MIL-R-83459A
29 September 1978
SUPERSEDING
MIL-R-83459 (USAF)
20 February 1975

MILITARY SPECIFICATION

RIVET, TITANIUM, BIMETAL 95 KSI F_{su} GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This specification covers the requirements for 95 kSI F_{su} bimetal titanium rivets.

1.2 Classification. Rivets furnished under this specification shall be of the following types:

Type I - Rivet, titanium, bimetal, 95 KSI F_{su}, protruding head

Type II - Rivet, titanium, bimetal, 95 KSI F_{su}, full flush crown head

Type III - Rivet, titanium, bimetal, 95 KSI F_{su}, reduced flush crown head

2 APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bid or request for proposal, form a part of this specification to the extent specified herein

SPECIFICATIONS

FEDERAL

PPP-H-1581 Hardware (Fasteners and Related Items), Packaging and Packing for Shipment and Storage of

MILITARY

MIL-H-81200 Heat Treatment of Titanium and Titanium Alloys

MIL-L-87132 Lubricant, Cetyl Alcohol, 1-Hexadecanol, Application to Fasteners

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson AFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

STANDARDS

MILITARY

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 Marking for Shipment and Storage
MIL-STD-1312 Fastener, Test Methods

HANDBOOKS

MILITARY

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

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

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

Society of Automotive Engineers

AMS4967 Titanium Alloy Bars, Forgings and Rings, 6A1-4V, Annealed, Heat Treatable
AMS4982 Titanium Alloy Bars, 45Cb, Annealed, Heat Treatable

(Application for copies should be addressed to the Society of Automotive Engineers, Incorporated, 400 Commonwealth Drive, Warrendale, Pa 15096.)

American National Standards Institute

ANSI B46.1 Surface Texture, Surface Roughness, Waviness and Lay

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, New York 10018.)

American Society for Testing and Materials

ASTM E-120 Chemical Analysis of Titanium and Titanium Base Alloys

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specifications sheets, the latter shall govern.

3.2 Materials

3.2.1 The materials used in the manufacture of high strength, bimetal rivets shall be as follows:

Body - 6A1-4V	Titanium alloy in accordance with AMS4967 heat treated to 95 KSI minimum shear
Tail - 45Cb	Titanium alloy in accordance with AMS4982 heat treated to 50 KSI minimum shear

Heat treatment shall be in accordance with MIL-H-81200.

3.3 Design and construction

3.3.1 Dimensions. The rivets shall conform dimensionally to the applicable specification sheet.

3.3.2 Construction. The rivet shall be of one piece construction consisting of a manufactured head and shank of 6A1-4V titanium alloy joined to the tail by welding as shown on figure 1. The tail shall be of 45Cb titanium alloy and shall be sufficiently ductile to facilitate upsetting by tools presently available at Government facilities and in use by airframe manufacturers.

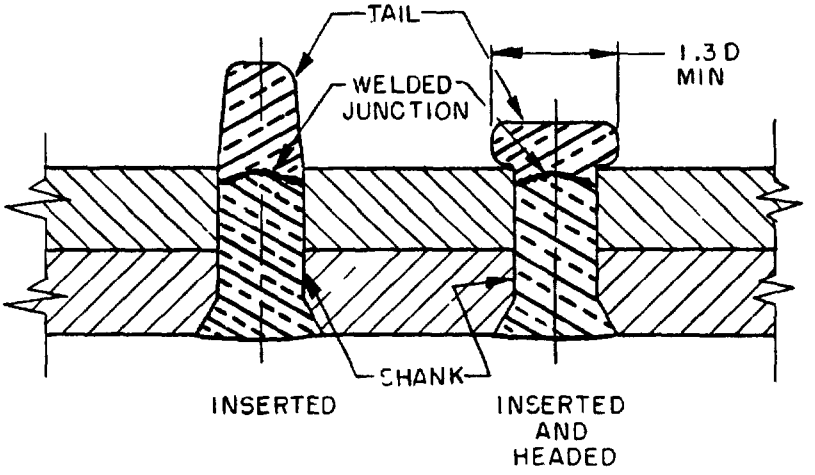
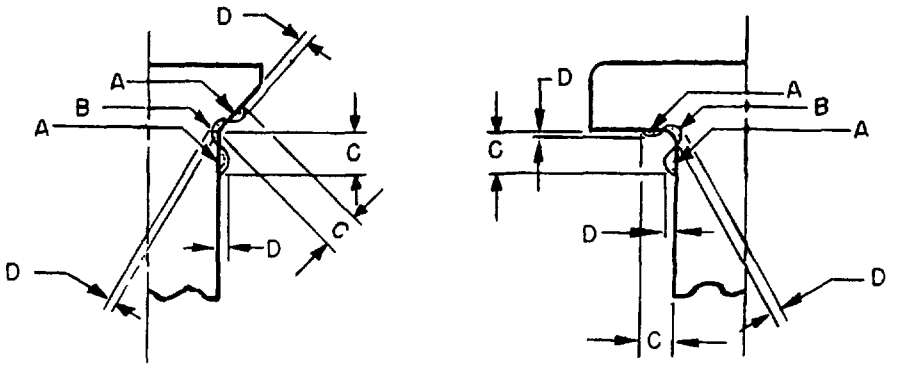


FIGURE 1. Typical construction.

3.3.3 Head-to-shank fillet. Unless otherwise specified, head-to-shank fillet shall be cold worked subsequent to all thermal treatment. Fillet radius, after cold working, shall conform to the applicable specification sheet. Cold working of head to shank fillet may cause distortion of fillet area. Distortion from the smooth contour, which results from cold working, shall not exceed .002 in area A or area B as shown in figure 2. distortion shall not extend beyond the limits indicated The fillet shall show no evidence of seams or inclusions.



1st Dash No. (Dia)	-5	-6	-8	-10	-12
Nominal Diameter Shank Diameter	5/32 .1635	3/16 .1895	1/4 2495	5/16 .3120	3/8 .3745
C MAX D MAX	.060 .002	.062 .002	.062 002	094 .002	.094 .002

FIGURE 2. Head-to-shank fillet distortion allowance

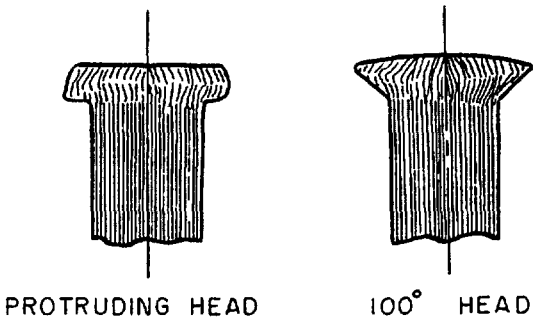


FIGURE 3 Head structure and grain flow.

3.3 4 Head structure and grain flow. A section of the head shall show no detrimental defects. Flow lines in the fillet area immediately below the surface shall closely conform to the pattern shown in figure 3 The flow lines may be slightly broken by the finish machining or grinding operation.

3.3.5 Weld. The weld shall be homogeneous. Weld interface shall be free of detrimental inclusions and undesirable precipitates. There shall be no evidence of lack of fusion in any area. The integrity of the weld shall be evidenced by capability of meeting tension-tension fatigue requirements of 3.6 3.

TABLE I. Fatigue loading.

Nominal Diameter	Tension Type		Upset Diameter
	High Load	Low Load	
5/32	715	72	0.230
3/16	1050	105	0.266
1/4	1950	195	0.350
5/16	3140	314	0.437
3/8	4850	485	0.525

NOTES: 1. Average fatigue life shall be over 30,000 cycles and minimum individual shall be over 15,000 cycles. Tests running over 60,000 cycles shall use 60,000 cycles for averaging.

2. Rivets shall be tested in maximum grip condition.

3.3.6 Weld location. The weld location shall be as specified on Figure 5.

3.3.7 Finish. Unless otherwise specified, the rivets shall be supplied without any supplementary surface treatment.

3.3.8 Lubrication. Unless otherwise specified, the rivets shall be supplied with a lubricant coating of chlorine-free cetyl alcohol in accordance with MIL-L-87132.

3.3 9 Surface texture. The surface texture of the rivets shall conform to the values shown in the applicable specification sheet. The surface roughness shall be measured in accordance with ANSI B46.1.

3.4 Installation. The rivets shall install satisfactorily with no cracks in any plane. The minimum upset head diameter shall be 1.3 times the shank diameter and have a minimum head height of 0.5 times the shank diameter.

3.4.1 Squeeze load. The load to deform the tail to 1.3 D diameter shall not exceed the values of table II.

TABLE II. Squeeze load.

Nominal Diameter	Fastener Diameter	Sheet Hole Diameter +0.002/-0.000	Upset Diameter (1.3D) Min	Squeeze Load (Lbs) Max
5/32	0.1635	0.1640	0.213	4300
3/16	0.1985	0.190	0.246	5800
1/4	0.2495	0.250	0.324	10500
5/16	0.3120	0.312	0.406	17000
3/8	0.3745	0.376	0.487	23500

NOTE: Sheet thickness shall be the minimum grip +0.005,-0.000.

3.4.2 Shank expansion. The rivet shank shall not expand upon driving and shall not be construed to be hole filling, unless installed in an interference fit.

3.5 Marking. The rivets shall be marked in accordance with the applicable specification sheet.

3.6 Mechanical properties

3.6.1 Shear strength. The ultimate single shear strength of the installed rivet shall be as tabulated in table III.

TABLE III. Single shear values.

Nominal Diameter	Shank Diameter +0.0000/-0.005	Minimum Load Pounds	Upset Diameter (1.4D)
5/32	0.1635	2,007	0.230
3/16	0.1895	2,694	0.265
1/4	0.2495	4,660	0.349
5/16	0.3120	7,290	0.437
3/8	0.3745	10,490	0.524

NOTES:
1. Rivets with minimum grip lengths less than 1.0 D for protruding heads and 1.5 D for flush heads shall not be tested.
2. Shear load based on 95 KSI and basic shank diameter per table 8.1.5(a), MIL-HDBK-5.
3. Rivets too short for testing shall have shear tests performed on wire from material lot and subjected to thermal treatment at the same time as the manufacturing lot.
4. Rivets shall be upset to the diameter shown ±0.005 inch when tested in the installed condition.
5. Rivets may be tested in either the installed or uninstalled condition.

3.6.2 Tensile strength. The ultimate tensile strength of the installed rivet shall be as tabulated in table IV.

TABLE IV. Tensile values.

Nominal Diameter	Upset Height	Ultimate Tensile Strength (Lbs. Min.)
5/32	.082	1,600
3/16	.095	2,210
1/4	.125	4,080
5/16	.156	6,500
3/8	.187	10,100

NOTES: 1. Rivets with minimum grip less than 1.0 D shall not be tested.
2. Rivets shall be tested in maximum grip condition ±.005.
3. Rivets shall be upset to the heights shown.
4. Test hole diameter limits shall be as specified in MIL-STD-1312, test No. 8.

3.6.3 Tension-tension fatigue. The tension-tension fatigue strength of the installed rivet shall be as specified in note 1 of table I.

3.7 Metallurgical properties

3.7.1 Hydrogen content. The body of the rivet, the tail and weld area shall have a hydrogen content not in excess of 80 parts per million (PPM).

3.7.2 Cracks. The rivets shall be free of cracks in any location. (See 6.3.4)

3.7.3 Discontinuities. There shall be no laps or folds, seams, or discontinuities or other interruption in grain flow of the driving surface of the rivet tail such as could cause cracking during installation. No grinding burns shall be permitted.

3.7.4 Microstructures and overheating. Microstructures shall be free from bursts, voids, or gross alloy segregation. Microstructure shall also be free from indications that is has been heated to a temperature above beta transus without subsequently receiving significant mechanical reduction in the alpha-beta temperature range. Slight overheating adjacent to the top of the head is permissible, provided measurement normal to the top surface of the head to the greatest depth of overheating does not exceed 0.020 inch. Structure of 6A1-4V titanium alloys that has outlines of equiaxial prior all beta grains and no primary alpha is considered overheated.

3.7.5 Work effect. The rivet head-to-shank fillet area shall show evidence of working when examined as specified in section 4.

3.8 Workmanship. Workmanship shall be in conformance to the design requirements specified herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or disapproved by the Government, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. All of the examinations and tests specified herein shall be classified as quality conformance inspections.

4.2.1 Lot. A lot shall consist of rivets of the same diameter, head style and grip length, made from the same mill heats of material, fabricated, solution heat treated, welded and aged in one batch and submitted for final inspection at the same time.

4.2.2 Sampling. Test samples shall be selected at random in accordance with MIL-STD-105, inspection level, and acceptance quality level (AQL) as specified in table V. Identical sample items may be used for any of the tests, provided selection of random samples is maintained and known characteristics of the sample are not used to influence the integrity of test results.

TABLE V. Quality conformance examination.

Test	Reference Paragraph	MIL-STD-105 Sampling Level	AQL %
1. Examination	4.4.1	I	1.0
2. Shear Strength	4.4.2	S-2	1.5
3. Squeeze Load	4.4.3	S-2	1.5
4. Tension Strength	4.4.4	S-2	1.5
5. Head-Shank Fillet	4.4.5	S-2	1.0
6. Metallurgical	4.4.6	S-2	1.0
7. Hydrogen Content	4.4.7 1/	-	-
8. Tension-Tension Fatigue	4.4.8	S-2	1.5

1/ Sampling for hydrogen content shall be one rivet (two tests) per heat treat lot.

4.2.3 Acceptance of flush head configuration. Acceptance of the flush head configuration constitutes acceptance of the equivalent protruding head configuration, except that tensile strength tests shall be performed on all head styles.

4.3 Report of tests. The manufacturer shall furnish a certified test report showing that the manufacturer's product satisfactorily conforms to this specification. The test report shall include, as minimum, actual results of each of the tests specified herein in their order of appearance. When this report is submitted, it shall be accompanied by a detail drawing that

completely describes the manufacturer's product by specifying all dimensions and tolerances, composition of material selected, coating or plating applied, and the heat treatment. The manufacturer's part number for each diameter and length shall be included on the above drawing.

4.4 Examination and tests

4.4.1 Examination. Each of the sample rivets selected for examination shall be examined for conformance to the requirements for dimensions, workmanship, identification, and to all requirements not covered by tests. Mill certification on all material shall be kept on file and made available to Government inspectors.

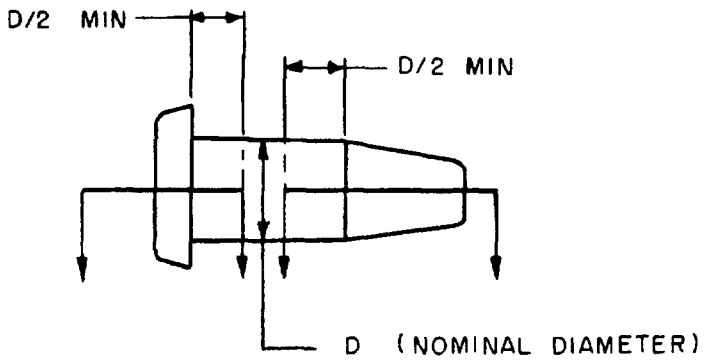
4.4.2 Shear strength. Single shear test shall be performed in accordance with MIL-STD-1312, method 20.

4.4.3 Squeeze load. Install the applicable rivet in a test sheet whose thickness is equal to the minimum grip of the rivet Apply a compression load sufficient to squeeze the tail to the diameter specified in table II (1.3 D). The load required shall not exceed the value shown in table II.

4.4.4 Tensile strength. Install the applicable rivet in test plates of maximum grip condition. The rivets shall develop the required loads of table IV when squeezed to the aplicable upset head thickness, and tested in accordance with MIL-STD-1312, Method 8.

4.4.5 Head-shank fillet. The distortion due to fillet rolling shall be measured using an optical comparator with a magnification not less than 25X. Distortion shall not exceed the limits specified in 3.3.3.

4.4.6 Metallurgical. The rivet (see figure 4) shall be microscopically examined on transverse sections. The area to be examined shall cover head-to-shank junction, weld area adjacent to the weld in both 6A1-4V titanium material and 45Cb titanium material. Etch with kroll's etchant. Examine at 50x, use 100x or 200x to examine suspect areas.



CUT METALLURGICAL SPECIMENS AS INDICATED BY ARROWS

FIGURE 4. Metallurgical specimen.

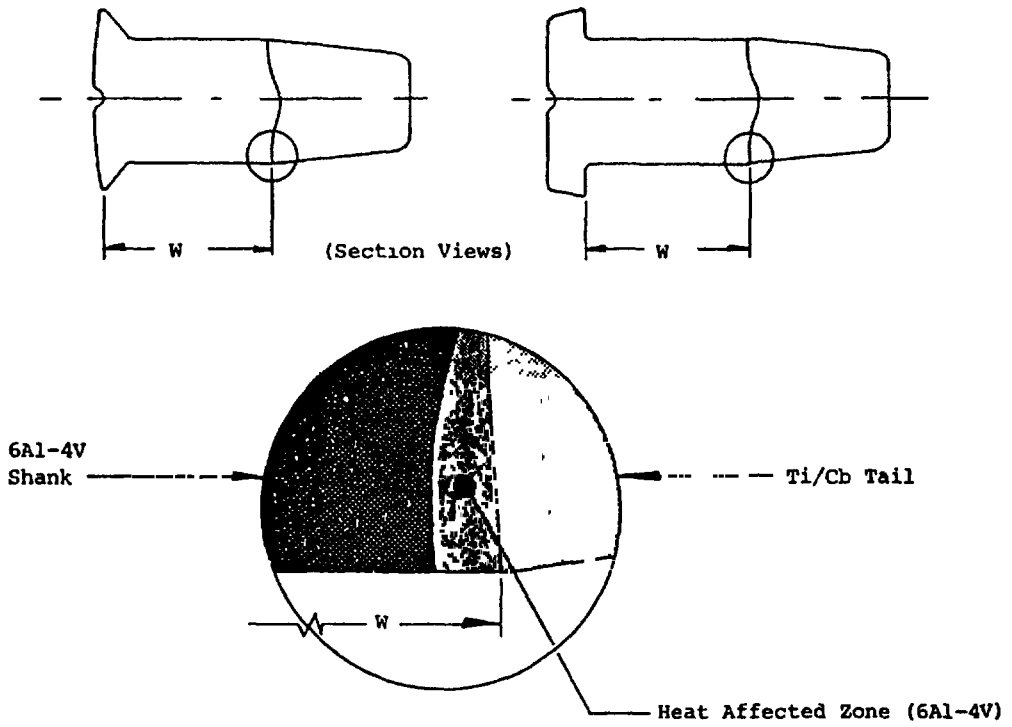


FIGURE 5. Weld location.

TABLE VI. Weld location.

2nd Dash Number (Grip).	W +.006 -.004	2nd Dash Number (Grip)	W +.006 -.004	2nd Dash Number (Grip)	W +.006 -.004
2R	.008	7R	.401	12R	.713
3	.120	8	.432	13	.745
3R	.151	8R	.463	13R	.776
4	.182	9	.495	14	.807
4R	.213	9R	.526	14R	.838
5	.245	10	.557	15	.870
5R	.276	10R	.588	15R	.901
6	.307	11	.620	16	.932
6R	.338	11R	.651	16R	.963
7	.370	12	.682	--	--

4.4.7 Hydrogen content. A sample for hydrogen analysis of the two components shall be taken at least 1/32 inch away from the weld line. Analysis shall be by vacuum fusion in accordance with ASTM E-120 method modified to conform to Leco equipment.

4.4.8 Tension-tension fatigue. Requirements for fatigue strength apply only to rivets having a grip length equal to or greater than two times their diameter. The fatigue testing machines, specimen holding fixtures and test procedure shall conform to MIL-STD-1312, test 11. Tests shall be conducted at room temperature. The fatigue loading shall be tension-tension and shall conform to table I.

5. PACKAGING

5.1 Preservation, packaging, and packing. The rivets shall be preserved, packaged, packed, and marked in accordance with PPP-M-1581. Preservation and Packaging shall be Level A or C and packing shall be Level A, B or C, as specified (see 6.2). Fiberboard boxes used for Level A Packaging and Level B packing shall be weather resistant and shall be waterproof-sealed with tape as specified in the appendix to the box specification.

Marking of shipments. In addition to any special marking required by the contract or purchase order, unit and intermediate packages and shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The bimetal titanium rivets are intended for structural application in aerospace structures, military equipment, and other permanent applications where the load carried is primarily shear.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification
b. Type and composition of rivet by specification sheet part number
c. Quantity
d. Selection of applicable preservation, packaging, and packing in accordance with PPP-H-1581

6.3 Definitions

6.3.1 Crack. A clean, crystalline break passing thriugh the grain or boundary without the inclusion of foreign elements.

6.3.2 Shank. That portion of the rivet that carries the shear load of the joint which it fastens.

6.3.3 Tail. That portion of the rivet that has sufficient ductility to allow it to be plastically deformed by squeezing or bucking to form an upset head.

6.3.4 Tail ductility. Property that allows the upsetting of the tail end of the rivet to form an upset head within the specified limits without evidence of cracks.

Custodian:

Army - AV
Navy - AS
Air Force - 11

Reviewer:

Army -
Navy -
Air Force - 89, 99
DLA - IS

Preparing activity:

Air Force - 11

Project No. 5320-0304

APPENDIX

RIVET, TITANIUM, BIMETAL 95 KSI F_{su}
GENERAL SPECIFICATION FOR

10. SCOPE

10.1 This appendix defines the application and usage for the rivets covered by this specification.

20. APPLICATION AND USAGE

20.1 These rivets are intended primarily for applications where the load will be carried by the shank in shear.

20.2 Do not use where the operating temperature exceed 600°F.

20 3 Do not shave manufactured head.

20.4 The manufactured rivet shall not be cut to length for use in a different grip dimension.

20.5 When backside angularity exists, grip dimensions shall be measured at the minimum side of hole as shown in figure 1.

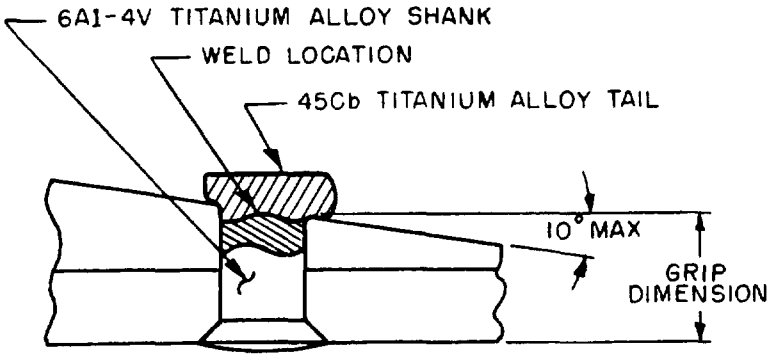


FIGURE 1. Grip dimension when backside angularity exists.

20.6 All rivet sizes may be squeeze upset except as stated in 20.7. Sizes 1/4 inch and smaller may be gun driven where appropriate.

20.7 Rivets shall be squeeze upset and not gun driven for installations in thin flanges.

20.8 Installation tools. The rivets covered by this specification are intended to be installed with tools available at aerospace manufacturing and Government facilities as referenced in table I.

TABLE I. Recommended riveting guns and bucking bar weights.

Nominal Diameter	Model Number 1/				Bar Weights Lbs
	Jiffy	Ingersoll Rand	Chicago Pneumatic	Cleveland Pneumatic	
5/32	300	AVC12	4XB	E4	3-5
3/16	300	AVC13	5XB	E5	5-8
1/4	400	AVC14	9XB	G5	8-12
5/16	2/	2/	2/	2/	2/
3/8	2/	2/	2/	2/	2/

1/ Gun selection is based on 70-90 psi air line pressure.

2/ Squeeze only.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No 22-R255

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MILITARY SPECIFICATION

RIVET, TITANIUM, BIMETAL 95 KSI FSU GENERAL SPECIFICATION FOR

MIL-R-83459A dated 29-SEP-78 has been reviewed and determined to be valid for use in acquisition.

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

Preparing activity:
DLA-IS

AMSC N/A

FSC 5320

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