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INTERNATIONAL
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AEROSPACE STANDARD

SAE MA3378 | REV. B

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Superseding MA3378A

Submitted for recognition as an American National Standard

(R) BOLTS AND SCREWS, UNS N07001 730°C, 1210 MPa Procurement Specification For, Metric

FSC 5306

1. SCOPE:

(R)

This procurement specification covers aircraft quality metric bolts and screws with forged heads made from a corrosion and heat resistant nickel-base alloy of the type identified under the Unified Numbering System as UNS N07001, having minimum tensile strength of 1210 MPa at room temperature and stress-rupture rated at 730°C.

1.1 Safety-Hazardous Materials:

(R)

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. REFERENCES:

2.1 Applicable Documents:

(R)

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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2.1.1.1 Aerospace Material Specifications:
(R)

AMS-2645 Fluorescent Penetrant Inspection
AMS-2750 Pyrometry
AMS-5708 Alloy Bars and Forgings, Corrosion and Heat Resistant, 58Ni-19.5Cr-13.5Co-4.4Mo-3.0Ti-1.4Al, Consumable Electrode or Vacuum Induction Melted, 1975°F (1080°C) Solution Heat Treated

2.1.1.2 Aerospace Standards:

MA1370 Screw Threads - MJ Profile, Metric
MA1518 Bolts, Screws and Nuts - External Wrenching, Metric MJ Threads - Design Parameters For
MA1520 Areas for calculating stress or Load for Metric MJ Externally Threaded Fasteners
MA1566 Gaging Practice and Gage Requirements for MJ Metric Screw Threads
AS3062 Bolts, Screws, and Studs, Screw Thread Requirements
AS3063 Bolts, Screws, and Studs, Geometric Control Requirements

2.1.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 112 Determining Average Grain Size
ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

2.1.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.4 Military Standards:
(R)

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1312 Fasteners, Test Methods
MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

2.1.5 ANSI Publication: Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI/ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

2.2 Definitions:

PRODUCTION INSPECTION LOT: Shall be all finished parts of the same part number, made from a single heat of alloy, heat treated at the same time to the same specified condition, produced as one continuous run, and submitted for vendor's inspection at the same time.

2.3 Unit Symbols:

cm^3	- cubic centimeter
°C	- degree Celsius
°F	- degree Fahrenheit
°	- degree, angle
g	- gram
h	- hour
HRC	- hardness Rockwell C scale
kN	- kilonewton
min	- minute (time)
mm	- millimeter
MPa	- megapascal
%	- percent (1/100)
sp gr	- specific gravity

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be AMS-5708 heading stock.

3.2 Design:

Finished (completely manufactured) parts shall conform to the following requirements:

3.2.1 Dimensions: The dimensions of finished parts, after all processing, including plating, shall conform to the part drawing. Dimensions apply after plating but before coating with dry film lubricants.

3.2.2 Surface Texture: Surface texture of finished parts, prior to plating or coating, shall conform to the requirements as specified on the part drawing, determined in accordance with ANSI/ASME B46.1.

3.2.3 Threads: Metric screw thread MJ profile and dimensions shall be in accordance with MA1370, unless otherwise specified.

3.2.3.1 Incomplete Threads: Incomplete threads are permissible at the chamfered end and the juncture of the unthreaded portion of the shank or adjacent to the head as specified in AS3062.

3.2.3.2 Chamfer: The entering end of the thread shall be chamfered as specified on the part drawing.

3.2.4 Geometric Tolerances: Part features shall be within the geometric tolerances specified on the part drawing and, where applicable, controlled in accordance with AS3063.

3.3 Fabrication:

3.3.1 Blanks: Heads shall be formed by forging; machined heads are not permitted, except lightening holes may be produced by any suitable method. Wrenching recesses may be forged or machined. Flash or chip clearance in machined recesses shall not cause recess dimensions to exceed the specified limits.

3.3.2 Heat Treatment: Headed blanks shall, before finishing the shank and the bearing surface of the head, cold working the head-to-shank fillet radius, and rolling the threads, be solution and stabilization heat treated as follows; precipitation heat treatment shall follow cold working of the fillet radius and rolling the threads.

3.3.2.1 (R) Heating Equipment: Furnaces may be any type ensuring uniform temperature throughout the parts being heated and shall be equipped with, and operated by, automatic temperature controllers and data recorders conforming to AMS-2750. The heating medium or atmosphere shall cause no surface hardening by carburizing or nitriding.

3.3.2.2 Solution Heat Treatment: Blanks shall be solution heat treated by heating to a temperature within the range 1040 to 1080°C, holding at the selected temperature within ±15°C for 1 to 4 h, and cooling at a rate equivalent to air cool or faster.

3.3.2.2.1 A temperature lower than 1040°C may be used provided that the furnace control is such that during the holding period no part is below 1025°C.

3.3.2.3 Stabilization Heat Treatment: Solution heat treated blanks shall be stabilization heat treated by heating to 845°C ± 8, holding at heat for 4 h ± 0.5, and cooling in air.

3.3.2.4 Precipitation Heat Treatment: After cold working the fillet radius as in 3.3.4 and rolling the threads as in 3.3.5, parts shall be precipitation heat treated by heating to 760°C ± 8, holding at heat for 16 h ± 1, and cooling in air.

3.3.3 Oxide Removal: Surface oxide and oxide penetration resulting from prior heat treatment shall be removed from the full body diameter and the bearing surface of the head of the solution and stabilization heat treated blanks prior to cold working the fillet radius and rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks. The metal removed from the bearing surface of the head and the full body diameter of the shank shall be as little as practicable to obtain a clean, smooth surface and in no case shall be so great as to produce more cutting of flow lines in the head-to-shank junction than shown in Figure 1B.

3.3.4 Cold Working of Fillet Radius: After removal of oxide as in 3.3.3, the head-to-shank fillet radius of headed parts having the radius complete throughout the circumference of the part shall be cold worked sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold working shall conform to Figure 2, unless otherwise specified on the part drawing. No raised metal (excrescence) is permitted on the head bearing surface (face) or depressed metal more than 0.025 mm below the fillet radius contour as shown in Figure 2; the unthreaded shank at the position shown in Figure 2, inclusive of distortion, shall not exceed the unthreaded shank diameter by an amount more than that specified in Figure 2. In configurations having an undercut associated with the fillet radius, the cold working will be required only for 90° of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head. In addition to cold working the head-to-shank fillet radius, shouldered bolts, having an unthreaded shank diameter larger than the thread major diameter and having an undercut associated with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for 90° of fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank. For parts with compound radii between head and shank, cold work only the radius that blends with the head.

3.3.5 Thread Rolling: Threads shall be formed on the finished, solution and stabilization heat treated blanks by a single rolling process after removal of oxide as in 3.3.3.

3.3.6 Cleaning: Parts, after finishing, shall be degreased and then immersed in one of the following solutions for the time and the temperature shown:

a. One volume of nitric acid (sp gr 1.42) and 9 volumes of water for not less than 20 min at room temperature.

b. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 30 to 40 min at room temperature.

c. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 10 to 15 min at 60 to 70°C.

3.4 Product Marking:

Each part shall be identification marked as specified by the part drawing. The markings may be formed by forging or stamping, raised or depressed not more than 0.25 mm maximum, with rounded root form on depressed characters.

3.5 Plating:

Where required, surfaces shall be plated as specified by the part drawing.

3.6 Mechanical Properties:
(R)

Parts shall conform to the requirements of 3.6.1, 3.6.2, and 3.6.3. Threaded members of gripping fixtures for tensile and stress-rupture tests shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The loaded portion of the shank shall have a minimum of three full thread turns from the thread runout exposed between the loading fixtures during tensile and stress-rupture tests. Finished parts shall be tested in accordance with the following applicable test methods in Table 1:

TABLE 1 - Test Methods

Requirement	Test Method
Hardness	MIL-STD-1312-6
Room temperature ultimate tensile strength	DOD-STD-1312-108
Stress-Rupture Strength at 730°C	MIL-STD-1312-10

3.6.1 Ultimate Tensile Strength at Room Temperature:
(R)

3.6.1.1 Finished Parts: Parts shall have an ultimate tensile load not lower
(R) than that specified in Table 4 and shall be tested to failure, first measuring and recording the maximum tensile load achieved. If the size or shape of the part is such that failure would occur outside the threaded section but the part can be tested satisfactorily, such as parts having a shank diameter equal to or less than the thread root diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 1210 MPa; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part. Tension fasteners with either standard spline drive or hexagon-type heads having a minimum metal condition in the head equal to the design parameters specified in MA1518 shall not fracture in the head-to-shank fillet radius except when this radius is associated with an undercut or with a shank diameter less than the minimum pitch diameter of the thread.

3.6.1.2 Machined Test Specimens: If the size or shape of the part is such that a tensile test cannot be made on the part, tensile tests shall be conducted in accordance with ASTM E 8 on specimens prepared as in 4.4. Such specimens shall meet the following requirements shown in Table 2:

(R) TABLE 2 - Specimen Properties

Ultimate tensile strength, minimum	1210 MPa
Yield strength at 0.2% offset, minimum	790 MPa
Elongation in 5D, minimum	15%
Reduction of area, minimum	18%

3.6.1.2.1 When permitted by purchaser, hardness tests on the end of the parts may be substituted for tensile tests of machined specimens.

3.6.2 Hardness: Shall be uniform and within the range 34 to 44 HRC,
(R) but hardness of the threaded section and of the head-to-shank fillet area may be higher as a result of the cold working operations.

3.6.3 Stress-Rupture Strength at 730°C:
(R)

3.6.3.1 Finished Parts: Finished parts, maintained at 730°C ± 2 while the
(R) tensile load specified in Table 4 is applied continuously, shall not rupture in less than 23 h. If the shank diameter of the part is less than the maximum root diameter of the thread but the part can be tested satisfactorily, parts shall conform to the requirements of 3.6.3.1.1.

3.6.3.1.1 Parts having a shank diameter less than the maximum root diameter of the thread shall be tested as in 3.6.3.1 except that the load shall be as specified in 3.6.3.2. The diameter of the area on which stress is based shall be the actual measured minimum diameter of the part.

3.6.3.2 Machined Test Specimens: If the size or shape of the part is such that
(R) a stress-rupture test cannot be made on the part, a test specimen prepared as in 4.4, maintained at 730°C ± 2 while a load sufficient to produce an initial axial stress of 520 MPa is applied continuously, shall not rupture in less than 23 h. Tests shall be conducted in accordance with ASTM E 139.

3.7 Quality:
(R)

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials, and from imperfections detrimental to their performance.

3.7.1 Macroscopic Examination: Parts or sections of parts, as applicable, shall be etched in a solution consisting of approximately 40% hydrochloric acid (sp gr 1.19), 10% of a 30% solution of hydrogen peroxide, and 50% water, or other suitable etchant, for sufficient time to reveal flow lines but not longer than 30 min, shall be examined at a magnification of approximately 20X to determine conformance to the following requirements, except that examination for the thread imperfections as specified in 3.7.1.3 should be made by microscopic examination of specimens polished and etched as in 3.7.2.

3.7.1.1 Flow Lines:

3.7.1.1.1 Head-to-Shank: Examination of a longitudinal section through the part shall show flow lines in the shank, head-to-shank fillet, and bearing surface which follow the contour of the part as shown in Figure 1A, except that slight cutting of flow lines by the oxide removal process of 3.3.3 is permissible as shown in Figure 1B; excessive cutting of flow lines in the shank, head-to-shank fillet, and bearing surface, as shown in Figure 1C, is not permissible except when an undercut is associated with the fillet radius. The head style shown in Figures 1A through 1C is for illustrative purposes only but other symmetrical head styles shall conform to the above requirements. Flow lines in heads on parts having special heads, such as Dee- or Tee-shaped heads or thinner than MA1518 standard heads, shall be as agreed upon by purchaser and vendor.

3.7.1.1.2 Threads: Flow lines in threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at root of thread (see Figure 3).

3.7.1.2 Internal Defects: Examination of longitudinal sections of the head and shank and of the threads shall reveal no cracks, laps, or porosity except laps in threads as permitted in 3.7.1.3.3 and 3.7.1.3.4. The head and shank section shall extend not less than D/2 from the bearing surface of the head and the threaded section shall extend not less than D/2 beyond the thread runout where "D" is the nominal diameter of the shank after heading. If the two sections would overlap, the entire length of the part shall be sectioned and examined as a whole.

3.7.1.3 Threads:

3.7.1.3.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (see Figure 4).

3.7.1.3.2 Multiple laps on the flanks of threads are not permissible regardless of location. Single laps on the flanks of threads that extend toward the root are not permissible (see Figures 5 and 6).

3.7.1.3.3 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 7). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or nonpressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (see Figure 7).

3.7.1.3.4 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible provided that the imperfections do not extend deeper than 20% of the basic thread height (see Table 3) as measured from the thread crest when the thread major diameter is at minimum size (see Figure 8). The major diameter of the thread shall be measured prior to sectioning. As the major diameter of the thread approaches maximum size, values for depth of crest crater and crest lap imperfections listed in Table 3 may be increased by one-half of the difference between the minimum major diameter and actual major diameter as measured on the part.

3.7.2 Microscopic Examination: Specimens cut from parts shall be polished, etched in Kalling's reagent (100 cm^3 of absolute ethyl alcohol, 100 cm^3 of hydrochloric acid (sp gr 1.19), and 5 g of cupric chloride), Marble's reagent (20 cm^3 of hydrochloric acid (sp gr 1.19), 20 cm^3 of water, and 4 g of cupric sulfate pentahydrate), or other suitable etchant, and examined at not lower than 100X magnification to determine conformance to the requirements of 3.7.1.3, 3.7.2.1, 3.7.2.2, and 3.7.2.3.

3.7.2.1 Microstructure: Parts shall have microstructure of completely recrystallized material except in the area of the threads and the head-to-shank fillet radius.

3.7.2.2 (R) Grain Size: Shall be an average of 2 to 6 with no grains finer than 7 or coarser than 1 as determined by comparison of the specimen with the chart in ASTM E 112. In case of disagreement on grain size by the comparison method, the intercept (Heyn) procedure shall be used.

3.7.2.3 Surface Hardening: Parts shall have no change in hardness from core to surface except as produced during cold working of the head-to-shank fillet radius and during rolling of threads. There shall be no evidence of carburization or nitriding. In case of dispute over results of the microscopic examination, microhardness testing shall be used as a referee method; a Vickers hardness reading within 0.08 mm of an unrolled surface which exceeds the reading in the core by more than 30 points shall be evidence of nonconformance to this requirement.

3.7.3 Fluorescent Penetrant Inspection: Parts shall be subject to fluorescent penetrant inspection in accordance with AMS-2645; any required plating or coating shall be removed for this inspection.

3.7.3.1 The following conditions shall be cause for rejection of parts inspected:

3.7.3.1.1 Discontinuities transverse to grain flow (i.e., at an angle of more than 10° to the axis of the shank), such as grinding checks and quench cracks.

3.7.3.1.2 Longitudinal indications (i.e., at an angle of 10° or less to the axis of the shank) due to imperfections other than seams, forming laps, and nonmetallic inclusions.

3.7.3.2 The following conditions shall be considered acceptable on parts inspected:

3.7.3.2.1 Parts having longitudinal indications (i.e., at an angle of 10° or less to the axis of the shank) of seams and forming laps parallel to the grain flow that are within the limits specified in 3.7.3.2.2 through 3.7.3.2.5 provided the separation between indications is not less than 1.6 mm in all directions.

3.7.3.2.2 Sides of Head: There shall be not more than three indications per head. The length of each indication may be the full height of the surface but no indication shall break over either edge to a depth greater than 0.8 mm or the equivalent of the basic thread height (see Table 3), whichever is less.

3.7.3.2.3 (R) Shank or Stem: There shall be not more than five indications. The length of any indication may be the full length of the surface but the total length of all indications shall not exceed twice the length of the surface. No indication shall break into a fillet or over an edge.

3.7.3.2.4 Threads: There shall be no indications, except as permitted in 3.7.1.3.

3.7.3.2.5 Top of Head and End of Stem: The number of indications is not restricted but the depth of any individual indication shall not exceed 0.25 mm, as shown by sectioning representative samples. No indication, except those of 3.7.3.2.2 shall break over an edge.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of parts shall supply all samples and shall be responsible for performing all required tests. Purchaser reserves the right to perform such confirmatory testing as deemed necessary to ensure that the parts conform to the requirements of this specification.

4.2 Acceptance Tests:

Tests to determine conformance to all technical requirements of this specification are acceptance tests and shall be performed on each production inspection lot. A summary of acceptance tests is specified in Table 5.

4.3 Acceptance Test Sampling:

4.3.1 Nondestructive Test - Visual and Dimensional: A random sample will be selected from each production inspection lot; the size of the sample to be as specified in Table 6. The classification of defects for parts shall be as specified in Table 7. Defects not classified in Table 7 shall be classified as Minor B defects. All dimensional characteristics are considered defective when out of tolerance.

4.3.2 Hardness Test (see 3.6.2): A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 8, Column A. The sample units may be selected from those that have been subjected to and passed the visual and dimensional inspection, with additional units selected at random from the production inspection lot as necessary.

4.3.3 Fluorescent Penetrant Inspection: A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 6 and the A.Q.L. shall be as specified in Table 7. The sample units may be selected from those that have been subjected to and passed the visual and dimensional inspection, with additional units selected at random from the production inspection lot as necessary.

4.3.4 Destructive Tests: A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 8, Column B. The sample units may be selected from those that have been subjected to and passed the nondestructive tests and the fluorescent penetrant inspection, with additional units selected at random from the production inspection lot as necessary.

4.3.5 Acceptance Quality: The acceptance quality level and acceptance number of defectives for the acceptance tests shall be as specified in Tables 6, 7, and 8.

4.4 Test Specimens:

Specimens for tensile and stress-rupture testing of machined test specimens shall be of standard proportions in accordance with ASTM E 8 with either 6 mm diameter at the reduced parallel gage section or smaller specimens proportional to the standard when required. Specimens shall be machined from finished parts or coupons of the same lot of alloy and be processed together with the parts they represent. Specimens shall be machined from the center of parts 18 mm and under in diameter, from the center of coupons 20 mm and under in nominal diameter or distance between parallel sides, and from mid-radius of larger parts or coupons.

4.5 Reports:

The vendor of parts shall furnish with each shipment a report stating that the chemical composition of the parts conforms to the applicable material specification, showing the results of tests to determine conformance to the room temperature ultimate tensile strength, hardness, and stress-rupture strength requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, MA3378 Revision B, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.6 Resampling and Retesting:

If any part or specimen used in the above tests fails to meet the specified requirements for mechanical properties and quality as in 3.6 and 3.7, disposition of the parts may be based on the results of testing three additional parts or specimens for each original nonconforming part or specimen. Failure of any retest part or specimen to meet the specified requirements shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Parts having different part numbers shall be packed in separate containers.

5.1.2 Each container of parts shall be marked to show the following information:

METRIC FASTENERS, NICKEL BASE ALLOY, CORROSION AND HEAT RESISTANT
MA 3378 REV B
PART NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

5.1.3 Threaded fasteners shall be suitably protected from abrasion and chafing during handling, transportation, and storage.

5.1.4 (R) Containers of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.1.5 (R) For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, industrial packaging, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention MA3378 in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

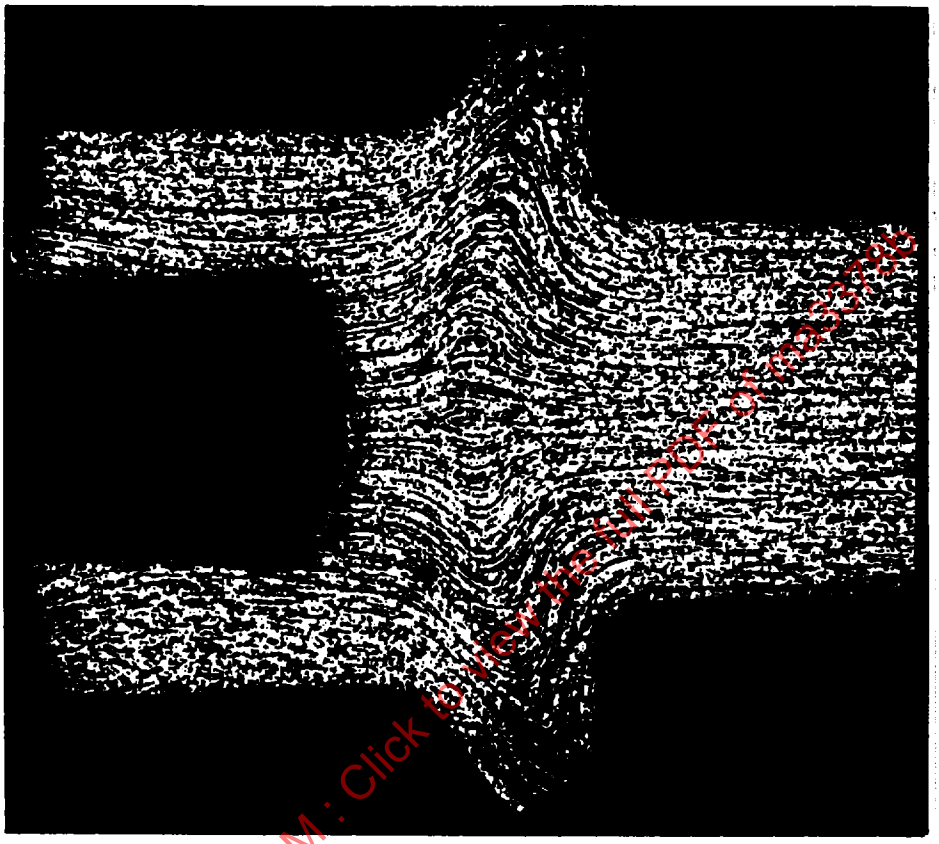
8. NOTES:

8.1 The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. The (R) symbol is used to indicate technical changes from the previous issue of this specification. Editorial changes are not included in a complete redraft of the document.

8.2 For direct U.S. Military procurement, purchase documents should specify the following:

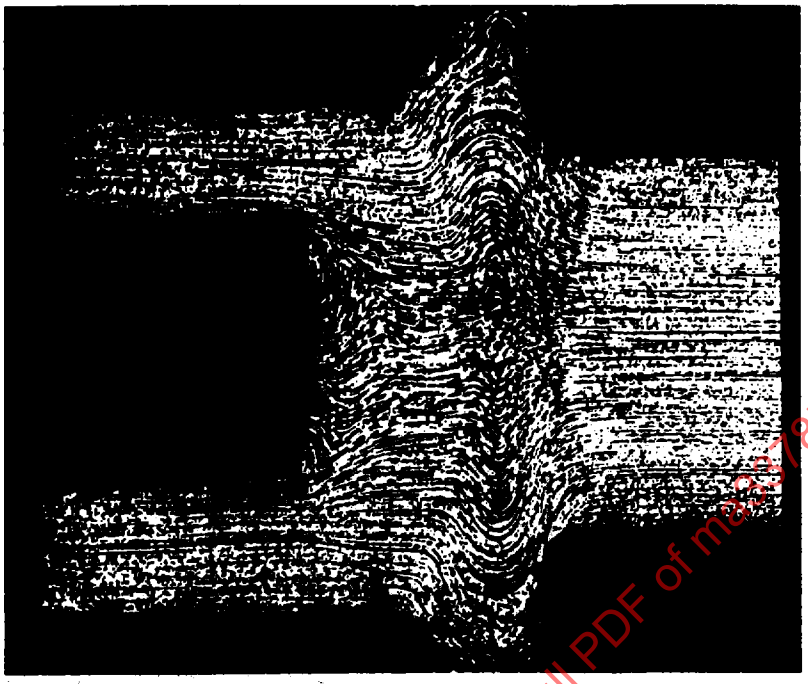
Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired
Applicable level of packaging (see 5.1.5)

PREPARED BY SAE COMMITTEE E-25,
GENERAL STANDARDS FOR AEROSPACE PROPULSION SYSTEMS



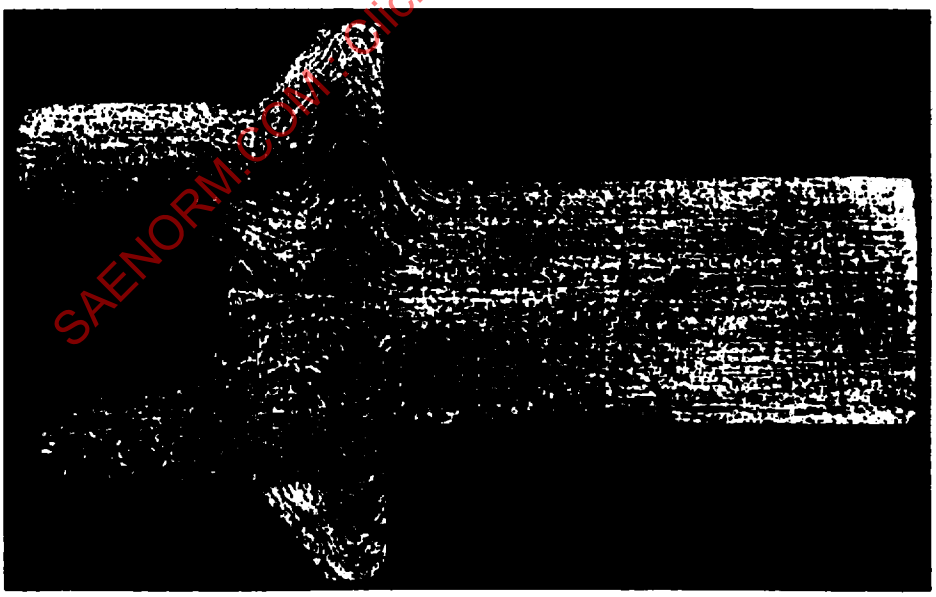
Showing a smooth, well formed grain flow following the contour of the under head fillet radius.

FIGURE 1A - Satisfactory Grain Flow



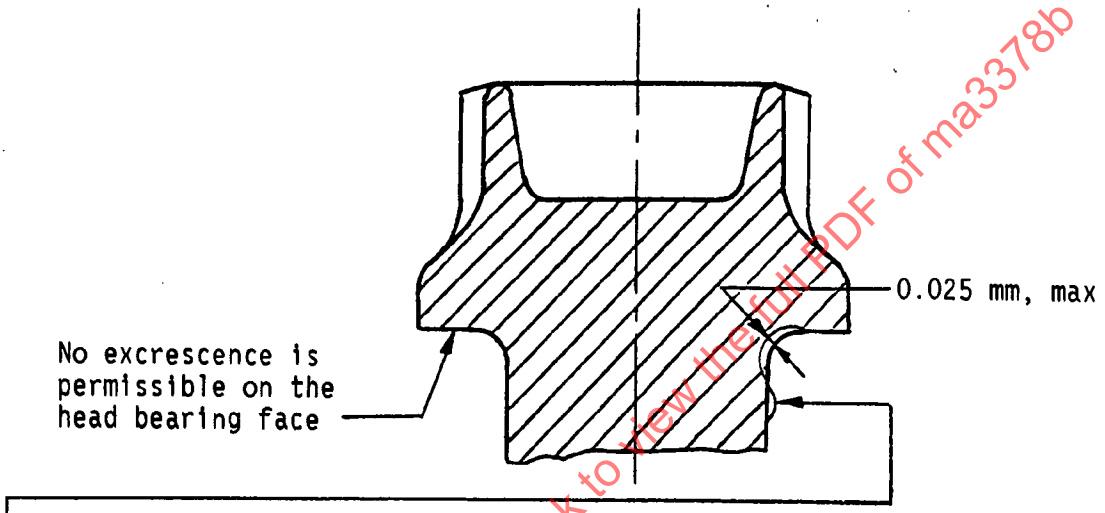
Showing maximum permissible cutting of grain flow after machining to remove contamination oxide.

FIGURE 1B - Minimum Acceptable Standard



Showing excessive cutting of grain flow in the shank, fillet and bearing surface which is not permissible.

FIGURE 1C - Unacceptable Grain Flow



The shank diameter at this position, inclusive of distortion shall:

a. On full shank close tolerance bolts, not to exceed the nominal thread diameter.
b. On full shank coarse tolerance bolts, not to exceed the actual shank diameter, prior to distortion, by more than 0.06 mm on diameter.
c. On PD shank bolts, not to exceed the actual PD shank diameter, prior to distortion, by more than 0.06 mm on diameter.

(R) FIGURE 2 - Permissible Distortion From Fillet Working

FIGURE 3 - Flow Lines, Rolled Thread

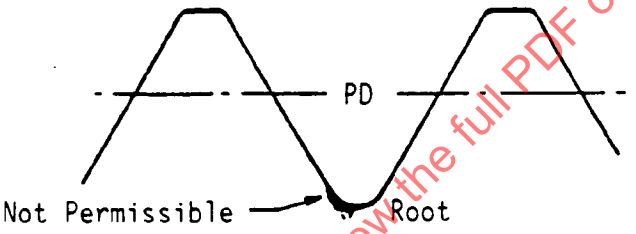


FIGURE 4 - Root Defects, Rolled Thread

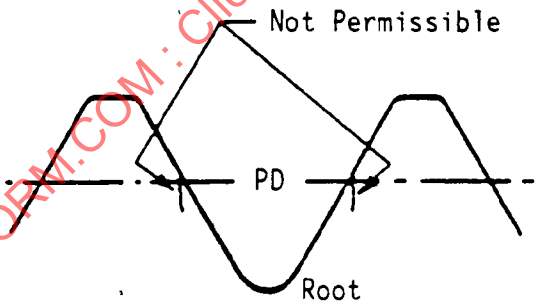


FIGURE 5 - Laps Below PD Extending Toward Root, Rolled Thread

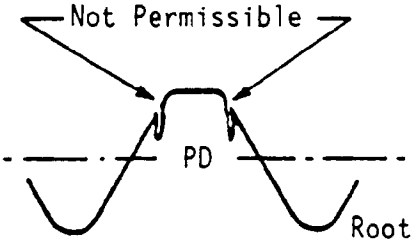


FIGURE 6 - Laps Above PD Extending Toward Root, Rolled Thread

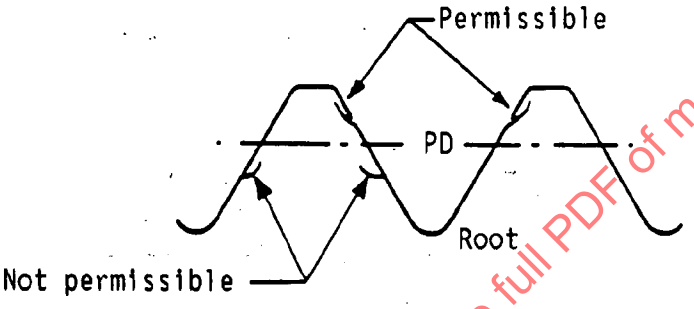
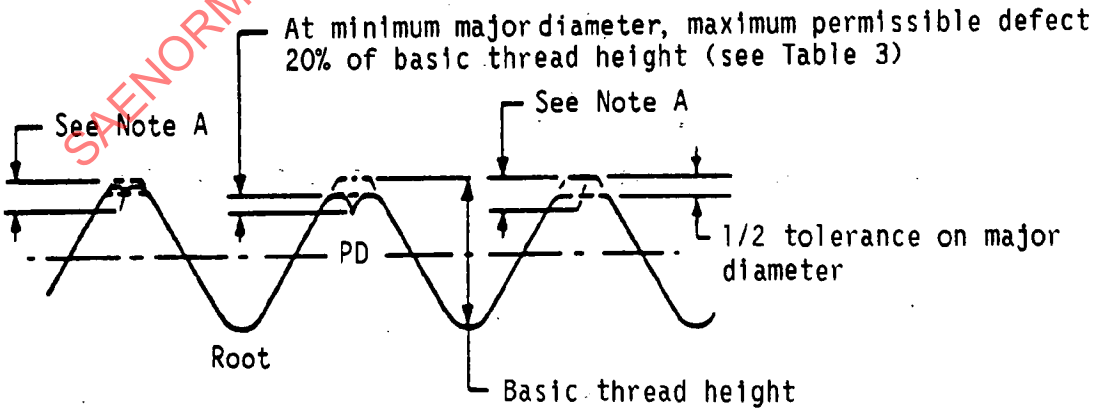


FIGURE 7 - Laps Extending Towards Crest, Rolled Thread



Note A: Depth of defect equals 20% of basic thread height plus 1/2 the difference of the actual major diameter and minimum major diameter.

FIGURE 8 - Crest Craters and Crest Laps, Rolled Thread

TABLE 3 - Thread Height

Thread Pitch mm	Basic Thread Height Ref (See Note 1) mm	20% Basic Thread Height mm
0.5	0.30	0.06
0.6	0.36	0.07
0.7	0.42	0.08
0.8	0.48	0.10
1	0.60	0.12
1.25	0.75	0.15
1.5	0.90	0.18
1.75	1.05	0.21
2	1.20	0.24
2.5	1.5	0.30
3	1.80	0.36

NOTE 1: Basic thread height is defined as being equivalent to 0.6 times the thread pitch.

(R) TABLE 4 - Test Loads

Thread Size	Ultimate Tensile Strength Room Temperature Standard MJ Threads Test Load, kN min	Stress-Rupture Tensile Test Load kN
3 x 0.5	6.175	2.398
3.5 x 0.6	8.318	3.218
4 x 0.7	10.78	4.161
5 x 0.8	17.39	6.785
6 x 1	24.69	9.587
7 x 1	35.33	13.95
8 x 1	47.87	19.14
10 x 1.25	74.81	29.90
12 x 1.25	112.3	45.52
14 x 1.5	152.0	61.47
16 x 1.5	203.9	83.14
18 x 1.5	263.4	108.1
20 x 1.5	330.4	136.3
22 x 1.5	405.1	167.8
24 x 2	468.2	192.2

NOTE 1: Requirements above apply to parts with metric MJ threads to the sizes shown, to class 4h6h tolerances. Area upon which stress for ultimate tensile strength load requirements is based is the tensile stress area as defined in MA1520, for threads rolled prior to precipitation heat treatment, and calculated from Equation 1:

$$A = 0.7854\ [0.5(d_2\ \text{max} + d_3\ \text{max})]^2 \qquad \text{(Eq.1)}$$

where:

A = tensile stress area at mean diameter between d_2 max and d_3 max
d_2 max = maximum pitch diameter
d_3 max = maximum root diameter

Area upon which stress-rupture tensile test load requirements is based is the area at the maximum root diameter for MJ threads as defined in MA1520, calculated from Equation 2:

$$A = 0.7854[(d_3\ \text{max})^2 \qquad \text{(Eq.2)}$$

where:

A = area at maximum root diameter
d_3 max = maximum root diameter