | 531 | 566 | ... |
| 0.071 | 530 | 625 | 698 | ... | 530 | 625 | 698 | ... | 530 | 625 | 698 | ... |
| 0.080 | 607 | 725 | 835 | ... | 607 | 725 | 835 | ... | 586 | 725 | 835 | ... |
| 0.090 | 693 | 832 | 966 | 1135 | 648 | 832 | 966 | 1135 | 590 | 832 | 966 | 1135 |
| 0.100 | 713 | 943 | 1095 | 1345 | ... | 943 | 1095 | 1345 | ... | 904 | 1095 | 1345 |
| 0.125 | ... | 1090 | 1420 | 1815 | ... | 993 | 1410 | 1815 | ... | ... | 1305 | 1815 |
| 0.160 | ... | ... | 1580 | 2430 | ... | ... | 1430 | 2430 | ... | ... | ... | 2345 |
| 0.180 | ... | ... | ... | 2775 | ... | ... | ... | 2590 | ... | ... | ... | 2360 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.
b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
c Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi at R.T., $F_{su}$ = 50 ksi at 500°F, and $F_{su}$ = 45 ksi at 700°F.
d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1(e). Static Joint Strength of Blind 100° Flush-Head Monel Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS20601M ($F_{su}$ = 55 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | 7075-T6 | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 320[a,b] | ... | ... | ... |
| 0.050 | 393 | 494[a,b] | ... | ... |
| 0.063 | 487 | 612[a] | 747[a,b] | ... |
| 0.071 | 545 | 684 | 832[a] | ... |
| 0.080 | 565 | 766 | 930[a] | ... |
| 0.090 | 587 | 840 | 1040 | 1425[a,b] |
| 0.100 | 610 | 867 | 1150 | 1570[a] |
| 0.125 | ... | 937 | 1270 | 1940 |
| 0.160 | ... | ... | 1385 | 2260 |
| 0.190 | ... | ... | ... | 2390 |
| Rivet shear strength[c] | 713 | 1090 | 1580 | 2855 |
| | Yield Strength[d], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 146 | ... | ... | ... |
| 0.050 | 228 | 226 | ... | ... |
| 0.063 | 395 | 369 | 343 | ... |
| 0.071 | 496 | 495 | 444 | ... |
| 0.080 | 526 | 640 | 615 | ... |
| 0.090 | 561 | 769 | 806 | 660 |
| 0.100 | 595 | 811 | 1000 | 912 |
| 0.125 | ... | 918 | 1195 | 1560 |
| 0.160 | ... | ... | 1375 | 2105 |
| 0.190 | ... | ... | ... | 2310 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Yield value is less than 2/3 of the indicated ultimate strength value.
b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
c Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 55 ksi.
d Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1(f). Static Joint Strength of Blind 100° Flush Head Aluminum Alloy (2117-T3) Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | MS20601AD and MS20603AD ($F_{su}$ = 30 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) | (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 159[a] | ... | ... | ... |
| 0.050 | 236 | 258[a] | ... | ... |
| 0.063 | 327 | 369 | 398[a] | ... |
| 0.071 | 360 | 439 | 485 | ... |
| 0.080 | 388 | 511 | 577 | ... |
| 0.090 | ... | 561 | 684 | 795[a] |
| 0.100 | ... | 596 | 768 | 945 |
| 0.125 | ... | ... | 862 | 1270 |
| Rivet shear strength[b] | 388 | 596 | 862 | 1550 |
| | Yield Strength[c], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 110 | ... | ... | ... |
| 0.050 | 198 | 185 | ... | ... |
| 0.063 | 300 | 308 | 296 | ... |
| 0.071 | 336 | 384 | 391 | ... |
| 0.080 | 377 | 468 | 497 | ... |
| 0.090 | ... | 524 | 614 | 621 |
| 0.100 | ... | 592 | 709 | 793 |
| 0.125 | ... | ... | 862 | 1150 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

b Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 30 ksi.

c Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.1(g). Static Joint Strength of Blind 100° Flush Head Aluminum Alloy (5056-H321) Rivets in Machine-Countersunk Magnesium Alloy Sheet**

| Rivet Type | MS20601B ($F_{su}$ = 28 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | AZ31B-H24 | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 167[a] | ... | ... | ... |
| 0.050 | 208 | 257[a] | ... | ... |
| 0.063 | 262 | 324 | 390[a] | ... |
| 0.071 | 295 | 366 | 440 | ... |
| 0.080 | 333 | 413 | 495 | ... |
| 0.090 | 363 | 464 | 557 | 749[a] |
| 0.100 | ... | 516 | 620 | 833 |
| 0.125 | ... | 556 | 774 | 1040 |
| 0.160 | ... | ... | 802 | 1332 |
| 0.190 | ... | ... | ... | 1450 |
| Rivet shear strength[b] | 363 | 556 | 802 | 1450 |
| | Yield Strength[c], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 158 | ... | ... | ... |
| 0.050 | 197 | 244 | ... | ... |
| 0.063 | 248 | 308 | 370 | ... |
| 0.071 | 279 | 346 | 417 | ... |
| 0.080 | 315 | 391 | 469 | ... |
| 0.090 | 354 | 440 | 527 | 710 |
| 0.100 | ... | 489 | 587 | 789 |
| 0.125 | ... | 556 | 734 | 986 |
| 0.160 | ... | ... | 802 | 1262 |
| 0.190 | ... | ... | ... | 1450 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

b Rivet shear strength based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 28 ksi.

c Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.2(a). Static Joint Strength of Blind 100° Flush Head Locked Spindle A-286 Rivets in Machine-Countersunk Alloy Steel Sheet**

| Rivet Type | NAS1399C[a] ($F_{su}$ = 75 ksi) | | | CR 2642[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|---|---|---|
| Sheet Material | Alloy Steel, $F_{tu}$ = 180 ksi | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.040 | 380[b,c] | ... | ... | 380[b,c] | ... | ... |
| 0.050 | 475[b] | 588[b,c] | ... | 475 | 588[b,c] | ... |
| 0.063 | 698 | 741[b] | 890[b,c] | 698 | 741 | 890[b,c] |
| 0.071 | 840 | 908 | 1004[b] | 840 | 908 | 1004[b] |
| 0.080 | 970 | 1108 | 1171[b] | 1002 | 1108 | 1171 |
| 0.090 | ... | 1333 | 1438 | 1185 | 1333 | 1438 |
| 0.100 | ... | 1490 | 1710 | 1230 | 1559 | 1710 |
| 0.125 | ... | ... | 2150 | ... | 1885 | 2380 |
| 0.160 | ... | ... | ... | ... | ... | 2720 |
| Rivet shear strength | 970[d] | 1490[d] | 2150[d] | 1230[e] | 1885[e] | 2720[e] |
| | Yield Strength[f], lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.040 | 137 | ... | ... | 180 | ... | ... |
| 0.050 | 292 | 219 | ... | 320 | 278 | ... |
| 0.063 | 494 | 468 | 387 | 536 | 513 | 432 |
| 0.071 | 614 | 620 | 570 | 665 | 675 | 628 |
| 0.080 | 755 | 793 | 776 | 816 | 860 | 847 |
| 0.090 | ... | 983 | 1003 | 981 | 1063 | 1090 |
| 0.100 | ... | 1176 | 1236 | 1144 | 1267 | 1337 |
| 0.125 | ... | ... | 1809 | ... | 1777 | 1950 |
| 0.160 | ... | ... | ... | ... | ... | 2720 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.042 | 0.055 | 0.070 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength is documented in NAS1400.
e Shear strength is based on areas computed from nominal hole diameters in Table 8.1.2(a) and $F_{su}$ = 95 ksi.
f Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.2(b). Static Joint Strength of Blind 100° Flush Head Locked Spindle Monel Rivets in Machine-Countersunk Stainless Steel Sheet**

| Rivet Type | NAS1399 MS or MW[a] ($F_{su}$ = 55 ksi) | | |
|---|---|---|---|
| Sheet Material | AISI 301-1/2 Hard | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 287[b,c] | ... | ... |
| 0.050 | 363 | 445[b,c] | ... |
| 0.063 | 491 | 569 | 671[b,c] |
| 0.071 | 569 | 668 | 755[b] |
| 0.080 | 657 | 776 | 886 |
| 0.090 | 710 | 898 | 1032 |
| 0.100 | ... | 1019 | 1182 |
| 0.125 | ... | 1090 | 1580 |
| Rivet shear strength[d] | 710 | 1090 | 1580 |
| | Yield Strength[e], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 163 | ... | ... |
| 0.050 | 243 | 253 | ... |
| 0.063 | 348 | 384 | 401 |
| 0.071 | 413 | 463 | 496 |
| 0.080 | 487 | 554 | 606 |
| 0.090 | 568 | 655 | 726 |
| 0.100 | ... | 753 | 846 |
| 0.125 | ... | 1004 | 1156 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength is documented in NAS1400.
e Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.2(c). Static Joint Strength of 100° Flush Head Locked Spindle A-286 Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1921C[a] ($F_{su}$ = 80 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in. | | | |
| 0.050 | 612[b] | ... | ... |
| 0.063 | 749[b] | 956[b] | ... |
| 0.071 | 831[b] | 1060[b] | ... |
| 0.080 | 923[b] | 1180[b] | 1450[b] |
| 0.090 | 1110[b] | 1305[b] | 1605[b] |
| 0.100 | 1090[b] | 1435[b] | 1755[b] |
| 0.125 | ... | 1670[b] | 2130[b] |
| 0.160 | ... | ... | 2400[b] |
| Rivet shear strength[c] | 1090 | 1670 | 2400 |
| | Yield Strength[d], lbs | | |
| Sheet thickness, in.: | | | |
| 0.050 | 365 | ... | ... |
| 0.063 | 466 | 571 | ... |
| 0.071 | 528 | 649 | ... |
| 0.080 | 598 | 737 | 873 |
| 0.090 | 639 | 835 | 990 |
| 0.100 | 686 | 931 | 1105 |
| 0.125 | 804 | 1065 | 1325 |
| 0.160 | ... | ... | 1605 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Huck Manufacturing Company.
b Yield value is less than 2/3 of indicated ultimate strength value.
c Rivet shear strength is documented in NAS1900.
d Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985 from the greater of 0.012 inch or 4% of nominal diameter).

**Table 8.1.3.2.2(d). Static Joint Strength of Blind 100° Flush Head Locked Spindle Monel Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1399 MS or MW[a] ($F_{su}$ = 55 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 323[b,c] | ... | ... |
| 0.050 | 404[b] | 499[b,c] | ... |
| 0.063 | 500[b] | 631[b] | 757[b,c] |
| 0.071 | 557 | 703[b] | 855[b] |
| 0.080 | 610 | 784 | 958[b] |
| 0.090 | 636 | 873 | 1065[b] |
| 0.100 | 662 | 937 | 1175 |
| 0.125 | 710 | 1015 | 1370 |
| 0.160 | ... | 1090 | 1505 |
| 0.190 | ... | ... | 1580 |
| Rivet shear strength[d] | 710 | 1090 | 1580 |
| | Yield Strength[e], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 139 | ... | ... |
| 0.050 | 223 | 218 | ... |
| 0.063 | 331 | 353 | 351 |
| 0.071 | 397 | 436 | 451 |
| 0.080 | 472 | 529 | 563 |
| 0.090 | 556 | 633 | 687 |
| 0.100 | 562 | 737 | 811 |
| 0.125 | 574 | 873 | 1120 |
| 0.160 | ... | 894 | 1260 |
| 0.190 | ... | ... | 1280 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength is documented in NAS1400.
e Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985, from the greater of 0.005 inch or 2.5% of nominal diameter).

**Table 8.1.3.2.2(e). Static Joint Strength of 100° Flush Head Locked Spindle Monel Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS 1921 M[a] ($F_{su}$ = 75 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in. | | | |
| 0.050 | 595[b] | ... | ... |
| 0.063 | 732[b] | 927[b] | ... |
| 0.071 | 816[b] | 1035[b] | ... |
| 0.080 | 913[b] | 1158[b] | 1400[b] |
| 0.090 | 946[b] | 1289[b] | 1570[b] |
| 0.100 | 980[b] | 1415[b] | 1720[b] |
| 0.125 | 1020 | 1525[b] | 2055[b] |
| 0.160 | ... | 1565[b] | 2245[b] |
| 0.190 | ... | ... | 2260 |
| Rivet shear strength[c] | 1020 | 1565 | 2260 |
| | Yield Strength[d], lbs | | |
| Sheet thickness, in.: | | | |
| 0.050 | 354 | ... | ... |
| 0.063 | 447 | 554 | ... |
| 0.071 | 504 | 625 | ... |
| 0.080 | 569 | 707 | 843 |
| 0.090 | 607 | 796 | 952 |
| 0.100 | 626 | 885 | 1060 |
| 0.125 | 686 | 972 | 1265 |
| 0.160 | ... | 1080 | 1430 |
| 0.190 | ... | ... | 1540 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Huck Manufacturing Company.
b Yield value is less than 2/3 of indicated ultimate strength value.
c Rivet shear strength is documented in NAS 1900.
d Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985 from the greater of 0.012 inch or 4% of nominal diameter).

**Table 8.1.3.2.2(f). Static Joint Strength of Blind 100° Flush Head Aluminum Alloy (2219) Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | CR 2A62[a] ($F_{su}$ = 36 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T81 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in. | | | |
| 0.050 | 203 | ... | ... |
| 0.063 | 289 | 319 | ... |
| 0.071 | 342 | 385 | ... |
| 0.080 | 393 | 461 | 503 |
| 0.090 | 416 | 542 | 603 |
| 0.100 | 439 | 610 | 701 |
| 0.125 | 478 | 682 | 894 |
| 0.160 | ... | 741 | 1013 |
| 0.190 | ... | ... | 1063 |
| Rivet shear strength[b] | 478 | 741 | 1063 |
| | Yield Strength[c], lbs | | |
| Sheet thickness, in.: | | | |
| 0.050 | 169 | ... | ... |
| 0.063 | 247 | 267 | ... |
| 0.071 | 295 | 326 | ... |
| 0.080 | 349 | 394 | 423 |
| 0.090 | 409 | 468 | 514 |
| 0.100 | 424 | 544 | 603 |
| 0.125 | 448 | 658 | 827 |
| 0.160 | ... | 670 | 960 |
| 0.190 | ... | ... | 1002 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Cherry Fasteners.
b Shear strength values are based on indicated nominal hole diameters and $F_{su}$ = 36 ksi.
c Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(g). *Static Joint Strength of Blind 100 degree Flush Head Locked Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet***

| Rivet Type | NAS1921B0()-0(), NAS1921B0()S0(), NAS1921B0()S0()U[a] ($F_{su}$ = 36 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 171[b] | --- | --- |
| 0.050 | 232 | 267[b] | --- |
| 0.063 | 313 | 366 | 411[b] |
| 0.071 | 360 | 427 | 484 |
| 0.080 | 416 | 498 | 566 |
| 0.090 | 477 | 571 | 658 |
| 0.100 | 494 | 647 | 748 |
| 0.125 | --- | 755 | 978 |
| 0.160 | --- | --- | 1090 |
| Rivet shear strength[c] | 495 | 755 | 1090 |
| | Yield Strength, lbs[d] | | |
| Sheet thickness, in.: | | | |
| 0.040 | 110 | --- | --- |
| 0.050 | 161 | 171 | --- |
| 0.063 | 247 | 254 | 270 |
| 0.071 | 303 | 315 | 330 |
| 0.080 | 354 | 395 | 399 |
| 0.090 | 373 | 484 | 506 |
| 0.100 | 393 | 549 | 611 |
| 0.125 | --- | 610 | 803 |
| 0.160 | --- | --- | 906 |
| Head height [ref.], in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Huck Manufacturing Company.
b Values above the horizontal line in each column are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring activity.
c Rivet shear strength is documented in NAS1900.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(h). Static Joint Strength of Blind 100° Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1399B[a] (5056) ($F_{su}$ = 30 ksi) | | | NAS1399D[a] (2017) ($F_{su}$ = 36 ksi) | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.040 | 149[b,c] | ... | ... | 149[b,c] | ... | ... |
| 0.050 | 223[b] | 230[b,c] | ... | 223[b] | 230[b,c] | ... |
| 0.063 | 310[b] | 349[b] | 356[b,c] | 319[b] | 349[b] | 356[b,c] |
| 0.071 | 366 | 415[b] | 448[b] | 379[b] | 420[b] | 448[b] |
| 0.080 | 388 | 492[b] | 544[b] | 423 | 506[b] | 547[b] |
| 0.090 | ... | 578 | 646[b] | 459 | 600[b] | 660[b] |
| 0.100 | ... | 596 | 751[b] | 494 | 652 | 775[b] |
| 0.125 | ... | ... | 862 | ... | 755 | 969 |
| 0.160 | ... | ... | ... | ... | ... | 1090 |
| Rivet shear strength[d] | 388 | 596 | 862 | 494 | 755 | 1090 |
| | Yield Strength[e], lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.040 | 72 | ... | ... | 72 | ... | ... |
| 0.050 | 114 | 113 | ... | 114 | 113 | ... |
| 0.063 | 197 | 182 | 170 | 197 | 182 | 170 |
| 0.071 | 247 | 245 | 220 | 247 | 245 | 220 |
| 0.080 | 304 | 316 | 304 | 304 | 316 | 304 |
| 0.090 | ... | 396 | 399 | 367 | 396 | 399 |
| 0.100 | ... | 473 | 493 | 431 | 473 | 493 |
| 0.125 | ... | ... | 729 | ... | 672 | 729 |
| 0.160 | ... | ... | ... | ... | ... | 1060 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.042 | 0.055 | 0.070 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength is documented in NAS1900.
e Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985, from the greater of 0.005 inch or 2.5% of nominal diameter).

**Table 8.1.3.2.2(i). *Static Joint Strength of Blind 100° Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk and Dimpled Aluminum Alloy Sheet***

| Rivet Type | NAS1739B[a] and NAS1739E[a,b] ($F_{su}$ = 34 ksi) | | | NAS1739B[c] and NAS1739E[b,c] ($F_{su}$ = 34 ksi) | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.144) | (0.178) | (0.207) | (0.144) | (0.178) | (0.207) |
| | Ultimate Strength, lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.020 | ... | ... | ... | 246 | 334 | 418 |
| 0.025 | ... | ... | ... | 281 | 376 | 465 |
| 0.032 | 212[d] | ... | ... | 330 | 436 | 536 |
| 0.040 | 266 | 326[d] | ... | 386 | 506 | 616 |
| 0.050 | 344 | 410 | ... | 456 | 592 | 716 |
| 0.063 | 441 | 533 | 606[d] | 546 | 703 | 845 |
| 0.071 | 504 | 608 | 696 | ... | 771 | 926 |
| 0.080 | 554 | 693 | 794 | ... | 837 | 1015 |
| 0.090 | ... | 787 | 900 | ... | ... | 1110 |
| 0.100 | ... | 837 | 1015 | ... | ... | ... |
| 0.125 | ... | ... | 1128 | ... | ... | ... |
| Rivet shear strength[e] | 554 | 837 | 1128 | 554 | 837 | 1128 |
| | Yield Strength[f], lbs. | | | | | |
| Sheet thickness, in.: | | | | | | |
| 0.020 | ... | ... | ... | ... | ... | ... |
| 0.025 | ... | ... | ... | ... | ... | ... |
| 0.032 | 159 | ... | ... | ... | ... | ... |
| 0.040 | 212 | 247 | ... | ... | ... | ... |
| 0.050 | 279 | 331 | ... | ... | ... | ... |
| 0.063 | 365 | 437 | 492 | ... | ... | ... |
| 0.071 | 418 | 503 | 568 | ... | ... | ... |
| 0.080 | 448 | 577 | 654 | ... | ... | ... |
| 0.090 | ... | 659 | 750 | ... | ... | ... |
| 0.100 | ... | 689 | 845 | ... | ... | ... |
| 0.125 | ... | ... | 960 | ... | ... | ... |
| Head height (ref.), in. | 0.035 | 0.047 | 0.063 | 0.035 | 0.047 | 0.063 |

a Machine-countersunk holes.
b Data supplied by Cherry Fasteners. Confirmatory data for machine-countersunk holes provided by Allfast Fastening Systems, Inc.
c Dimpled holes. These allowables apply to double dimpled sheets and to the upper sheet dimpled into a machine-countersunk lower sheet. Sheet gauge is that of the thinnest sheet for double dimpled joints and of the upper dimpled, machine-countersunk joints. The thickness of the machine-countersunk sheet must be at least one tabulated gauge thicker than the upper sheet. In no case shall allowables be obtained by extrapolation for gauges other than those shown.
d The values in the table above the horizontal line in each column are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
e Rivet shear strength is documented in NAS1740.
f Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985, from the greater of 0.005 inch or 2.5% of nominal diameter).

**Table 8.1.3.2.2(j). Static Joint Strength of Blind 100° Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Magnesium Alloy Sheet**

| Rivet Type | NAS1399B[a] ($F_{su}$ = 30 ksi) | | | | NAS1739B and NAS 1739E[a] ($F_{su}$ = 34 ksi) | | |
|---|---|---|---|---|---|---|---|
| Sheet Material | AZ31B-H24 | | | | | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.) | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.032 | ... | ... | ... | ... | 188[b,c] | ... | ... |
| 0.040 | 178[b,c] | ... | ... | ... | 235[b] | 292[b,c] | ... |
| 0.050 | 223[b] | 274[b,c] | ... | ... | 295 | 362[b] | ... |
| 0.063 | 292[b] | 349[b] | 418[b,c] | ... | 371 | 457 | 530[b,c] |
| 0.071 | 334[b] | 399[b] | 471[b] | ... | 418 | 514 | 600[b] |
| 0.080 | 383[b] | 459[b] | 536[b] | ... | 471 | 580 | 671 |
| 0.090 | 388 | 526[b] | 613[b] | 803[b,c] | 531 | 651 | 756 |
| 0.100 | ... | 593[b] | 693[b] | 892[b] | 554 | 725[b] | 843 |
| 0.125 | ... | 596 | 862 | 1153[b] | ... | 837[b] | 1052[b] |
| 0.160 | ... | ... | ... | 1532[b] | ... | ... | ... |
| Rivet shear strength | 388[d] | 596[d] | 862[d] | 1550[d] | 554[e] | 837[e] | 1128[e] |
| | Yield Strength[f], lbs. | | | | | | |
| Sheet thickness, in.: | | | | | | | |
| 0.032 | ... | ... | ... | ... | 106 | ... | ... |
| 0.040 | 49 | ... | ... | ... | 147 | 164 | ... |
| 0.050 | 94 | 76 | ... | ... | 197 | 227 | ... |
| 0.063 | 158 | 152 | 128 | ... | 262 | 307 | 340 |
| 0.071 | 197 | 200 | 186 | ... | 300 | 355 | 399 |
| 0.080 | 242 | 254 | 250 | ... | 314 | 414 | 462 |
| 0.090 | 291 | 315 | 323 | 277 | 330 | 459 | 534 |
| 0.100 | ... | 375 | 396 | 376 | 336 | 478 | 608 |
| 0.125 | ... | 530 | 580 | 621 | ... | 508 | 667 |
| 0.160 | ... | ... | ... | 968 | ... | ... | ... |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 | 0.035 | 0.047 | 0.063 |

a Data supplied by Cherry Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Rivet shear strength is documented in NAS1400.
e Rivet shear strength is documented in NAS1740 dated March 1968.
f Permanent set at yield load: the greater of 0.005 inch or 2.5% of nominal diameter.

**Table 8.1.3.2.2(k). Static Joint Strength of Blind 100° Flush Head Locked Spindle A-286 Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | CR 4622[a] ($F_{su}$ = 75 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 595[c] | ... | ... | ... |
| 0.063 | 733[c] | 932[c] | ... | ... |
| 0.071 | 817[c] | 1035[c] | ... | ... |
| 0.080 | 913 | 1160[c] | 1410[c] | ... |
| 0.090 | 947 | 1290[c] | 1570[c] | ... |
| 0.100 | 982 | 1420 | 1725[c] | 2360[c] |
| 0.125 | 995 | 1525 | 2060 | 2880[c] |
| 0.160 | ... | 1545 | 2215 | 3605 |
| 0.190 | ... | ... | ... | 3810 |
| 0.250 | ... | ... | ... | 3920 |
| Rivet shear strength[d] | 995 | 1545 | 2215 | 3920 |
| | Yield Strength[e], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 211 | ... | ... | ... |
| 0.063 | 348 | 339 | ... | ... |
| 0.071 | 489 | 470 | ... | ... |
| 0.080 | 608 | 620 | 574 | ... |
| 0.090 | 664 | 787 | 774 | ... |
| 0.100 | 720 | 947 | 970 | 853 |
| 0.125 | 860 | 1120 | 1400 | 1505 |
| 0.160 | ... | 1365 | 1695 | 2410 |
| 0.190 | ... | ... | ... | 2740 |
| 0.250 | ... | ... | ... | 3405 |
| Head height (ref.), in. | 0.041 | 0.054 | 0.069 | 0.095 |

a Data supplied by Cherry Fasteners.
b Allowable loads developed from test with nominal hole diameters as listed.
c Yield value is less than 2/3 of the indicated ultimate strength value.
d Fastener shear strength based upon nominal hole diameters and $F_{su}$ = 75 ksi from data analysis.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(l). Static Joint Strength of Blind 100° Flush Head Locked Spindle Monel Rivets in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Rivet Type | CR 4522[a] ($F_{su}$ = 65 ksi) | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Rivet Diameter (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) | 1/4 (0.258) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.050 | 529[c] | ... | ... | ... |
| 0.063 | 632[c] | 828[c] | ... | ... |
| 0.071 | 694[c] | 906[c] | ... | ... |
| 0.080 | 754 | 995[c] | 1240[c] | ... |
| 0.090 | 776 | 1095 | 1360[c] | ... |
| 0.100 | 797 | 1170 | 1475[c] | ... |
| 0.125 | 852 | 1240 | 1695 | 2485[c] |
| 0.160 | 863 | 1335 | 1810 | 2975 |
| 0.190 | ... | 1340 | 1910 | 3105 |
| 0.250 | ... | ... | 1920 | 3365 |
| 0.312 | ... | ... | ... | 3400 |
| Rivet shear strength[d] | 863 | 1340 | 1920 | 3400 |
| | Yield Strength[e], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.050 | 169 | ... | ... | ... |
| 0.063 | 346 | 273 | ... | ... |
| 0.071 | 454 | 408 | ... | ... |
| 0.080 | 561 | 562 | 483 | ... |
| 0.090 | 621 | 732 | 688 | ... |
| 0.100 | 682 | 874 | 888 | ... |
| 0.125 | 833 | 1060 | 1300 | 1355 |
| 0.160 | 863 | 1325 | 1615 | 2225 |
| 0.190 | ... | 1340 | 1885 | 2585 |
| 0.250 | ... | ... | 1920 | 3300 |
| 0.312 | ... | ... | ... | 3400 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 | 0.095 |

a Data supplied by Cherry Fasteners.
b Allowable loads developed from test with nominal hole diameters as listed.
c Yield value is less than 2/3 of the indicated ultimate strength value.
d Fastener shear strength based upon nominal hole diameters and $F_{su}$ = 65 ksi from data analysis.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(m). Static Joint Strength of Blind 100° Flush Head Locked Spindle Aluminum Alloy (7050) Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1721KE and NAS1721KE ( )L[a] ($F_{su}$ = 33 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 221[c,d] | ... | ... |
| 0.050 | 277[d] | 342[c,d] | ... |
| 0.063 | 351 | 435[d] | 518[c,d] |
| 0.071 | 396 | 491[d] | 586[d] |
| 0.080 | 448 | 555 | 662[d] |
| 0.090 | 450 | 626 | 747 |
| 0.100 | ... | 697 | 832 |
| 0.125 | ... | 700 | 950 |
| Rivet shear strength[e] | 450 | 700 | 950 |
| | Yield Strength[f], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 62 | ... | ... |
| 0.050 | 150 | 99 | ... |
| 0.063 | 263 | 240 | 182 |
| 0.071 | 333 | 327 | 287 |
| 0.080 | 386 | 425 | 404 |
| 0.090 | 403 | 534 | 534 |
| 0.100 | ... | 600 | 665 |
| 0.125 | ... | 653 | 874 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Avdel Corp.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, ±0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring agency.
d Yield value is less than 2/3 of indicated ultimate value.
e Rivet shear strength is documented in NAS1722.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(n). Static Joint Strength of Blind 100° Flush Head Locked Spindle A-286 Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | NAS1721C and NAS1721C( )L[a] ($F_{su}$ = 75 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 454[c, d] | ... | ... |
| 0.050 | 585[d] | 707[c,d] | ... |
| 0.063 | 751[d] | 919[d] | 1075[c,d] |
| 0.071 | 853[d] | 1045[d] | 1230[d] |
| 0.080 | 881[d] | 1190[d] | 1405[d] |
| 0.090 | 896 | 1345[d] | 1595[d] |
| 0.100 | 912 | 1365[d] | 1785[d] |
| 0.125 | 951 | 1415 | 1970 |
| 0.160 | 1000 | 1485 | 2055 |
| 0.190 | ... | 1500 | 2125 |
| 0.250 | ... | ... | 2200 |
| Rivet shear strength[e] | 1000 | 1500 | 2200 |
| | Yield Strength[f], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 77 | ... | ... |
| 0.050 | 220 | 122 | ... |
| 0.063 | 375 | 352 | 246 |
| 0.071 | 470 | 471 | 425 |
| 0.080 | 578 | 604 | 585 |
| 0.090 | 615 | 753 | 763 |
| 0.100 | 641 | 902 | 942 |
| 0.125 | 707 | 997 | 1330 |
| 0.160 | 799 | 1110 | 1470 |
| 0.190 | ... | 1210 | 1585 |
| 0.250 | ... | ... | 1820 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Avdel Corp.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, ±0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring agency.
d Yield value is less than 2/3 of indicated ultimate value.
e Rivet shear strength is documented in NAS1722.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(o). Static Joint Strength of Blind Flush Head Locked Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheets**

| Rivet Type | HC3212 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 280[c,d] | --- | --- |
| 0.050 | 318 | 436[c,d] | --- |
| 0.063 | 367 | 497 | 643[c,d] |
| 0.071 | 397 | 535 | 688 |
| 0.080 | 431 | 577 | 739 |
| 0.090 | 469 | 624 | 795 |
| 0.100 | 507 | 671 | 851 |
| 0.125 | 602 | 789 | 992 |
| 0.160 | 664 | 954 | 1190 |
| 0.190 | --- | 1030 | 1355 |
| 0.250 | --- | --- | 1480 |
| Rivet shear strength[e] | 664 | 1030 | 1480 |
| | Yield Strength, lbs[f] | | |
| Sheet thickness, in.: | | | |
| 0.040 | 151 | --- | --- |
| 0.050 | 244 | 236 | --- |
| 0.063 | 366 | 387 | 382 |
| 0.071 | 397 | 480 | 494 |
| 0.080 | 431 | 577 | 619 |
| 0.090 | 454 | 624 | 758 |
| 0.100 | 476 | 671 | 851 |
| 0.125 | 532 | 740 | 979 |
| 0.160 | 610 | 837 | 1095 |
| 0.190 | --- | 921 | 1195 |
| 0.250 | --- | --- | 1395 |
| Head height [ref.], in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Huck International Inc.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires specific approval of the procuring activity.
d Yield value is less than 2/3 of indicated ultimate strength value.
e Rivet shear strength is documented on HC3212 standards drawing.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(p). Static Joint Strength of Blind 100° Flush Head Locked Spindle 2014 Aluminum Alloy Rivets in Machine Countersunk Aluminum Alloy Sheet**

| Rivet Type | MBC 4807 and 4907 ($F_{su}$ = 33 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 183[c] | ... | ... |
| 0.050 | 243 | 286[c] | ... |
| 0.063 | 320 | 382 | 437[c] |
| 0.071 | 368 | 441 | 508 |
| 0.080 | 412 | 508 | 588 |
| 0.090 | 435 | 582 | 677 |
| 0.100 | 450 | 641 | 766 |
| 0.125 | ... | 700 | 937 |
| 0.160 | ... | ... | 950 |
| Rivet shear strength[d] | 450 | 700 | 950 |
| | Yield Strength, lbs.[e] | | |
| Sheet thickness, in.: | | | |
| 0.040 | 102 | ... | ... |
| 0.050 | 173 | 160 | ... |
| 0.063 | 264 | 274 | 263 |
| 0.071 | 309 | 345 | 347 |
| 0.080 | 333 | 423 | 441 |
| 0.090 | 360 | 486 | 546 |
| 0.100 | 387 | 519 | 651 |
| 0.125 | ... | 602 | 765 |
| 0.160 | ... | ... | 904 |
| Head height (ref.), in. | 0.041 | 0.053 | 0.068 |

a Data supplied by Avdel Systems Ltd.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring agency.
d Rivet shear strength is documented in NAS 1722, and rivets meet the requirements of NAS 1721.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(q). Static Joint Strength of Blind Protruding Head Locked Spindle 2014 Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | MBC 4801 and 4901 ($F_{su}$ = 33 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.025 | 247 | ... | ... |
| 0.032 | 284 | 389 | ... |
| 0.040 | 326 | 441 | 571 |
| 0.050 | 378 | 507 | 650 |
| 0.063 | 415 | 589 | 751 |
| 0.071 | 437 | 617 | 814 |
| 0.080 | 450 | 649 | 864 |
| 0.090 | ... | 684 | 906 |
| 0.100 | ... | 700 | 948 |
| 0.125 | ... | ... | 950 |
| Rivet shear strength[c] | 450 | 700 | 950 |
| | Yield Strength, lbs.[d] | | |
| Sheet thickness, in.: | | | |
| 0.025 | 238 | ... | ... |
| 0.032 | 277 | 375 | ... |
| 0.040 | 321 | 431 | 552 |
| 0.050 | 368 | 500 | 635 |
| 0.063 | 381 | 572 | 743 |
| 0.071 | 389 | 583 | 810 |
| 0.080 | 399 | 594 | 828 |
| 0.090 | ... | 607 | 843 |
| 0.100 | ... | 619 | 858 |
| 0.125 | ... | ... | 896 |

a Data supplied by Avdel Systems Ltd.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, ±0.001 inch.
c Rivet shear strength is documented in NAS 1722, and rivets meet the requirements of NAS 1720.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(r). Static Joint Strength of 100° Flush Head Locked Spindle Aluminum Alloy Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HC6222[a] ($F_{su}$ = 50 ksi) Nominal | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.040 | 270[b] | ... | ... |
| 0.050 | 317 | 420[b] | ... |
| 0.063 | 377 | 496 | 624[b] |
| 0.071 | 414 | 542 | 680 |
| 0.080 | 456 | 594 | 743 |
| 0.090 | 503 | 652 | 812 |
| 0.100 | 550 | 711 | 882 |
| 0.125 | 664 | 856 | 1055 |
| 0.160 | ... | 1030 | 1299 |
| 0.190 | ... | ... | 1480 |
| 0.250 | ... | ... | ... |
| Rivet shear strength[d] | 664 | 1030 | 1480 |
| | Yield Strength[e], lbs | | |
| Sheet thickness, in.: | | | |
| 0.040 | 196 | 237[c] | ... |
| 0.050 | 252 | 306 | ... |
| 0.063 | 323 | 395 | 464 |
| 0.071 | 368 | 451 | 530 |
| 0.080 | 417 | 512 | 605 |
| 0.090 | 445 | 581 | 687 |
| 0.100 | 459 | 650 | 770 |
| 0.125 | 494 | 714 | 972 |
| 0.160 | ... | 775 | 1045 |
| 0.190 | ... | ... | 1108 |
| 0.250 | ... | ... | ... |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Huck International, Inc.
b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
c Yield value is less than 2/3 of the indicated ultimate.
d Rivet shear strength is documented in MIL-R-7885D.
e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.2.2(s). Static Joint Strength of 100° Flush Head Locked Spindle Aluminum Alloy Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HC6252[a] ($F_{su}$ = 50 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.) | (0.144) | (0.178) | (0.207) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.032 | 265 [b,c] | ... | ... |
| 0.040 | 304 | 408 [b,c] | ... |
| 0.050 | 352 | 467 | ... |
| 0.063 | 414 | 544 | 665 [c] |
| 0.071 | 452 | 591 | 720 |
| 0.080 | 495 | 645 | 782 |
| 0.090 | 543 | 704 | 851 |
| 0.100 | 591 | 763 | 920 |
| 0.125 | 701 | 911 | 1092 |
| 0.160 | 814 | 1097 | 1332 |
| 0.190 | ... | 1237 | 1505 |
| 0.250 | ... | 1245 | 1685 |
| Rivet shear strength[d] | 814 | 1245 | 1685 |
| | Yield Strength[e], lbs | | |
| Sheet thickness, in.: | | | |
| 0.032 | 154 | ... | ... |
| 0.040 | 214 | 240 | ... |
| 0.050 | 288 | 332 | ... |
| 0.063 | 384 | 451 | 500 |
| 0.071 | 444 | 524 | 586 |
| 0.080 | 494 | 607 | 682 |
| 0.090 | 513 | 698 | 788 |
| 0.100 | 531 | 758 | 895 |
| 0.125 | 576 | 814 | 1048 |
| 0.160 | 640 | 893 | 1139 |
| 0.190 | ... | 961 | 1218 |
| 0.250 | ... | 1096 | 1376 |
| Head height (ref.), in. | 0.035 | 0.047 | 0.063 |

a Data supplied by Huck International, Inc.
b Yield value is less than 2/3 of the indicated ultimate.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring activity.
d Rivet shear strength is documented in MIL-R-7885D.
e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.3.2.2($t_1$). Static Joint Strength of 100° Flush Shear Head Locked Spindle Aluminum Alloy Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HC6224[a] ($F_{su}$ = 50 ksi) Nominal | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.032 | 230 | 294[c] | |
| 0.040 | 282 | 358 | 437[c] |
| 0.050 | 347 | 439 | 534 |
| 0.063 | 431 | 544 | 660 |
| 0.071 | 456 | 608 | 737 |
| 0.080 | 493 | 681 | 824 |
| 0.090 | 535 | 716 | 921 |
| 0.100 | 576 | 768 | 979 |
| 0.125 | 664 | 897 | 1135 |
| 0.160 | ... | 1030 | 1350 |
| 0.190 | ... | ... | 1480 |
| Rivet shear strength[d] | 664 | 1030 | 1480 |
| | Yield Strength[e], lbs | | |
| Sheet thickness, in.: | | | |
| 0.032 | 185 | 209 | |
| 0.040 | 248 | 288 | 320 |
| 0.050 | 328 | 387 | 438 |
| 0.063 | 431 | 516 | 592 |
| 0.071 | 448 | 595 | 687 |
| 0.080 | 457 | 681 | 794 |
| 0.090 | 467 | 697 | 912 |
| 0.100 | 477 | 710 | 979 |
| 0.125 | 503 | 742 | 1030 |
| 0.160 | ... | 786 | 1080 |
| 0.190 | ... | ... | 1125 |
| Head height (ref.), in. | 0.028 | 0.037 | 0.046 |

a Data supplied by Huck International, Inc.

b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194 ± 0.0002.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring activity.

d Rivet shear strength is documented in MIL-R-7885D.

e Permanent set at yield load: 4% of nominal hole diameter.

**TABLE 8.1.3.2.2($t_2$). Static Joint Strength of 100° Flush Shear Head Locked Spindle Aluminum Alloy Blind Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HC3214[a](Fsu = 50 ksi)Nominal | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in) | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in: | | | |
| 0.032 | 214 | 272[b] | |
| 0.040 | 264 | 333 | 405[b] |
| 0.050 | 325 | 410 | 497 |
| 0.063 | 406 | 511 | 617 |
| 0.071 | 427 | 572 | 691 |
| 0.080 | 464 | 621 | 774 |
| 0.090 | 504 | 671 | 856 |
| 0.100 | 544 | 721 | 916 |
| 0.125 | 644 | 846 | 1066 |
| 0.160 | 664 | 1020 | 1275 |
| 0.190 | ... | 1030 | 1455 |
| 0.250 | ... | ... | 1480 |
| Rivet shear strength[c] | 664 | 1030 | 1480 |
| | Yield Strength[d], lbs | | |
| Sheet thickness, in: | | | |
| 0.032 | 196 | 230 | |
| 0.040 | 256 | 305 | 348 |
| 0.050 | 325 | 399 | 461 |
| 0.063 | 406 | 511 | 607 |
| 0.071 | 427 | 572 | 691 |
| 0.080 | 453 | 621 | 774 |
| 0.090 | 475 | 678 | 856 |
| 0.100 | 497 | 705 | 916 |
| 0.125 | 552 | 773 | 1030 |
| 0.160 | 628 | 868 | 1140 |
| 0.190 | ... | 950 | 1240 |
| 0.250 | ... | ... | 1435 |
| Head height (ref), in | 0.028 | 0.037 | 0.046 |

a Data supplied by Huck International Inc.

b Values above the horizontal line in each column are for knife-edge conditions, the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring activity.

c Rivet shear strength is based upon nominal hole diameter and $F_{su}$ = 50 ksi.

d Permanent set at yield: 4% of nominal hole diameter.

**Table 8.1.3.2.2(u). Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheets**

| Rivet Type | AF3212 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 143[c] | --- | --- |
| 0.050 | 247 | 224[c] | --- |
| 0.063 | 383 | 393 | 370[c] |
| 0.071 | 414 | 497 | 494 |
| 0.080 | 435 | 614 | 634 |
| 0.090 | 457 | 647 | 790 |
| 0.100 | 480 | 676 | 902 |
| 0.125 | 537 | 746 | 987 |
| 0.160 | 616 | 846 | 1105 |
| 0.190 | --- | 931 | 1205 |
| 0.250 | --- | --- | 1410 |
| **THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.** | | | |
| Rivet shear strength[d] | 664 | 1030 | 1480 |
| | Yield Strength, lbs[e] | | |
| Sheet thickness, in.: | | | |
| 0.040 | 143 | --- | --- |
| 0.050 | 235 | 224 | --- |
| 0.063 | 310 | 371 | 370 |
| 0.071 | 330 | 431 | 491 |
| 0.080 | 353 | 486 | 572 |
| 0.090 | 379 | 518 | 662 |
| 0.100 | 404 | 549 | 713 |
| 0.125 | 468 | 629 | 808 |
| 0.160 | 557 | 740 | 914 |
| 0.190 | --- | 835 | 1055 |
| 0.250 | --- | --- | 1280 |
| Head height [ref.], in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Allfast Fastening Systems Inc.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires specific approval of the procuring activity.
d Rivet shear strength is documented on AF3212 standards drawing.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(v). *Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet***

| Rivet Type | CR3212 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in.<br>(Nominal Hole Diameter, in.)[b] | 1/8<br>(0.130) | 5/32<br>(0.162) | 3/16<br>(0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 297[c, d] | --- | --- |
| 0.050 | 342[d] | 462[c, d] | --- |
| 0.063 | 401[d] | 535[d] | 683[c, d] |
| 0.071 | 437[d] | 580[d] | 737[d] |
| 0.080 | 477 | 630[d] | 798[d] |
| 0.090 | 513 | 687[d] | 865[d] |
| 0.100 | 536 | 743 | 932 |
| 0.125 | 594 | 834 | 1100 |
| Rivet shear strength[e] | 664 | 1030 | 1480 |
| | Yield Strength, lbs[f] | | |
| Sheet thickness, in.: | | | |
| 0.040 | 131 | --- | --- |
| 0.050 | 181 | 204 | --- |
| 0.063 | 247 | 286 | 317 |
| 0.071 | 287 | 336 | 377 |
| 0.080 | 333 | 393 | 444 |
| 0.090 | 361 | 456 | 520 |
| 0.100 | 371 | 518 | 595 |
| 0.125 | 394 | 576 | 783 |
| Head height [ref.], in. | 0.042 | 0.055 | 0.070 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

a Data supplied by Textron Aerospace Fasteners.
b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires specific approval of the procuring activity.
d Yield value is less than 2/3 of indicated ultimate strength value.
e Rivet shear strength is documented on CR3212 standards drawing.
f Permanent set at yield load: 4% of nominal diameter.

## Table 8.1.3.2.2(w). Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet

| Rivet Type | AF3242 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.032 | 193[c] | --- | --- |
| 0.040 | 250 | 299[c] | --- |
| 0.050 | 321 | 387 | --- |
| 0.063 | 414 | 501 | 573[c] |
| 0.071 | 470 | 571 | 654 |
| 0.080 | 524 | 651 | 746 |
| 0.090 | 550 | 738 | 849 |
| 0.100 | 577 | 804 | 951 |
| 0.125 | 643 | 886 | 1120 |
| 0.160 | 736 | 1000 | 1250 |
| 0.190 | 814 | --- | 1365 |
| Rivet shear strength[d] | 814 | 1245 | 1685 |
| | Yield Strength, lbs[e] | | |
| Sheet thickness, in.: | | | |
| 0.032 | 192 | --- | --- |
| 0.040 | 250 | 298 | --- |
| 0.050 | 321 | 387 | --- |
| 0.063 | 414 | 501 | 573 |
| 0.071 | 470 | 571 | 654 |
| 0.080 | 524 | 651 | 746 |
| 0.090 | 550 | 738 | 849 |
| 0.100 | 577 | 804 | 951 |
| 0.125 | 643 | 886 | 1120 |
| 0.160 | 736 | 1000 | 1250 |
| 0.190 | 814 | --- | 1365 |
| Head height (ref.), in. | 0.035 | 0.047 | 0.063 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

a Data supplied by Allfast Fastening Systems Inc.
b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring activity.
d Rivet shear strength is documented on AF3242 standards drawing.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(x). Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | CR3242 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.144) | 5/32 (0.178) | 3/16 (0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.032 | 245[c,d] | --- | --- |
| 0.040 | 302 | 378[c,d] | --- |
| 0.050 | 374 | 467 | --- |
| 0.063 | 467 | 582 | 681[c] |
| 0.071 | 568 | 653 | 764 |
| 0.080 | 584 | 732 | 856 |
| 0.090 | 602 | 872 | 959 |
| 0.100 | 620 | 894 | 1165 |
| 0.125 | 664 | 950 | 1230 |
| | **THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.** | | |
| Rivet shear strength[e] | 814 | 1245 | 1685 |
| | Yield Strength, lbs[f] | | |
| Sheet thickness, in.: | | | |
| 0.032 | 158 | --- | --- |
| 0.040 | 206 | 245 | --- |
| 0.050 | 265 | 318 | --- |
| 0.063 | 330 | 413 | 472 |
| 0.071 | 361 | 471 | 540 |
| 0.080 | 395 | 514 | 616 |
| 0.090 | 434 | 562 | 678 |
| 0.100 | 473 | 609 | 734 |
| 0.125 | 569 | 729 | 873 |
| Head height (ref.), in. | 0.035 | 0.047 | 0.063 |

a Data supplied by Textron Aerospace Fasteners.
b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.
c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring activity.
d Yield value is less than 2/3 of indicated ultimate strength value.
e Rivet shear strength is documented on CR3242 standards drawing.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(y). Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HC3242 ($F_{su}$ = 51 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in.<br>(Nominal Hole Diameter, in.[b] | 1/8<br>(0.144) | 5/32<br>(0.178) | 3/16<br>(0.207) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.032 | 267[c,d] | --- | --- |
| 0.040 | 310 | 411[c,d] | --- |
| 0.050 | 363 | 477 | --- |
| 0.063 | 433 | 563 | 682[c] |
| 0.071 | 475 | 616 | 744 |
| 0.080 | 522 | 675 | 813 |
| 0.090 | 560 | 741 | 889 |
| 0.100 | 597 | 803 | 966 |
| 0.125 | 690 | 918 | 1130 |
| 0.160 | 814 | 1075 | 1320 |
| 0.190 | --- | 1215 | 1480 |
| 0.250 | --- | --- | 1685 |
| Rivet shear strength[e] | 814 | 1245 | 1685 |
| | Yield Strength, lbs[f] | | |
| Sheet thickness, in.: | | | |
| 0.032 | 138 | --- | --- |
| 0.040 | 218 | 217 | --- |
| 0.050 | 317 | 340 | --- |
| 0.063 | 433 | 500 | 529 |
| 0.071 | 475 | 598 | 643 |
| 0.080 | 510 | 675 | 772 |
| 0.090 | 527 | 741 | 889 |
| 0.100 | 543 | 781 | 966 |
| 0.125 | 585 | 833 | 1075 |
| 0.160 | 644 | 906 | 1160 |
| 0.190 | --- | 968 | 1235 |
| 0.250 | --- | --- | 1375 |
| Head height (ref.), in. | 0.035 | 0.047 | 0.063 |

**THIS FASTENER HAS ONLY BEEN TESTED IN THE SHEET GAGES SHOWN IN THIS TABLE. DESIGN DATA FOR SHEET GAGES OR DIAMETERS OTHER THAN THOSE SHOWN HERE CANNOT BE EXTRAPOLATED.**

a Data supplied by Huck International Inc.

b Loads developed from tests with hole diameters of 0.144, 0.178, and 0.207, +/-0.001 inch.

c The values in the table above the horizontal line in each column are for knife-edge conditions, and the use of fasteners in this condition is undesirable. The use of knife-edge conditions in the design of military aircraft requires the specific approval of the procuring activity.

d Yield value is less than 2/3 of indicated ultimate strength value.

e Rivet shear strength is documented on HC3242 standards drawing.

f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(z). Static Joint Strength of Blind Flush Head Locked Spindle Aluminum Alloy Rivets in Aluminum Alloy Sheet**

| Rivet Type | AF3222 ($F_{su}$ = 50 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. | 1/8 | 5/32 | 3/16 |
| (Nominal Hole Diameter, in.)[b] | (0.130) | (0.162) | (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 202[c] | ... | ... |
| 0.050 | 287 | 316[c] | ... |
| 0.063 | 388 | 452 | 492[c] |
| 0.071 | 412 | 536 | 593 |
| 0.080 | 439 | 608 | 706 |
| 0.090 | 469 | 645 | 832 |
| 0.100 | 498 | 683 | 891 |
| 0.125 | 573 | 775 | 1000 |
| 0.160 | 664 | 905 | 1155 |
| 0.190 | ... | 1015 | 1290 |
| 0.250 | ... | 1030 | 1480 |
| Rivet shear strength[d] | 664 | 1030 | 1480 |
| | Yield Strength[e], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 160 | ... | ... |
| 0.050 | 216 | 249 | ... |
| 0.063 | 290 | 341 | 383 |
| 0.071 | 335 | 397 | 451 |
| 0.080 | 379 | 460 | 527 |
| 0.090 | 421 | 531 | 611 |
| 0.100 | 462 | 591 | 696 |
| 0.125 | 566 | 720 | 880 |
| 0.160 | 664 | 901 | 1095 |
| 0.190 | ... | 1015 | 1280 |
| 0.250 | ... | 1030 | 1480 |
| Head height (ref.), in. | 0.042 | 0.055 | 0.070 |

a Data supplied by Allfast Fastening Systems Inc.

b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.001 inch.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in the design of military aircraft requires specific approval of the procuring agency.

d Rivet shear strength as documented in Allfast Fastening Systems Inc. P-127.

e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.2(aa). Static Joint Strength of Flush Head 5056 Aluminum Alloy Rivets in Clad Aluminum Alloy Sheet**

| Rivet Type | CR3222 ($F_{su}$ = 50 ksi approx.)[a] | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Rivet Diameter, in. (Nominal Hole Diameter, in.)[b] | 1/8 (0.130) | 5/32 (0.162) | 3/16 (0.194) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 286[c,d] | ... | ... |
| 0.050 | 328[d] | 445[c,d] | ... |
| 0.063 | 382[d] | 513[d] | 658[c,d] |
| 0.071 | 416 | 555[d] | 708[d] |
| 0.080 | 454 | 602[d] | 764[d] |
| 0.090 | 496 | 654 | 827[d] |
| 0.100 | 528 | 706 | 889 |
| 0.125 | 589 | 821 | 1045 |
| 0.160 | 664 | 928 | 1215 |
| 0.190 | ... | 1020 | 1325 |
| 0.250 | ... | 1030 | 1480 |
| Rivet shear strength[e] | 664 | 1030 | 1480 |
| | Yield Strength[f], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.040 | 158 | ... | ... |
| 0.050 | 199 | 247 | ... |
| 0.063 | 252 | 313 | 373 |
| 0.071 | 285 | 354 | 422 |
| 0.080 | 322 | 399 | 476 |
| 0.090 | 362 | 450 | 537 |
| 0.100 | 384 | 501 | 598 |
| 0.125 | 425 | 597 | 750 |
| 0.160 | 483 | 669 | 881 |
| 0.190 | ... | 731 | 955 |
| 0.250 | ... | 854 | 1100 |
| Head height (ref.), in. | 0.041 | 0.054 | 0.069 |

a Data supplied by Textron Aerospace Fasteners.

b Loads developed from tests with hole diameters of 0.130, 0.162, and 0.194, +/- 0.0005 inch.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in the design of military aircraft requires the specific approval of the procuring agency.

d Yield values is less than 2/3 of indicated ultimate strength value.

e Rivet shear strength as documented in Textron Aerospace Fasteners PS-CMR-3000.

f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.3(a). Static Joint Strength of Blind 100° Flush Head A-286 Bolts in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | MS21140[a] ($F_{su}$ = 95 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 5/32 (0.163) | 3/16 (0.198) | 1/4 (0.259) | 5/16 (0.311) | 3/8 (0.373) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 1165[b,c] | ... | ... | ... | ... |
| 0.080 | 1330[b] | 1600[b,c] | ... | ... | ... |
| 0.090 | 1515[b] | 1805[b] | ... | ... | ... |
| 0.100 | 1700[b] | 2020[b] | 2615[b,c] | ... | ... |
| 0.125 | 1980[b] | 2595[b] | 3295[b] | 3935[b,c] | ... |
| 0.160 | ... | 2925[b] | 4335[b] | 5080[b] | 6010[b,c] |
| 0.190 | ... | ... | 5005[b] | 6150[b] | 7205[b] |
| 0.200 | ... | ... | ... | 6520[b] | 6580[b] |
| 0.250 | ... | ... | ... | 7215[b] | 9810[b] |
| 0.312 | ... | ... | ... | ... | 10380[b] |
| Fastener shear strength[d] | 1980 | 2925 | 5005 | 7215 | 10380 |
| | Yield Strength[e], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 478 | ... | ... | ... | ... |
| 0.080 | 584 | 627 | ... | ... | ... |
| 0.090 | 702 | 730 | ... | ... | ... |
| 0.100 | 819 | 901 | 1025 | ... | ... |
| 0.125 | 1115 | 1260 | 1435 | 1540 | ... |
| 0.160 | ... | 1760 | 2090 | 2285 | 2430 |
| 0.190 | ... | ... | 2655 | 2965 | 3235 |
| 0.200 | ... | ... | ... | 3190 | 3510 |
| 0.250 | ... | ... | ... | 4320 | 4860 |
| 0.312 | ... | ... | ... | ... | 6460 |
| Head height (ref.), in. | 0.074 | 0.082 | 0.108 | 0.140 | 0.168 |

a Data supplied by Huck Manufacturing Company.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Fastener shear strength is documented in MIL-F-8975.
e Permanent set at yield load: 4% of nominal diameter (revised May 1, 1986, from the greater of 0.012 inch or 4% of nominal diameter).

**Table 8.1.3.2.3($b_1$). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | MS90353, MS90353S, and MS90353U[a] ($F_{su}$ = 112 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 2024-T3 and T351 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 5/32 (0.163) | 3/16 (0.198) | 1/4 (0.259) | 5/16 (0.311) | 3/8 (0.373) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 1120[b,c] | ... | ... | ... | ... |
| 0.080 | 1305[b] | 1480[b,c] | ... | ... | ... |
| 0.090 | 1510[b] | 1735[b] | ... | ... | ... |
| 0.100 | 1740[b] | 2000[b] | 2380[b,c] | ... | ... |
| 0.125 | 2080[b] | 2670[b] | 3210[b] | 3625[b,c] | ... |
| 0.160 | 2340[b] | 3195[b] | 4440[b] | 5060[b] | 5700[b,c] |
| 0.190 | ... | 3450[b] | 5090[b] | 6310[b] | 7180[b] |
| 0.250 | ... | ... | 5900[b] | 7860[b] | 9890[b] |
| 0.312 | ... | ... | ... | 8500[b] | 11600[b] |
| 0.375 | ... | ... | ... | ... | 12200[b] |
| Fastener shear strength[d] | 2340 | 3450 | 5900 | 8500 | 12200 |
| | Yield Strength[e], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 403 | ... | ... | ... | ... |
| 0.080 | 513 | 501 | ... | ... | ... |
| 0.090 | 636 | 652 | ... | ... | ... |
| 0.100 | 759 | 799 | 1045 | ... | ... |
| 0.125 | 989 | 1170 | 1525 | 1620 | ... |
| 0.160 | 1170 | 1510 | 2200 | 2430 | 2610 |
| 0.190 | ... | 1700 | 2700 | 3120 | 3440 |
| 0.250 | ... | ... | 3330 | 4170 | 5095 |
| 0.312 | ... | ... | ... | 4955 | 6175 |
| 0.375 | ... | ... | ... | ... | 7135 |
| Head height (ref.), in. | 0.072 | 0.080 | 0.105 | 0.137 | 0.165 |

a Data supplied by Huck Manufacturing Company.

b Yield strength value is less than 2/3 of indicated ultimate strength value.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Fastener shear strength is documented in MIL-F-81177.

e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.3($b_2$). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Rivet Type | MS90353[a] ($F_{su}$ = 112 ksi) | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad or Bare 7075-T6 and T651 | | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Hole Diameter, in.) | (0.163) | (0.198) | (0.259) | (0.311) | (0.373) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 1360[b,c] | ... | ... | ... | ... |
| 0.080 | 1535[c] | 1830[b,c] | ... | ... | ... |
| 0.090 | 1710[c] | 2090[c] | ... | ... | ... |
| 0.100 | 1880[c] | 2330[c] | 2970[b,c] | ... | ... |
| 0.125 | 2200[c] | 2825[c] | 3805[c] | 4490[b,c] | ... |
| 0.160 | 2340 | 3365 | 4760[c] | 5850[c] | 6960[b,c] |
| 0.190 | ... | 3450 | 5370[c] | 6790[c] | 8310[c] |
| 0.250 | ... | ... | 5900 | 8290[c] | 10450[c] |
| 0.312 | ... | ... | ... | 8500 | 12200 |
| 0.375 | ... | ... | ... | ... | 12200 |
| Fastener shear strength[d] | 2340 | 3450 | 5900 | 8500 | 12200 |
| | Yield Strength[e], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.071 | 557 | ... | ... | ... | ... |
| 0.080 | 666 | 757 | ... | ... | ... |
| 0.090 | 787 | 875 | ... | ... | ... |
| 0.100 | 909 | 1025 | 1240 | ... | ... |
| 0.125 | 1215 | 1395 | 1640 | 1860 | ... |
| 0.160 | 1640 | 1910 | 2315 | 2590 | 2850 |
| 0.190 | ... | 2355 | 2895 | 3290 | 3675 |
| 0.250 | ... | ... | 4055 | 4680 | 5345 |
| 0.312 | ... | ... | ... | 6125 | 7075 |
| 0.375 | ... | ... | ... | ... | 8830 |
| Head height (ref.), in. | 0.072 | 0.080 | 0.105 | 0.137 | 0.165 |

a Data supplied by Huck Manufacturing Company.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Yield value is less than 2/3 of indicated ultimate strength value.

d Fastener shear strength is documented in MIL-F-81177.

e Permanent set at yield load: 4% of nominal diameter revised May 1, 1986, from the greater of 0.012 inch or 4% of nominal diameters.

**Table 8.1.3.2.3(c). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | FF-200[a] | | FF-260[a] | | FF-312[a] | |
|---|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 2024-T42 | Clad 7075-T6 | Clad 2024-T42 | Clad 7075-T6 | Clad 2024-T42 | Clad 7075-T6 |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.198) | 3/16 (0.198) | 1/4 (0.259) | 1/4 (0.259) | 5/16 (0.311) | 5/16 (0.311) |
| | Ultimate Strength, lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.071 | 1220[b,c] | 1360[b,c] | ... | ... | ... | ... |
| 0.080 | 1380[b] | 1500[b] | ... | ... | ... | ... |
| 0.090 | 1520[b] | 1620[b] | ... | ... | ... | ... |
| 0.100 | 1650[b] | 1740[b] | 2250[b,c] | 2700[b,c] | ... | ... |
| 0.125 | 1890[b] | 1960 | 2940[b] | 3220[b] | 2720[c] | 3080[b,c] |
| 0.160 | 2160 | 2200 | 3390[b] | 3570[b] | 3600[b] | 3940[b] |
| 0.190 | 2400 | 2420 | 3730[b] | 2860[b] | 4490[b] | 4810[b] |
| 0.250 | 2620 | 2620 | 4260[b] | 4320 | 5550[b] | 6000[b] |
| 0.312 | ... | ... | 4500 | 4500 | 6000[b] | ... |
| Fastener shear strength[d] | 2620 | 2620 | 4500 | 4500 | 6000 | 6000 |
| | Yield Strength[e], lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.071 | 685 | 850 | ... | ... | ... | ... |
| 0.080 | 770 | 930 | ... | ... | ... | ... |
| 0.090 | 870 | 1025 | ... | ... | ... | ... |
| 0.100 | 980 | 1130 | 1120 | 1280 | ... | ... |
| 0.125 | 1200 | 1350 | 1380 | 1600 | 1440 | 1540 |
| 0.160 | 1500 | 1640 | 1700 | 2050 | 1820 | 1980 |
| 0.190 | 1800 | 1960 | 2010 | 2470 | 2200 | 2520 |
| 0.250 | 2400 | 2550 | 2600 | 3190 | 2950 | 3710 |
| 0.312 | ... | ... | 3200 | 3880 | 3690 | ... |
| Head height (ref.), in. | 0.077 | | 0.102 | | 0.134 | |

a Data supplied by Monogram Aerospace Fasteners.
b Yield value is less than 2/3 of indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Fastener shear strength is documented in NAS1675.
e Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.3.2.3(d). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | NS 100[a] | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 5/32 (0.163) | 3/16 (0.198) | 1/4 (0.259) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.063 | 1085[b,c] | ... | ... |
| 0.071 | 1295[b] | 1400[b,c] | ... |
| 0.080 | 1525[b] | 1710[b] | ... |
| 0.090 | 1695[b] | 2020[b] | ... |
| 0.100 | 1830[b] | 2335[b] | 2715[b,c] |
| 0.125 | 2170[b] | 2745[b] | 3765[b] |
| 0.160 | 2190 | 3325[b] | 4615[b] |
| 0.190 | ... | 3325[b] | 5280[b] |
| 0.250 | ... | ... | 5690[b] |
| Fastener shear strength[d] | 2190 | 3325 | 5690 |
| | Yield Strength[e], lbs | | |
| Sheet thickness, in.: | | | |
| 0.063 | 516 | ... | ... |
| 0.071 | 602 | 690 | ... |
| 0.080 | 698 | 805 | ... |
| 0.090 | 804 | 936 | ... |
| 0.100 | 911 | 1065 | 1300 |
| 0.125 | 1180 | 1390 | 1725 |
| 0.160 | 1500 | 1835 | 2320 |
| 0.190 | ... | 2165 | 2830 |
| 0.250 | ... | ... | 3725 |
| Head height (ref.), in. | 0.069 | 0.077 | 0.102 |

a Data supplied by Monogram Aerospace Fasteners.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Fastener shear strength values are A basis from analysis of test data.
e Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985, from the greater of 0.012 inch or 4% of nominal diameter).

**Table 8.1.3.2.3(e). Static Joint Strength of Blind 100° Flush Head Aluminum Alloy Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | SSHFA-200[a] ($F_{su}$ = 50 ksi) | | SSHFA-260[a] ($F_{su}$ = 50 ksi) | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T42 | Clad 7075-T6 | Clad 2024-T42 | Clad 7075-T6 |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.198) | 3/16 (0.198) | 1/4 (0.259) | 1/4 (0.259) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 500[b] | 590[b] | ... | ... |
| 0.063 | 640 | 750 | ... | ... |
| 0.071 | 790 | 880 | ... | ... |
| 0.080 | 1040 | 1060 | 1310[b] | 1480[b] |
| 0.090 | 1270 | 1270 | 1480 | 1650 |
| 0.100 | 1450 | 1450 | 1680 | 1850 |
| 0.125 | 1550 | 1550 | 2010 | 2250 |
| 0.160 | ... | ... | 2300 | 2650 |
| 0.190 | ... | ... | 2520 | ... |
| 0.250 | ... | ... | 2650 | ... |
| Fastener shear strength[c] | 1550 | 1550 | 2650 | 2650 |
| | Yield Strength[d], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 500 | 520 | ... | ... |
| 0.063 | 630 | 700 | ... | ... |
| 0.071 | 740 | 800 | ... | ... |
| 0.080 | 860 | 915 | 940 | 1160 |
| 0.090 | 990 | 1040 | 1080 | 1300 |
| 0.100 | 1130 | 1180 | 1230 | 1460 |
| 0.125 | 1340 | 1420 | 1550 | 1790 |
| 0.160 | ... | ... | 1980 | 2240 |
| 0.190 | ... | ... | 2420 | ... |
| 0.250 | ... | ... | 2650 | ... |
| Head height (ref.), in. | 0.061 | 0.061 | 0.088 | 0.088 |

a Data supplied by Monogram Aerospace Fasteners.
b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
c Fastener shear strength is documented in NAS1675.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.3.2.3(f). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | PLT-150[a] ($F_{su}$ = 112 ksi) (H-11 Nut and screw, Inconel X-750 or A-286 Sleeve) | | | |
|---|---|---|---|---|
| Sheet or Plate Material | Clad 7075-T6 and T651 | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 3/8 |
| (Nominal Shank Diameter, in.) | (0.163) | (0.198) | (0.259) | (0.373) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 1120[b,c] | ... | ... | ... |
| 0.071 | 1320[b] | 1470[b,c] | ... | ... |
| 0.080 | 1550[b] | 1755[b] | ... | ... |
| 0.090 | 1730[b] | 2060[b] | ... | ... |
| 0.100 | 1885[b] | 2350[b] | 2820[b,c] | ... |
| 0.125 | 2300[b] | 2850[b] | 3825[b] | ... |
| 0.160 | 2340[b] | 3450[b] | 4790[b] | 6695[b,c] |
| 0.190 | ... | ... | 5570[b] | 8440[b] |
| 0.250 | ... | ... | 5900[b] | 10700[b] |
| 0.312 | ... | ... | ... | 12250[b] |
| Fastener shear strength[d] | 2340 | 3450 | 5900 | 12250 |
| | Yield Strength[e], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 534 | ... | ... | ... |
| 0.071 | 615 | 730 | ... | ... |
| 0.080 | 705 | 830 | ... | ... |
| 0.090 | 805 | 953 | ... | ... |
| 0.100 | 906 | 1075 | 1345 | ... |
| 0.125 | 1235 | 1390 | 1750 | ... |
| 0.160 | 1545 | 1910 | 2310 | 3160 |
| 0.190 | ... | ... | 2965 | 3850 |
| 0.250 | ... | ... | 3840 | 5395 |
| 0.312 | ... | ... | ... | 6985 |
| Head height (ref.), in. | 0.069 | 0.077 | 0.102 | 0.160 |

a Data supplied by Voi-Shan Industries (Inconel X-750 Sleeve) and Monogram Aerospace Fasteners (A-286 Sleeve).

b Yield value is less than 2/3 of the indicated ultimate strength value.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Fastener shear strength based on area computed from nominal shank diameter in Table 9.4.1.2(a) and $F_{su}$ = 112 ksi.

e Permanent set at yield load: 4% of nominal diameter (revised May 1, 1985, from the greater of 0.012 inch or 4% of nominal diameter).

**Table 8.1.3.2.3(g). Static Joint Strength of Blind 100° Flush Head Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | NAS1670-L[a] | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | |
| Fastener Diameter, in.[b] (Nominal Shank Diameter, in.) | 5/32 (0.163) | 3/16 (0.198) | 1/4 (0.259) | 5/16 (0.311) | 3/8 (0.373) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.063 | 1110[c,d] | ... | ... | ... | ... |
| 0.071 | 1230[c] | 1530[c,d] | ... | ... | ... |
| 0.080 | 1365[c] | 1700[c] | ... | ... | ... |
| 0.090 | 1525[c] | 1885[c] | ... | ... | ... |
| 0.100 | 1678[c] | 2065[c] | 2800[c,d] | ... | ... |
| 0.125 | 1678 | 2530[c] | 3400[c] | 4165[c,d] | ... |
| 0.160 | 1678 | 2620[c] | 4255[c] | 5190[c] | 6350[c,d] |
| 0.190 | ... | 2620 | 4500[c] | 6000[c] | 7395[c] |
| 0.250 | ... | ... | 4500 | 6000 | 9625[c] |
| 0.312 | ... | ... | ... | ... | 9750 |
| 0.375 | ... | ... | ... | ... | 9750 |
| Fastener shear strength[e] | 1678 | 2620 | 4500 | 6000 | 9750 |
| | Yield Strength[f], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.063 | 500 | ... | ... | ... | ... |
| 0.071 | 601 | 647 | ... | ... | ... |
| 0.080 | 711 | 788 | ... | ... | ... |
| 0.090 | 802 | 941 | ... | ... | ... |
| 0.100 | 887 | 1085 | 1255 | ... | ... |
| 0.125 | 1105 | 1340 | 1770 | 1930 | ... |
| 0.160 | 1405 | 1700 | 2250 | 2720 | 3055 |
| 0.190 | ... | 2020 | 2655 | 3200 | 3890 |
| 0.250 | ... | ... | 3480 | 4185 | 5020 |
| 0.312 | ... | ... | ... | ... | 6280 |
| 0.375 | ... | ... | ... | ... | 7520 |
| Head height (ref.), in. | 0.069 | 0.077 | 0.102 | 0.134 | 0.160 |

a Data supplied by Monogram Aerospace Fasteners.

b Fasteners installed in 0.165/0.166, 0.200/0.201, 0.261/0.262, 0.312/0.313, 0.375/0.376 inch holes.

c Yield value is less than 2/3 of the indicated ultimate strength value.

d Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

e Fastener shear strength is documented in NAS1675.

f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.3.2.3(h). Static Joint Strength of Blind 100° Flush Head Aluminum Alloy Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | NAS1674-L[a] | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.163) | (0.198) | (0.259) |
| | Ultimate Strength, lbs | | |
| Sheet thickness, in.: | | | |
| 0.050 | 548[c] | ... | ... |
| 0.063 | 756[c] | 853 | ... |
| 0.071 | 882[c] | 1010 | ... |
| 0.080 | 960 | 1185 | ... |
| 0.090 | ... | 1375 | 1645 |
| 0.100 | ... | 1550 | 1900 |
| 0.125 | ... | ... | 2535 |
| 0.160 | ... | ... | 2650 |
| Fastener shear strength[d] | 960 | 1550 | 2650 |
| | Yield Strength[e], lbs | | |
| Sheet thickness, in.: | | | |
| 0.050 | 356 | ... | ... |
| 0.063 | 481 | 666 | ... |
| 0.071 | 561 | 774 | ... |
| 0.080 | 650 | 892 | ... |
| 0.090 | ... | 1025 | 1275 |
| 0.100 | ... | 1155 | 1450 |
| 0.125 | ... | ... | 1880 |
| 0.160 | ... | ... | 2480 |
| Head height (ref.), in. | 0.049 | 0.061 | 0.088 |

a Data supplied by Monogram Aerospace Fasteners.
b Fasteners installed in 0.165/0.166, 0.199/0.200, 0.260/0.261 inch holes.
c Yield value is less than 2/3 of the indicated ultimate strength value.
d Fastener shear strength is documented in NAS1675.
e Permanent set at yield load: 4% of nominal diameter.

**8.1.4 SWAGED COLLAR/UPSET-PIN FASTENERS** — The strengths shown in the following tables are applicable only when grip lengths and hole tolerances are as recommended by respective fastener manufacturers. For some fastener systems, permanent set at yield load may be increased if hole sizes greater than those listed in the applicable table are used. This condition may exist even though the test hole size lies within the manufacturer's recommended hole size range (refer to Section 9.4.1.3.3).

The ultimate allowable shear load for lockbolts and lockbolt stumps may be obtained from Table 8.1.4 for the appropriate shear stress level. Tensile strengths of lockbolts and lockbolt stumps also are contained in Table 8.1.4.

For lockbolts under combined loading of shear and tension installed in material having a thickness large enough to make the shear cutoff strength critical for shear loading, the following interaction equations are applicable:

Steel lockbolts, $R_t + R_s^{10} = 1.0$
7075-T6 lockbolts, $R_t + R_s^{5} = 1.0$

where $R_t$ and $R_s$ are the ratios of applied load to allowable load in tension and shear, respectively.

Unless otherwise specified, yield load is defined in Section 9.4.1.3.3 as the load which results in a joint permanent set equal to 4% D, where D is the decimal equivalent of the fastener shank diameter, as defined in 9.4.1.2(a).

**8.1.4.1 *Protruding-Head Swaged Collar Fastener Joints*** — Tables 8.1.4.1(a) and (b) contain joint allowables for various protruding-head swaged collar fastener/sheet material combinations. It has been shown that protruding shear head (representative configurations are NAS 2406 to NAS 2412 and M43859/1) fastener joints may not develop the full bearing strength of joint material. Therefore, static allowable loads for protruding shear head fasteners must be established from test data using the criteria specified in Section 9.4.1. For shear joints with protruding tension head fasteners, the load per fastener at which shear or bearing type of failure occurs is calculated separately and the lower of the two governs the design. Allowable shear loads are obtained from Table 8.1.4.

The design bearing stresses for various materials at room and other temperatures are given in strength properties stated for each alloy or group of alloys, and are applicable to joints with pins in cylindrical holes and where $t/D \geq 0.18$. Where $t/D < 0.18$, tests to substantiate yield and ultimate bearing strengths must be performed. These bearing stresses are applicable only for design of rigid joints where there is no possibility of relative motion of the parts joined without deformation of such parts.

For convenience, "unit" sheet bearing strengths for pins, based on bearing stress of 100 ksi and nominal fastener diameters, are given in Table 8.1.5.1. The strength for a specific combination of fastener, sheet thickness, and sheet material is obtained by multiplying the proper "unit" strength by the ratio of material allowable bearing stress (ksi) to 100.

**8.1.4.2 *Flush-Head Swaged Collar Fastener Joints*** — Tables 8.1.4.2(a) through (j) contain joint allowables for various flush-head swaged collar fastener/sheet material combinations. The allowable loads for flush-head swaged collar fasteners were established from test data using the following criteria, unless otherwise noted in the footnotes of individual tables.

*Ultimate Load* — Design allowable ultimate load as defined in Section 9.7.1.5. Prior to 2003 this value was computed as the average ultimate test load divided by a factor of 1.15. This factor is not applicable to shear strength cutoff values which may be either the procurement specification shear strength (S value) of the fastener or, if no specification exists, a statistical value determined from test results.

The allowable loads shown for flush-head swaged collar fasteners are applicable to joints having e/D equal to or greater than 2.0.

For machine countersunk joints, the sheet gage specified in the tables is that of countersunk sheet. When the noncountersunk sheet is thinner than the countersunk sheet, the bearing allowable for the noncountersunk sheet-fastener combination should be computed, compared to the table value, and the lower of the two values selected.

**Table 8.1.4. Ultimate Single-Shear and Tensile Strengths of Lockbolts and Lockbolt Stumps[a]**

| Nominal Diameter (inches) | Heat Treated Alloy Steel[b](160 ksi) | | | 7075-T6[c] | |
|---|---|---|---|---|---|
| | Single-Shear Strength, lbs. | Tensile Strength, lbs. | | Single-Shear Strength, lbs. | Tensile Strength, lbs. |
| | | Tensile Type[d] | Shear Type[e] | Tensile Type[d] | |
| | | NAS 1456 thru 1462<br>NAS 1465 thru 1472<br>NAS 1475 thru 1482<br>NAS 1486 thru 1492<br>NAS 1496 thru 1502 | NAS 1414 thru 1422<br>NAS 1424 thru 1432<br>NAS 1436 thru 1442<br>NAS 1446 thru 1452 | NAS 1516 thru 1522<br>NAS 1525 thru 1532<br>NAS 1535 thru 1542<br>NAS 1546 thru 1552<br>NAS 1556 thru 1562 | |
| 5/32 . . . . . | 2007[f]/1822[g] | 1100[f] | 705[g] | 960[f] | 740[f] |
| 3/16 . . . . . | 2623 | 2210 | 1105 | 1260 | 1195 |
| 1/4 . . . . . | 4660 | 4080 | 2040 | 2185 | 2200 |
| 5/16 . . . . . | 7290 | 6500[d] | 3250 | 3450 | 3500 |
| 3/8 . . . . . | 10490 | 10100[h] | 5050 | 4970 | 5455 |

a Lockbolts are pull-gun driven; lockbolt stumps are hammer or squeeze driven.
b Used with 2024-T4 aluminum alloy collar, NAS 1080.
c Used with 6061-T6 aluminum alloy collar.
d Tensile type have a higher head and more grooves than the shear type and can be either protruding or 100° flush head. Strength value listed refers to lowest strength fastener configuration within this type.
e Shear type have shorter head and less grooves than the tensile type and can be either protruding or 100° flush head. Strength values listed refer to lowest strength fastener configuration within this type.
f Available as lockbolt only (0.164 dia. for #8 lockbolts).
g Available as lockbolt stump only (0.156 dia. for 5/32 stumps).
h Five groove design on lockbolts.

**Table 8.1.4.1(a). Static Joint Strength of Protruding Shear Head Ti-6Al-4V Cherrybuck Fasteners in Aluminum Alloy Sheet**

| Fastener Type | CSR 925[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.)[b] | 5/32 (0.164) | 3/16 (0.190) | 1/4 (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 995 | ... | ... |
| 0.063 | 1227 | 1442 | ... |
| 0.071 | 1371 | 1607 | ... |
| 0.080 | 1532 | 1792 | 2415 |
| 0.090 | 1711 | 2001 | 2688 |
| 0.100 | 1890 | 2205 | 2960 |
| 0.125 | 2007 | 2694 | 3641 |
| 0.160 | ... | ... | 4595 |
| 0.190 | ... | ... | 4660 |
| Fastener shear strength[c] | 2007 | 2694 | 4660 |
| | Yield Strength[d], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 861 | ... | ... |
| 0.063 | 1013 | 1225 | ... |
| 0.071 | 1107 | 1334 | ... |
| 0.080 | 1213 | 1455 | 2067 |
| 0.090 | 1331 | 1592 | 2246 |
| 0.100 | 1448 | 1727 | 2425 |
| 0.125 | 1741 | 2068 | 2873 |
| 0.160 | ... | ... | 3499 |
| 0.190 | ... | ... | 4036 |

a Data supplied by Cherry Fasteners.
b Fasteners installed in clearance holes (0.0005" - 0.002").
c Fastener shear strength based on area computed from nominal shank diameters in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.1(b). Static Joint Strength of Protruding Shear Head Ti-6Al-4V Cherrybuck Fasteners in Aluminum Alloy Sheet**

| Fastener Type | CSR 925[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 807 | ... | ... |
| 0.063 | 1020 | 1180 | ... |
| 0.071 | 1150 | 1335 | ... |
| 0.080 | 1300 | 1505 | 1970 |
| 0.090 | 1465 | 1695 | 2220 |
| 0.100 | 1630 | 1885 | 2470 |
| 0.125 | 2007 | 2360 | 3095 |
| 0.160 | ... | 2694 | 3975 |
| 0.190 | ... | ... | 4660 |
| Fastener shear strength[c] | 2007 | 2694 | 4660 |
| | Yield Strength[d], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 619 | ... | ... |
| 0.063 | 747 | 889 | ... |
| 0.071 | 827 | 981 | ... |
| 0.080 | 916 | 1085 | 1495 |
| 0.090 | 1015 | 1200 | 1645 |
| 0.100 | 1115 | 1315 | 1795 |
| 0.125 | 1360 | 1600 | 2175 |
| 0.160 | ... | 2000 | 2705 |
| 0.190 | ... | ... | 3155 |

a Data supplied by Cherry Fasteners.
b Fasteners installed in clearance holes (0.0005" - 0.002").
c Fastener shear strength based on area computed from nominal diameters in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(a). Static Joint Strength of 100° Flush Shear Head Alloy Steel Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | NAS 1436-1442[a] ($F_{su}$ = 95 ksi) | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.071 | 1684 | ... | ... | ... |
| 0.080 | 1875 | ... | ... | ... |
| 0.090 | 2077 | ... | ... | ... |
| 0.100 | 2286 | 3075 | ... | ... |
| 0.125 | 2620 | 3750 | 4811 | ... |
| 0.160 | ... | 4625 | 5994[b] | 7350 |
| 0.190 | ... | 4650 | 6993 | 8554 |
| 0.250 | ... | ... | 7300 | 10435 |
| 0.312 | ... | ... | ... | 10500 |
| Fastener shear strength[c] | 2620 | 4650 | 7300 | 10500 |
| | Yield Strength[d], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.071 | 1405 | ... | ... | ... |
| 0.080 | 1598 | ... | ... | ... |
| 0.090 | 1717 | ... | ... | ... |
| 0.100 | 1850 | 2395 | ... | ... |
| 0.125 | 2232 | 2790 | 3327 | ... |
| 0.160 | ... | 3415 | 3851 | 5656 |
| 0.190 | ... | 3765 | 4666 | 6342 |
| 0.250 | ... | ... | 5248 | 7910 |
| 0.312 | ... | ... | ... | 8946 |
| Head height (max.), in. | 0.049 | 0.063 | 0.071 | 0.081 |

a Data supplied by Huck Manufacturing Company.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Fastener shear strength is documented in NAS 1413.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.4.2(b). Static Joint Strength of 100° Flush Shear/Tension Head Alloy Steel Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | NAS 7024-7032[a,b] ($F_{su}$ = 108 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | | |
| Fastener Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in.) | (0.125) | (0.156) | (0.190) | (0.250) | (0.312) | (0.375) |
| | Ultimate Strength, lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.040 | 563[c] | ... | ... | ... | ... | ... |
| 0.050 | 846[d] | 881[c] | 1071[c] | ... | ... | ... |
| 0.063 | 1040[d] | 1341[d] | 1398 | ... | ... | ... |
| 0.071 | 1147 | 1494[d] | 1743[d] | 2001[c] | ... | ... |
| 0.080 | 1231 | 1645[d] | 2083[d] | 2256 | ... | ... |
| 0.090 | 1289 | 1813 | 2288[d] | 2823 | 3071[c] | ... |
| 0.100 | 1325 | 1921 | 2493[d] | 3390[d] | 3425 | 4225[c] |
| 0.125 | ... | 2070 | 2878 | 4140[d] | 5200[d] | 5500 |
| 0.160 | ... | ... | 3060 | 4930 | 6490 | 8080[d] |
| 0.190 | ... | ... | ... | 5280 | 7530 | 8725[d] |
| 0.250 | ... | ... | ... | 5300 | 7870 | 10010 |
| 0.312 | ... | ... | ... | ... | 8220 | 11270 |
| 0.324 | ... | ... | ... | ... | 8280 | 11340 |
| 0.375 | ... | ... | ... | ... | ... | 11620 |
| 0.433 | ... | ... | ... | ... | ... | 11930 |
| Fastener shear strength[e] | 1325 | 2070 | 3060 | 5300 | 8280 | 11930 |
| | Yield Strength[f], lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.040 | 426 | ... | ... | ... | ... | ... |
| 0.050 | 537 | 666 | 804 | ... | ... | ... |
| 0.063 | 682 | 846 | 1024 | ... | ... | ... |
| 0.071 | 770 | 957 | 1159 | 1508 | ... | ... |
| 0.080 | 870 | 1082 | 1311 | 1708 | ... | ... |
| 0.090 | 981 | 1221 | 1430 | 1931 | 2392 | ... |
| 0.100 | 1092 | 1360 | 1649 | 2152 | 2669 | 3177 |
| 0.125 | ... | 1705 | 2071 | 2709 | 3363 | 4010 |
| 0.160 | ... | ... | 2595 | 3486 | 4340 | 4975 |
| 0.190 | ... | ... | ... | 4050 | 5170 | 5760 |
| 0.250 | ... | ... | ... | 4140 | 6210 | 7340 |
| 0.312 | ... | ... | ... | ... | 7040 | 8730 |
| 0.324 | ... | ... | ... | ... | 7200 | 8810 |
| 0.375 | ... | ... | ... | ... | ... | 9160 |
| 0.433 | ... | ... | ... | ... | ... | 9560 |
| Head height (ref.), in. | 0.042 | 0.050 | 0.060 | 0.077 | 0.094 | 0.111 |

a Data supplied by Huck Manufacturing Company.

b Used with NAS1080K aluminum alloy collar.

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Yield value is less than 2/3 of indicated ultimate strength value.

e Fastener shear strength is documented in NAS1413.

f Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.4.2(c). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Cherrybuck Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | CSR 924[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 941 | ... | ... |
| 0.063 | 1207 | 1383 | ... |
| 0.071 | 1385 | 1588 | ... |
| 0.080 | 1557 | 1779 | 2281 |
| 0.090 | 1775 | 2050 | 2594 |
| 0.100 | 1876 | 2263 | 2919 |
| 0.125 | 1950 | 2542 | 3765 |
| 0.160 | 2007 | 2660 | 4387 |
| 0.190 | ... | 2694 | 4525 |
| 0.250 | ... | ... | 4660 |
| Fastener shear strength[b] | 2007 | 2694 | 4660 |
| | Yield Strength[c], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 659 | ... | ... |
| 0.063 | 887 | 985 | ... |
| 0.071 | 1022 | 1148 | ... |
| 0.080 | 1116 | 1325 | 1625 |
| 0.090 | 1189 | 1480 | 1894 |
| 0.100 | 1257 | 1545 | 2162 |
| 0.125 | 1393 | 1733 | 2619 |
| 0.160 | 1608 | 1978 | 2950 |
| 0.190 | ... | 2191 | 3231 |
| 0.250 | ... | ... | 3794 |
| Head height (ref.), in. | 0.034 | 0.046 | 0.060 |

a Data supplied by Cherry Fasteners.
b Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
c Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(d). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Cherrybuck Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | CSR 924[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 737 | ... | ... |
| 0.063 | 1019 | 1118 | ... |
| 0.071 | 1152 | 1319 | ... |
| 0.080 | 1279[c] | 1509 | 1837 |
| 0.090 | 1419[c] | 1673[c] | 2168 |
| 0.100 | 1560[c] | 1834[c] | 2500 |
| 0.125 | 1898[c] | 2242[c] | 3036[c] |
| 0.160 | 2007[c] | 2680[c] | 3786[c] |
| 0.190 | ... | 2694 | 4404[c] |
| 0.250 | ... | ... | 4660 |
| Fastener shear strength[d] | 2007 | 2694 | 4660 |
| | Yield Strength[e], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 511 | ... | ... |
| 0.063 | 712 | 778 | ... |
| 0.071 | 786 | 922 | ... |
| 0.080 | 840 | 1039 | 1276 |
| 0.090 | 900 | 1109 | 1513 |
| 0.100 | 960 | 1178 | 1750 |
| 0.125 | 1110 | 1352 | 1979 |
| 0.160 | 1321 | 1596 | 2300 |
| 0.190 | ... | 1805 | 2575 |
| 0.250 | ... | ... | 3125 |
| Head height (ref.), in. | 0.034 | 0.046 | 0.060 |

a Data supplied by Cherry Fasteners.
b Fasteners installed in clearance holes (0.0005 - 0.002).
c Yield load is less than 2/3 of indicated ultimate.
d Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(e). Static Joint Strength of 100° Flush Shear Head A-286 Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | HSR201[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | 7075-T6 | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 1055 | 1095 | ... |
| 0.063 | 1330 | 1545 | 2030 |
| 0.071 | 1500 | 1740 | 2285 |
| 0.080 | 1690 | 1955 | 2575 |
| 0.090 | 1900 | 2200 | 2895 |
| 0.100 | 2007 | 2445 | 3220 |
| 0.125 | ... | 2694 | 4025 |
| 0.160 | ... | ... | 4660 |
| Fastener shear strength[c] | 2007 | 2694 | 4660 |
| | Yield Strength[d], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 835 | 870 | ... |
| 0.063 | 1055 | 1225 | 1605 |
| 0.071 | 1185 | 1380 | 1810 |
| 0.080 | 1340 | 1550 | 2040 |
| 0.090 | 1505 | 1745 | 2295 |
| 0.100 | 1675 | 1940 | 2550 |
| 0.125 | ... | 2420 | 3190 |
| 0.160 | ... | ... | 4180 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 |

a Data supplied by Hi-Shear Corporation.
b Hole Size: Fastener installed in 0.000 interference to 0.005 clearance.
c Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(f). Static Joint Strength of 100° Flush Shear Head Ti-8Mo-8V-2Fe-3Al Rivets in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | HSR101[a] ($F_{su}$ = 95 ksi) | | |
|---|---|---|---|
| Sheet Material | 7075-T6 | | |
| Rivet Diameter, in. | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 1040 | 1205 | ... |
| 0.063 | 1310 | 1520 | 2000 |
| 0.071 | 1480 | 1715 | 2255 |
| 0.080 | 1665 | 1930 | 2540 |
| 0.090 | 1875 | 2170 | 2855 |
| 0.100 | 2007 | 2410 | 3175 |
| 0.125 | ... | 2694 | 3965 |
| 0.160 | ... | ... | 4660 |
| Rivet shear strength[c] | 2007 | 2694 | 4660 |
| | Yield Strength[d], lbs. | | |
| Sheet thickness, in.: | | | |
| 0.050 | 797 | 921 | ... |
| 0.063 | 1005 | 1165 | 1530 |
| 0.071 | 1130 | 1310 | 1725 |
| 0.080 | 1275 | 1475 | 1945 |
| 0.090 | 1435 | 1660 | 2185 |
| 0.100 | 1595 | 1845 | 2430 |
| 0.125 | ... | 2310 | 3035 |
| 0.160 | ... | ... | 3885 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 |

a Data supplied by Hi-Shear Corporation.
b Hole Size: Fastener installed in 0.000 interference to 0.005 clearance.
c Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and 1/4 = 0.250 and $F_{su}$ = 95 ksi.
d Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(g). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Rivet Type | GPL3SC-V Pin[a,b] ($F_{su}$ = 95 ksi), 2SC-3C Collar | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter, in. | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in)[c] | (0.190) | (0.250) | (0.312) | (0.375) |
| | Ultimate Strength, lbs. | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 1105 | ... | ... | ... |
| 0.063 | 1500 | 1800[d] | ... | ... |
| 0.071 | 1740 | 2125 | 2430 | ... |
| 0.080 | 2020 | 2485 | 2865 | 3170[d] |
| 0.090 | 2200 | 2885 | 3365 | 3780 |
| 0.100 | 2355 | 3310 | 3865 | 4390 |
| 0.125 | 2694 | 3945 | 5135 | 5880 |
| 0.160 | ... | 4660 | 6245 | 8005 |
| 0.190 | ... | ... | 7010 | 8955 |
| 0.250 | ... | ... | 7290 | 10490 |
| Rivet shear strength[e] | 2694 | 4660 | 7290 | 10490 |
| | Yield Strength[f], lbs. | | | |
| Sheet thickness, in.: | | | | |
| 0.050 | 948 | ... | ... | ... |
| 0.063 | 1160 | 1585 | ... | ... |
| 0.071 | 1290 | 1755 | 2265 | ... |
| 0.080 | 1435 | 1945 | 2500 | 3090 |
| 0.090 | 1600 | 2160 | 2765 | 3415 |
| 0.100 | 1760 | 2375 | 3030 | 3740 |
| 0.125 | 2095 | 2910 | 3705 | 4535 |
| 0.160 | ... | 3585 | 4640 | 5670 |
| 0.190 | ... | ... | 5440 | 6635 |
| 0.250 | ... | ... | 6270 | 8230 |
| Head height (ref.), in. | 0.048 | 0.063 | 0.070 | 0.081 |

a Data supplied by Huck Manufacturing Company and Voi-Shan Industries.
b Aluminum coated per NAS 4006.
c Hole Size: Fastener installed in 0.005" interference to 0.0005" clearance.
d Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
e Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and 1/4 = 0.250 and $F_{su}$ = 95 ksi.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(h). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Rivet Type | GPL3SC-V Pin[a,b] ($F_{su}$ = 95 ksi), 2SC-3C Collar | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | |
| Rivet Diameter, in. | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in.)[c] | (0.190) | (0.250) | (0.312) | (0.375) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.050 | 938 | ... | ... | ... |
| 0.063 | 1255 | 1535[d] | ... | ... |
| 0.071 | 1455 | 1795 | 2085 | ... |
| 0.080 | 1680 | 2085 | 2440 | 2740[f] |
| 0.090 | 1920[e] | 2410 | 2845 | 3230 |
| 0.100 | 2080[e] | 2735 | 3245 | 3725 |
| 0.125 | 2460[e] | 3470[e] | 4270 | 4930 |
| 0.160 | 2694 | 4175[e] | 5505[e] | 6645 |
| 0.190 | ... | 4590[e] | 6260[e] | 7885[e] |
| 0.250 | ... | 4660 | 7230 | 9705[e] |
| 0.312 | ... | ... | 7290 | 10490 |
| 0.375 | ... | ... | ... | ... |
| Rivet shear strength[f] | 2694 | 4660 | 7290 | 10490 |
| Sheet thickness, in.: | Yield Strength[g], lbs. | | | |
| 0.050 | 777 | ... | ... | ... |
| 0.063 | 945 | 1285 | ... | ... |
| 0.071 | 1050 | 1435 | 1810 | ... |
| 0.080 | 1140 | 1590 | 2030 | 2440 |
| 0.090 | 1230 | 1760 | 2260 | 2750 |
| 0.100 | 1320 | 1910 | 2475 | 3065 |
| 0.125 | 1545 | 2205 | 2975 | 3705 |
| 0.160 | 1860 | 2620 | 3495 | 4475 |
| 0.190 | ... | 2975 | 3935 | 5010 |
| 0.250 | ... | 3685 | 4820 | 6075 |
| 0.312 | ... | ... | 5740 | 7175 |
| Head height (ref.), in. | 0.048 | 0.063 | 0.070 | 0.081 |

a Data supplied by Huck Manufacturing Company and Voi-Shan Industries.
b Aluminum coated per NAS 4006.
c Hole size: Fasteners installed in 0.005" interference to 0.0005" clearance.
d Values above line are for knife-edge condition and the use of fasteners in this condition is undersirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
e Yield load is less than 2/3 of indicated ultimate.
f Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
g Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(i). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Rivet Type | LGPL2SC-V Pin[a,b] ($F_{su}$ = 95 ksi), 3SLC-C Collar | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Rivet Diameter, in. | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in.)[c] | (0.190) | (0.250) | (0.312) | (0.375) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.050 | 1040 | ... | ... | ... |
| 0.063 | 1370 | 1710[d] | ... | ... |
| 0.071 | 1575 | 1980 | 2345 | ... |
| 0.080 | 1805 | 2280 | 2715 | 3105[d] |
| 0.090 | 2060 | 2615 | 3130 | 3620 |
| 0.100 | 2315 | 2950 | 3550 | 4130 |
| 0.125 | 2590 | 3790 | 4605 | 5375 |
| 0.160 | 2694 | 4430 | 6070 | 7150 |
| 0.190 | ... | 4660 | 6750 | 8660 |
| 0.250 | ... | ... | 7290 | 10154 |
| 0.312 | ... | ... | ... | 10490 |
| Rivet shear strength[e] | 2694 | 4660 | 7290 | 10490 |
| Sheet thickness, in.: | Yield Strength[f], lbs. | | | |
| 0.050 | 948 | ... | ... | ... |
| 0.063 | 1160 | 1585 | ... | ... |
| 0.071 | 1290 | 1755 | 2265 | ... |
| 0.080 | 1435 | 1945 | 2500 | 3090 |
| 0.090 | 1600 | 2160 | 2765 | 3415 |
| 0.100 | 1760 | 2375 | 3030 | 3740 |
| 0.125 | 2095 | 2910 | 3705 | 4535 |
| 0.160 | 2395 | 3585 | 4640 | 5670 |
| 0.190 | ... | 3900 | 5440 | 6635 |
| 0.250 | ... | ... | 6270 | 8230 |
| 0.312 | ... | ... | ... | 9255 |
| Head height (ref.), in. | 0.048 | 0.063 | 0.070 | 0.081 |

a Data supplied by Huck Manufacturing Company and Voi-Shan Industries.
b Aluminum coated per NAS 4006.
c Hole size: Fasteners installed in 0.005" interference to 0.0005" clearance.
d Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
e Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
f Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.4.2(j). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Lockbolt Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Rivet Type | LGPL2SC-V Pin[a,b] ($F_{su}$ = 95 ksi), 3SLC-C Collar | | | |
|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | |
| Rivet Diameter, in. | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in.)[c] | (0.190) | (0.250) | (0.312) | (0.375) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.050 | 836 | ... | ... | ... |
| 0.063 | 1180 | 1350[d] | ... | ... |
| 0.071 | 1395 | 1630 | 1775 | ... |
| 0.080 | 1640 | 1950 | 2155 | 2270[d] |
| 0.090 | 1900[e] | 2300 | 2595 | 2800 |
| 0.100 | 2115[e] | 2650 | 3035 | 3335 |
| 0.125 | 2340 | 3530[e] | 4140 | 4640 |
| 0.160 | 2655 | 4000 | 5645[e] | 6500 |
| 0.190 | 2694 | 4355 | 6085 | 8080[e] |
| 0.250 | ... | 4660 | 6965 | 9180 |
| 0.312 | ... | ... | 7290 | 10270 |
| 0.375 | ... | ... | ... | 10490 |
| Rivet shear strength[f] | 2694 | 4660 | 7290 | 10490 |
| Sheet thickness, in.: | Yield Strength[g], lbs. | | | |
| 0.050 | 733 | ... | ... | ... |
| 0.063 | 901 | 1220 | ... | ... |
| 0.071 | 1005 | 1360 | 1745 | ... |
| 0.080 | 1125 | 1515 | 1930 | 2270 |
| 0.090 | 1250 | 1685 | 2140 | 2635 |
| 0.100 | 1380 | 1855 | 2355 | 2895 |
| 0.125 | 1640 | 2280 | 2895 | 3530 |
| 0.160 | 1910 | 2795 | 3640 | 4430 |
| 0.190 | 2140 | 3100 | 4230 | 5200 |
| 0.250 | ... | 3700 | 4985 | 6440 |
| 0.312 | ... | ... | 5760 | 7375 |
| 0.375 | ... | ... | ... | 8325 |
| Head height (ref.), in. | 0.048 | 0.063 | 0.070 | 0.081 |

a Data supplied by Huck Manufacturing Company and Voi-Shan Industries.
b Aluminum coated per NAS 4006.
c Hole size: Fasteners installed in 0.0005" interference to 0.0005" clearance.
d Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
e Yield load is less than 2/3 of indicated ultimate.
f Fastener shear strength based on area computed from nominal shank diameter in Table 9.7.1.1 and $F_{su}$ = 95 ksi.
g Permanent set at yield load: 4% of nominal diameter.

**8.1.5 THREADED FASTENERS** — The strengths shown in the following tables are applicable only when grip lengths and hole tolerances are as recommended by the respective fastener manufacturers. For some fastener systems, permanent set at yield load may be increased if hole sizes greater than those listed in the applicable table are used. This condition may exist even though the test hole size lies within the manufacturer's recommended hole size range (refer to Section 9.7.1.1).

The ultimate single shear strength of threaded fasteners at full diameter is shown in Table 8.1.5(a). The ultimate tensile strength of threaded fasteners is shown in Tables 8.1.5($b_1$) and ($b_2$). In both tables values shown are a product of the indicated strength and area, with the area based on the following:

*Shear* — Based on basic shank diameter.

*Tension* — Based on the nominal minor diameter of the thread as published in Table 2.21 of Handbook H-28.

For any given threaded fastener the allowable load shall be chosen using an appropriate category corresponding to minimum tensile strength, shear strength, or other requirements of the pertinent procurement specification.

It is recognized that some procurement specifications may provide higher tensile strengths than those reported in Tables 8.1.5($b_1$) and ($b_2$), since they may be based on a larger effective area than shown in the table. The values listed herein have been judged acceptable for design, acknowledging that they may be slightly conservative since they are based on the nominal minor diameter area.

Unless otherwise specified, the yield load is defined in Section 9.7.1.1 for threaded fasteners as the load at which the joint permanent is set equal to 0.04D, where D is the decimal equivalent of the fastener shank diameter as defined in Table 9.4.1.2(a).

**8.1.5.1 *Protruding-Head Threaded Fastener Joints*** — It has been shown that protruding shear head (representative configuration is NAS 1982) fastener joints may not develop the full bearing strength of the joint material. Therefore, static allowable loads for protruding shear head fasteners must be established from test data using the criteria specified in Section 9.7. For shear joints with protruding tension head fasteners, the load per fastener at which shear or bearing type of failure occurs is separately calculated, and the lower of the two values so determined governs the design. Allowable shear loads may be obtained from Table 8.1.5(a).

The design bearing stresses for various materials at room and other temperatures are given in the properties for each alloy or group of alloys, and are applicable to joints with fasteners in cylindrical holds and where $t/D \geq 0.18$. Where $t/D < 0.18$, tests to substantiate yield and ultimate bearing strengths must be performed. These bearing stresses are applicable only for design of rigid joints where there is no possibility of relative motion of the parts joined without deformation of such parts.

For convenience, "unit" sheet bearing strengths for threaded fasteners, based on a strength of 100 ksi and nominal fastener diameters, are given in Table 8.1.5.1. The strength for a specific combination of fasteners, sheet thickness, and sheet material is obtained by multiplying the proper "unit" strength by the ratio of material allowable bearing stress (ksi) to 100.

The following interaction formula is applicable to AN3 series bolts under combined shear and tension loading: $R_s^3 + R_t^2 = 1.0$, where $R_s$ and $R_t$ are ratios of applied load to allowable load in shear and tension, respectively.

**8.1.5.2** ***Flush-Head Threaded Fastener Joints*** — Tables 8.1.5.2(a) through (o) contain joint allowables for various flush-head threaded fastener/sheet material combinations. Unless otherwise noted, the allowable loads for flush-head threaded fasteners were established from test data using the following criteria;

*Ultimate Load* — Design allowable ultimate load as defined in Section 9.7.1.5. Prior to 2003 this value was computed as the average ultimate test load divided by a factor of 1.15. This factor is not applicable to shear strength cutoff values which may be either procurement specification shear strength (S value) of the fastener or, if no specification exists, a statistical value determined from test results. It should coincide with shear values from Table 8.1.5(a).

The allowables shown for flush-head threaded fasteners are applicable to joints having e/D equal to or greater than 2.0.

For machine countersunk joints, the sheet gage specified in the tables is that of the countersunk sheet. When the noncountersunk sheet is thinner than the countersunk sheet, the bearing allowable for the noncountersunk sheet-fastener combination should be computed, compared to the table value, and the lower of the two values selected.

## Table 8.1.5(a). Ultimate Single Shear Strength of Threaded Fasteners

| Shear Stress of Fastener, ksi | | | 35 | 38 | 75 | 90 | 95 | 108 | 125 | 132 | 145 | 156 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fastener Diameter | | Basic Shank | | | | | | | | | | |
| in. | Size[a] | Area | Ultimate Single Shear Strength, lbs. | | | | | | | | | |
| 0.112 | #4 | 0.0098520 | 345 | 374 | 739 | 887 | 936 | 1060 | 1230 | 1300 | 1425 | 1535 |
| 0.125 | 1/8 | 0.012272 | 430 | 466 | 920 | 1105 | 1165 | 1325 | 1530 | 1620 | 1775 | 1910 |
| 0.138 | #6 | 0.014957 | 523 | 568 | 1120 | 1345 | 1420 | 1615 | 1870 | 1970 | 2165 | 2330 |
| 0.156 | 5/32 | 0.019175 | 671 | 729 | 1435 | 1725 | 1820 | 2070 | 2395 | 2530 | 2780 | 2990 |
| 0.164 | #8 | 0.021124 | 739 | 803 | 1580 | 1900 | 2005 | 2280 | 2640 | 2785 | 3060 | 3295 |
| 0.188 | 3/16 | 0.027612 | 966 | 1045 | 2070 | 2485 | 2620 | 2980 | 3450 | 3645 | 4005 | 4310 |
| 0.190 | #10 | 0.028353 | 992 | 1075 | 2125 | 2550 | 2690 | 3060 | 3540 | 3740 | 4110 | 4420 |
| 0.216 | #12 | 0.036644 | 1280 | 1390 | 2745 | 3295 | 3480 | 3955 | 4580 | 4840 | 5315 | 5720 |
| 0.219 | 7/32 | 0.037582 | 1315 | 1425 | 2815 | 3380 | 3570 | 4060 | 4700 | 4960 | 5445 | 5860 |
| 0.250 | 1/4 | 0.049087 | 1715 | 1865 | 3680 | 4420 | 4660 | 5300 | 6140 | 6480 | 7115 | 7660 |
| 0.312 | 5/16 | 0.076699 | 2680 | 2915 | 5750 | 6900 | 7290 | 8280 | 9590 | 10100 | 11100 | 11950 |
| 0.375 | 3/8 | 0.11045 | 3865 | 4200 | 8280 | 9935 | 10450 | 11900 | 13800 | 14550 | 16000 | 17200 |
| 0.438 | 7/16 | 0.15033 | 5260 | 5710 | 11250 | 13500 | 14250 | 16200 | 18750 | 19800 | 21750 | 23450 |
| 0.500 | 1/2 | 0.19635 | 6870 | 7460 | 14700 | 17650 | 18650 | 21200 | 24500 | 25900 | 28450 | 30600 |
| 0.562 | 9/16 | 0.24850 | 8700 | 9440 | 18600 | 22350 | 23600 | 26800 | 31050 | 32800 | 36000 | 38750 |
| 0.625 | 5/8 | 0.30680 | 10700 | 11650 | 23000 | 27600 | 29150 | 33100 | 38350 | 40500 | 44500 | 47900 |
| 0.750 | 3/4 | 0.44179 | 15450 | 16750 | 33100 | 39750 | 42000 | 47700 | 55200 | 58300 | 64000 | 68900 |
| 0.875 | 7/8 | 0.60132 | 21050 | 22850 | 45100 | 54100 | 57100 | 64900 | 75200 | 79400 | 87200 | 93800 |
| 1.000 | 1 | 0.78540 | 27450 | 29850 | 58900 | 70700 | 74600 | 84800 | 98200 | 103500 | 113500 | 122500 |
| 1.125 | 1-1/8 | 0.99402 | 34750 | 37750 | 74600 | 89500 | 94400 | 107000 | 124000 | 131000 | 144000 | 155000 |
| 1.250 | 1-1/4 | 1.2272 | 43000 | 46600 | 92000 | 110000 | 116500 | 132500 | 153000 | 162000 | 177500 | 191000 |
| 1.375 | 1-3/8 | 1.4849 | 52000 | 56400 | 111000 | 133500 | 141000 | 160000 | 185500 | 196000 | 215000 | 231500 |
| 1.500 | 1-1/2 | 1.7671 | 61800 | 67100 | 132500 | 159000 | 167500 | 190500 | 220500 | 233000 | 256000 | 275500 |

a Fractional equivalent or screw number.

**Table 8.1.5($b_1$). Ultimate Tensile Strength of Threaded Fasteners**

| Tensile Stress of Fastener, ksi | | | 55 | 62 | 62.5 | 125 | 140 | 160 | 180 |
|---|---|---|---|---|---|---|---|---|---|
| Fastener Diameter | | Nominal Minor | MIL-S-7742 | | | | | | |
| in. | Size[a] | Area[b] | Ultimate Tensile Strength, lbs.[c,d] | | | | | | |
| 0.112 | 4-40 | 0.0050896 | 280 | 316 | 318 | 636 | 713 | 814 | 916 |
| 0.138 | 6-32 | 0.0076821 | 423 | 476 | 480 | 960 | 1075 | 1225 | 1380 |
| 0.164 | 8-32 | 0.012233 | 673 | 758 | 765 | 1525 | 1710 | 1955 | 2200 |
| 0.190 | 10-32 | 0.018074 | 994 | 1120 | 1130 | 2255 | 2530 | 2890 | 3250 |
| 0.250 | 1/4-28 | 0.033394 | 1835 | 2070 | 2085 | 4170 | 4680 | 5340 | 6010 |
| 0.312 | 5/16-24 | 0.053666 | 2950 | 3325 | 3350 | 6710 | 7510 | 8590 | 9660 |
| 0.375 | 3/8-24 | 0.082397 | 4530 | 5110 | 5150 | 10300 | 11500 | 13150 | 14800 |
| 0.438 | 7/16-20 | 0.11115 | 6110 | 6890 | 6950 | 13850 | 15550 | 17750 | 20000 |
| 0.500 | 1/2-20 | 0.15116 | 8310 | 9370 | 9450 | 18900 | 21150 | 24150 | 27200 |
| 0.562 | 9/16-18 | 0.19190 | 10550 | 11900 | 11950 | 23950 | 26850 | 30700 | 34500 |
| 0.625 | 5/8-18 | 0.24349 | 13350 | 15100 | 15200 | 30400 | 34050 | 38950 | 43800 |
| 0.750 | 3/4-16 | 0.35605 | 19550 | 22050 | 22250 | 44500 | 49800 | 57000 | 64100 |
| 0.875 | 7/8-14 | 0.48695 | 26750 | 30150 | 30400 | 60900 | 68200 | 77900 | 87700 |
| 1.000 | 1-12 | 0.63307 | 34800 | 39250 | 39550 | 79100 | 88600 | 101000 | 114000 |
| 1.125 | 1-1/8-12 | 0.82162 | 45200 | 50900 | 51400 | 102500 | 115000 | 131500 | 147500 |
| 1.250 | 1-1/4-12 | 1.0347 | 56900 | 64200 | 64700 | 129000 | 144500 | 165500 | 186000 |
| 1.375 | 1-3/8-12 | 1.2724 | 70000 | 78900 | 79500 | 159000 | 178000 | 203500 | 229000 |
| 1.500 | 1-1/2-12 | 1.5345 | 84400 | 95100 | 95900 | 191500 | 214500 | 245500 | 276000 |

a Fractional equivalent or number and threads per inch.
b The tension fastener allowables above are based on the nominal minor diameter thread area for MIL-S-7742 threads from Table 2.2.1 of Handbook H-28.
c Values shown above heavy line are for 2A threads, all other values are for 3A threads.
d Nuts and fastener heads designed to develop the ultimate tensile strength of the fastener are required to develop the tabulated tension loads.

**Table 8.1.5($b_2$). Ultimate Tensile Strength of Threaded Fasteners (Continued)**

| Tensile Stress of Fastener, ksi | | | 160 | 180 | 220 | 260 |
|---|---|---|---|---|---|---|
| Fastener Diameter | | Maximum Minor | MIL-S-8879 | | | |
| in. | Size[a] | Area[b] | Ultimate Tensile Strength, lbs.[c,d] | | | |
| 0.112 | 4-40 | 0.0054367 | 869 | 979 | 1195 | 1410 |
| 0.138 | 6-32 | 0.0081553 | 1305 | 1465 | 1790 | 2120 |
| 0.164 | 8-32 | 0.012848 | 2055 | 2310 | 2825 | 3340 |
| 0.190 | 10-32 | 0.018602 | 2975 | 3345 | 4090 | 4840 |
| 0.250 | 1/4-28 | 0.034241 | 5480 | 6160 | 7530 | 8900 |
| 0.312 | 5/16-24 | 0.054905 | 8780 | 9880 | 12050 | 14250 |
| 0.375 | 3/8-24 | 0.083879 | 13400 | 15100 | 18450 | 21800 |
| 0.438 | 7/16-20 | 0.11323 | 18100 | 20350 | 24900 | 29400 |
| 0.500 | 1/2-20 | 0.15358 | 24550 | 27600 | 33750 | 39900 |
| 0.562 | 9/16-18 | 0.19502 | 31200 | 35100 | 42900 | 50700 |
| 0.625 | 5/8-18 | 0.24700 | 39500 | 44500 | 54300 | 64200 |
| 0.750 | 3/4-16 | 0.36082 | 57700 | 64900 | 79400 | 93800 |
| 0.875 | 7/8-14 | 0.49327 | 78900 | 88800 | 108500 | 128000 |
| 1.000 | 1-12 | 0.64156 | 102500 | 115500 | 141000 | 166500 |
| 1.125 | 1-1/8-12 | 0.83129 | 133000 | 149500 | 182500 | 216000 |
| 1.250 | 1-1/4-12 | 1.0456 | 167000 | 188000 | 230000 | 271500 |
| 1.375 | 1-3/8-12 | 1.2844 | 205500 | 231000 | 282500 | 333500 |
| 1.500 | 1-1/2-12 | 1.5477 | 247500 | 278500 | 340500 | 402000 |

a Fractional equivalent or number and threads per inch.
b The tension fastener allowables above are based on the maximum minor diameter thread area for MIL-S-8879 threads from Tables II and III of MIL-S-8879.
c Values are for 3A threads.
d Nuts and fastener heads designed to develop the ultimate tensile strength of the fastener are required to develop the tabulated tension loads.

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## Table 8.1.5.1. Unit Bearing Strength of Sheet and Plate in Joints With Threaded Fasteners or Pins; $F_{br}$ = 100 ksi

| | Unit Bearing Strength of Sheet for Fastener Diameter Indicated, lbs.[a] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fastener, Diameter, in. | 0.156 | 0.164 | 0.188 | 0.190 | 0.250 | 0.312 | 0.375 | 0.438 | 0.500 | 0.562 | 0.625 | 0.750 | 0.875 | 1.000 |
| Thickness, in. | | | | | | | | | | | | | | |
| 0.032 | 500 | 525 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.036 | 563 | 590 | 675 | 684 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.040 | 625 | 656 | 750 | 760 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.045 | 704 | 738 | 845 | 855 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.050 | 781 | 820 | 940 | 950 | 1250 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.063 | 985 | 1033 | 1180 | 1197 | 1575 | 1969 | ... | ... | ... | ... | ... | ... | ... | ... |
| 0.071 | 1110 | 1164 | 1330 | 1349 | 1775 | 2219 | 2662 | ... | ... | ... | ... | ... | ... | ... |
| 0.080 | 1250 | 1312 | 1500 | 1520 | 2000 | 2500 | 3000 | 3500 | ... | ... | ... | ... | ... | ... |
| 0.090 | 1407 | 1476 | 1690 | 1710 | 2250 | 2812 | 3375 | 3938 | 4500 | ... | ... | ... | ... | ... |
| 0.100 | 1562 | 1640 | 1875 | 1900 | 2500 | 3125 | 3750 | 4375 | 5000 | ... | ... | ... | ... | ... |
| 0.125 | 1953 | 2050 | 2340 | 2375 | 3125 | 3906 | 4688 | 5469 | 6250 | 7030 | 7812 | ... | ... | ... |
| 0.160 | 2500 | 2624 | 3000 | 3040 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 | 12000 | ... | ... |
| 0.200 | 3125 | 3280 | 3750 | 3800 | 5000 | 6250 | 7500 | 8750 | 10000 | 11250 | 12500 | 15000 | 17500 | 20000 |
| 0.250 | 3916 | 4100 | 4688 | 4750 | 6250 | 7812 | 9375 | 10940 | 12500 | 14060 | 15625 | 18750 | 21875 | 25000 |
| 0.312 | 4867 | 5117 | 5866 | 5928 | 7800 | 9734 | 11700 | 13670 | 15600 | 17530 | 19500 | 23400 | 27300 | 31200 |
| 0.375 | 5850 | 6150 | 7050 | 7125 | 9375 | 11700 | 14063 | 16425 | 18750 | 21075 | 23400 | 28125 | 32810 | 37500 |
| 0.500 | 7800 | 8200 | 9400 | 9500 | 12500 | 15600 | 18750 | 21900 | 25000 | 28100 | 31250 | 37500 | 43750 | 50000 |
| 0.625 | 9750 | 10250 | 11750 | 11875 | 15625 | 19500 | 23440 | 27375 | 31250 | 35125 | 39062 | 46875 | 54690 | 62500 |
| 0.750 | 11700 | 12300 | 14100 | 14250 | 18750 | 23400 | 28125 | 32850 | 37500 | 42150 | 46875 | 56250 | 65625 | 75000 |
| 0.875 | 13650 | 14350 | 16450 | 16625 | 21875 | 27300 | 32810 | 38325 | 43750 | 49175 | 56690 | 65625 | 76560 | 87500 |
| 1.000 | 15600 | 16400 | 18800 | 19000 | 25000 | 31200 | 37600 | 43800 | 50000 | 56200 | 62500 | 75000 | 87500 | 100000 |

a Bearing strengths shown are based on nominal fastener diameter.

**Table 8.1.5.2($a_1$). Static Joint Strength of 100° Flush Head Alloy Steel Screws in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | AN509[a] steel screw ($F_{su}$ = 75 ksi) w/MS20365 or equiv. steel nut | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 2024-T3 and T351 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) | ½ (0.500) |
| | Ultimate Strength[e], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.080 | 1576[b,c] | ... | ... | ... | ... |
| 0.090 | 1726[b] | ... | ... | ... | ... |
| 0.100 | 1877[b] | 2567[b,c] | ... | ... | ... |
| 0.125 | 2126[b] | 3054[b] | 3922[b,c] | 4579[b,c] | ... |
| 0.160 | ... | 3536[b] | 4722[b] | 5878[b] | ... |
| 0.190 | ... | 3682 | 5405[b] | 6872[b] | 9408[b,c] |
| 0.250 | ... | ... | 5750 | 8280[b] | 12201[b] |
| 0.312 | ... | ... | ... | 8280[b] | 14141[b] |
| 0.375 | ... | ... | ... | ... | 14730 |
| Fastener shear strength[d] | 2126 | 3682 | 5750 | 8280 | 14730 |
| | Yield Strength[e,f], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.080 | 903 | ... | ... | ... | ... |
| 0.090 | 989 | ... | ... | ... | ... |
| 0.100 | 1084 | 1490 | ... | ... | ... |
| 0.125 | 1296 | 1748 | 2001 | 2559 | ... |
| 0.160 | 1615 | 2116 | 2334 | 2939 | ... |
| 0.190 | ... | 2484 | 2702 | 3361 | 6012 |
| 0.250 | ... | ... | 3404 | 4197 | 7306 |
| 0.312 | ... | ... | ... | 5092 | 8452 |
| 0.375 | ... | ... | ... | ... | 9996 |
| Head height (ref.), in. | 0.080 | 0.106 | 0.133 | 0.159 | 0.213 |

a This fastener is no longer manufactured; do not specify for new designs.
b Yield value is less than 2/3 of the indicated ultimate strength value.
c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.
d Fastener shear strength based on area computed from nominal shank diameters in Table 9.7.1.1 and $F_{su}$ = 75 ksi.
e Test data from which the yield and ultimate strengths were derived can be found in Reference 8.1.5.2.
f Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2($a_2$). Static Joint Strength of 100° Flush Head Alloy Steel Screws in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | AN509[a] steel screw ($F_{su}$ = 75 ksi) w/MS20365 or equiv. steel nut | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) | ½ (0.500) |
| | Ultimate Strength[b], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.080 | 1632[c,d] | ... | ... | ... | ... |
| 0.090 | 1762[c] | ... | ... | ... | ... |
| 0.100 | 1892 | 2723[c,d] | ... | ... | ... |
| 0.125 | 2126 | 3109[c] | 4180[c,d] | 5216[c,d] | ... |
| 0.160 | ... | 3551[c] | 4858[c] | 6193[c] | ... |
| 0.190 | ... | 3682 | 5433[c] | 6996[c] | ... |
| 0.250 | ... | ... | 5750 | 8280[c] | 12421[c,d] |
| 0.312 | ... | ... | ... | 8280 | 14185[c] |
| 0.375 | ... | ... | ... | ... | 14730 |
| Fastener shear strength[e] | 2126 | 3682 | 5750 | 8280 | 14730 |
| | Yield Strength[b,f], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.080 | 965 | ... | ... | ... | ... |
| 0.090 | 1063 | ... | ... | ... | ... |
| 0.100 | 1179 | 1600 | ... | ... | ... |
| 0.125 | 1462 | 1895 | 2098 | 2699 | ... |
| 0.160 | ... | 2363 | 2501 | 3088 | ... |
| 0.190 | ... | 2926 | 3018 | 3601 | ... |
| 0.250 | ... | ... | 4312 | 4868 | 8041 |
| 0.312 | ... | ... | ... | 6624 | 9437 |
| 0.375 | ... | ... | ... | ... | 11686 |
| Head height (ref.), in. | 0.080 | 0.106 | 0.133 | 0.159 | 0.213 |

a This fastener is no longer manufactured; do not specify for new designs.

b Test data from which the yield and ultimate strengths were derived can be found in Reference 8.1.5.2.

c Yield value is less than 2/3 of the indicated ultimate strength value.

d Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

e Fastener shear strength based on area computed from nominal shank diameters in Table 9.7.1.1 and $F_{su}$ = 75 ksi.

f Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(b). Static Joint Strength of 100° Flush Head Stainless Steel (PH13-8Mo-H1000) Fasteners in Machine-Countersunk Titanium Alloy Sheet and Plate**

| Fastener Type | PBF 11[a] ($F_{su}$ = 125 ksi) | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Annealed Ti-6Al-4V | | | |
| Rivet Diameter, in. (Nominal Shank Diameter, in.)[b] | 5/32 (0.164) | 1/4 (0.250) | 3/8 (0.375) | 1/2 (0.500) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.040 | 1535[c] | ... | ... | ... |
| 0.050 | 1963 | ... | ... | ... |
| 0.063 | 2528 | 3656 | ... | ... |
| 0.071 | 2640 | 4213 | ... | ... |
| 0.080 | ... | 4813 | 6820 | ... |
| 0.090 | ... | 5438 | 7818 | ... |
| 0.100 | ... | 6140 | 8775 | 11250[c] |
| 0.125 | ... | ... | 11264 | 14575 |
| 0.160 | ... | ... | 13810 | 19250 |
| 0.190 | ... | ... | ... | 23200 |
| 0.200 | ... | ... | ... | 24540 |
| Fastener shear strength[d] | 2640 | 6140 | 13810 | 24540 |
| | Yield Strength[e], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.040 | 1237 | ... | ... | ... |
| 0.050 | 1543 | ... | ... | ... |
| 0.063 | 1947 | 2969 | ... | ... |
| 0.071 | 2049 | 3350 | ... | ... |
| 0.080 | ... | 3756 | 5667 | ... |
| 0.090 | ... | 4219 | 6370 | ... |
| 0.100 | ... | 4600 | 7101 | 9500 |
| 0.125 | ... | ... | 8789 | 11825 |
| 0.160 | ... | ... | 10645 | 15025 |
| 0.190 | ... | ... | ... | 17825 |
| 0.200 | ... | ... | ... | 18400 |
| Head height (nom.), in. | 0.040 | 0.060 | 0.077 | 0.101 |

a Data supplied by Huck Manufacturing Company and PB Fasteners.

b Fasteners installed in clearance holes (0.0025-0.0030).

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Fastener shear strength based on areas computed from indicated nominal shank diameter $F_{su}$ = 125 ksi.

e Permanent set at yield load: 4% of nominal diameter.

**Table 8.1.5.2(c). Static Joint Strength of 100° Flush Head Tapered Alloy Steel Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | TL 100[a] ($F_{su}$ = 108 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 3/16 (0.1969) | 1/4 (0.2585) | 5/16 (0.3214) | 3/8 (0.3860) | 7/16 (0.4490) | ½ (0.5122) |
| | Ultimate Strength, lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.100 | 2435 | ... | ... | ... | ... | ... |
| 0.125 | 2913 | 3745 | 4443 | ... | ... | ... |
| 0.160 | 3290 | 4831 | 6017 | 7016 | 7993 | ... |
| 0.190 | ... | 5269 | 7017 | 8511 | 9737 | 10900 |
| 0.250 | ... | 5670 | 8148 | 11120 | 13220 | 14890 |
| 0.285 | ... | ... | 8760 | 11360 | 15000 | 17240 |
| 0.312 | ... | ... | ... | 11570 | 15280 | 19000 |
| 0.344 | ... | ... | ... | 11800 | 15560 | 19800 |
| 0.375 | ... | ... | ... | 12030 | 15820 | 20110 |
| 0.500 | ... | ... | ... | 12640 | 16870 | 21320 |
| Fastener shear strength[b] | 3290 | 5670 | 8760 | 12640 | 17100 | 22250 |
| | Yield Strength[c], lbs | | | | | |
| Sheet or plate thickness, in.: | | | | | | |
| 0.100 | 1960 | ... | ... | ... | ... | ... |
| 0.125 | 2350 | 2990 | 3818 | ... | ... | ... |
| 0.160 | 2840 | 3550 | 4650 | 5650 | 6703 | ... |
| 0.190 | ... | 3970 | 5308 | 6596 | 7806 | 9045 |
| 0.250 | ... | 4830 | 6450 | 8209 | 9903 | 11560 |
| 0.285 | ... | ... | 7060 | 9090 | 10930 | 12840 |
| 0.312 | ... | ... | ... | 9680 | 11780 | 13930 |
| 0.344 | ... | ... | ... | 10010 | 12710 | 14930 |
| 0.375 | ... | ... | ... | 10430 | 13200 | 16000 |
| 0.500 | ... | ... | ... | ... | 15160 | 18490 |
| Head height (max.), in. | 0.048 | 0.063 | 0.070 | 0.081 | 0.100 | 0.110 |

a Data supplied by Briles Manufacturing Company.

b Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 108 ksi.

c Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(d). Static Joint Strength of 100° Flush Head Tapered STA Ti-6Al-4V Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | TLV 10[a] ($F_{su}$ = 95 ksi) | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 1/8 (0.1437) | 5/32 (0.1688) | 3/16 (0.1965) | 1/4 (0.2583) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.032 | 488[b] | ... | ... | ... |
| 0.040 | 610 | 713[b] | 826[b] | ... |
| 0.050 | 768 | 896 | 1050 | ... |
| 0.063 | 967 | 1145 | 1312 | 1730[b] |
| 0.071 | 1120 | 1290 | 1491 | 1960 |
| 0.080 | 1260 | 1470 | 1690 | 2223 |
| 0.090 | 1377 | 1670 | 1910 | 2505 |
| 0.100 | 1441 | 1845 | 2130 | 2800 |
| 0.125 | 1530 | 2010 | 2580 | 3540 |
| 0.160 | 1540 | 2125 | 2800 | 4410 |
| 0.190 | ... | ... | 2880 | 4750 |
| 0.250 | ... | ... | ... | 4980 |
| Fastener shear strength[c] | 1540 | 2125 | 2880 | 4980 |
| | Yield Strength[d], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.032 | 488 | ... | ... | ... |
| 0.040 | 610 | 713 | 826 | ... |
| 0.050 | 753 | 890 | 1050 | ... |
| 0.063 | 925 | 1118 | 1301 | 1730 |
| 0.071 | 1035 | 1240 | 1467 | 1960 |
| 0.080 | 1138 | 1377 | 1637 | 2192 |
| 0.090 | 1238 | 1522 | 1806 | 2455 |
| 0.100 | 1321 | 1639 | 1976 | 2711 |
| 0.125 | 1480 | 1880 | 2331 | 3304 |
| 0.160 | 1540 | 2111 | 2683 | 3986 |
| 0.190 | ... | ... | 2880 | 4437 |
| 0.250 | ... | ... | ... | 4980 |
| Head height (max.), in. | 0.033 | 0.041 | 0.048 | 0.063 |

a Data supplied by Lockheed Georgia Company.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 95 ksi.

d Permanent set at yield load: the greater of 0.012 inch or 4% of fractional diameter.

**Table 8.1.5.2(e). Static Joint Strength of 70° Flush Head Tapered Ti-6Al-4V Fasteners in Non-Matching Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | HPB-V[a] ($F_{su}$ = 95 ksi) | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Fastener Diameter (Nominal Shank Diameter, in.)[b] | 3/16 (0.1976) | 1/4 (0.2587) | 5/16 (0.3211) | 3/8 (0.3850) |
| Sheet Countersink Angle | 82° | 82° | 82° | 75° |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 1355 | ... | ... | ... |
| 0.071 | 1554 | 2041 | ... | ... |
| 0.080 | 1710 | 2296 | ... | ... |
| 0.090 | 1847 | 2583 | 3207 | ... |
| 0.100 | 1984 | 2864 | 3567 | 4269 |
| 0.125 | 2319 | 3293 | 4454 | 5336 |
| 0.160 | 2792 | 3908 | 5176 | 6611 |
| 0.190 | 2913 | 4444 | 5836 | 7396 |
| 0.250 | ... | 4993 | 7155 | 8968 |
| 0.312 | ... | ... | 7692 | 10613 |
| 0.375 | ... | ... | ... | 11058 |
| 0.500 | ... | ... | ... | 11058 |
| Fastener shear strength[c] | 2913 | 4993 | 7692 | 11058 |
| | Yield Strength[d], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 1269 | ... | ... | ... |
| 0.071 | 1429 | 1874 | ... | ... |
| 0.080 | 1613 | 2108 | ... | ... |
| 0.090 | 1812 | 2376 | 2949 | ... |
| 0.100 | 1984 | 2637 | 3279 | 3928 |
| 0.125 | 2319 | 3299 | 4093 | 4906 |
| 0.160 | 2718 | 3908 | 5176 | 6285 |
| 0.190 | 2913 | 4397 | 5836 | 7396 |
| 0.250 | ... | 4993 | 6980 | 8968 |
| 0.312 | ... | ... | 7692 | 10257 |
| 0.375 | ... | ... | ... | 11058 |
| 0.500 | ... | ... | ... | 11058 |
| Head height (max.), in. | 0.057 | 0.067 | 0.076 | 0.086 |

a Data supplied by PB Fasteners.
b Fasteners installed in interference holes (0.0015-0.0048).
c Fastener shear strength based on areas computed from the indicated nominal shank diameter and $F_{su}$ = 95 ksi.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(f). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | KLBHV Pin ($F_{su}$ = 95 ksi), KFN 600 Nut[a] | | | | |
|---|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.)[b] | 5/32 (0.164) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.3125) | 3/8 (0.375) |
| | Ultimate Strength, lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.040 | 748[c] | ... | ... | ... | ... |
| 0.050 | 987 | 1112 | ... | ... | ... |
| 0.063 | 1291 | 1462 | 1813[c] | ... | ... |
| 0.071 | 1428 | 1679 | 2100 | ... | ... |
| 0.080 | 1571 | 1888 | 2438 | 2902 | ... |
| 0.090 | 1722 | 2058 | 2794 | 3322 | 3867 |
| 0.100 | 1883 | 2231 | 3150 | 3810 | 4402 |
| 0.125 | 2007 | 2694 | 3725 | 4924 | 5724 |
| 0.160 | ... | ... | 4531 | 4901 | 7397 |
| 0.190 | ... | ... | 4660 | 6790 | 8452 |
| 0.200 | ... | ... | ... | 7083 | 8789 |
| 0.250 | ... | ... | ... | 7290 | 10490 |
| Fastener shear strength[d] | 2007 | 2694 | 4660 | 7290 | 10490 |
| | Yield Strength[e], lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.040 | 594 | ... | ... | ... | ... |
| 0.050 | 740 | 859 | ... | ... | ... |
| 0.063 | 931 | 1079 | 1419 | ... | ... |
| 0.071 | 1049 | 1213 | 1600 | ... | ... |
| 0.080 | 1176 | 1368 | 1806 | 2267 | ... |
| 0.090 | 1283 | 1534 | 2031 | 2540 | 3052 |
| 0.100 | 1375 | 1675 | 2250 | 2824 | 3375 |
| 0.125 | 1606 | 1942 | 2813 | 3517 | 4219 |
| 0.160 | ... | ... | 3306 | 4455 | 5386 |
| 0.190 | ... | ... | 3725 | 4983 | 6385 |
| 0.200 | ... | ... | ... | 5168 | 6581 |
| 0.250 | ... | ... | ... | 6038 | 7636 |
| Head height (ref.), in. | 0.043 | 0.048 | 0.063 | 0.070 | 0.081 |

a Data supplied by Kaynar Manufacturing Co., Inc.

b Fasteners installed in interference holes (0.003-0.055).

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 95 ksi.

e Permanent set at yield load: 4% of the nominal diameter.

**Table 8.1.5.2(g). Static Joint Strength of 100° Flush Shear AISI 431[a] Hi-Lok Fasteners in Aluminum Alloy Sheet and Plate**

| Rivet Type | HL 61 Pin ($F_{su}$ = 125 ksi), HL 70 Collar[b] | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Rivet Diameter (Nominal Shank Diameter, in.) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.090 | 2327 | ... | ... | ... |
| 0.100 | 2430 | 3740 | ... | ... |
| 0.125 | 2695 | 4080 | ... | ... |
| 0.160 | 3070 | 4560 | 6500[c] | ... |
| 0.190 | 3390 | 4970 | 7160 | 9100 |
| 0.250 | 3544 | 5800 | 8320 | 10230 |
| 0.312 | ... | 6140 | 9590 | 11390 |
| 0.375 | ... | ... | ... | 12580 |
| 0.500 | ... | ... | ... | 13810 |
| Fastener shear strength[d] | 3544 | 6140 | 9590 | 13810 |
| | Yield Strength[e], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.090 | 1840 | ... | ... | ... |
| 0.100 | 1943 | 2900 | ... | ... |
| 0.125 | 2195 | 3240 | ... | ... |
| 0.160 | 2540 | 3700 | 4030 | ... |
| 0.190 | 2840 | 4020 | 5430 | 7120 |
| 0.250 | 3110 | 4870 | 6590 | 8500 |
| 0.312 | ... | 5350 | 7580 | 9700 |
| 0.375 | ... | ... | 7890 | 10410 |
| 0.500 | ... | ... | ... | 12070 |
| Head height (max.), in. | 0.049 | 0.063 | 0.077 | 0.051 |

a AISI 431 is prohibited from use in Air Force and Navy structure by MIL-STD-1568 and SD-24, respectively, because of its sensitivity to heat treatment. Use of fasteners made of this material in design of military aerospace structures requires the specific approval of the procuring agency.

b Data supplied by Hi-Shear Corporation.

c Yield value is less than 2/3 of the indicated ultimate strength value.

d Fastener shear strength based on areas computed from the indicated nominal shank diameter and $F_{su}$ = 125 ksi.

e Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(h). Static Joint Strength of 100° Flush Shear Head Alloy Steel Hi-Lok Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | HL 719 Pin ($F_{su}$ = 108 ksi), HL 79 Collar[a] | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | 7075-T6 and T651 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.)[b] | 5/32 (0.164) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.040 | 734[c] | ... | ... | ... | ... |
| 0.050 | 1044 | 1131 | ... | ... | ... |
| 0.063 | 1384 | 1565 | 1813 | ... | ... |
| 0.071 | 1518 | 1820 | 2216 | ... | ... |
| 0.080 | 1668 | 1998 | 2594 | 2916 | ... |
| 0.090 | 1764 | 2193 | 3015 | 3532 | 3724 |
| 0.100 | 1825 | 2345 | 3338 | 4059 | 4516 |
| 0.125 | 1979 | 2524 | 3980 | 5229 | 6167 |
| 0.160 | 2195 | 2774 | 4350 | 6347 | 7928 |
| 0.190 | ... | 2989 | 4634 | 6702 | 9087 |
| 0.250 | ... | 3062 | 5200 | 7512 | 9985 |
| 0.312 | ... | ... | 5300 | 8146 | 10870 |
| 0.375 | ... | ... | ... | 8280 | 11760 |
| Fastener shear strength[d] | 2281 | 3062 | 5300 | 8280 | 11930 |
| | Yield Strength[e], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.040 | 690 | ... | ... | ... | ... |
| 0.050 | 861 | 1000 | ... | ... | ... |
| 0.063 | 1086 | 1261 | 1664 | ... | ... |
| 0.071 | 1224 | 1421 | 1876 | ... | ... |
| 0.080 | 1346 | 1601 | 2114 | 2647 | ... |
| 0.090 | 1478 | 1771 | 2378 | 2978 | 3578 |
| 0.100 | 1610 | 1924 | 2642 | 3309 | 3976 |
| 0.125 | 1845 | 2308 | 3210 | 4136 | 4970 |
| 0.160 | 2022 | 2583 | 3920 | 5124 | 6362 |
| 0.190 | ... | 2750 | 4344 | 5886 | 7330 |
| 0.250 | ... | 3062 | 4785 | 6925 | 9160 |
| 0.312 | ... | ... | ... | 7496 | 10130 |
| 0.375 | ... | ... | ... | 8158 | 10820 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 | 0.067 | 0.077 |

a Data supplied by Hi-Shear Corporation.

b Fasteners installed in interference holes (0.001-0.002).

c Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

d Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 108 ksi.

e Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(i). Static Joint Strength of 100° Flush Shear Head Ti-6Al-4V Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | HL 11 Pin ($F_{su}$ = 95 ksi), HL 70 Collar[a] | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 5/16 |
| (Nominal Shank Diameter, in.) | (0.164) | (0.190) | (0.250) | (0.312) |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.040 | 734[b] | 837[b] | ... | ... |
| 0.050 | 941 | 1083 | 1343[b] | ... |
| 0.063 | 1207 | 1393 | 1762 | 2170[b] |
| 0.071 | 1385 | 1588 | 2012 | 2463 |
| 0.080 | 1557 | 1779 | 2281 | 2823 |
| 0.090 | 1775 | 2050 | 2594 | 3193 |
| 0.100 | 1876 | 2263 | 2919 | 3631 |
| 0.125 | 1950 | 2542 | 3765 | 4594 |
| 0.160 | 2007 | 2660 | 3970 | 5890 |
| 0.190 | ... | 2694 | 4165 | 6105 |
| 0.250 | ... | ... | 4530 | 6580 |
| 0.312 | ... | ... | 4660 | 7050 |
| 0.375 | ... | ... | ... | 7290 |
| Fastener shear strength[c] | 2007 | 2694 | 4660 | 7290 |
| | Yield Strength[d], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.040 | 674 | 794 | ... | ... |
| 0.050 | 835 | 982 | 1325 | ... |
| 0.063 | 1038 | 1230 | 1655 | 2141 |
| 0.071 | 1130 | 1355 | 1813 | 2338 |
| 0.080 | 1230 | 1480 | 2062 | 2620 |
| 0.090 | 1342 | 1625 | 2250 | 2880 |
| 0.100 | 1440 | 1750 | 2470 | 3420 |
| 0.125 | 1670 | 2020 | 2930 | 3860 |
| 0.160 | 1891 | 2360 | 3480 | 4620 |
| 0.190 | ... | 2560 | 3840 | 5150 |
| 0.250 | ... | ... | 4440 | 6170 |
| 0.312 | ... | ... | 4660 | 6900 |
| 0.375 | ... | ... | ... | 7290 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 | 0.067 |

a Data supplied by Hi-Shear Corporation.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 95 ksi.

d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(j). Static Joint Strength of 100° Flush Shear Head Ti-6Al-6V-2Sn Fasteners in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | HL 911 Pin ($F_{su}$ = 108 ksi), HL 70 Collar[a] | | | | |
|---|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 5/16 | 3/8 |
| (Nominal Shank Diameter, in.) | (0.164) | (0.190) | (0.250) | (0.312) | (0.375) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.040 | 780[b] | ... | ... | ... | ... |
| 0.050 | 982 | 1137 | 1456[b] | ... | ... |
| 0.063 | 1264 | 1458 | 1863 | 2287[b] | ... |
| 0.071 | 1426 | 1642 | 2094 | 2570 | 3096[b] |
| 0.080 | 1622 | 1866 | 2425 | 2920 | 3473 |
| 0.090 | 1740 | 2105 | 2750 | 3339 | 3965 |
| 0.100 | 1794 | 2310 | 3063 | 3777 | 4415 |
| 0.125 | 1915 | 2455 | 3875 | 4770 | 5666 |
| 0.160 | 2098 | 2660 | 4219 | 6181 | 7339 |
| 0.190 | 2252 | 2840 | 4450 | 6483 | 8788 |
| 0.250 | 2281 | 3062 | 4925 | 7067 | 9589 |
| 0.312 | ... | ... | 5300 | 7670 | 10362 |
| 0.375 | ... | ... | ... | 8280 | 11079 |
| 0.500 | ... | ... | ... | ... | 11930 |
| Fastener shear strength[c] | 2281 | 3062 | 5300 | 8280 | 11930 |
| | Yield Strength[d], lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.040 | 734 | ... | ... | ... | ... |
| 0.050 | 882 | 1044 | 1394 | ... | ... |
| 0.063 | 1076 | 1300 | 1750 | 2190 | ... |
| 0.071 | 1184 | 1406 | 1938 | 2472 | 2995 |
| 0.080 | 1320 | 1540 | 2188 | 2774 | 3332 |
| 0.090 | 1392 | 1680 | 2375 | 3066 | 3768 |
| 0.100 | 1480 | 1810 | 2569 | 3358 | 4120 |
| 0.125 | 1700 | 2085 | 3031 | 4010 | 5019 |
| 0.160 | 1870 | 2380 | 3563 | 4818 | 6074 |
| 0.190 | 1978 | 2530 | 3937 | 5354 | 6749 |
| 0.250 | 2178 | 2740 | 4375 | 6269 | 8183 |
| 0.312 | ... | ... | 4687 | 6883 | 9209 |
| 0.375 | ... | ... | ... | 7418 | 9870 |
| 0.500 | ... | ... | ... | ... | 11039 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 | 0.067 | 0.077 |

a Data supplied by Hi-Shear Corporation.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 108 ksi.

d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(k). Static Joint Strength of 100° Flush Head Ti-6Al-6V-2Sn or Alloy Steel, Shear Type Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | NAS 4452S and KS 100-FV Pins[a] ($F_{su}$ = 108 ksi), NAS 4445DD Nut | | | |
|---|---|---|---|---|
| Sheet Material | 7075-T6 | | | |
| Fastener Diameter, in. | 1/8 | 5/32 | 3/16 | 1/4 |
| (Nominal Shank Diameter, in.) | (0.138) | (0.164) | (0.190) | (0.250) |
| | Ultimate Strength, lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 644 | ... | ... | ... |
| 0.050 | 857 | 976 | 1065 | ... |
| 0.063 | 1131 | 1305 | 1458 | 1750[b] |
| 0.071 | 1268 | 1512 | 1697 | 2062 |
| 0.080 | 1428 | 1703 | 1964 | 2406 |
| 0.090 | 1499 | 1910 | 2227 | 2794 |
| 0.100 | 1539 | 2084 | 2458 | 3181 |
| 0.125 | 1615 | 2200 | 2848 | 4063 |
| 0.160 | ... | 2281 | 3036 | 4900 |
| 0.190 | ... | ... | 3062 | 5113 |
| 0.250 | ... | ... | ... | 5300 |
| Fastener shear strength[c] | 1615 | 2281 | 3062 | 5300 |
| | Yield Strength[d], lbs | | | |
| Sheet thickness, in.: | | | | |
| 0.040 | 609 | ... | ... | ... |
| 0.050 | 766 | 906 | 1029 | ... |
| 0.063 | 946 | 1157 | 1325 | 1706 |
| 0.071 | 1044 | 1278 | 1505 | 1956 |
| 0.080 | 1152 | 1412 | 1668 | 2219 |
| 0.090 | 1261 | 1555 | 1848 | 2500 |
| 0.100 | 1320 | 1694 | 2014 | 2762 |
| 0.125 | 1444 | 1904 | 2397 | 3350 |
| 0.160 | ... | 2106 | 2661 | 4100 |
| 0.190 | ... | ... | 2845 | 4419 |
| 0.250 | ... | ... | ... | 4925 |
| Head height (max.), in. | 0.037 | 0.040 | 0.049 | 0.063 |

a Data supplied by Huck Manufacturing Company.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Fastener shear strength is documented in NAS 4444.

d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(l). Static Joint Strength of 70° Flush Head Straight Shank Ti-6Al-4V Fasteners in Non-Matching Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | HPT-V[a] ($F_{su}$ = 95 ksi) | | | |
|---|---|---|---|---|
| Sheet and Plate Material | Clad 7075-T6 and T651 | | | |
| Fastener Diameter (Nominal Shank Diameter, in.)[b] | 3/16 (0.193) | 1/4 (0.255) | 5/16 (0.3175) | 3/8 (0.380) |
| Sheet Countersink Angle | 82° | 82° | 82° | 75° |
| | Ultimate Strength, lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 1348 | ... | ... | ... |
| 0.071 | 1546 | 1970 | ... | ... |
| 0.080 | 1704 | 2275 | ... | ... |
| 0.090 | 1814 | 2580 | 3125 | ... |
| 0.100 | 1948 | 2873 | 3528 | 4100 |
| 0.125 | 2265 | 3282 | 4465 | 5270 |
| 0.160 | 2700 | 3868 | 5171 | 6642 |
| 0.190 | 2779 | 4361 | 5826 | 7393 |
| 0.250 | ... | 4851 | 7056 | 8880 |
| 0.312 | ... | ... | 7521 | 10396 |
| 0.375 | ... | ... | ... | 10774 |
| Fastener shear strength[c] | 2779 | 4851 | 7521 | 10774 |
| | Yield Strength[d], lbs | | | |
| Sheet or plate thickness, in.: | | | | |
| 0.063 | 1180 | ... | ... | ... |
| 0.071 | 1378 | 1651 | ... | ... |
| 0.080 | 1590 | 1944 | ... | ... |
| 0.090 | 1702 | 2321 | 2631 | ... |
| 0.100 | 1818 | 2620 | 3024 | 3350 |
| 0.125 | 2112 | 3055 | 4133 | 4664 |
| 0.160 | 2496 | 3601 | 4848 | 6209 |
| 0.190 | 2734 | 4062 | 5413 | 6902 |
| 0.250 | ... | 4745 | 6552 | 8288 |
| 0.312 | ... | ... | 7378 | 9631 |
| 0.375 | ... | ... | ... | 10584 |
| Head height (max.), in. | 0.060 | 0.070 | 0.080 | 0.090 |

a Data supplied by PB Fasteners.
b Fasteners installed in interference holes (0.0045-0.0055).
c Fastener shear strength based on areas computed from the indicated nominal shank diameter and $F_{su}$ = 95 ksi.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(m). Static Joint Strength of 100° Flush Shear Head STA Ti-6Al-4V Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | NAS 4452V Pin ($F_{su}$ = 95 ksi), NAS 4445D Nut[a] | | | | |
|---|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | | |
| Fastener Diameter, in. (Nominal Shank Diameter, in.) | 5/32 (0.164) | 3/16 (0.190) | 1/4 (0.250) | 5/16 (0.312) | 3/8 (0.375) |
| | Ultimate Strength, lbs | | | | |
| Sheet or plate thickness, in.: | | | | | |
| 0.040 | 766[b] | ... | ... | ... | ... |
| 0.050 | 1092 | 1173 | ... | ... | ... |
| 0.063 | 1450 | 1639 | 1886[b] | ... | ... |
| 0.071 | 1633 | 1889 | 2290 | ... | ... |
| 0.080 | 1805 | 2136 | 2710 | 3028 | ... |
| 0.090 | 1955 | 2368 | 3135 | 3651 | ... |
| 0.100 | 2007 | 2557 | 3515 | 4230 | 4669 |
| 0.125 | ... | 2694 | 4273 | 5485 | 6428 |
| 0.160 | ... | ... | 4660 | 6776 | 8426 |
| 0.190 | ... | ... | ... | 7290 | 9708 |
| 0.250 | ... | ... | ... | ... | 10490 |
| Fastener shear strength[c] | 2007 | 2694 | 4660 | 7290 | 10490 |
| | Yield Strength[d], lbs | | | | |
| Sheet thickness, in.: | | | | | |
| 0.040 | 712 | ... | ... | ... | ... |
| 0.050 | 891 | 1034 | ... | ... | ... |
| 0.063 | 1103 | 1295 | 1712 | ... | ... |
| 0.071 | 1223 | 1445 | 1932 | ... | ... |
| 0.080 | 1349 | 1604 | 2169 | 2715 | ... |
| 0.090 | 1475 | 1768 | 2420 | 3056 | ... |
| 0.100 | 1489 | 1920 | 2658 | 3383 | 4082 |
| 0.125 | ... | 2241 | 3196 | 4145 | 5072 |
| 0.160 | ... | ... | 3812 | 5076 | 6321 |
| 0.190 | ... | ... | ... | 5746 | 7265 |
| 0.250 | ... | ... | ... | ... | 8802 |
| Head height (max.), in. | 0.040 | 0.049 | 0.063 | 0.077 | 0.091 |

a Data supplied by Huck Manufacturing Company.

b Values above line are for knife-edge condition and the use of fasteners in this condition is undesirable. The use of knife-edge condition in design of military aircraft requires specific approval of the procuring agency.

c Fastener shear strength is documented in NAS 4444.

d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(n). Static Joint Strength of Protruding Shear Head Alloy Steel Hi-Lok Fasteners in Aluminum Alloy Sheet**

| Fastener Type | HL 18 Pin ($F_{su}$ = 95 ksi), HL 70 Collar[a] | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 5/16 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) | (0.312) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.050 | 1078 | ... | ... | ... |
| 0.063 | 1353 | 1559 | ... | ... |
| 0.071 | 1520 | 1776 | ... | ... |
| 0.080 | 1718 | 1957 | 2593 | ... |
| 0.090 | 1890 | 2224 | 2937 | ... |
| 0.100 | 1930 | 2473 | 3250 | 4050 |
| 0.125 | 2007 | 2580 | 4063 | 5075 |
| 0.160 | ... | 2694 | 4450 | 6509 |
| 0.190 | ... | ... | 4620 | 6880 |
| 0.250 | ... | ... | 4660 | 7290 |
| Rivet shear strength[c] | 2007 | 2694 | 4660 | 7290 |
| Sheet thickness, in.: | Yield Strength[d], lbs. | | | |
| 0.050 | 976 | ... | ... | ... |
| 0.063 | 1251 | 1426 | ... | ... |
| 0.071 | 1430 | 1624 | ... | ... |
| 0.080 | 1589 | 1848 | 2344 | ... |
| 0.090 | 1746 | 2065 | 2687 | ... |
| 0.100 | 1875 | 2242 | 3031 | 3660 |
| 0.125 | ... | 2563 | 3750 | 4734 |
| 0.160 | ... | ... | 4406 | 6051 |
| 0.190 | ... | ... | ... | 6686 |

a Data supplied by Hi-Shear Corporation.
b Fasteners installed in clearance holes (0.0005-0.0025).
c Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 95 ksi.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**Table 8.1.5.2(o). Static Joint Strength of 100° Flush Shear Head Alloy Steel Hi-Lok Fasteners in Machine-Countersunk Aluminum Alloy Sheet**

| Fastener Type | HL 19 Pin ($F_{su}$ = 95 ksi), HL 70 Collar[a] | | | |
|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | |
| Fastener Diameter, in. | 5/32 | 3/16 | 1/4 | 5/16 |
| (Nominal Shank Diameter, in.)[b] | (0.164) | (0.190) | (0.250) | (0.312) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | |
| 0.050 | 968 | ... | ... | ... |
| 0.063 | 1251 | 1408 | ... | ... |
| 0.071 | 1400 | 1606 | ... | ... |
| 0.080 | 1595 | 1823 | 2344 | ... |
| 0.090 | 1815 | 2050 | 2675 | ... |
| 0.100 | 1903 | 2300 | 3000 | 3660 |
| 0.125 | 2005 | 2570 | 3781 | 4685 |
| 0.160 | ... | 2694 | 4420 | 6051 |
| 0.190 | ... | ... | 4625 | 6832 |
| 0.250 | ... | ... | 4660 | 7290 |
| Rivet shear strength[c] | 2007 | 2694 | 4660 | 7290 |
| Sheet thickness, in.: | Yield Strength[d], lbs. | | | |
| 0.050 | 839 | ... | ... | ... |
| 0.063 | 1031 | 1191 | ... | ... |
| 0.071 | 1141 | 1336 | ... | ... |
| 0.080 | 1279 | 1480 | 2013 | ... |
| 0.090 | 1416 | 1632 | 2219 | ... |
| 0.100 | 1540 | 1805 | 2420 | 3143 |
| 0.125 | 1807 | 2173 | 3000 | 3777 |
| 0.160 | ... | 2545 | 3670 | 4800 |
| 0.190 | ... | ... | 4144 | 5514 |
| 0.250 | ... | ... | ... | 6686 |
| Head height (nom.), in. | 0.040 | 0.046 | 0.060 | 0.067 |

a Data supplied by Hi-Shear Corporation.
b Fasteners installed in clearance holes (0.0005-0.0025).
c Fastener shear strength based on areas computed from indicated nominal shank diameter and $F_{su}$ = 95 ksi.
d Permanent set at yield load: the greater of 0.012 inch or 4% of nominal diameter.

**8.1.6 SPECIAL FASTENERS** — Due to the special nature of this classification of fastener, care must be exercised in their application. Consideration should be given to the proposed fastener application and its compatibility with data presented in this section. In particular, test and analysis methods used for fasteners in this section may necessarily be different than those used in preceding sections.

**8.1.6.1 *Fastener Sleeves*** — Fastener sleeves are precision-formed, tubular elements designed to replace oversize fasteners used in the repair of damaged or enlarged holes.

8.1.6.1.1 *A-286 ACRES Sleeves in 7075-T6 Aluminum Alloy Sheet and Plate* — Analysis of static lap joint data indicates that a single 100° low profile head, A-286 [ACRES Sleeve (part number JK5512C)] installed with titanium or steel Hi-Loks and alloy steel lockbolts (up to 108 ksi $F_{su}$) provided static joint allowable shear loads equivalent to those developed by the above-noted fasteners when tested without sleeves. Fasteners and sleeves were installed to the same comparable hole tolerance and fit condition as fasteners when tested alone. The analysis was restricted to static lap joint data (in accordance with MIL-STD-1312 Test 4) and equivalency to fastener systems other than those listed above is not implied. Other properties such as tensile strength, preload, fatigue strength, and corrosion characteristics should be verified by test data. When using sleeves, knife-edge conditions should be avoided.

**8.1.6.2 *Sleeve Bolts*** — Tables 8.1.6.2(a) and (b) contain joint allowables for various sleeve bolt/sheet material combinations. Sleeve bolts are made of precision-formed aluminum alloy sleeve elements assembled on standard taper shank bolts. When the assembly is placed in a cylindrical hole and the bolt is drawn into the sleeve, the sleeve expands, thus filling the hole and causing an interference-fit condition.

The allowable loads were established from test data using the following criteria:

*Ultimate Load* — Design allowable ultimate load as defined in Section 9.7.1.5. Prior to 2003 this value was computed as the average ultimate test load divided by a factor of 1.15. This factor is not applicable to shear strength cutoff values which are defined by the procurement specification.

*Yield Load* — Design allowable yield load as defined in Section 9.7.1.5. Prior to 2003 this value was computed as the average yield test load or the load which results in a joint permanent set equal to 0.04D, where D is the hole size.

The allowable loads shown for flush-head fasteners are applicable to joints having e/D equal to or greater than 2.0.

For machine countersunk joints, the sheet gage specified in the tables herein is that of the countersunk sheet. When the noncountersunk sheet is thinner than the countersunk sheet, the bearing allowable for the noncountersunk sheet-fastener combination should be computed, compared to the table value, and the lower of the two values selected.

**Table 8.1.6.2(a). Static Joint Strength of 100° Reduced Flush Head, Alloy Steel Pin, Aluminum Alloy Sleeve, Fastener in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | MIL-B-8831/4[a] ($F_{su}$ = 108 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 7075-T6 | | | | | |
| Fastener Diameter, in. (Nominal Hole Diameter, in.)[b,c] | 3/16 (0.2390) | 1/4 (0.3032) | 5/16 (0.3695) | 3/8 (0.4350) | 7/16 (0.5022) | ½ (0.5735) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | | | |
| 0.100 | 2585 | ... | ... | ... | ... | ... |
| 0.125 | 3205 | 4100 | 5035 | ... | ... | ... |
| 0.160 | 3290 | 5205 | 6385 | 7560 | 8790 | ... |
| 0.190 | ... | 5670 | 7535 | 8925 | 10360 | 11900 |
| 0.250 | ... | ... | 8760 | 11640 | 13495 | 15480 |
| 0.312 | ... | ... | ... | 12395 | 16195 | 19180 |
| 0.375 | ... | ... | ... | 12640 | 16625 | 21265 |
| 0.500 | ... | ... | ... | ... | 17100 | 22250 |
| Rivet shear strength[d] | 3290 | 5670 | 8760 | 12640 | 17100 | 22250 |
| Sheet thickness, in.: | Yield Strength[e], lbs. | | | | | |
| 0.100 | 2080 | ... | ... | ... | ... | ... |
| 0.125 | 2570 | 3300 | 4075 | ... | ... | ... |
| 0.160 | 3255 | 4170 | 5135 | 6105 | 7125 | ... |
| 0.190 | ... | 4915 | 6040 | 7175 | 8360 | 9635 |
| 0.250 | ... | ... | 7855 | 9310 | 10825 | 12450 |
| 0.312 | ... | ... | ... | 11520 | 13375 | 15360 |
| 0.375 | ... | ... | ... | 12355 | 15620 | 18320 |
| 0.500 | ... | ... | ... | ... | ... | 21570 |
| Sleeve head height (ref.), in. | 0.062 | 0.075 | 0.082 | 0.093 | 0.115 | 0.120 |

a Data supplied by P.B. Fasteners.

b Nominal hole diameter based on $\left(\frac{\text{max. expanded sleeve} - \text{min. hole}}{2}\right)$ + min. hole using larger expanded diameter from MIL-B-8831/4 dated 23 August 1982.

c Fasteners installed to interference levels of 0.0025-0.008 in.

d Fastener shear strength is documented in NAS 1724 as 108 ksi.

e Permanent set at yield load: 4% of nominal hole diameter.

**Table 8.1.6.2(b). Static Joint Strength of 100° Reduced Flush Head, Alloy Steel Pin, Aluminum Alloy Sleeve, Fastener in Machine-Countersunk Aluminum Alloy Sheet and Plate**

| Fastener Type | MIL-B-8831/4[a] ($F_{su}$ = 108 ksi) | | | | | |
|---|---|---|---|---|---|---|
| Sheet Material | Clad 2024-T3 | | | | | |
| Fastener Diameter, in. (Nominal Hole Diameter, in.)[b,c] | 3/16 (0.2390) | 1/4 (0.3032) | 5/16 (0.3695) | 3/8 (0.4350) | 7/16 (0.5022) | 1/2 (0.5735) |
| Sheet thickness, in.: | Ultimate Strength, lbs. | | | | | |
| 0.100 | 2175 | ... | ... | ... | ... | ... |
| 0.125 | 2720 | 3450 | 4205 | ... | ... | ... |
| 0.160 | 3290 | 4415 | 5380 | 6335 | 7315 | ... |
| 0.190 | ... | 5240 | 6390 | 7525 | 8685 | 9920 |
| 0.250 | ... | 5480 | 7945 | 9895 | 11425 | 13050 |
| 0.312 | ... | 5655 | 8165 | 11085 | 14260 | 16285 |
| 0.375 | ... | 5670 | 8385 | 11345 | 14845 | 19070 |
| 0.500 | ... | ... | 8760 | 11865 | 15445 | 19755 |
| 0.625 | ... | ... | ... | 12385 | 16045 | 20440 |
| 0.750 | ... | ... | ... | 12640 | 16645 | 21225 |
| 0.875 | ... | ... | ... | ... | 17100 | 21805 |
| 1.000 | ... | ... | ... | ... | ... | 22250 |
| Rivet shear strength[d] | 3290 | 5670 | 8760 | 12640 | 17100 | 22250 |
| Sheet thickness, in.: | Yield Strength[e], lbs. | | | | | |
| 0.100 | 1575 | ... | ... | ... | ... | ... |
| 0.125 | 1880 | 2505 | 3200 | ... | ... | ... |
| 0.160 | 2310 | 3050 | 3865 | 4720 | 5655 | ... |
| 0.190 | ... | 3515 | 4435 | 5395 | 6430 | 7595 |
| 0.250 | ... | 4450 | 5570 | 6735 | 7980 | 9360 |
| 0.312 | ... | 5055 | 6745 | 8115 | 9580 | 11185 |
| 0.375 | ... | 5560 | 7460 | 9525 | 11205 | 13040 |
| 0.500 | ... | ... | 8680 | 11010 | 13655 | 16720 |
| 0.625 | ... | ... | ... | 12385 | 15315 | 18625 |
| 0.750 | ... | ... | ... | 12640 | 16645 | 20520 |
| 0.875 | ... | ... | ... | ... | 17100 | 21805 |
| 1.000 | ... | ... | ... | ... | ... | 22250 |
| Sleeve head height (ref.), in. | 0.062 | 0.075 | 0.082 | 0.093 | 0.115 | 0.120 |

a Data supplied by P.B. Fasteners.

b Nominal hole diameter based on $\left(\frac{\text{max. expanded sleeve} - \text{min. hole}}{2}\right)$ + min. hole using larger expanded diameter from MIL-B-8831/4 dated 23 August 1982.

c Fasteners installed to interference levels of 0.002-0.008 in.

d Fastener shear strength is documented in NAS 1724 as 108 ksi.

e Permanent set at yield load: 4% of nominal hole diameter.

## 8.2 METALLURGICAL JOINTS

In the design of metallurgical joints, the strength of the joining material (for example, weld metal) and the adjacent parent material must be considered. The joint should be analyzed on the basis of its loading, the specified allowable strengths, dimensions and geometry.

**8.2.1 INTRODUCTION AND DEFINITIONS** — The allowable strength for both the adjacent parent metal and the weld metal is given below in the particular section dealing with the method of forming used, and the material being joined. The following subparagraphs define certain joining processes.

*Welding* — Welding consists of joining two or more pieces of metal by applying heat, pressure or both, with or without filler material, to produce a localized union through fusion or recrystallization across the joint interface. Examples of common welding processes include: fusion [inert-gas, shielded-arc welding with tungsten electrode (TIG) and inert-gas shielded metal-arc welding using covered electrodes (MIG)], resistance (spot and seam), and flash. Several terms used in describing various sections of a welded joint are illustrated in Figure 8.2.1.

*Brazing* — Brazing consists of joining metals by the application of heat causing the flow of a thin layer, capillary thickness, of nonferrous filler metal into the space between the pieces. Bonding results from the intimate contact produced by the dissolution of a small amount of base metal in the molten filler metal, without fusion of the base metal.

**8.2.2 WELDED JOINTS** — The weld metal section of a joint should be analyzed on the basis of its loading, specified allowable strength, dimensions and geometry. The effects of the parent metal are to be accounted for as specified herein.

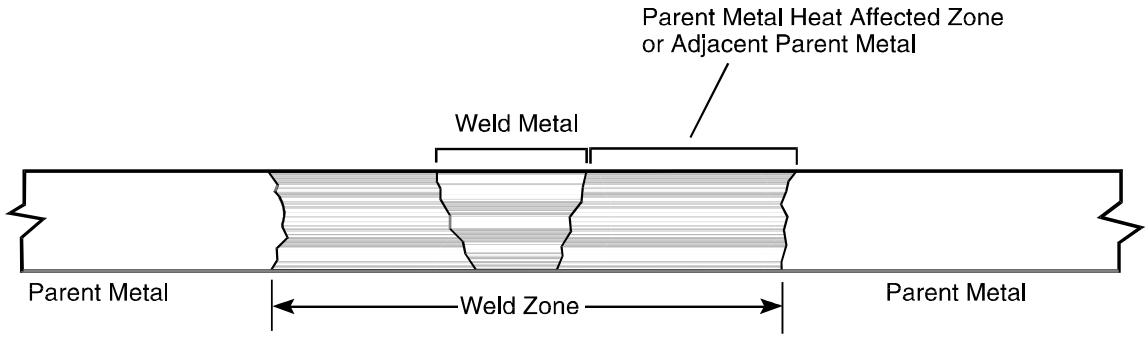



**Figure 8.2.1. Schematic diagram of weld and parent metal.**

**8.2.2.1 *Fusion Welding—Arc and Gas*** — Section 9.4.2 contains a detailed discussion of one acceptable method of establishing fusion welding allowables. As stated in that section, other methods can be employed as approved by certifying agencies. The following subsections contain specific information for a number of materials.

8.2.2.1.1 *Strength of Fusion Welded Joints of Steel Alloys* — Allowable fusion weld-metal strengths of steel alloys are shown in Table 8.2.2.1.1(a). Design allowable stresses for the weld metal are based on 85 percent of the respective minimum tensile ultimate test values.

For steel joints welded after heat treatment, the allowable strengths near the weld are given in Tables 8.2.2.1.1(b) and (c).

**Table 8.2.2.1.1(a). Strength of Fusion Welded Joints of Steel Alloys**

| Material | Heat Treatment Subsequent to Welding | Welding Rod or Electrode | $F_{su}$, ksi | $F_{tu}$, ksi |
|---|---|---|---|---|
| Carbon and alloy steels | None | AMS 6457 | 32 | 51 |
| | | AWSA5.1 classes E6010 and E6013 | 32 | 51 |
| Alloy steels | None | AMS 6452 | 43 | 72 |
| Alloy steels | Stress relieved | AWSA5.5 class E10013 | 50 | 85 |
| | | MIL-E-22200/10, classes MIL-10018-M1 | | |

**Table 8.2.2.1.1(b). Allowable Ultimate Tensile Stresses Near Fusion Welds in 4130, 4140, or 8630 Steels[a]**

| Section Thickness ¼ inch or less | |
|---|---|
| Type of Joint | Ultimate Tensile Stress, ksi |
| Tapered joints of 30° or less[b] | 90 |
| All others | 80 |

a Welded after heat treatment or normalized after weld.
b Gussets or plate inserts considered 0° taper with centerline.

**Table 8.2.2.1.1(c). Allowable Bending Modulus of Rupture Near Fusion Weld in 4130, 4140, 4340, or 8630 Steels[a]**

| Type of Joint | Bending Modulus of Rupture, ksi |
|---|---|
| Tapered joints of 30° or less[b] | $F_b$ from Figure 2.8.1.1 for $F_{tu}$ = 90 ksi |
| All others | 0.9 of the values of $F_b$ from Figure 2.8.1.1 for $F_{tu}$ = 90 ksi |

a Welded after heat treatment or normalized after weld.
b Gussets or plate inserts considered 0° taper with centerline.

For materials heat treated after welding, the allowable strength in the parent metal near a welded joint may equal the allowable strength for the material in the heat treated condition as given in the tables of design mechanical properties of the specific alloys; however, it should be noted that the weld metal allowables are based on 85 percent of these values.

**8.2.2.2 *Flash and Pressure Welding*** — The ultimate tensile allowable strength and bending allowable modulus of rupture for flash and pressure welds are given in Tables 8.2.2.2(a) and (b). A higher efficiency may be permitted in special cases by the applicable procuring or certifying agency upon approval of the manufacturer's process specification.

**8.2.2.3 *Spot and Seam Welding*** — Permission to use spot and seam welding on structural parts is governed by the requirements of the procuring or certifying agency. Table 8.2.2.3 gives the recommended allowable edge distance for spot and seam welds.

8.2.2.3.1 *Design Shear Strengths for Spot and Seam Welds in Uncoated Steels and Nickel and Cobalt Alloys* — The design shear strength for spot welds for these materials are given in Tables 8.2.2.3.1(a) and (b). The thickness ratio of the thickest sheet to the thinnest outer sheet in the combination should not exceed 4:1.

8.2.2.3.1.1 *Effects of Spot-Welds on the Parent Metal Strength of 300 Series Stainless Steel* — In applications of spot welding where ribs, intercostals, or doublers are attached to sheet, either at splices or at other joints on the sheet panels, the allowable ultimate strength of the spot-welded stainless steel sheet shall be determined by multiplying the ultimate tensile strength of the sheet (A or S-value) by the appropriate efficiency factors shown in Figures 8.2.2.3.1.1(a) through (c). Efficiencies for gages under 0.012 shall be determined by test.

8.2.2.3.2 *Design Shear Strengths for Spot and Seam Weldings in Aluminum Alloys* — The acceptable aluminum and aluminum alloy combinations for spot and seam welding are given in Table 8.2.2.3.2(a).

Design shear-strength for spot welds in aluminum alloys are given in Tables 8.2.2.3.2(b) and (c). The thickness ratio of the thickest to the thinnest outer sheet in the combination should not exceed 4:1.

Design shear-strength for spot-welded joints, based on tearing of the sheet, is given in Table 8.2.2.3.2(d) for some aluminum alloys, together with the "maximum" pitches that permit attainment of these strengths. Joints having larger pitches fail in the spot welds rather than by tearing of the sheet, and are governed by Tables 8.2.2.3.2(b) and (c). The design shear strengths listed are also applicable to seam welds.

*8.2.2.3.2.1 Effects of Spot Welds on Parent Metal Strength of Aluminum Alloys* — In applications of spot welding other than splices, where ribs, intercostals, or doublers are attached to sheet, the allowable ultimate strength of the spot-welded sheet may be determined by multiplying the ultimate tensile strength of the sheet (A or S-values) by the appropriate efficiency factor shown on Figure 8.2.2.3.2.1. Efficiencies for gages under 0.020 shall be determined by test.

*8.2.2.3.2.2 Fatigue Strength of Spot-Welded Joints in Aluminum Alloys* — The fatigue strength of spot-welded joints in aluminum alloy are given in Figures 8.2.2.3.2.2(a) through 8.2.2.3.2.2(e).

8.2.2.3.3 *Design Shear Strengths for Spot and Seam Welds in Magnesium Alloys* — Design shear-strength for spot welds in magnesium alloys are given in Table 8.2.2.3.3. The thickness ratio of the thickest sheet to the thinnest outer sheet in the combination should not exceed 4:1.

8.2.2.3.4 *Design Shear Strengths for Spot and Seam Welds in Titanium and Titanium Alloys* — Design shear strength for spot welds in titanium and titanium alloys are given in Tables 8.2.2.3.4(a) and (b). The thickness ratio of the thickest sheet to the thinnest outer sheet in the combination should not exceed 4:1.

**Table 8.2.2.2(a). Allowable Ultimate Tensile Stress for Flash Welds in Steel Tubing**

| Tubing | Allowable Ultimate Tensile Stress of Welds |
|---|---|
| Normalized tubing — not heat treated (including normalizing) after welding | 1.0 $F_{tu}$ (based on $F_{tu}$ of normalized tubing) |
| Heat-treated tubing welded after heat treatment | 1.0 $F_{tu}$ (based on $F_{tu}$ of normalized tubing) |
| Tubing heat treated (including normalizing) after welding. $F_{tu}$ of unwelded material in heat-treated condition: | |
| < 100 ksi | 0.9 $F_{tu}$ |
| 100 to 150 ksi | 0.6 $F_{tu}$ + 30 |
| > 150 ksi | 0.8 $F_{tu}$ |

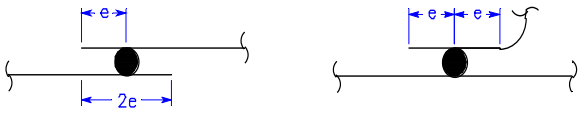
**Table 8.2.2.2(b). Allowable Bending Modulus of Rupture for Flash Welds in Steel Tubing**

| Tubing | Allowable Bending Modulus of Rupture of Welds ($F_b$ from Figure 2.8.1.1 using values of $F_{tu}$ listed) |
|---|---|
| Normalized tubing — not heat treated (including normalizing after welding | 1.0 $F_{tu}$ (based on $F_{tu}$ of normalized tubing) |
| Heat-treated tubing welded after heat treatment | 1.0 $F_{tu}$ (based on $F_{tu}$ of normalized tubing) |
| Tubing heat treated (including normalizing) after welding. $F_{tu}$ of unwelded material in heat-treated condition: | |
| < 100 ksi | 0.9 $F_{tu}$ |
| 100 to 150 ksi | 0.6 $F_{tu}$ + 30 |
| > 150 ksi | 0.8 $F_{tu}$ |

**Table 8.2.2.3. Recommended Minimum Edge Distance and Spacing for Spot-Welded Joints[a]**

| Nominal Thickness[b] of Thinner Sheet, inch | Minimum Lap Joint[c,d] Edge Distance, inch | Minimum Spacing[e], inch |
|---|---|---|
| 0.016 | 0.19 | 0.19 |
| 0.020 | 0.20 | 0.30 |
| 0.025 | 0.22 | 0.38 |
| 0.032 | 0.25 | 0.46 |
| 0.040 | 0.28 | 0.52 |
| 0.050 | 0.31 | 0.58 |
| 0.063 | 0.38 | 0.67 |
| 0.071 | 0.41 | 0.73 |
| 0.080 | 0.44 | 0.79 |
| 0.090 | 0.47 | 0.89 |
| 0.100 | 0.50 | 1.00 |
| 0.125 | 0.56 | 1.25 |
| 0.160 | 0.69 | 1.60 |

a Reference Aluminum Association and American Welding Society Handbook.
b Intermediate gages will require interpolation between adjacent gages.
c Edge distances are measured materials in contact; this can be to a free edge or to a sheet metal radius where one material bends away from another. Edge distances less than those specified above may be used provided there is no expulsion of weld material or bulging of the edge of the sheet; however, these joints may have less static strength and shorter fatigue life.




d Minimum contacting overlap is twice the minimum edge distance.
e Less than minimum recommended spacing may cause shunting that leads to deterioration of weld strengths and joint life.

**Table 8.2.2.3.1(a). Spot-Weld Design Shear Strength[a,b] in Thin Sheet and Foil for Uncoated Steels[c] and Nickel and Cobalt Alloys (Welding Specification MIL-W-6858)**

| Thickness of Thinnest Outer Sheet, in. | Spots/inch | | Material Ultimate Tensile Strength, ksi | | | |
|---|---|---|---|---|---|---|
| | Standard (Ns)[d] | Range[e,f] | Above 185 | 150 to 185 | 90 to 149 | Below 90 |
| | | | Design Shear Strength, pounds per linear inch (Xm) | | | |
| 0.001 | 40 | 1-50 | 72 | 64 | 52 | 36 |
| 0.002 | 20 | 1-30 | 144 | 128 | 104 | 72 |
| 0.003 | 12 | 1-17 | 240 | 208 | 164 | 120 |
| 0.004 | 10 | 1-14 | 324 | 280 | 228 | 152 |
| 0.005 | 9 | 1-13 | 392 | 340 | 272 | 188 |
| 0.006 | 7 | 1-10 | 432 | 380 | 304 | 220 |
| 0.007 | 6 | 1-8 | 504 | 440 | 352 | 256 |
| 0.008 | 5 | 1-7 | 552 | 488 | 392 | 284 |

a Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.

b The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

c Refers to plain carbon steels containing not more than 0.15 percent carbon, austenitic, heat and corrosion resistant, and precipitation hardening steels. The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.

d When the number of spots per inch is within 15 percent of the standard spot per inch requirement, the design shear strengths tabulated above shall apply.

e When the number of spots differs from the standard spots per inch by 15 percent or greater, but does not exceed the noted range of spots per inch, applicable design strength shall be determined as noted below:

$$\frac{Xm}{Ns}(K)\,Nr = Xr$$

where

Xm = design shear strength in accordance with the above table
Ns = standard spots per inch in accordance with the above table
Nr = required spots per inch (production part)
Xr = actual design shear strength requirement
K = 1.15 when number of spots per inch is reduced more than 15 percent of the standard spacing of the above table
K = 0.90 when number of spots is increased more than 15 percent of the standard spacing but within range of the tabular spacing.

f When the number of spots per inch is above the range indicated in the table, the design shear strength shall remain constant at the value obtained at the top of the range.

**Table 8.2.2.3.1(b). Spot-Weld Design Shear Strength[a,b] in Panels for Uncoated Steels[c] and Nickel and Cobalt Alloys (Welding Specification MIL-W-6858)**

| Material Ultimate Tensile Strength, ksi | Design Shear Strength, pounds per spot | | | |
|---|---|---|---|---|
| | Above 185 | 150 to 185 | 90 to 149 | Below 90 |
| Nominal thickness of thinner sheet, in.: | | | | |
| 0.009 | 160 | 140 | 104 | 80 |
| 0.010 | 196 | 164 | 128 | 92 |
| 0.012 | 280 | 220 | 160 | 120 |
| 0.016 | 384 | 320 | 236 | 172 |
| 0.018 | 472 | 392 | 272 | 200 |
| 0.020 | 508 | 424 | 312 | 224 |
| 0.022 | 584 | 488 | 360 | 264 |
| 0.025 | 696 | 580 | 424 | 320 |
| 0.028 | 820 | 684 | 508 | 372 |
| 0.032 | 1000 | 836 | 620 | 452 |
| 0.036 | 1200 | 1004 | 736 | 552 |
| 0.040 | 1400 | 1168 | 852 | 652 |
| 0.045 | 1680 | 1436 | 1028 | 804 |
| 0.050 | 1960 | 1700 | 1204 | 956 |
| 0.056 | 2304 | 2040 | 1416 | 1168 |
| 0.063 | 2840 | 2472 | 1688 | 1408 |
| 0.071 | 3360 | 2984 | 2028 | 1664 |
| 0.080 | 3880 | 3528 | 2404 | 1964 |
| 0.090 | 4480 | 4072 | 2812 | 2308 |
| 0.100 | 5040 | 4576 | 3200 | 2640 |
| 0.112 | 5600 | 5092 | 3636 | 3036 |
| 0.125 | 6228 | 5664 | 4052 | 3440 |

a Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.

b The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

c Refers to plain carbon steels containing not more than 0.15 percent carbon and to austenitic heat and corrosion resistant, precipitation hardening steels. The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.

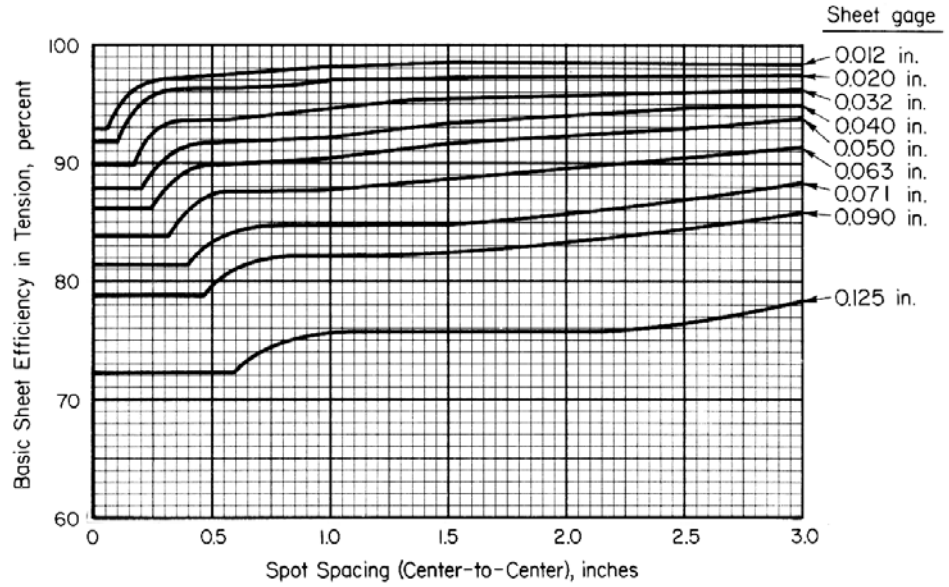



**Figure 8.2.2.3.1.1(a). Efficiency of the parent metal in tension for spot-welded AISI 301-A, and AISI 347-A, and AISI 301-1/4 stainless steel.**

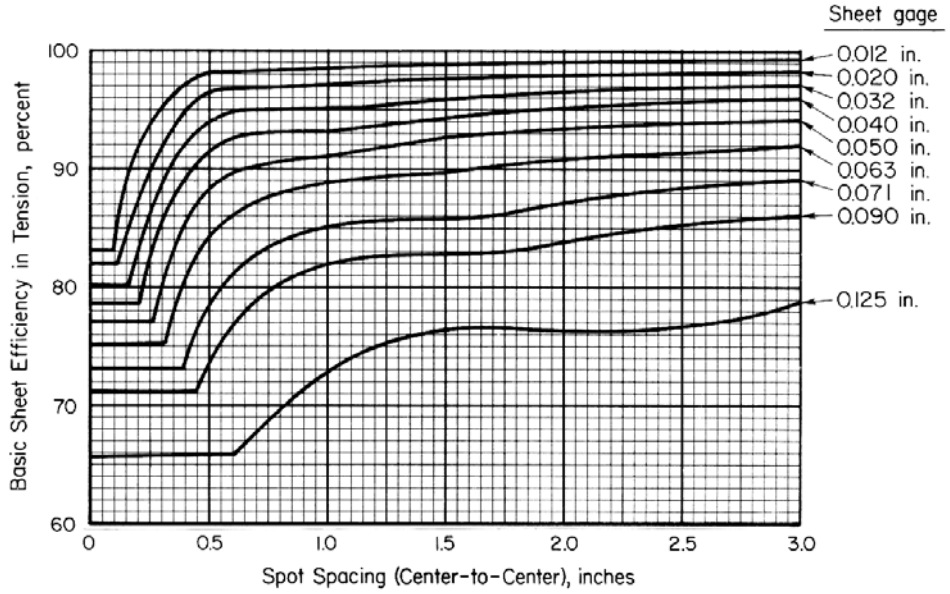



**Figure 8.2.2.3.1.1(b). Efficiency of the parent metal in tension for spot-welding AISI 301-1/2H stainless steel.**

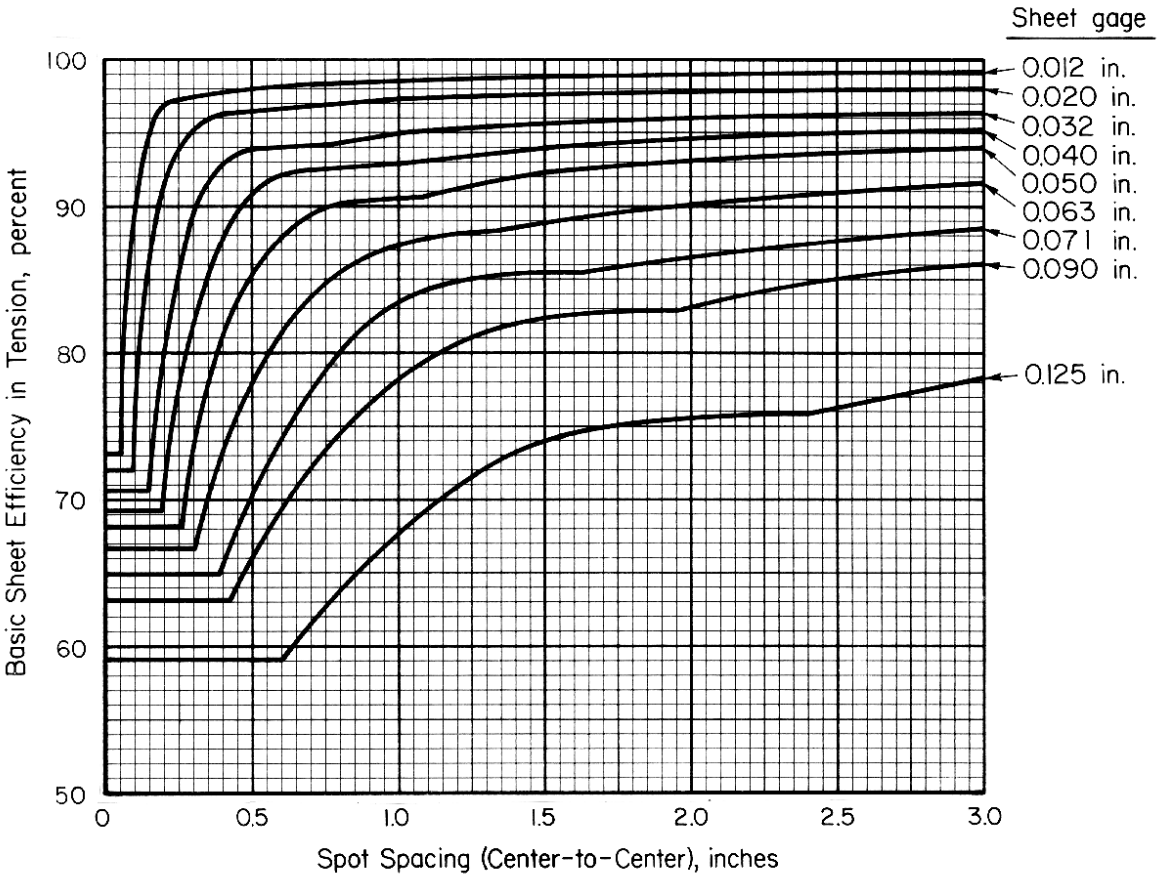



**Figure 8.2.2.3.1.1(c). Efficiency of the parent metal in tension for spot-welded AISI 301-H stainless steel.**

**Table 8.2.2.3.2(a). Acceptable Aluminum and Aluminum Alloy Combination[a] for Spot and Seam Welding**

| Specification | | AMS-QQ-A-250/1 | AMS-4029[b] | AMS-QQ-A-250/3 | AMS-QQ-A-250/4[b] | AMS-QQ-A-250/5 | AMS-QQ-A-250/2 | AMS-QQ-A-250/8 | AMS-QQ-A-250/11 | AMS-QQ-A-250/12[b] | AMS-QQ-A-250/13[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Material | | 1100 | Bare 2014 | Clad 2014 | Bare 2024 | Clad 2024 | 3003 | 5052 | 6061 | Bare 7075 | Clad 7075 |
| Specification | Material | | | | | | | | | | |
| AMS-QQ-A-250/1 | 1100 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| AMS-4029 | Bare 2014[b] | ... | * | * | * | ... | ... | ... | ... | * | ... |
| AMS-QQ-A-250/3 | Clad 2014 | ... | * | ... | * | ... | ... | ... | ... | * | ... |
| AMS-QQ-A-250/4 | Bare 2024[b] | ... | * | * | * | ... | ... | ... | ... | * | ... |
| AMS-QQ-A-250/5 | Clad 2024 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| AMS-QQ-A-250/2 | 3003 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| AMS-QQ-A-250/8 | 5052 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| AMS-QQ-A-250/11 | 6061 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| AMS-QQ-A-250/12 | Bare 7075[b] | ... | * | * | * | ... | ... | ... | ... | * | ... |
| AMS-QQ-A-250/13 | Clad 7075[b] | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

a The various aluminum and aluminum-alloy materials referred to in this table may be spot-welded in any combinations except the combinations indicated by the asterisk(*) in the table. The combinations indicated by the asterisk (*) may be spot-welded only with the specific approval of the procuring or certifying agency.

b This table applies to construction of land- and carrier-based aircraft only. The welding of bare, high-strength alloys in construction of seaplanes and amphibians is prohibited unless specifically authorized by the procuring or certifying agency.

c Clad heat-treated and aged 7075 material in thicknesses less than 0.020 inch shall not be welded without specific approval of the procuring or certifying agency.

**Table 8.2.2.3.2(b). Spot-Weld Design Shear Strength in Thin Sheet and Foil for Bare and Clad Aluminum Alloys[a,b,c] (Welding Specification MIL-W-6858)**

| Thickness of Thinnest Outer Sheet, in. | Spots/inch | | Material Ultimate Tensile Strength, ksi | |
|---|---|---|---|---|
| | | | 56 and Above | Below 56 |
| | Standard (Ns)[d] | Range[e,f] | Design Shear Strength, pounds per linear inch (Xm) | |
| 0.001..... | 40 | 1-50 | 24 | 16 |
| 0.002..... | 20 | 1-30 | 48 | 32 |
| 0.003..... | 12 | 1-17 | 80 | 52 |
| 0.004..... | 10 | 1-14 | 108 | 72 |
| 0.005..... | 9 | 1-13 | 132 | 92 |
| 0.006..... | 7 | 1-10 | 148 | 100 |
| 0.007..... | 6 | 1-8 | 168 | 112 |
| 0.008..... | 5 | 1-7 | 188 | 128 |

a The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.

b Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.

c The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

d When the number of spots per inch is within 15 percent of the standard spot per inch requirement, the design shear strengths tabulated above shall apply.

e When the number of spots differs from the standard spots per inch by 15 percent or greater, but does not exceed the noted range of spots per inch, applicable design strength shall be determined as noted below:

$$\frac{XM}{Ns}(K)\,Nr = Xr$$

where

Xm = design shear strength in accordance with the above table
Ns = standard spots per inch in accordance with the above table
Nr = required spots per inch (production part)
Xr = actual design shear strength requirement
K = 1.15 when number of spots per inch is reduced more than 15 percent of the standard spacing of the above table
K = 0.90 when number of spots is increased more than 15 percent of the standard spacing but within range of the tabular spacing.

f When the number of spots per inch is above the range indicated in the table, the design shear strength shall remain constant at the value obtained at the top of the range.

**Table 8.2.2.3.2(c). Spot-Weld Design Shear Strength in Panels for Bare and Clad Aluminum Alloys[a,b,c] (Welding Specification MIL-W-6858)**

| | Design Shear Strength, pounds per spot | | | |
|---|---|---|---|---|
| Material Ultimate Tensile Strength, ksi... | 56 and Above | 35 to 56 | 19.5 to 34.9 | Below 19.5 |
| Nominal thickness of thinner sheet, in.: | | | | |
| 0.010 | 48 | 40 | ... | ... |
| 0.012 | 60 | 52 | 24 | 16 |
| 0.016 | 88 | 80 | 56 | 40 |
| 0.018 | 100 | 92 | 68 | 52 |
| 0.020 | 112 | 108 | 80 | 64 |
| 0.022 | 128 | 124 | 96 | 76 |
| 0.025 | 148 | 140 | 116 | 88 |
| 0.028 | 172 | 164 | 140 | 108 |
| 0.032 | 208 | 188 | 168 | 132 |
| 0.036 | 244 | 220 | 204 | 156 |
| 0.040 | 276 | 248 | 240 | 180 |
| 0.045 | 324 | 296 | 280 | 208 |
| 0.050 | 372 | 344 | 320 | 236 |
| 0.056 | 444 | 412 | 380 | 272 |
| 0.063 | 536 | 488 | 456 | 316 |
| 0.071 | 660 | 576 | 516 | 360 |
| 0.080 | 820 | 684 | 612 | 420 |
| 0.090 | 1004 | 800 | 696 | 476 |
| 0.100 | 1192 | 936 | 752 | 540 |
| 0.112 | 1424 | 1072 | 800 | 588 |
| 0.125 | 1696 | 1300 | 840 | 628 |
| 0.140 | 2020 | 1538 | ... | ... |
| 0.160 | 2496 | 1952 | ... | ... |
| 0.180 | 2980 | 2400 | ... | ... |
| 0.190 | 3228 | 2592 | ... | ... |
| 0.250 | 5880 | 5120 | ... | ... |

a The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.
b Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.
c The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

## Table 8.2.2.3.2(d). Maximum Static Strength of Spot-Welded Joints in Aluminum Alloys and Corresponding Maximum Design Spot-Weld Pitch[a,b]

| | Single Row Joints | | | | | | Multiple Row Joints | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material..... | 7075-T6 clad | | 2024-T3 clad | | 6061-T6 | | 7075-T6 clad | | 2024-T3 clad | | 6061-T6 | |
| Thickness of Thinnest Sheet, in. | Strength, lbs/in. | Pitch, in. | Strength, lbs/in. | Pitch, in. | Strength, lbs/in. | Pitch, in. | Strength, lbs/in. | Pitch÷No. of Rows, in. | Strength, lbs/in. | Pitch÷No. of Rows, in. | Strength, lbs/in. | Pitch÷No. of Rows, in. |
| 0.010..... | 288 | 0.167 | 250 | 0.192 | 210 | 0.190 | 438 | 0.110 | 384 | 0.125 | 329 | 0.122 |
| 0.012..... | 346 | 0.173 | 300 | 0.200 | 252 | 0.206 | 526 | 0.114 | 461 | 0.130 | 395 | 0.132 |
| 0.016..... | 461 | 0.191 | 400 | 0.220 | 336 | 0.238 | 701 | 0.126 | 614 | 0.143 | 526 | 0.152 |
| 0.020..... | 577 | 0.194 | 500 | 0.224 | 420 | 0.257 | 876 | 0.128 | 768 | 0.146 | 658 | 0.164 |
| 0.025..... | 721 | 0.205 | 625 | 0.237 | 525 | 0.267 | 1095 | 0.135 | 960 | 0.154 | 822 | 0.170 |
| 0.032..... | 923 | 0.225 | 800 | 0.260 | 672 | 0.280 | 1402 | 0.148 | 1229 | 0.169 | 1053 | 0.179 |
| 0.040..... | 1059 | 0.261 | 918 | 0.301 | 778 | 0.319 | 1752 | 0.158 | 1536 | 0.180 | 1316 | 0.188 |
| 0.050..... | 1230 | 0.302 | 1067 | 0.349 | 910 | 0.378 | 2190 | 0.170 | 1920 | 0.194 | 1645 | 0.209 |
| 0.063..... | 1452 | 0.369 | 1259 | 0.426 | 1082 | 0.451 | 2759 | 0.194 | 2419 | 0.222 | 2073 | 0.235 |
| 0.071..... | 1589 | 0.415 | 1378 | 0.479 | 1187 | 0.485 | 3110 | 0.212 | 2726 | 0.242 | 2336 | 0.247 |
| 0.080..... | 1742 | 0.471 | 1511 | 0.543 | 1306 | 0.524 | 3504 | 0.234 | 3072 | 0.267 | 2632 | 0.260 |
| 0.090..... | 1913 | 0.525 | 1660 | 0.605 | 1438 | 0.556 | 3942 | 0.255 | 3456 | 0.290 | 2961 | 0.270 |
| 0.100..... | 2084 | 0.572 | 1808 | 0.659 | 1580 | 0.596 | 4380 | 0.272 | 3840 | 0.310 | 3290 | 0.284 |
| 0.112..... | 2289 | 0.622 | 1986 | 0.717 | 1728 | 0.620 | 4906 | 0.290 | 4301 | 0.331 | 3685 | 0.291 |
| 0.125..... | 2511 | 0.675 | 2179 | 0.788 | 1900 | 0.684 | 5475 | 0.310 | 4800 | 0.353 | 4112 | 0.316 |

a For multiple row joints row spacing is at minimum and same pitch in all rows.
b For pitches greater than those shown, strength is governed by Tables 8.2.2.3.2(b) and (c).

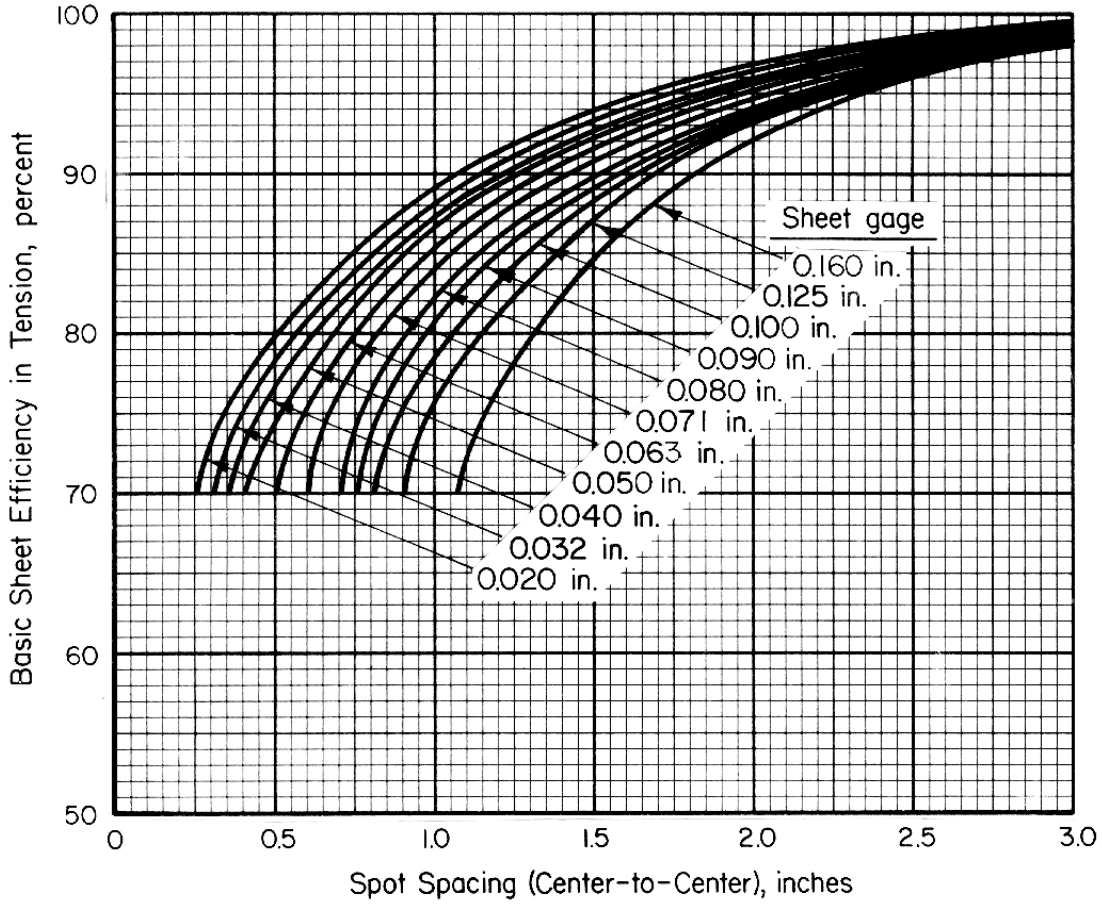



**Figure 8.2.2.3.2.1. Efficiency of the parent metal in tension for spot-welded aluminum alloys.**

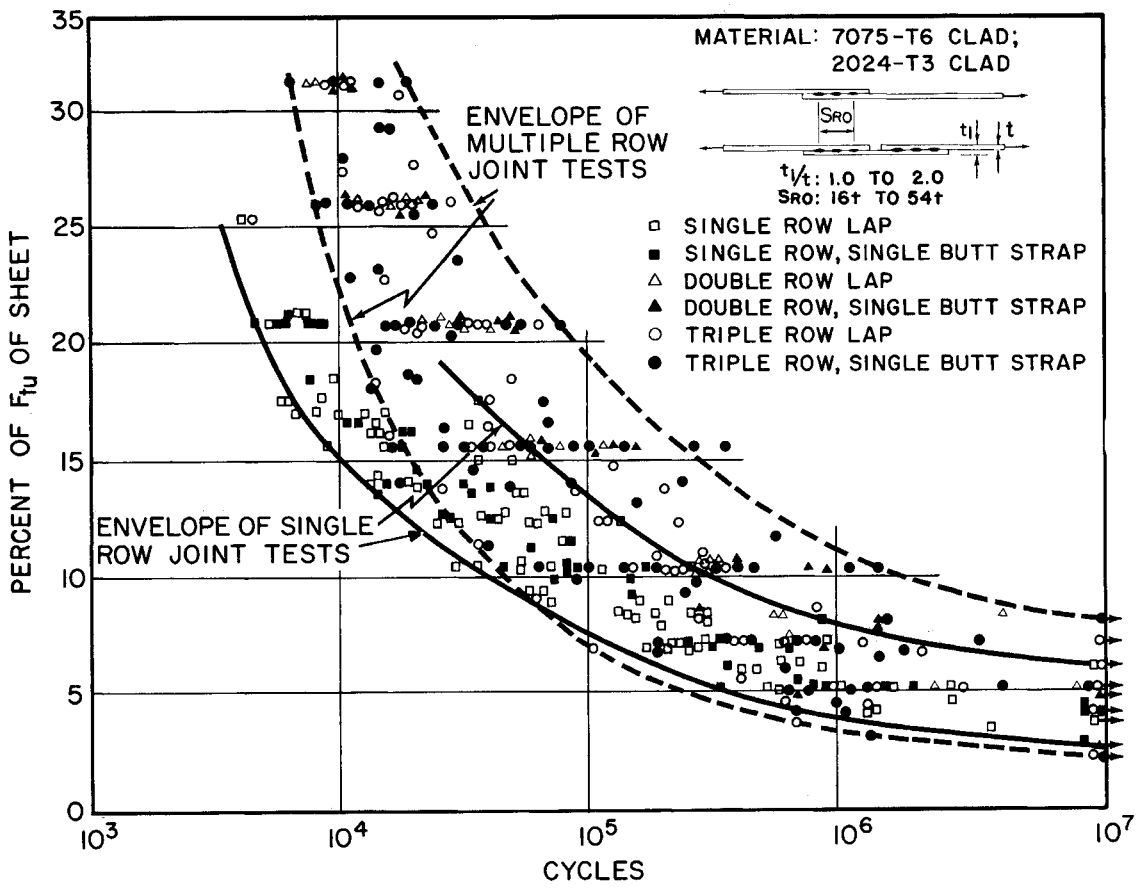



**Figure 8.2.2.3.2.2(a). Fatigue strength of spot-welded joints in aluminum alloy sheet. Load Ratio = 0.05 (static failure by tearing sheet).**

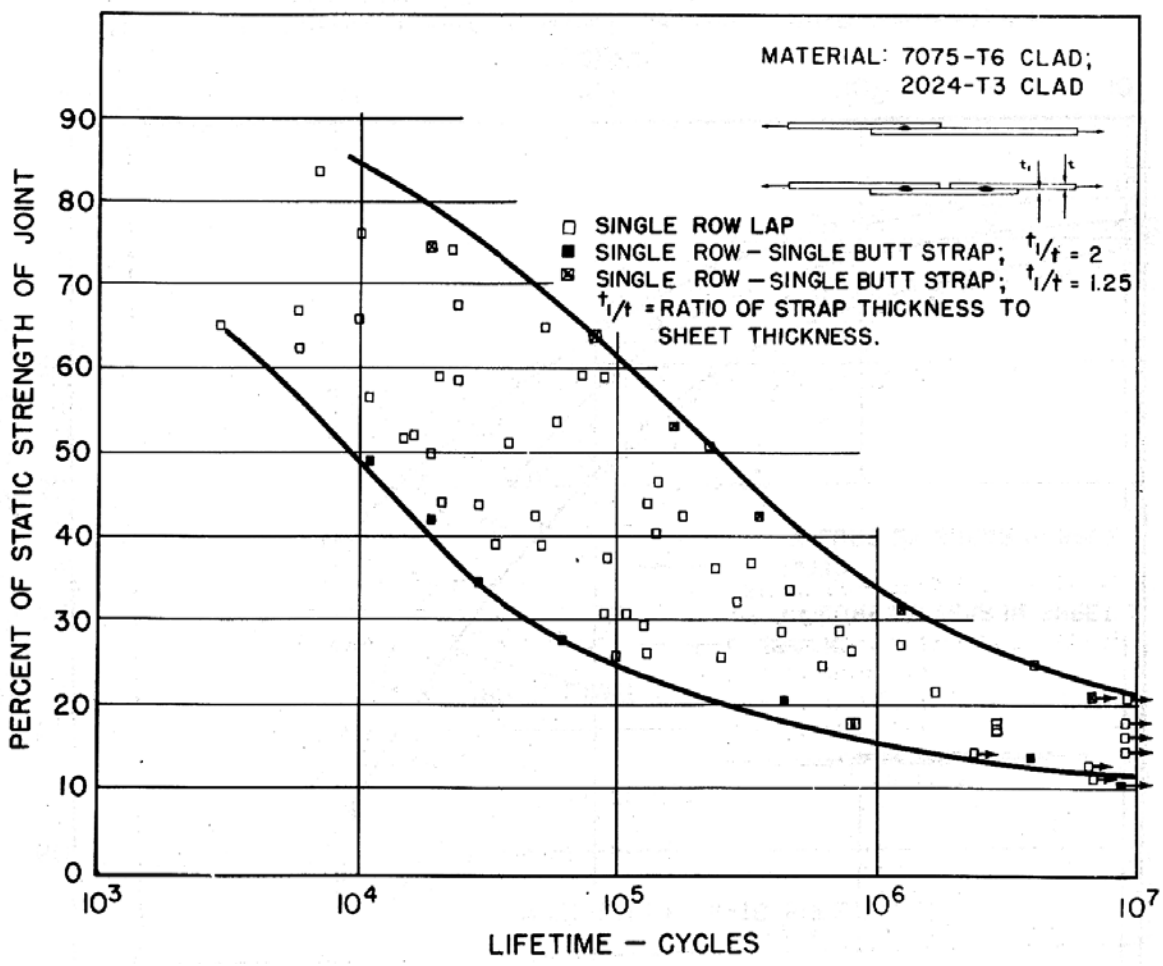



**Figure 8.2.2.3.2.2(b). Fatigue strength of spot-welded joints in aluminum alloy sheet. Load Ratio = 0.05 (static failure by shear in the spot welds).**

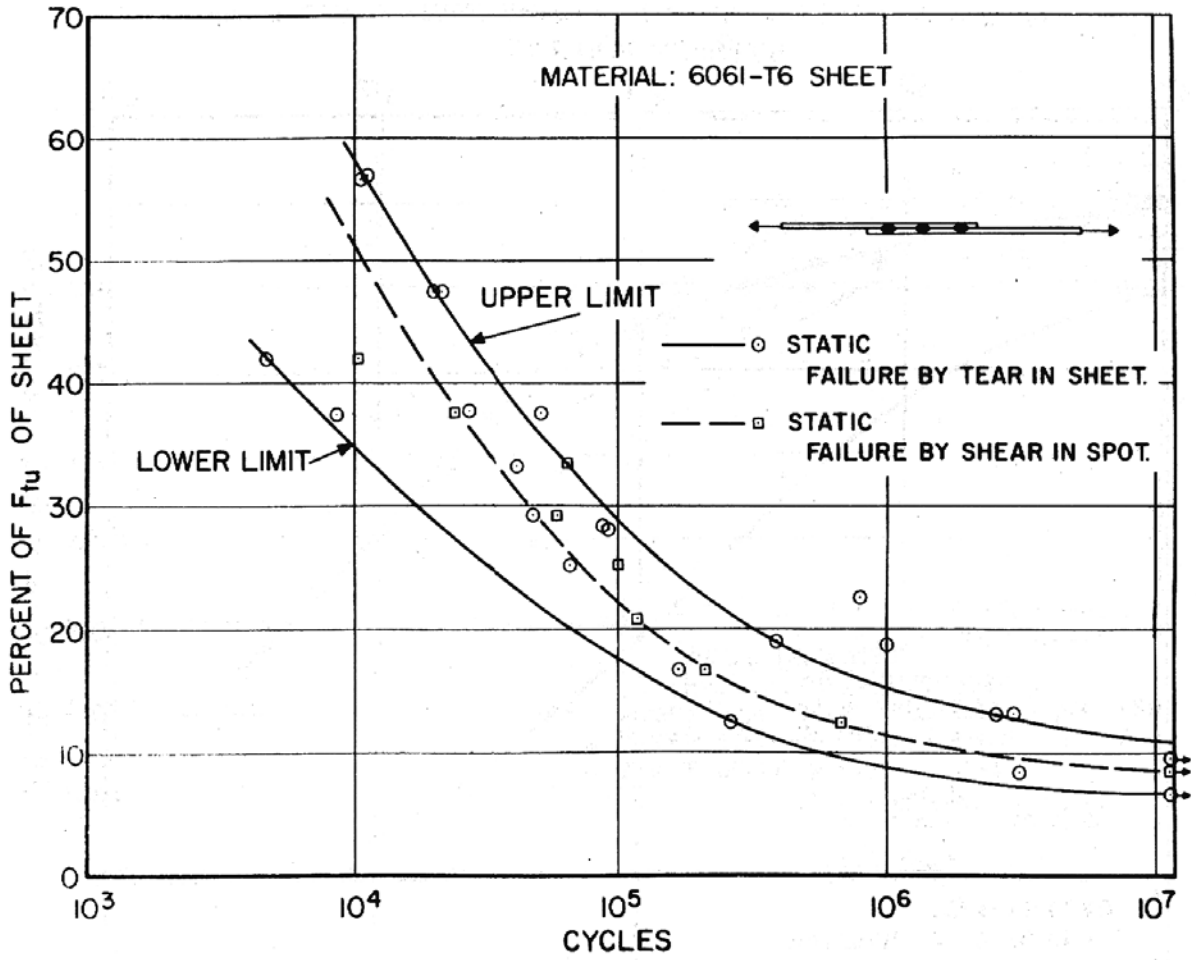



**Figure 8.2.2.3.2.2(c). Fatigue strength of triple row spot-welded lap joints in 6061-T6 aluminum alloy sheet. Load Ratio = 0.05.**

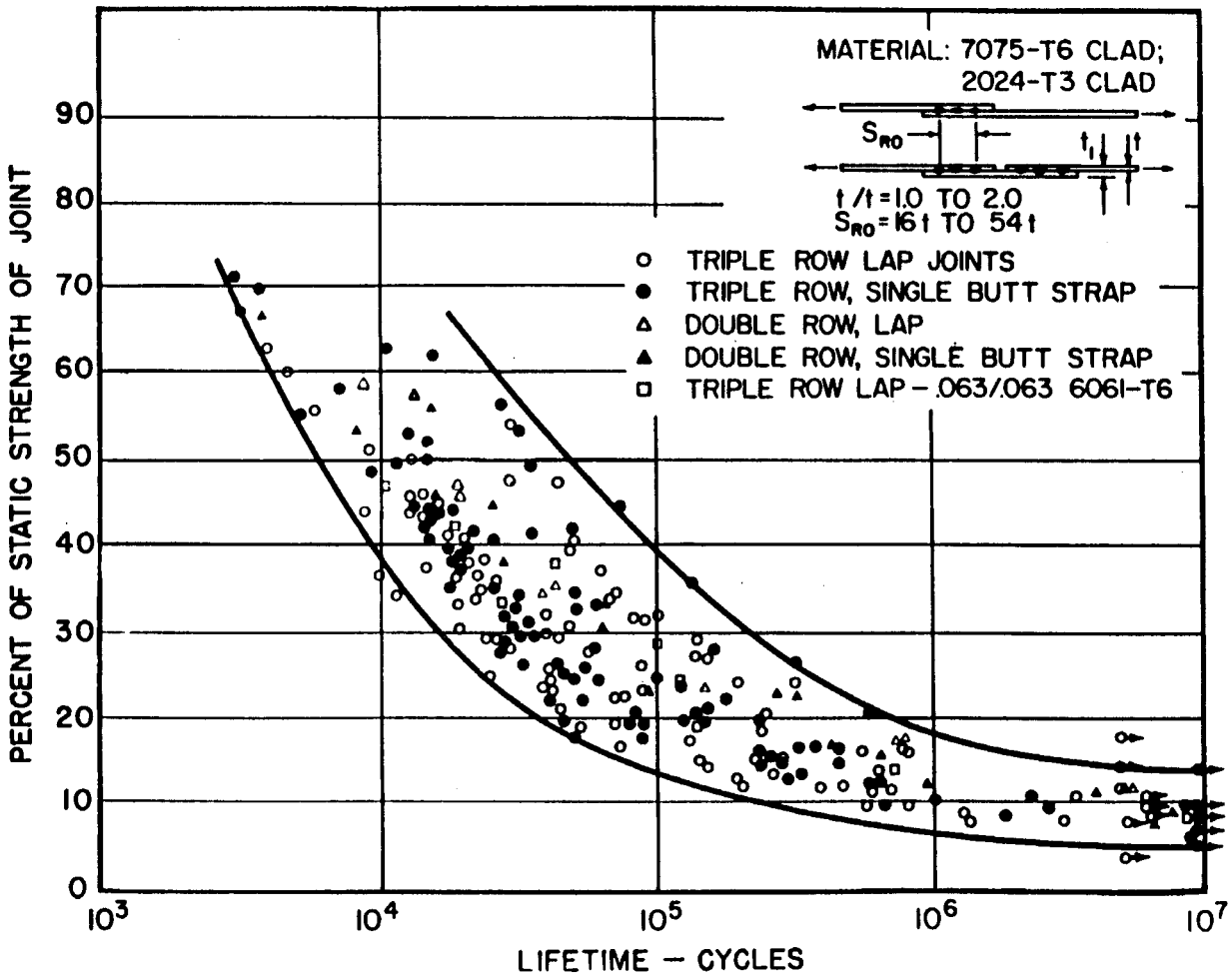



**Figure 8.2.2.3.2.2(d). Fatigue strength of spot-welded multiple row joints in aluminum alloy sheet. Load Ratio = 0.05 (static failure by shear in the spot welds).**

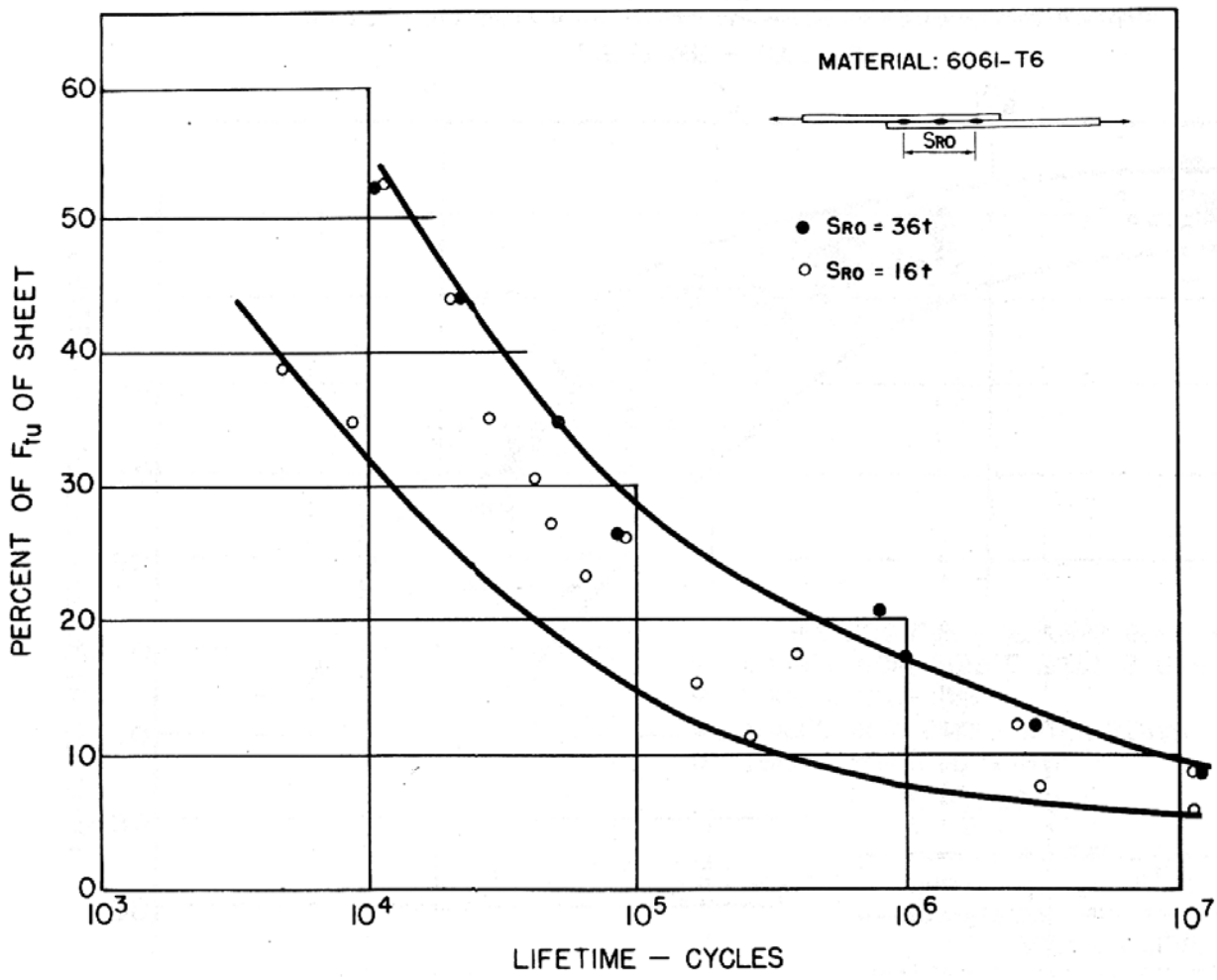



**Figure 8.2.2.3.2.2(e). Fatigue strength of triple row spot-welded lap joints in 6061-T6 aluminum alloy sheet. Load Ratio = 0.05 (static failure by tear in sheets).**

**Table 8.2.2.3.3. Spot-Weld Design Shear Strength in Panels for Magnesium Alloys[a,b,c] (Welding Specification MIL-W-6858)**

| | Design Shear Strength, pounds per spot | |
|---|---|---|
| Material Ultimate Tensile Strength, ksi... | Greater than 19.5 | Less than 19.5 |
| Nominal thickness of thinner sheet, in.: | | |
| 0.012 | 24 | 16 |
| 0.016 | 56 | 40 |
| 0.018 | 68 | 52 |
| 0.020 | 80 | 64 |
| 0.022 | 96 | 76 |
| 0.025 | 116 | 88 |
| 0.028 | 140 | 108 |
| 0.032 | 168 | 132 |
| 0.036 | 204 | 156 |
| 0.040 | 240 | 180 |
| 0.045 | 280 | 208 |
| 0.050 | 320 | 236 |
| 0.056 | 380 | 272 |
| 0.063 | 456 | 316 |
| 0.071 | 516 | 360 |
| 0.080 | 612 | 420 |
| 0.090 | 696 | 476 |
| 0.100 | 752 | 540 |
| 0.112 | 800 | 588 |
| 0.125 | 840 | 628 |

a Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.
b The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.
c Magnesium alloys AZ31B and HK31A may be spot-welded in any combination.

**Table 8.2.2.3.4(a). Spot-Weld Design Shear Strength in Thin Sheet and Foils for Titanium and Titanium Alloys[a,b,c] (Welding Specification MIL-W-6858)**

| Thickness of Thinnest Outer Sheet, in. | Spots/inch | | Materials Ultimate Tensile Strength, ksi | | | |
|---|---|---|---|---|---|---|
| | Standard (Ns)[d] | Range[e,f] | Above 185 | 150 to 185 | 90 to 149 | Below 90 |
| | | | Design Shear Strength, pounds per linear inch (Xm) | | | |
| 0.001 . . . . . | 40 | 1-50 | 72 | 64 | 52 | 36 |
| 0.002 . . . . . | 20 | 1-30 | 144 | 128 | 104 | 72 |
| 0.003 . . . . . | 12 | 1-17 | 240 | 208 | 164 | 120 |
| 0.004 . . . . . | 10 | 1-14 | 324 | 280 | 228 | 152 |
| 0.005 . . . . . | 9 | 1-13 | 392 | 340 | 272 | 188 |
| 0.006 . . . . . | 7 | 1-10 | 432 | 380 | 304 | 220 |
| 0.007 . . . . . | 6 | 1-8 | 504 | 440 | 352 | 256 |
| 0.008 . . . . . | 5 | 1-7 | 552 | 488 | 392 | 284 |

a The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.

b Strength based on 80 percent of minimum values specified in Specification MIL-W-6858.

c The allowable tensile strength of spot-welds is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

d When the number of spots per inch is within 15 percent of the standard spot per inch requirement, the design shear strengths tabulated above shall apply.

e When the number of spots differs from the standard spots per inch by 15 percent or greater, but does not exceed the noted range of spots per inch, applicable design strength shall be determined as noted below:

$$XM/Ns(K)Nr = Xr$$

where

Xm = design shear strength in accordance with the above table
Ns = standard spots per inch in accordance with the above table
Nr = required spots per inch (production part)
Xr = actual design shear strength requirement
K = 1.15 when number of spots per inch is reduced more than 15 percent of the standard spacing of the above table
K = 0.90 when number of spots is increased more than 15 percent of the standard spacing but within range of the tabular spacing.

f When the number of spots per inch is above the range indicated in the table, the design shear strength shall remain constant at the value obtained at the top of the range.

**Table 8.2.2.3.4(b). Spot-Weld Design Shear Strength in Panels for Titanium and Titanium Alloy[a,b,c] (Welding Specification MIL-W-6858)**

| | Design Shear Strength, pounds per spot | |
|---|---|---|
| Material Ultimate Tensile Strength, ksi . . . . . | Above 100 | 100 and Below |
| Nominal thickness of thinner sheet, in.: | | |
| 0.010 . . . . . | 164 | 128 |
| 0.012 . . . . . | 220 | 160 |
| 0.016 . . . . . | 320 | 236 |
| 0.018 . . . . . | 392 | 272 |
| 0.020 . . . . . | 424 | 312 |
| 0.022 . . . . . | 488 | 360 |
| 0.025 . . . . . | 580 | 424 |
| 0.028 . . . . . | 684 | 508 |
| 0.032 . . . . . | 836 | 620 |
| 0.036 . . . . . | 1004 | 736 |
| 0.040 . . . . . | 1168 | 852 |
| 0.045 . . . . . | 1438 | 1028 |
| 0.050 . . . . . | 1702 | 1204 |
| 0.056 . . . . . | 2040 | 1416 |
| 0.063 . . . . . | 2400 | 1688 |
| 0.071 . . . . . | 2702 | 1914 |
| 0.080 . . . . . | 3048 | 2160 |
| 0.090 . . . . . | 3430 | 2435 |
| 0.100 . . . . . | 3810 | 2702 |
| 0.112 . . . . . | 4260 | 3030 |
| 0.125 . . . . . | 4760 | 3380 |

a The reduction in strength of spot-welds due to the cumulative effects of time-temperature-stress factors is not greater than the reduction in strength of the parent metal.
b Strength based on 80 percent of minimum value specified in Specification MIL-W-6858.
c The allowable tensile strength of spot-wells is 25 percent of the design shear strength. Higher values may be used, however, if these are substantiated by tests acceptable to the procuring or certifying agency.

### 8.2.3 BRAZING

**8.2.3.1 *Copper Brazing*** — The allowable shear strength for copper brazing of steel alloys shall be 15 ksi, for all conditions of heat treatment. Higher values may be allowed upon approval of the procuring or certifying agency.

The effect of the brazing process on the strength of the parent or base metal of steel alloys shall be considered in the structural design. Where copper furnace brazing is employed, the calculated allowable strength of the base metal which is subjected to the temperatures of the brazing process shall be in accordance with the following:

| Material | Allowable Strength |
|---|---|
| Heat-treated material (including normalized) used in "as-brazed" condition | Mechanical properties of normalized material |
| Heat-treated material (including normalized) reheat-treated during or after brazing | Mechanical properties corresponding to heat treatment performed |

***8.2.3.2 Silver Brazing*** — Silver-brazed areas should not be subjected to temperatures exceeding 900°F. Silver brazing alloys are listed in specification QQ-B-654. Deviation from this specification may be allowed upon approval of the procuring or certifying agency.

The allowable shear strength for silver brazing of steel alloys shall be 15 ksi, provided that clearances or gaps between parts to be brazed do not exceed 0.010 in. Deviation from this specified allowable value may be allowed upon approval of the procuring or certifying agency.

The effect of silver brazing on the strength of the parent or base metal is the same as shown for copper brazing in Section 8.2.3.1.

## 8.3 BEARINGS, PULLEYS, AND WIRE ROPE

*Bearings* — Design, strengths, selection criteria, and other data for plain and antifriction bearings are found in AFSC Design Handbook AFSC DH-2-1, Chapters 3 and 6.

*Pulleys* — Pulley strengths and design data are to be utilized in accordance with Specification MIL-P-7034.

*Wire Rope* — Strengths and design data for wire rope are to be selected from the following specifications, whichever is appropriate: MIL-W-83420 or MIL-W-87161.

# REFERENCES

8.1 Hartman, E. C. and Westcoat, C., "The Shear Strength of Aluminum Alloy Driven Rivets as Affected by Increasing D/t Ratios," U.S. National Advisory Committee for Aeronautics, Technical Note No. 942, 23 pp (July 1944).

8.1.2.1 Fugazzi, G. R., "Results of Test Evaluation Program to Develop Design Joint Strength Load Allowable Values for A-286 Solid Rivets Under Room and Elevated Temperature Conditions," Almay Research and Testing Corporation Report No. G8058, 63 pp (November 1964).

8.1.2.2 "Report on Flush Riveted Joint Strength," Airworthiness Requirements Committee, A/C Industries Association of America, Inc., Airworthiness Project 12 (Revised May 25, 1948).

8.1.5.2 "Report on Flush Screw Joint Strength," Airworthiness Requirements Committee, A/C Industries Association of American, Inc., Airworthiness Project 20 (Revised April 6, 1953).

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