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400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE STANDARD

MA3375

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Revised

STUDS, A-286 CRES
Roll Threaded After Heat Treatment, Procurement Specification for, Metric

1. SCOPE:

1.1 Type: This procurement specification covers aircraft quality metric studs made of a corrosion and heat resistant age hardenable iron base alloy, A-286. Two types of studs are covered as follows:

Type I - Studs with the stud end having special oversize pitch diameter threads with undersize pitch diameter lead threads and the nut end having standard size pitch diameter threads.

Type II - Studs with stud end and nut end having standard size pitch diameter threads.

1.2 Application: Primarily for studding light alloy parts having high coefficients of expansion where studs having a good combination of strength and corrosion resistance are required. May also be used for studding corrosion resistant steel parts.

1.2.1 Type I studs are intended for torque driving into light alloy tapped hole by interference fit assembly of stud end threads per studding practice given in MAP1670.

1.2.2 Type II studs are intended for studding light alloy, steel or corrosion resistant steel parts by locking the assembled stud end threads in the boss to resist rotation by an auxiliary method; for example:

a) By use of tapped holes having stud-locking helical coil threaded inserts.

b) By use of locking keys (individual or ring supported) driven into the assembled stud and boss threads parallel to thread axis.

c) By use of serrated lock ring driven into assembled studded boss so that internal serrations engage the stud serrated shank and external serrations broach the boss counterbore.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specification (AMS) and Aerospace Standard (AS & MA) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2645 - Fluorescent Penetrant Inspection
AMS 5731 - Steel Bars, Forgings, and Rings, Corrosion and Heat Resistant, 15Cr-26Ni-2.1Ti-0.30V, Consumable Electrode Melted, 980°C (1800°F) Solution Treated

AMS 5732 - Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant, 15Cr-26Ni-1.3Mo-2.1Ti-0.30V, Consumable Electrode Melted, 980°C (1800°F) Solution and Precipitation Treated

AMS 5734 - Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant, 15Cr-26Ni-1.3Mo-2.1Ti-0.3V, Consumable Electrode Melted, 900°C (1650°F) Solution Heat Treated

AMS 5737 - Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant, 15Cr-25.5Ni-1.3Mo-2.1Ti-0.006B-0.3V, Consumable Electrode Melted, 900°C (1650°F) Solution and Precipitation Heat Treated

2.1.2 Aerospace Standards:

MAP1670 - Studs, Installation Practice for Interference Fit-Metric (being prepared)
AS1520 - 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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E112- Estimating the Average Grain Size of Metals

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

ANSI B1.21M - Metric Screw Threads - MJ Profile
ANSI B46.1 - Surface Texture

2.4 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

2.4.1 Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1312 - Fasteners, Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be AMS 5731 or AMS 5734 heading stock or AMS 5732 or AMS 5737 steel.

3.1.1 Stock: Stock for heading shall be reduced 15 - 25% in cross sectional area during the final drawing or rolling at a temperature not higher than 870°C unless stock is so reduced or is otherwise processed, during manufacture of parts, to prevent grain growth during heat treatment. Hardness of stock reduced as above shall be 201 - 285 HB or equivalent.

3.2 Design: Finished 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, unless otherwise specified. Dimensions shall apply 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 part drawing, unless otherwise specified.

3.2.3 Threads:

3.2.3.1 Type I Studs: Unless otherwise specified on the part drawing the threads shall be as follows:

Nut end threads - Standard MJ metric screw threads specified in ANSI B1.21M.
Stud end threads - Special MJ metric screw threads as follows:

a) MJ thread form per ANSI B1.21M.
b) Dimensions for major, pitch, and minor diameters as specified on part drawing.
c) Undersized pitch diameter lead threads per AS3062.
d) Form tolerances for full stud threads per AS3062.

3.2.3.2 Type II Studs: Unless otherwise specified on the part drawing, the stud end threads and nut end threads shall be standard MJ metric screw threads as specified in ANSI B1.21M.

3.2.3.3 Incomplete Threads: Incomplete lead threads are permissible at the chamfered end and incomplete runout threads are permissible at the juncture of the unthreaded portion of the shank as specified in AS3062 except Type I studs shall have lead threads on stud end as in 3.2.3.1.

3.2.3.4 Chamfer: The entering point of the threads shall be chamfered as specified on the part drawing.

3.2.4 Geometric Tolerances: Part features shall be within the geometric tolerance specified on the part drawing and, where applicable, controlled per AS3063.

3.3 Fabrication:

3.3.1 Blanks: Blanks shall be machined sufficiently to remove surface defects. The smaller diameter or nut end of blanks for stepped studs may be reduced as necessary by extruding or machining or both, or the larger diameter or stud end may be upset. Upsetting to produce a shoulder or shoulders between the threaded ends is permissible. Heading stock to be hot upset shall not be heated to a temperature higher than 1150°C.

3.3.2 Heat Treatment: Blanks made from AMS 5731 or AMS 5734 solution heat treated stock shall, before finishing the shank and rolling the threads, be heat treated as follows:

3.3.2.1 Heating Equipment: Furnaces may be any type ensuring uniform temperature throughout the parts and shall be equipped with, and operated by, automatic temperature controllers. The heating medium shall not cause surface hardening by carburizing or nitriding.

3.3.2.2 Solution Heat Treatment: Upset or extruded blanks of AMS 5731 shall be solution heat treated by heating to 980°C ± 15, holding at heat for approximately 1 hr, and quenching in oil or water. Upset or extruded blanks of AMS 5734 shall be solution heat treated by heating to 900°C ± 15 for not less than 2 hr, and quenching in oil or water.

3.3.2.3 Precipitation Heat Treatment: All blanks, except those of AMS 5732 and AMS 5737, shall be precipitation heat treated by heating to a temperature within the range 700 - 760°C, holding at the selected temperature within ± 8°C for approximately 16 hr, and cooling in air.

3.3.3 Oxide Removal: The solution and precipitation heat treated blanks, before rolling the threads, shall have the full body and bearing surfaces of shoulders, as applicable, free from surface oxide and oxide penetration caused by prior heat treatment. The removal process shall produce no intergranular attack or corrosion of the blanks.

3.3.4 Thread Rolling: Threads shall be formed on the heat treated and finished blanks by a single rolling process for each end after removal of oxide as in 3.3.3.

3.3.5 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 30-40 min. at room temperature.

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

3.4 Product Marking: Each part shall be marked on the ends of the part as specified on the part drawing. The oversize studs shall be marked with the oversize identification on the stud thread end. The nut thread end shall be marked with the material code "EH19". Shouldered studs with sufficient marking area on shoulder OD shall be identification marked as specified on the part drawing. Unless otherwise specified, the markings shall be stamped, depressed 0.25 mm max, with rounded root form on the depressed characters.

3.5 Plating: Where required, all surfaces shall be plated as specified by the part drawing.

3.6 Mechanical Properties: Parts shall conform to the requirements of 3.6.1 and 3.6.2. Threaded members of gripping fixtures for tensile test shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The loaded protion of the shank shall have three full thread turns from thread runout exposed between the loading fixtures during the tensile test. Finished parts shall be tested in accordance with the following applicable test methods of MIL-STD-1312.

Requirement	Test Method
Hardness	No. 6
Room Temperature Tensile Strength	No. 8

3.6.1 Tensile Strength at Room Temperature:

3.6.1.1 Finished Parts: Finished parts shall withstand the minimum tensile load specified in Table II. Unless the part is of such size and shape that failure would occur outside the threaded section, such as parts having a shank diameter equal to or less than the thread root diameter (smaller thread root diameter for parts with unequal size threads) or having an undercut, parts shall fail in one of the threaded sections as specified in 3.6.1.1.1 through 3.6.1.1.3. If the size or shape of the part is such that failure would occur outside the threaded section, as specified above, parts shall conform to only the tensile strength requirement of 3.6.1.2; for such parts, the diameter on which stress is based shall be the actual measured minimum diameter of the part.

3.6.1.1.1 Parts having both ends threaded with the same diameter-pitch thread size may fail in either threaded section.

3.6.1.1.2 Parts having both ends threaded to the same diameter but different pitches shall fail in the coarser pitch threaded section.

3.6.1.1.3 Parts having threads of unequal diameter, whether of the same pitch or not, shall fail in the smaller diameter threaded section.

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 E8 on specimens prepared as in 4.3.3. Such specimens shall meet the following requirements:

Tensile Strength, min	900 MPa	
Yield Strength at 0.2 % Offset, min	590 MPa	
	AMS 5731 & AMS 5732	AMS 5734 & AMS 5737
Elongation in 5D, min	15 %	12 %
Reduction of Area, min	20 %	15 %

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

3.6.2 Hardness: Shall be uniform and within the range 26 - 39 HRC or equivalent but hardness of the threaded sections may be higher as a result of the cold working operations.

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

3.7.1 Macroscopic Examination: Parts or sections of parts as applicable, 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 may be made by microscopic examination of specimens polished and etched as in 3.7.2.

3.7.1.1 Flow Lines: Flow lines in threads shall be continuous, shall follow the general contour and shall be of maximum density at the root of the thread (See Fig. 1). Below the threaded roots, flow lines not affected by forming shall be parallel to the axis except that on the nut end of parts formed by extruding the flow lines may be oblique to the axis for a distance from the end of the larger diameter to the smaller diameter equal to 1.5 times the B dimension of Table II of AS3062.

3.7.1.2 Internal Defects: Examination of longitudinal sections of parts 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.

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 Fig. 2).

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 Figs. 3 and 4).

3.7.1.3.3 There shall be no laps along the flank of the thread below the pitch diameter (See Fig. 5). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or non-pressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (See Fig. 5).

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 I) as measured from the thread crest when the thread major diameter is at minimum size (See Fig. 6). 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 I 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.

3.7.2.2 Grain Size: Grain size shall be 5 or finer as determined by comparison of the specimen with the chart in ASTM E112. Up to 25 % by area of grains 2 ASTM numbers coarser than the general grain size are permitted in any specific area of 100 adjacent grains. Bands of fine or coarse grains are not permitted.

3.7.2.3 Surface Hardening: Parts shall have no change in hardness from core to surface except as produced 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.

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 degrees to the axis of the stud), such as grinding checks and quench cracks.

3.7.3.1.2 Longitudinal indications (i.e., at an angle of 10 degrees or less to the axis of the stud) 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 degrees or less to the axis of the stud) of seams and forming laps parallel to the grain flow that are within the limits specified in 3.7.3.2.2 thru 3.7.3.2.4 provided the separation between indications is not less than 1.6 mm in all directions.

3.7.3.2.2 Shank or Stem: There shall be not more than five indications. The length of any indication may be 5 mm with a depth not exceeding 0.05 mm 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.

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

3.7.3.2.4 Ends of Stud: 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 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. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the parts conform to the requirements of this specification.

4.2 Classification of Tests: The inspection and testing of parts are classified as follows:

a) Acceptance tests as in 4.3.1 which are to be performed on each production inspection lot.

b) Periodic tests which are to be performed periodically on production lots at the discretion of the vendor or purchaser. None required in this specification.

4.3 Production Inspection Lot: A 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.

4.3.1 Acceptance Tests: The acceptance tests shall be performed on each production inspection lot. The acceptance tests consist of all the tests specified in Table III. Parts shall be examined visually for design and construction, identification marking, and packaging using conventional methods and instruments.

4.3.2 Acceptance Test Sampling:

4.3.2.1 Non-Destructive 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 IV. The classification of defects for parts shall be as specified in Table V. Defects not classified in Table V shall be classified as Minor B defects. All dimensional characteristics are considered defective when out of tolerance.

4.3.2.2 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 VI; 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.

4.3.2.3 Non-Destructive Inspection: Parts shall be subject to fluorescent penetrant inspection.

4.3.2.4 Destructive Tests: A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table VI, column B. The sample units may be selected from those that have been subjected to and passed the non-destructive tests with additional units selected at random from the production inspection lot as necessary.

4.3.3 Test Specimens: Specimens for tensile testing of machined test specimens shall be of standard proportions in accordance with ASTM E8 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.

4.3.4 Acceptance Quality: The acceptance quality level and acceptance number of defectives for the acceptance tests shall be as specified in Tables IV and VI.

4.4 Reports: The vendor of parts shall furnish with each shipment three copies of a report stating that the chemical composition of the parts conform to the applicable material specification, showing the results of tests to determine conformance to the room-temperature tensile property and hardness requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, this specification number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.5 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, STEEL, CORROSION AND HEAT RESISTANT
MA3375
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 Containers of parts shall be prepared for shipment in accordance with commercial practice to ensure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.5 For direct U.S.A. Military procurement, packaging shall be as specified in the request for procurement.

6. ACKNOWLEGEMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

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

Title, number, and date of this specification.
Part number or size of parts desired.
Quantity of parts desired.
Applicable level of packaging.

PREPARED BY

SAE COMMITTEE E-25

ENGINE AND PROPELLER STANDARD UTILITY PARTS

TABLE I

Thread Pitch, mm	Basic Thread Height mm, Ref (See Note 1)	20% Basic Thread Height
0.5	0.30	0.06
0.6	0.36	0.07
0.7	0.42	0.08
0.8	0.48	0.09
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	1.50	0.30
3	1.80	0.36

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

TABLE II

Thread Size	Tensile Strength Load kN min Standard MJ Threads Room Temp.
3 x 0.5	5.1
3.5 x 0.6	6.8
4 x 0.7	8.9
5 x 0.8	14.2
6 x 1	20.2
7 x 1	28.5
8 x 1	38.2
10 x 1.25	59.7
12 x 1.25	88.5
14 x 1.5	120
16 x 1.5	159
18 x 1.5	205
20 x 1.5	256
22 x 1.5	312
24 x 2	364

Note 1. Requirements above apply to parts with metric MJ threads to the sizes shown, to class 4h6h tolerances. Area upon which stress for tensile strength load requirements is based is the tensile stress area as defined in AS1520, for threads rolled after heat treatment, and calculated from equation:

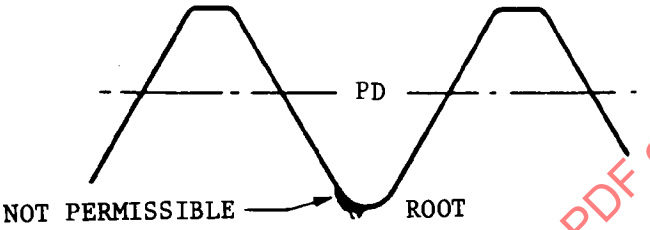
$$A = 0.7854(d_2)^2$$

where, A = tensile stress area
d_2 = basic pitch diameter

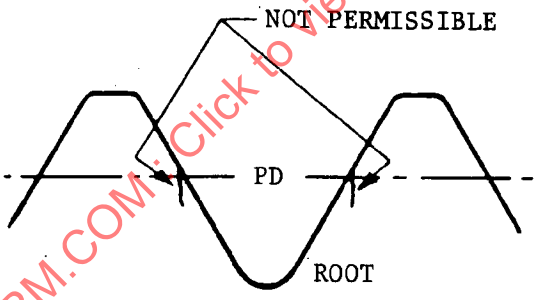
Load requirement is based on 900 MPa for tensile strength load.

Note 2. For sizes not shown, tensile strength loads for parts tested as parts, not as specimens machined from parts or from coupons of the stock, shall be based upon the area and stress given above.

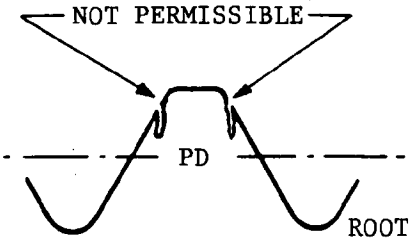
FLOW LINES, ROLLED THREAD
FIGURE 1



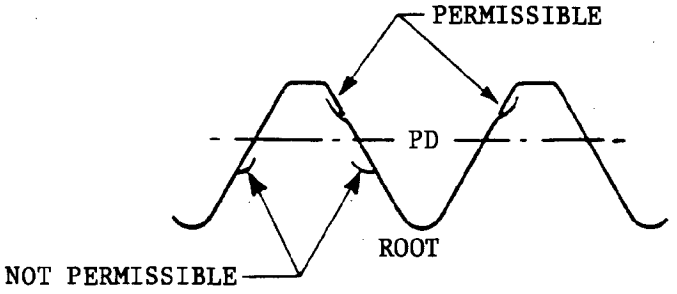
ROOT DEFECTS, ROLLED THREAD
FIGURE 2



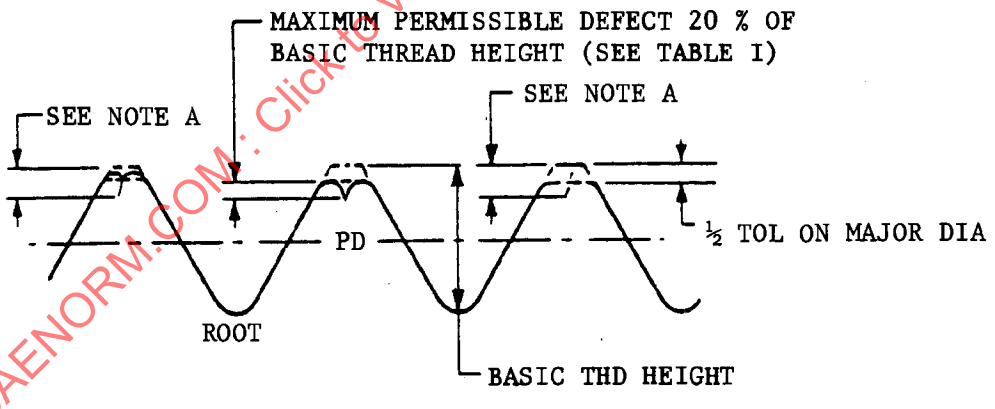
MULTIPLE LAPS BELOW PD EXTENDING TOWARD ROOT, ROLLED THREAD
FIGURE 3



MULTIPLE LAPS ABOVE PD EXTENDING TOWARD ROOT, ROLLED THREAD
FIGURE 4



LAPS EXTENDING TOWARDS CREST, ROLLED THREAD
FIGURE 5



Note A: Depth of defect equals 20 % of basic thread height plus ½ the difference of the actual major diameter and minimum major diameter.

CREST CRATERS & CREST LAPS, ROLLED THREAD
FIGURE 6

TABLE III

Summary of Acceptance Tests

Characteristic	Req. Para.	Sample Size	Test Method
Product Marking	3.4	Tables IV & V	Visual Examination
Packaging & Identification	5.1	None	Visual
Dimensions	3.2.1	Tables IV & V	Conventional measuring methods
Surface Texture	3.2.2	Tables IV & V	Per ANSI B46.1 by visual or fingernail comparison with standard texture specimens. In case of conflict, stylus instrument may be used if surface is accessible.
Thread Size	3.2.3	Tables IV & V	Gaging methods per MA1566
Geometric Tolerances	3.2.4	Tables IV & V	Conventional measuring methods
Plating	3.5	Tables IV & V	Non-destructive test of plating thickness per MIL-STD-1312, Test No. 12 when required.
Tensile Strength	3.6.1	Table VI, Col B	MIL-STD-1312, Test No. 8
Hardness	3.6.2	Table VI, Col A	MIL-STD-1312, Test No. 6 near center of thread end. Prepare a flat surface prior to plating or with plating removed.
Nondestructive Inspection	3.7.3	Table IV & V	Inspection per AMS 2645
Flow Lines	3.7.1.1	Table VI, Col B	Macroscopic examination per 3.7.1
Internal Defects	3.7.1.2	Table VI, Col B	Macroscopic examination per 3.7.1
Internal Defects, Threads	3.7.1.3	Table VI, Col B	Macroscopic or microscopic examination per 3.7.1 or 3.7.2
Microstructure	3.7.2.1	Table VI, Col B	Microscopic examination per 3.7.2
Grain Size	3.7.2.2	Table VI, Col B	Microscopic examination per 3.7.2 with chart in ASTM E112.
Surface Hardening	3.7.2.3	Table VI, Col B	Microscopic examination per 3.7.2 or Vickers hardness reading.