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SUPERSEDING
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MILITARY SPECIFICATION

BOLT, SLEEVE, STRAIGHT SHANK, PROTRUDING AND FLUSH HEAD

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

1. SCOPE

1.1 Scope. This specification establishes the requirements for sleeve bolts, consisting of a pin and a sleeve, for use in structured joints to provide a precision net fit or controlled interference fit.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-H-1581	Hardware (Fasteners and Related Items), Packaging Of

MILITARY

MIL-P-116	Preservation, Methods of
MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification for
MIL-L-46010	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (Code 53), Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5306

SPECIFICATIONS (continued)

MILITARY (continued)

MIL-C-85614(AS)	Coating, Externally Threaded or Unthreaded Fastener, Aluminum Pigmented, Organically Bonded
MIL-L-87132	Lubricant, Cetyl Alcohol, 1 Hexadecanol, Application to Fasteners

(See Supplement 1 for list of associated specification sheets.)

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
MIL-STD-1949	Inspection, Magnetic Particle
MIL-STD-6866	Inspection, Liquid Penetrant

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASME 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, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E8	Standard Test Methods of Tension Testing of Metallic Materials
ASTM E112	Standard Methods for Determining the Average Grain Size

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

3.2 Qualification. The sleeve bolt furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) at the time of award of contract (see 4.3 and 6.3).

3.2.1 Retention of qualification. To maintain status on a QPL, certification shall be submitted at two year intervals to indicate continued compliance with the requirements of this specification (see 4.3.2).

3.3 Material.

3.3.1 Pin. Pin material shall be alloy steel, corrosion resistant steel, nickel alloy steel or titanium alloy as specified in the applicable specification sheet.

3.3.2 Sleeve. Sleeve material shall be corrosion resistant steel or aluminum alloy as specified in the applicable specification sheet.

3.4 Design and construction.

3.4.1 Dimensions. The dimensions of the sleeve bolt shall be as specified in the applicable specification sheet.

3.4.2 Threads.

3.4.2.1 Thread dimensions and form. The sleeve bolt thread dimensions, form and contour shall conform to MIL-S-8879 and shall be right-handed.

3.4.2.2 Thread rolling. Threads shall be fully formed by any single rolling process subsequent to heat treatment.

3.4.2.3 Incomplete threads. The sleeve bolt thread runout, consisting of not more than two incomplete threads, shall fair onto the shank (see Figure 1). There shall be a thread runout of not less than one thread. Bottom and sides of threads in runout may deviate from true thread form, but shall be

smooth and devoid of tool marks. Incomplete threads shall conform to Figure 2 (see 4.5.1.1.3).

3.4.2.4 Grain flow. The grain flow in the threads shall be continuous and shall follow the thread contour with the maximum density at the bottom of the root radius (see Figure 3).

3.4.3 Heads. The sleeve bolt heads shall be forged. Forged or machined lightening holes for reduction of weight are acceptable for protruding head sleeve bolts.

3.4.3.1 Bearing surface (protruding head). The bearing surface of the protruding head sleeve bolt shall be at right angles to the shank within the limits shown in Figure 4. The angular error of the underside of the head must be uniform around the shank within + 10 minutes, as measured from the bearing surface of the head to a length equal to the diameter of the pin.

3.4.4 Fillet (head to shank). The sleeve bolt fillet radius shall be as specified on the applicable specification sheet. The working on the fillet radius shall be accomplished subsequent to the heat treatment of the pin. The fillet shall show no evidence of seams or inclusions when examined as specified in 4.5.3.1.1.

3.4.4.1 Distortion of fillet area. As illustrated in Figure 5, cold working distortion in the fillet area shall be not greater than height A and depth B and the distorted area shall not extend beyond C.

3.5 Surface texture. The surface texture of the pin shall be not greater than the values shown in Table I. The surface texture shall be measured in accordance with ANSI/ASME B46.1 (see 4.5.1.1).

TABLE I. Roughness height rating (R_a).

Area	Maximum microinches
Shank and underside of head	32
Head-to-shank fillet	32
Sides of thread and root area	32
Other surfaces	125

3.6 Straightness of shank. The straightness of the pin shank shall be within the values specified in Table II (see 4.5.1.1).

TABLE II. Straightness in shank.

Bolt diameter (inch)	Straightness of pin shank (inch per inch of bolt length) (maximum)
.3125 and under	0.0030
.3750 and .4375	0.0025
.5000 and larger	0.0020

3.7 Heat treatment.

3.7.1 Pin. The pin shall be heat treated in accordance with the applicable specification sheet.

3.7.2 Sleeve. The sleeve shall be heat treated in accordance with the applicable specification sheet.

3.8 Surface treatment.

3.8.1 Pin. The pin shall be coated in accordance with the applicable specification sheet.

3.8.2 Sleeve. The sleeve shall be coated in accordance with the applicable specification sheet.

3.9 Lubricants. Dry film lubricant shall be applied to the pin outside diameter in accordance with MIL-L-46010, Type I; 0.0001-inch overspray allowed on head and threads. In addition, the outside diameter of the pin and the inside diameter of the sleeve shall be lubricated with cetyl alcohol in accordance with MIL-L-87132.

3.10 Mechanical properties.

3.10.1 Ultimate tensile load. The sleeve bolts shall meet the ultimate tensile load specified in the applicable specification sheet (see 4.5.4.3).

3.10.2 Double shear strength. The sleeve bolts shall meet the double shear values specified in the applicable specification sheet (see 4.5.4.4).

3.10.3 Fatigue strength. The sleeve bolt shall meet the fatigue strength values specified in the applicable specification sheet (see 4.5.4.2). Bolts shall be capable of withstanding a minimum life of not less than 45,000 cycles, with an average life of the inspection lot not less than 65,000 cycles. 130,000 cycles shall be used to compute the average for any bolts that run longer than 130,000 cycles.

3.10.4 Ductility. For Nickel Alloy 718 bolts only, ductility shall not be less than 8 percent elongation and 15 percent reduction in area when tested in accordance with ASTM E8 (see 4.5.4.13).

3.11 Metallurgical properties.

3.11.1 Cold work effect. The sleeve bolt threads and head-to-shank fillet shall show evidence of cold working when tested as specified in 4.5.4.10.

3.11.2 Discontinuities. All pins shall be examined by liquid penetrant inspection as specified in 4.5.3.1.1 and 4.5.3.1.2. Any pins having discontinuities equal to or exceeding the limitations specified herein shall be rejected. Care must be exercised to avoid confusing cracks, as described herein (see 6.4.1), with other discontinuities.

3.11.2.1 Cracks. Pins shall be free from cracks (see 6.4.1) in any direction or location.

3.11.2.2 Laps and seams. Pins may possess laps (see 6.4.2) and seams (see 6.4.3), except in locations specified in 3.11.2.6. The depths shall not be greater than the amounts specified in Table III.

TABLE III. Discontinuity depths. 1/

Pin diameter (inch)	#10, .2500	.3125	.3750	.4375	.5000 thru 1.5000 incl
Seam Depth (inch) (maximum)	0.005	0.005	0.006	0.007	0.008

1/ Depth of discontinuity shall be measured normal to the surface at the point of greatest penetration.

3.11.2.3 Inclusions. The pin shall show no evidence of surface or subsurface inclusions at the thread root or head-to-shank fillet (see 4.5.3.1.1). Small inclusions on other parts of the pin are not indicative of unsatisfactory quality.

3.11.2.4 Head and shank discontinuities (seams, inclusions, or folds). Seams, inclusions, or folds along the top or sides of the pin head shall be not greater than twice the depth limits shown in Table III. The seams on the bearing surface shall be not greater than the limits shown in Table III. There shall be no discontinuities on the head-to-shank fillet.

3.11.2.5 Carburization. Alloy steel bolts only shall show no decarburization, carburization, or recarburization on the bearing surface of the head, head-to-shank fillet, shank or threads (see 4.5.4.9).

3.11.2.6 Thread discontinuities (laps, seams, and surface irregularities). Threads shall have no multiple or single laps at the root or between the minor and pitch diameters (see Figures 6 and 7). Laps are permissible at the crest which are not greater than 25 percent of basic thread depth. Laps are permissible above the pitch diameter (see Figure 7). Slight deviation from the thread contour is permissible at the crest of the thread as shown in Figure 7. The incomplete thread at each end of the thread may also deviate slightly from contour.

3.12 Head structure and grain flow. A section of the head, when examined as specified in 4.5.4.11 shall show no defects. Flow lines in the fillet area below the surface shall conform to the fillet contour as shown in Figure 9. The metal removed from the bearing surface shall be as little as practicable to obtain a clean, smooth surface. For protruding head sleeve bolts only, the intersection of the longitudinal axis of the pin and the approximate transverse axis of the flow lines shall be not less than D/7 inches from the bearing surface of the sleeve bolt where "D" is the nominal diameter of the pin (see 4.5.4.11).

3.12.1 Grinding burns. Alloy steel bolts only shall show no evidence of grinding burns when examined as specified in 4.5.4.8.

3.12.2 Hardness. Bolts shall have a Rockwell hardness in accordance with the applicable specification sheet.

3.13 Stress durability. There shall be no failure of the bolt when subjected to the stress durability test (see 4.5.4.6). Stress durability test is not required for sleeve bolts with pins manufactured from Nickel Alloy 718 or titanium.

3.14 Stress corrosion. There shall be no failure of the bolt when subjected to the stress corrosion test (see 4.5.4.7). Stress corrosion test is not required for sleeve bolts with pins manufactured from Nickel Alloy 718, titanium or A-286.

3.15 Sleeve expansion. When the sleeve is pushed to the pin head, the expanded sleeve diameter shall be as specified in the applicable specification sheet (see Figure 11).

3.16 Metallurgical condition. Microstructure of titanium components shall be free from indications that it has been heated to a temperature above beta transus without subsequently receiving a significant mechanical reduction in the alpha-beta temperature range. Slight overheating on the non-bearing surfaces of the sleeve and core bolt heads is permissible providing the measurement of the greatest depth of overheating, measured normal to the surface, does not exceed two times the value specified for the applicable component in Table IIIA. (Structure of 6AL-4V alloys which have outlines of equi-axes prior beta grains and no primary alpha is considered overheated.) Titanium components shall not show evidence of alpha case in excess of the limitations of Figure 8 when examined as specified in section 4.5.4.14.

TABLE IIIA. Discontinuity depth.

Component	Nominal diameter (inch)			
	.1562	.1875	.2500	.3125 & .3750
Sleeve body	.005	.005	.005	.005

3.16.1 Hydrogen content. Titanium components shall not have hydrogen exceeding .0125 percent (125 PPM) when examined per section 4.5.4.15.

3.17 Grain flow. Grain flow lines in the head to shank fillet area (below the surface) shall conform to the fillet contour lines shown in Figure 9.

3.17.1 Grain size. Prior to cold reduction, solution heat treated Nickel Alloy 718, Cres 304, A-286, PH13-Mo and 6AL-4V (bar and wire) grain size shall be size 5 or finer.

3.18 Identification of product. Each sleeve bolt shall be marked on top of the head or side of the flange. The manufacturer's identification and lot traceability symbols shall be marked on the top or side of the head or on the base of the lightening hole. Markings may be raised or indented not more than 0.010-inch, except that only raised markings shall be used on the lightening hole. Markings may be forged or stamped.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

4.3 Qualification inspections. The qualification inspections shall consist of all the tests listed in Table IV as specified under 4.5. The number of samples for each test shall be three, except work effect, carburization, head structure and grain flow, in which the number of samples shall be one.

4.3.1 Sampling size. The qualification test samples shall consist of 15 sleeve bolts of each diameter for which qualification is desired. Samples up to and including .5000-inch diameter shall have a grip length of 1.3750 inches; samples from .5625-inch diameter up to and including 1.5000-inch diameter shall have a minimum grip length of four inches. In addition, the manufacturer shall supply 15 nuts of the mating bolt material tested in accordance with MIL-STD-1312-11.

TABLE IV. Qualification inspections.

Type of inspections	No. of inspections	Requirement paragraph	Test paragraph
Finish Dimensions and Surface Texture	3	3.4.1 & 3.5	4.5.1.1.2
Threads	3	3.11.2.6	4.5.1.1.3 See Figs. 6 & 7
Ultimate Tensile Load	3	3.10.1	4.5.4.3
Double Shear Strength	3	3.10.2	4.5.4.4
Fatigue Strength	3	3.10.3	4.5.4.2
Work Effect	1	3.11.1	4.5.4.10
Discontinuities	3	3.11.2	4.5.3.1.1
Carburization	1	3.11.2.5	4.5.4.9
Head Structure and Grain Flow	1	3.12	4.5.4.11
Grinding Burns	3	3.12.1	4.5.4.8
Hardness	3	3.12.2	4.5.3.2
Stress Durability	3	3.13	4.5.4.6
Stress Corrosion	3	3.14	4.5.4.7

4.3.2 Retention of qualification. To maintain qualification status, each manufacturer listed on the QPL shall return DD Form 1718, Certification of Qualified Products, to the procuring activity. This shall be done at least every two years after the certification date on the QPL. Certification shall be requested from the manufacturer by the Naval Air Engineering Center (NAEC), Systems Engineering and Standardization Department (SESD), Code 5311, Lakehurst, NJ 08733-5100, who is acting under the direction of the Naval Air Systems Command. Certification shall be signed by a responsible official of management. The certification shall attest that the listed product(s) is still available from the listed plant, can be produced under the same conditions as originally qualified (i.e., same process, materials, construction, design, manufacturer's part number or designation), and meets the requirements of the current issue of the specification. Failure of the manufacturer to provide the certification will be cause for removal from the QPL. Upon completion of the certification review by NAEC, the QPL will be reprinted to show the date of certification.

4.4 Quality conformance inspections. The quality conformance inspections shall be as specified in Table V.

TABLE V. Quality conformance inspections.

Type of inspections	No. of inspections	Requirement paragraph	Test paragraph
Finish Dimensions and Surface Texture	3	3.4.1 & 3.5	4.5.1.1.2
Threads	3	3.11.2.6	4.5.1.1.3 See Figs. 6 & 7
Ultimate Tensile Load	3	3.10.1	4.5.4.3
Double Shear Strength	3	3.10.2	4.5.4.4
Fatigue Strength	3	3.10.3	4.5.4.2
Work Effect	1	3.11.1	4.5.4.10
Discontinuities	3	3.11.2	4.5.3.1.1
Carburization	1	3.11.2.5	4.5.4.9
Head Structure and Grain Flow	1	3.12	4.5.4.11
Grinding Burns	3	3.12.1	4.5.4.8
Hardness	3	3.12.2	4.5.3.2
Stress Durability	3	3.13	4.5.4.6

4.4.1 Sampling.

4.4.1.1 Inspection lot. An inspection lot shall consist of sleeve bolts, from a single production lot, of one part number which indicates one size and one grip length.

4.4.1.2 Production lot. A production lot shall consist of finished sleeve bolts, which have the same part number, fabricated from a single mill heat by the same process, heat treated in the same manner, and produced as one continuous run or order.

4.4.1.3 Random sample. A random sample is a sample drawn in such a manner that each unit sleeve bolt in the inspection lot has the same chance of being the first unit in the random sample; after the first unit in the sample is drawn, each of the remaining units in the inspection lot has the same chance of being the second unit in the sample, etc.

4.4.1.4 Inspection records. Copies of all records and examinations shall be certified and shall be supplied for each production lot or portion thereof. These records shall identify the manufacturers of the sleeve bolts and provide the address of the plant where the sleeve bolts were manufactured. The manufacturer's lot traceability code shall be identified along

with the production lot number. The records shall be available to the purchaser and shall be signed by an authorized representative of the manufacturer.

4.5 Test methods.

4.5.1 Sampling. A random sample shall be selected from each inspection lot in accordance with MIL-STD-105, Acceptable Quality Level (AQL) of 1.0 percent defective for Major defects, 2.5 percent defective for Minor A defects and 4.0 percent defective for Minor B defects.

4.5.1.1 Straightness and surface texture. Straightness shall be measured by the use of a dial-type indicator gage. Surface texture of threads shall be determined by a visual comparator method.

4.5.1.1.2 Finish dimensions and surface texture. Dimensions, thickness of cadmium coating and surface texture shall be inspected by means of applicable gages. Straightness shall be measured by the use of a dial-type indicator gage. Surface texture of threads shall be determined by a visual comparator method. In case of discrepancy, gages certified by Government laboratories shall be used.

4.5.1.1.3 Incomplete threads. Incomplete threads shall be inspected for compliance to Figure 2.

4.5.1.1.4 Classification of defects. All dimensional characteristics are considered defective when out of tolerance. The classification of defects for bolts shall be as specified in Table VI.

4.5.2 Use of identical sample bolts. Identical sample bolts may be used for the various acceptance inspections and tests, provided that none of the characteristics of the sample bolts are altered during the examination.

4.5.3 Nondestructive tests.

4.5.3.1 Sampling plan. Statistical sampling shall be in accordance with MIL-STD-105, except for liquid penetrant inspection (see 4.5.3.1.2) which shall be 100 percent inspected. The AQL shall be 2.5 percent defective and the inspection level shall be S-3. The sample units may be selected from those that have been subjected to and passed the visual and dimensional inspection.

4.5.3.1.1 Cracks and discontinuities. The presence of cracks and discontinuities in sleeve bolts such as laps, seams, and inclusions shall be determined by liquid penetrant or magnetic particle inspection (see 4.5.3.1.2).

4.5.3.1.2 Inspection methods. Magnetic particle inspection shall be performed on alloy steel or PH13-8Mo pins in accordance with MIL-STD-1949. Liquid penetrant inspection shall be performed on other material pins in accordance with MIL-STD-6866.

4.5.3.2 Hardness. Each bolt of the random sample shall be inspected for Rockwell hardness in accordance with MIL-STD-1312-6, on the threaded end of

TABLE VI. Classification of defects.

Category	Sleeve bolt components
Major:	
101	Thread size and form
102	Shank diameter
103	Imperfect threads
104	Grip length
105	Radius under head
106	Drilled holes in head missing (when required)
107	Squareness between head and shank (bearing surface)
108	Straightness of shank
109	Surface texture
110	Burrs and tool marks
111	Surface finish, plating
112	Identification
Minor A:	
201	Overall length
202	Head diameter
203	Head height
204	Socket dimensions
205	Concentricity of head and shank
206	Concentricity of shank and thread pitch diameter
207	Drilled hole diameters and location
Minor B:	
301	Chamfer on thread end
302	Flange height

the bolt. Hardness readings shall be taken after removal of plating and/or coating. Each bolt of the random sample shall have a Rockwell hardness in accordance with the applicable specification sheet in order for the inspection lot and the production lot to be considered acceptable. If readings are obtained outside this range, two samples each of the softest and hardest bolts shall be further tested in accordance with 4.5.4.5.

4.5.4 Destructive tests.

4.5.4.1 Sampling plan. The sampling procedure shall be in accordance with MIL-STD-105. Normal inspection shall be used at the start of each production lot. The AQL shall be 1.0 percent defective and the inspection level shall be S-2. The sample units may be selected from those that have been subjected to and passed the nondestructive tests with additional units selected at random from the inspection lot as necessary.

4.5.4.2 Fatigue strength. The fatigue loading applied to bolts shall conform to 3.10.3. The fatigue test shall be conducted at room temperature. The tension-tension fatigue testing method and fixture requirements shall be in accordance with MIL-STD-1312-11. Bolts having a grip length less than twice their shank diameter need not be fatigue tested. The bolt with the expandable sleeve installed at the bolt head shall be used for this test.

Cracks in the sleeve will not constitute failure of the bolt. The fatigue loading applied to the respective bolts shall be as specified in the applicable specification sheet.

4.5.4.3 Ultimate tensile load. The sleeve bolt shall be tested in tension between the head of the pin and a threaded member in accordance with MIL-STD-1312-8. In the event the bolts to be tested in tensile have a grip of less than two times the shank diameter, the single shear test with the bolt taper ground to the smallest diameter and in accordance with MIL-STD-1312-20 shall determine acceptability. This is a test of the pin only. For this test, the sleeve shall be removed from the pin.

4.5.4.4 Double shear strength. The sleeve shall be removed and the bolt taper shall be ground to the smallest diameter before the test is conducted. The double shear strength test shall be conducted in accordance with MIL-STD-1312-13. In the event the protruding head bolts to be tested in shear have a grip length smaller than two times their nominal diameter and flush head bolts have a grip length smaller than two and a half times their nominal diameter the strength of the bolts shall be verified by testing specimen material of sufficient length made from the same heat of material and processes.

4.5.4.5 Traverse hardness. The acceptance of bolts having grip lengths less than twice the nominal diameter size shall be based on the traverse hardness test taken on a circular cross section halfway between the head bearing surface and the thread. The Rockwell hardness shall be in accordance with the applicable specification sheet. Readings shall be taken at distances of .1250 inch from the surface, at one-half the radius where practicable, and at the core.

4.5.4.6 Stress durability. The stress durability test shall be in accordance with MIL-STD-1312-5 using the external sustained load method. The load shall be maintained for 72 hours. This is a test of the pin only. For this test, the sleeve shall be removed from the pin.

4.5.4.7 Stress corrosion. The stress corrosion test shall be in accordance with MIL-STD-1312-9. The load shall be maintained for 1500 hours. This is a test of the pin only. For this test, the sleeve shall be removed from the pin.

4.5.4.8 Grinding burns. Indications of grinding burns (untempered martensite) are white streaks appearing on the surface of the test sample after the following test has been conducted:

a. Remove all foreign matter from the bolt such as grease, dirt, plating or oxide fiber.

b. Rinse the bolt in cold water. If water breaks occur, bolts shall be recleaned.

c. Immerse and agitate the bolt in a 4 percent solution of nitric acid for approximately 30 seconds.

d. Rinse in cold water and dry bolt.

e. Immerse the bolt in 2 percent solution of hydrochloric acid in acetone for 30 seconds.

f. Rinse in cold water.

g. Rinse the bolt in 5 percent sodium bicarbonate solution.

h. Rinse the bolt in hot water and dry.

Indication of grinding burns shall be cause for rejection.

4.5.4.9 Carburization. Carburization, decarburization, and recarburization on the bearing surface of the head, head-to-shank fillet, shank and threads shall be determined by microexamination. Specimens shall be taken from the finished bolt as shown on Figure 10. The etchant shall be 5 percent nital. Microscopic examination shall be made at 100X magnification. In case of discrepancy over carburization, decarburization, and recarburization, microhardness testing of the shank shall be used as an arbitration method. Bolts shall be in compliance with the microhardness requirement if the difference in Vickers microhardness, when measured in a zone between 0.003 and 0.006 from the surface, is 45 points. This does not apply to the threads or fillet area. Carburization, decarburization and recarburization tests apply to alloy steel pins only.

4.5.4.10 Work effect. The cold work of the bolt threads and head-to-shank fillet shall be determined by microexamination as specified in 4.5.4.9.

4.5.4.11 Head structure and grain flow. Head structure and grain flow shall be determined by macroexamination at a magnification of 10 diameters. Flow lines shall be indicative of a forged product (see Figure 9) following the general contour of the head. They shall be continuous, except that slight cutting of the flow lines in the head-to-shank fillet, due to the oxide removal process, shall be acceptable. Flow lines are more difficult to resolve in CRES and super alloys (with respect to alloy steel) due to their cleanliness and homogeneity. It is recommended that flow line characterization be performed in the as-forged condition. For fully heat treated parts, etching times may need to be increased substantially.

Material	Etchant
Alloy Steel Titanium	50% Hydrochloric Acid
PH13-8MO A-286	Marble's Reagent
Nickel Alloy	1 Part by Vol 30% Hydrogen Peroxide (H_2O_2) 2 Parts by Vol Hydrochloric Acid (HCl)

4.5.4.12 Sleeve expansion. The sleeve shall be expanded by the method shown in Figure 11. Failure to meet the dimensions specified on the applicable specification sheet shall constitute failure.

4.5.4.13 Ductility. The specimen for the ductility test shall be prepared from a section of the raw material, processed with the production lot, or manufactured from the finished bolt. The ductility test shall be conducted in accordance with ASTM E8.

4.5.4.14 Metallurgical conditions. Two (2) samples out of each heat treat lot of titanium components shall be longitudinally sectioned, mounted and microscopically examined to verify compliance with requirements of 3.16.

4.5.4.15 Hydrogen content. Titanium components shall be checked for hydrogen using procedures and equipment that are capable of analyzing hydrogen to an accuracy of .0010 percent (10 PPM). Lubricant shall be removed before testing.

4.5.4.16 Grain size. Grain size shall be determined by the comparison method in accordance with ASTM E112. In case of disagreement on grain size by the comparison method, the intercept (Heyn) procedure shall be used.

4.5.5 Resubmitted inspection lots. The paragraph of MIL-STD-105 entitled "Resubmitted lots" shall apply, except that a resubmitted inspection lot shall be inspected by the contractor, using tightened inspection. Before an inspection lot is resubmitted, full particulars concerning the cause of previous rejection and the action taken to correct the defects found in the inspection lot shall be furnished by the contractor to the Government inspector.

4.6 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with section 5.

5. PACKAGING

5.1 Bolts shall be preserved, packaged, packed and marked for shipment in accordance with PPP-H-1581. The shanks, threads and unsupported portions of the sleeves of individual bolts shall be protected by cardboard or plastic tubes or similar cushioning material. Preservation and packaging shall be level A or C as specified in the contract or purchase order (see 6.2).

5.2 Packing shall be level A, B or C as specified in the contract or purchase order (see 6.2).

5.3 Marking of shipments. In addition to any special requirements of the contract or order, shipments shall be marked in accordance with MIL-STD-129.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Sleeve bolts covered by this specification are intended for use in applications which require a bolt assembly with the following:

a. 160 KSI Ftu tensile and 95 KSI Fsu shear strength (6AL-4V titanium pin, aluminum alloy or CRES 304 sleeve).

b. 220 KSI Ftu tensile and 125 KSI Fsu shear strength (PH13-8Mo CRES/nickel alloy (718) steel pin, CRES 304 sleeve).

c. 180 KSI Ftu tensile and 108 KSI Fsu shear strength (alloy steel pin, aluminum alloy sleeve).

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number and date of this specification.

b. Military part number (see 3.1).

c. Applicable levels of preservation, packaging and packing.

d. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List (QPL No. 85667) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command, Washington, DC 20361, and information pertaining to qualification of products may be obtained from that activity.

6.4 Definitions.

6.4.1 Crack. A crack is defined as a clean crystalline break passing through the grain or grain boundary without the inclusion of foreign elements.

6.4.2 Lap. A lap is a surface defect appearing at a seam caused by folding over hot metal fins or sharp corners and then rolling or forging them into the surface, but not welding them.

6.4.3 Seam. A seam is an unwelded fold or lap which appears as an opening in the raw material as received from the source.

6.5 Patent notice. The bolt assemblies identified herein are covered by the following patents: U.S. 4,087,896 (expiring May 9, 1997); 4,102,036 (expiring July 15, 1997); 4,048,898 (expiring September 20, 1996); Great Britain 1,524,886; Canada 1,023,585; Japan 50-125256; Italy 1,051,593; Israel 515578; and Germany 2,546,641.5. Additional patents are pending in France and Switzerland. The Government does not have a royalty-free license.

6.6 Part number. The part numbers to be used for the sleeve bolts are specified on the applicable specification sheet.

6.7 Subject term (keyword) listing.

Bolt
Sleeve
220 KSI Ftu
180 KSI Ftu
160 KSI Ftu

6.8 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

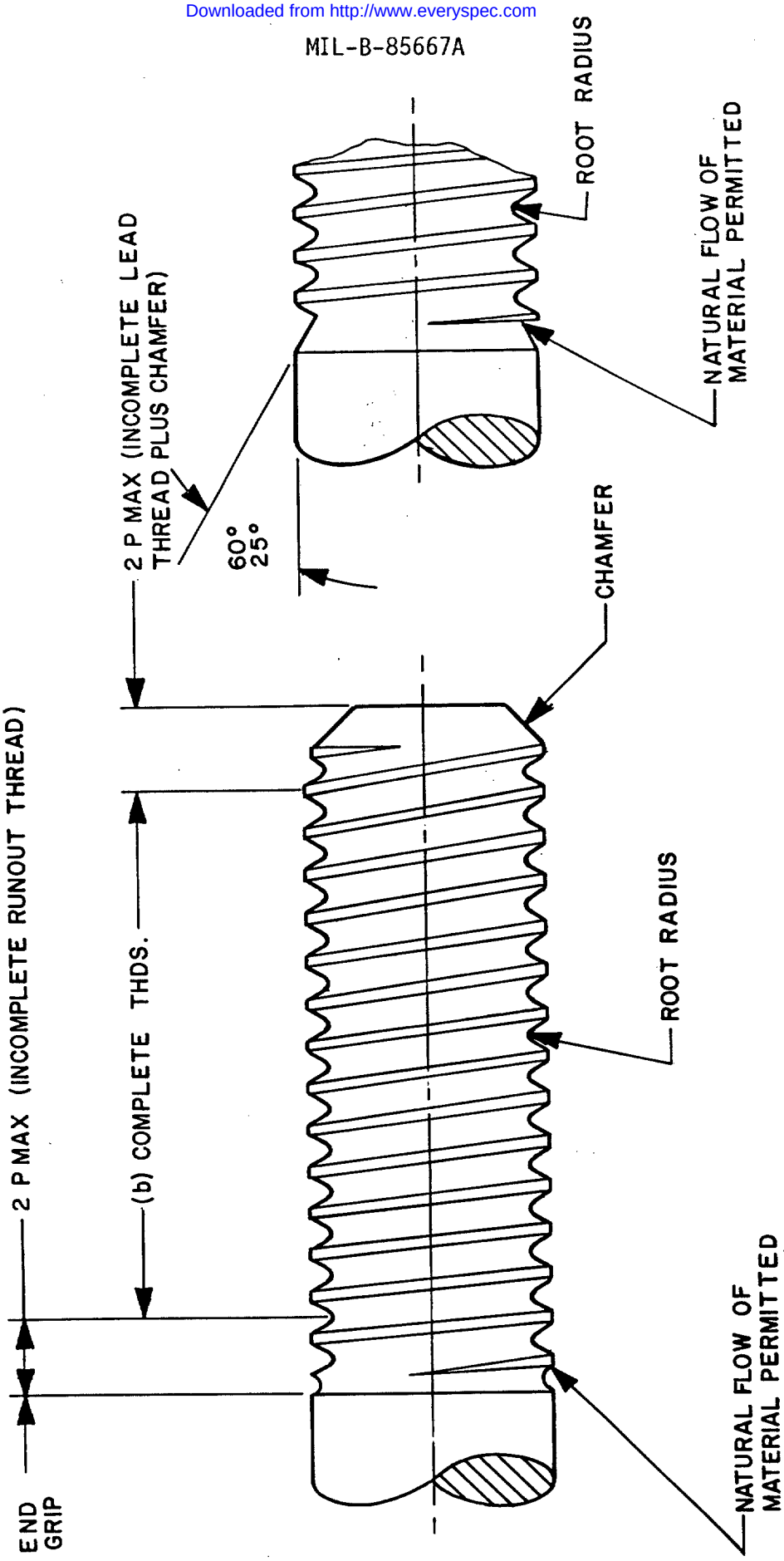


FIGURE 1. Incomplete threads and root radius.

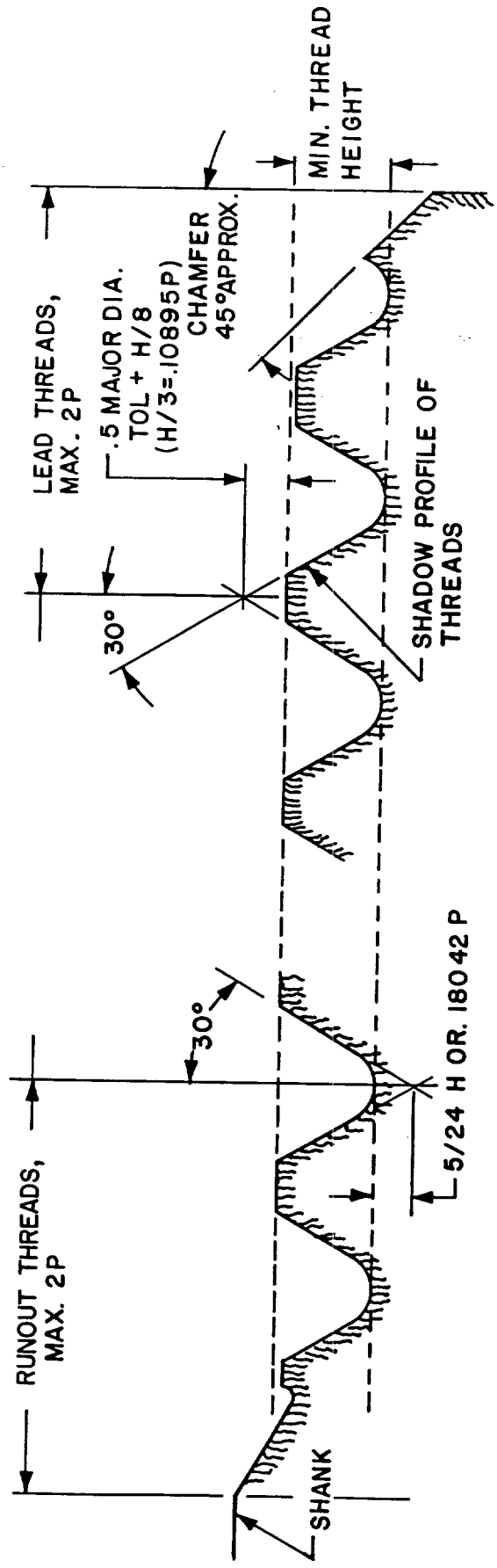


FIGURE 2. Determination of incomplete threads.

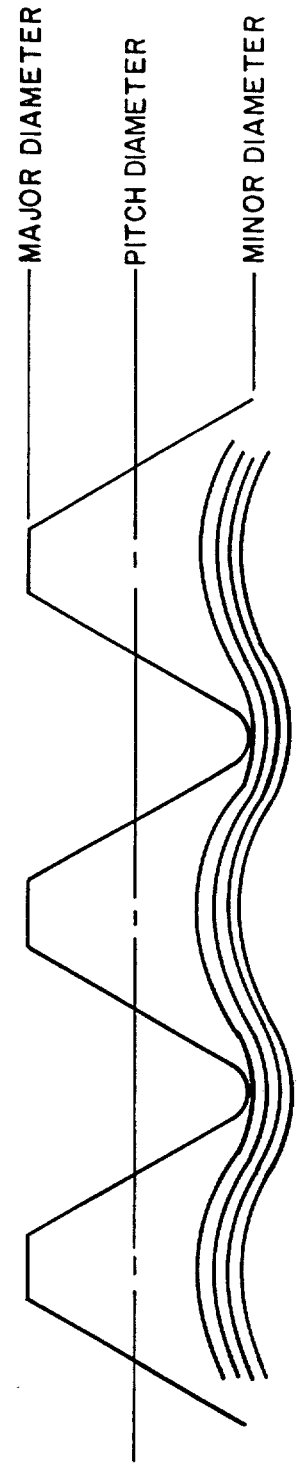


FIGURE 3. Grain flow in complete threads.

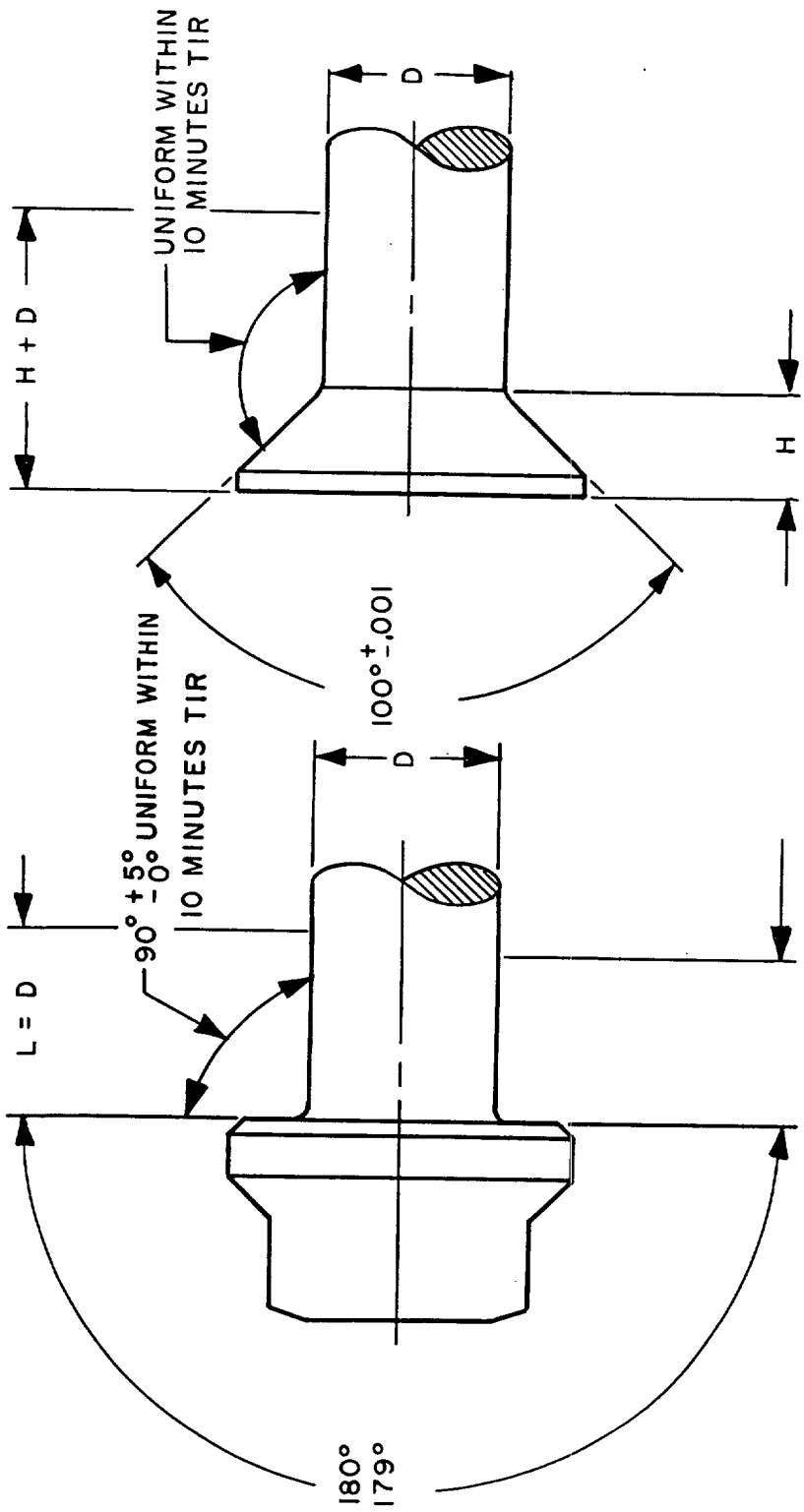
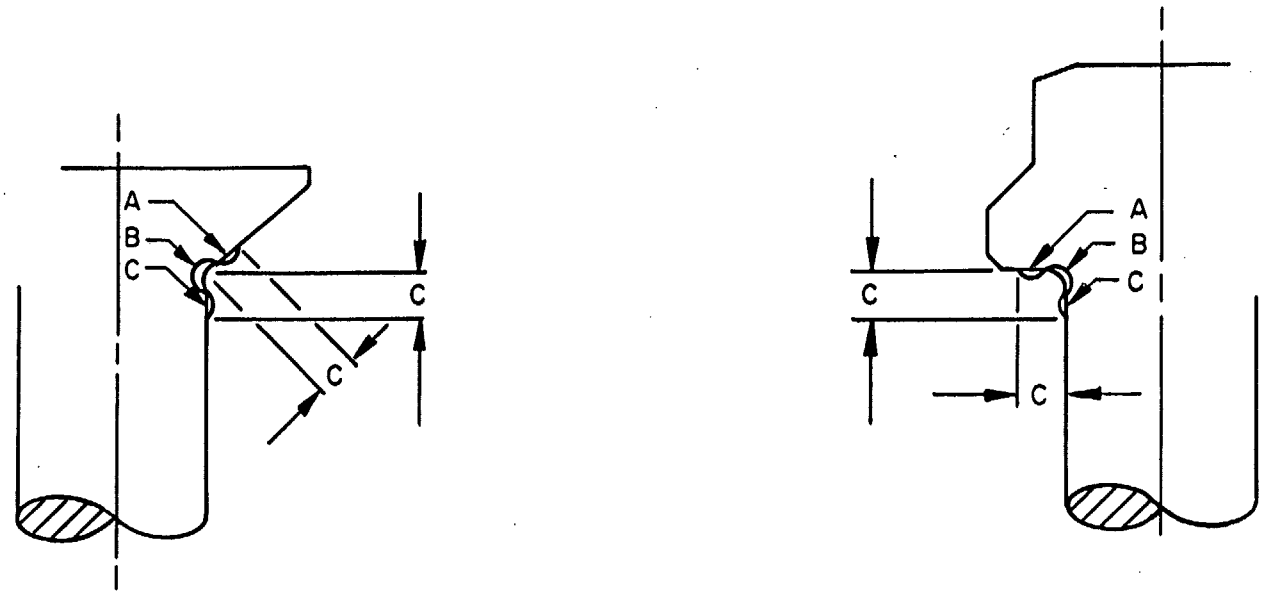


FIGURE 4. Head angularity.



NOMINAL DIA. SIZE	LESS THAN 0.312	0.312 THRU 0.375	0.437 THRU 0.625	0.750 THRU 1.000	GREATER THAN 1.000
	PROTRUDING HEAD				
A MAX	0.002	0.002	0.003	0.003	0.004
B MAX	0.002	0.002	0.003	0.003	0.004
C MAX	0.062	0.094	0.125	0.156	0.188
	REDUCED FLUSH HEAD				
A MAX	0.002	0.002	0.003	0.003	0.004
B MAX	0.002	0.002	0.003	0.003	0.004
C MAX	0.031	0.047	0.062	0.078	0.094

DIMENSIONS IN INCHES

FIGURE 5. Permissible fillet distortion (3.4.4.1).

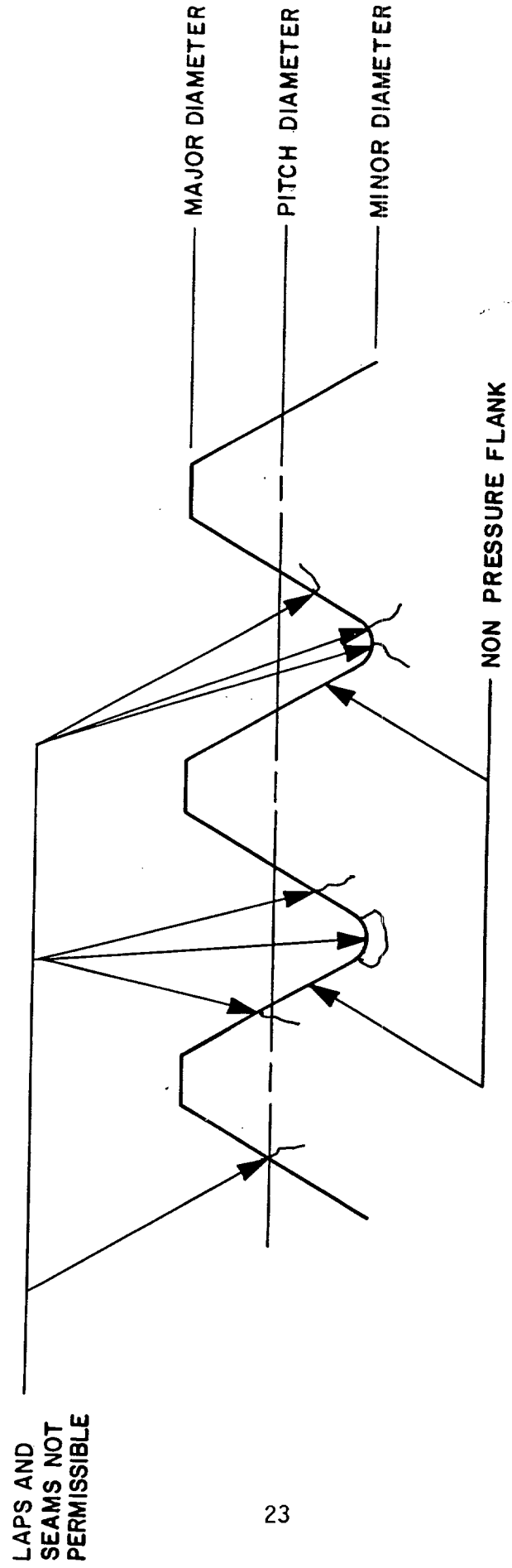


FIGURE 6. Nonpermissible laps, seams and surface irregularities.

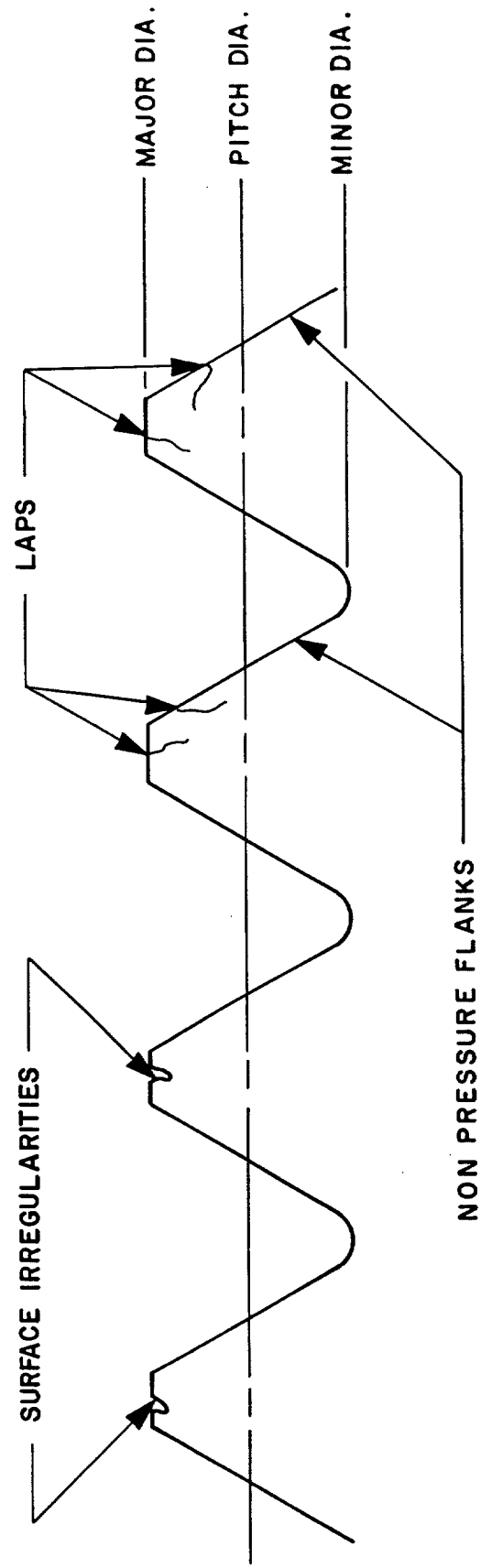
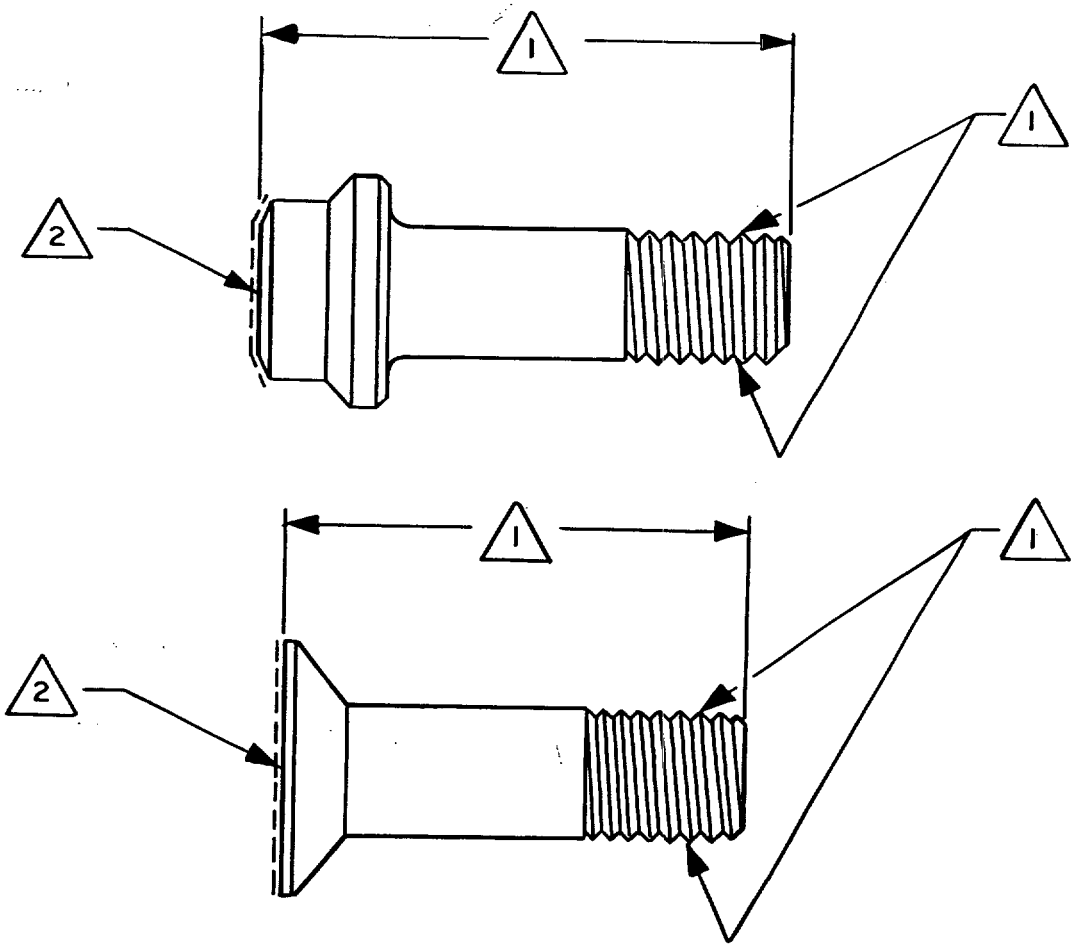


FIGURE 7. Permissible laps, seams and surface irregularities.



1 NO ALPHA CASE PERMITTED

2 ALPHA CASE PERMITTED TO MAX. DEPTH OF .002

FIGURE 8. Alpha case limitations.

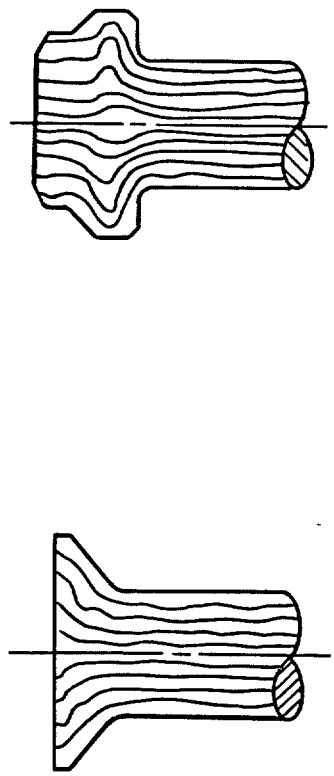


FIGURE 9. Forged head structure and grain flow.

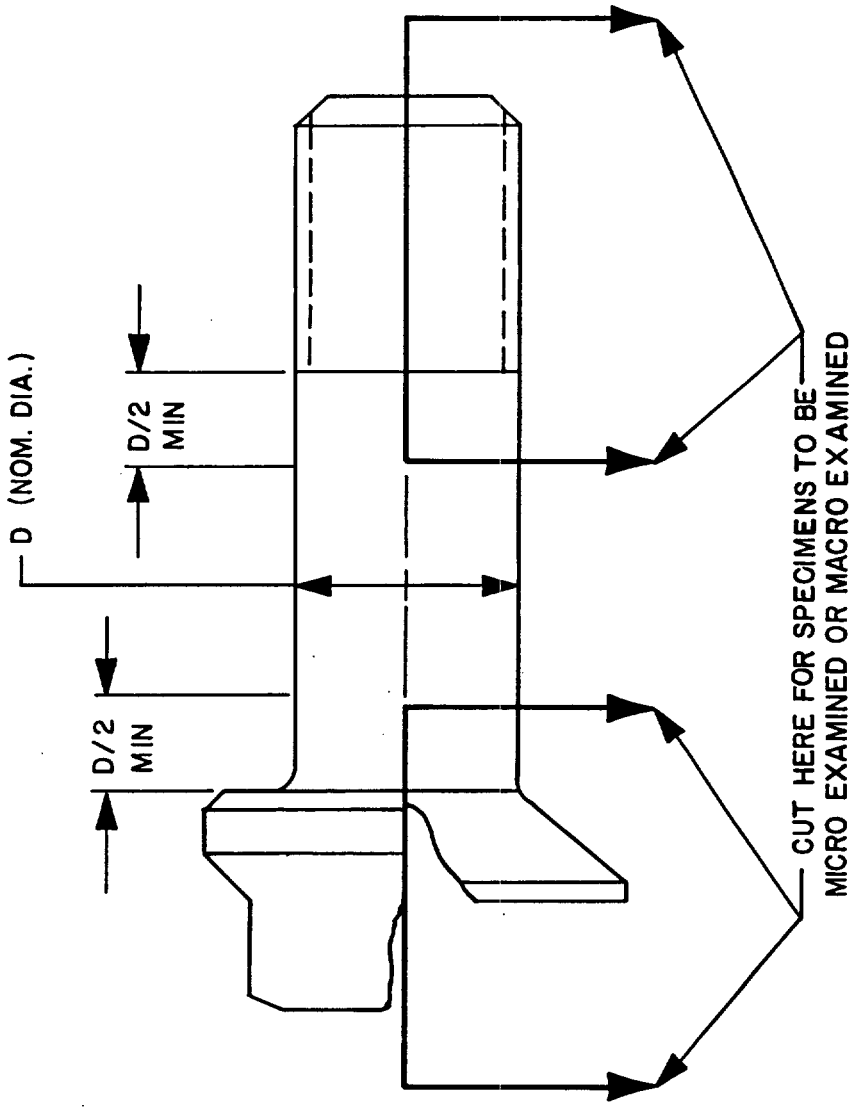
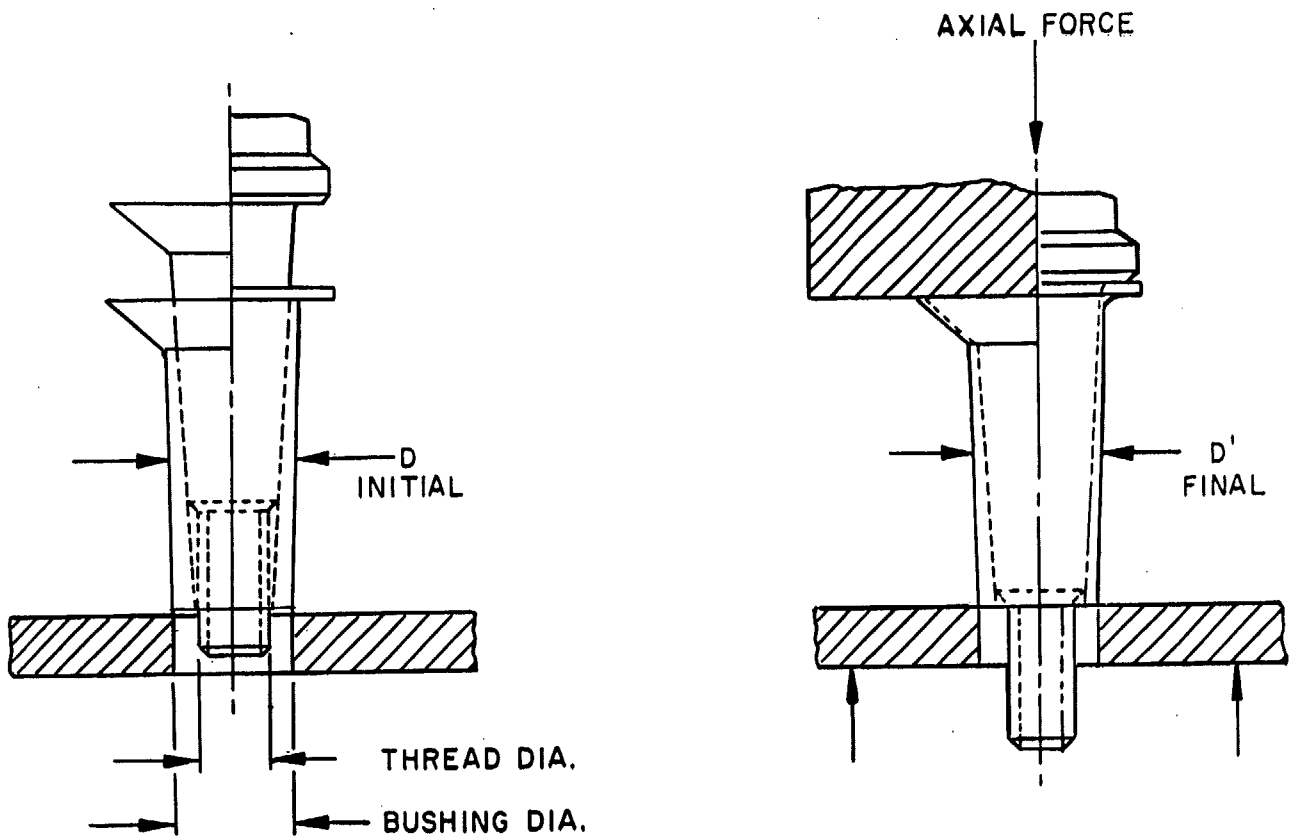


FIGURE 10. Metallurgical specimen.



SIZE DASH NO.	3	4	5	6	7	8	9	10	12	14	16
BUSHING I.D.	.188 .186	.248 .246	.311 .308	.373 .370	.437 .433	.499 .495	.561 .557	.625 .620	.750 .745	.875 .870	1.001 .995

DIMENSIONS IN INCHES

FIGURE 11. Sleeve expansion (4.5.4.12).

Custodians:
Army - AV
Navy - AS
Air Force - 99

Review:
Air Force - 82

Preparing Activity:
Navy - AS
(Project No. 5306-1378)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-B-85667A	2. DOCUMENT DATE (YYMMDD) 28 Jan 1991

3. DOCUMENT TITLE
BOLT,SLEEVE,STRAIGHT SHANK, PROTRUDING AND FLUSH HEAD

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Commanding Officer Naval Air Engineering Center	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON
c. ADDRESS (Include Zip Code) (Code 5311) Lakehurst, NJ 08733-5100	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340