SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS4976

Issued 1999-05
Reaffirmed 2012-11

Insert, Screw Thread, Non-Locking, UNS S66286, Locked In, Key Locked Procurement Specification For

FSC 5340

RATIONALE

AS4976 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Type:

This procurement specification covers inserts made from A286 alloy of the type identified under the Unified Numbering System as UNS S66286 which have non-locking internal threads and integrated locking keys to positively secure the insert against rotation when properly installed in threaded holes.

1.2 Application:

Inserts covered by this specification are intended as general purpose fasteners.

1.3 Safety - Hazardous Materials:

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:

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AS4976

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

AMS 2759/3	Heat Treatment of Precipitation Hardenable and Maraging Steel Parts
AMS 5731	Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant 15Cr 25.5Ni 1.2Mo 2.1Ti 0.006B 0.30V Consumable Electrode Melted, 1800 °F (982 °C), Solution Treated
AMS 5734	Bars, Forgings, and Tubing, Corrosion and Heat Resistant 15Cr 25.5Ni 1.2Mo 2.1Ti 0.006B 0.30V Consumable Electrode Melted, 1650 °F (899 °C), Solution Treated
AMS 5737	Steel Bars, Wire, Forgings, and Tubing, Corrosion and Heat Resistant 15Cr 25.5Ni 1.2Mo 2.1Ti 0.006B 0.30V Consumable Electrode Melted, 1650 °F (899 °C), Solution and Precipitation Heat Treated
AMS-QQ-A-225/6	Aluminum Alloy 2024, Bar, Rod, Wire and Special Shapes, Rolled, Drawn or Cold Finished
AMS-QQ-A-225/8	Aluminum Alloy 6061, Bar, Rod, Wire and Special Shapes, Rolled, Drawn or Cold Finished
AMS-QQ-A-250/4	Aluminum Alloy 2024 Plate and Sheet
AMS-QQ-A-250/11	Aluminum Alloy 6061 Plate and Sheet
AMS-QQ-P-35	Passivation Treatments for Corrosion Resistant Steel
AS1310	Fastener Torque for Threaded Applications, Definitions of
AS3572	Insert, Screw Thread, Non-Locking, Locked In, Key Locked, Heavy-Duty
AS3573	Insert, Screw Thread, Non-Locking, Locked In, Key Locked, Extra Heavy-Duty
AS4724	Insert, Locked In, Self-Broaching Keys - Hole Dimensions and Installation Requirements
AS8879	Screw Threads, Controlled Radius Root and Increased Minor Diameter, General Specification for

2.1.2 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-H28/2	Screw-Thread Standards for Federal Services, Section 2, Unified Inch Screw Threads UN and UNR Thread Forms
FED-STD-H28/20	Screw-Thread Standards for Federal Services, Section 20, Inspection Methods for Acceptability of UN, UNR, UNJ, M and MJ Screw-Threads
MIL-HDBK-57	Listing of Fastener Manufacturers' Identification Symbols

2.1.3 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 342	Test Methods for Permeability of Feebly Magnetic Materials
ASTM D 3951	Commercial Packaging
ASTM E 1417	Liquid Penetrant Examination

2.1.4 ANSI Publications: Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

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

2.1.5 NAS Publications: Available from National Standards Association, Inc., 1200 Quince Orchard Boulevard, Gaithersburg, MD 20878.

NASM 1312-6 Fastener Test Methods, Method 6, Hardness
NASM 1312-13 Fastener Test Methods, Method 13, Double Shear

2.2 Definitions:

Refer to AS1310 for definitions relating to fastener torque.

DEFECTIVE: A unit of product which contains one or more defects.

INSPECTION LOT: Shall consist of inserts from a single production lot of the same part number.

PRODUCTION LOT: Shall consist of finished inserts fabricated by the same process from a single heat of alloy, heat treated at the same time to the same condition, produced as one continuous run and submitted for vendor's inspection at the same time.

2.3 Unit Symbols:

% - percent (1% = 1/100)
in - inch
in² - square inch
lbf - pounds force
lbf·in - pound force per inch
ksi - kips (1000 pounds) per square inch
HRC - hardness, Rockwell C scale

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be a corrosion and heat resistant steel, AMS 5731, AMS 5734 or AMS 5737 as specified on the part drawing.

3.2 Design:

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

3.2.1 Dimensions: The dimensions of the finished parts, after all processing including surface treatment, 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 shall conform to the requirements as specified on the part drawing, determined in accordance with ANSI/ASME B46.1.

3.2.3 Threads:

3.2.3.1 Internal Threads: Screw thread UN profile and dimensions shall be in accordance with AS8879, unless otherwise specified on the part drawing.

3.2.3.2 External Threads: Screw thread UN profile and dimensions shall be in accordance with FED-STD-H28/2, unless otherwise specified on the part drawing. Minor diameters shall be as specified on the part drawing. Prior to the assembly of the keys, the threads shall be inspected in conformance with FED-STD-H28/20, System 22. Assembled inserts (after key installation) shall be checked in a tapped hole prepared in accordance with AS4724.

3.2.3.3 Lead Threads: External lead threads shall not exceed two pitches, including chamfer.

3.2.3.4 Thread Forming: Threads may be produced either by machining, grinding, or fully formed by a single rolling process.

3.3 Heat Treatment:

Shall conform to the technical requirements and other provisions specified in AMS 2759/3 for A286, 1650 °F solution treatment and 1325 °F aging treatment.

3.3.1 Solution Heat Treatment: Inserts, unless machined from solution heat treated stock or AMS 5737 steel, shall be solution heat treated as in 3.3.

3.3.2 Aging Treatment: Solution heat treated inserts shall be heat treated by aging as in 3.3.

3.4 Surface Treatment:

3.4.1 Inserts, less the keys, shall be passivated in accordance with AMS-QQ-P-35. The key wire material shall be passivated in accordance with AMS-QQ-P-35 prior to assembly in the insert.

3.5 Runout:

The internal thread pitch diameter shall have a circular runout with the external pitch diameter within .006 in FIM.

3.6 Source Identification Mark:

The insert shall be marked on the key tang or insert body. The source identification insignia for a manufacturer shall be in accordance with MIL-HDBK-57 or a private label distributor's insignia, as applicable. The source identification mark shall be legible and permanent.

3.7 Magnetic Permeability:

Inserts shall have a magnetic permeability of 2.0 maximum (Air = 1.0) for a field of H = 200 oersteds, when tested in conformance with ASTM A 342.

3.8 Mechanical Properties:

Parts shall conform to the requirements of 3.8.1, 3.8.3, and 3.8.4.

3.8.1 Tensile Strength (Proof): Parts shall withstand a proof load not lower than that specified in Table 1 with or without the locking keys installed. Inserts shall be installed in test blocks (Figure 2) specified in 4.5.1, and tested with test bolts as specified in 4.5.3.1. The test bolt shall be assembled into the insert and shall be of sufficient length to extend through the insert a minimum of two (2) pitches. The test shall be conducted in fixtures shown in Figure 1. The minimum proof load as specified in Table 1, as applicable, shall then be applied to the assembly without failure occurring. In the event of bolt failure below the applicable proof load, the test shall be repeated until the applicable proof rating of the insert is exceeded. The rate of loading shall not exceed 100 ksi per minute based on the shank area of the bolt.

3.8.2 Resistance to Pull-out (Reference only): Table 2 and Table 3 contain tabulated minimum shear engagement areas and the associated minimum pullout loads as a function of the internal thread size for each of the AS3572 and AS3573 inserts when installed in a material possessing a shear strength of 27 ksi. The data contained in Table 2 and Table 3 is provided as reference-only information for determining the pull-out strength of the inserts in materials other than that noted.

3.8.3 Rotational Resistance (Proof): Parts shall withstand a torque load not lower than that specified in Table 4. Inserts shall be installed in test blocks (Figure 2) as specified in 4.5.1, and tested with test bolts as specified in 4.5.3.1. The test shall be conducted as specified in Figure 3. The rotational force is to be applied with a torque wrench and the torque listed in Table 4, as applicable, shall be reached with no axial load exerted on the test block. Failure of the insert to remain in the test block shall be cause for rejection.

3.8.4 Hardness: Shall be uniform and within the range of 31 to 36 HRC but parts shall not be rejected on the basis of hardness as determined by NASM 1312-6 if the strength requirements of this specification are met.

3.9 Quality:

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs, foreign materials, and imperfections detrimental to the usage of the parts.

3.9.1 Fluorescent Penetrant Inspection: Inserts shall be subject to fluorescent penetrant inspection in accordance with ASTM E 1417, Type I, sensitivity level 2. The inspection shall be performed subsequent to any processing operation which could adversely affect the outcome of the inspection process. Penetrant inspection indications alone shall not be cause for rejection. If indications are considered cause for rejection, representative samples shall be taken from those inserts showing indications and these samples shall be further examined as specified in 3.9.2.

3.9.1.1 Discontinuities: Examination of longitudinal or transverse sections of the insert shall reveal no discontinuities such as cracks, laps, seams, or inclusions except laps in threads as permitted in 3.9.2.1.3 and 3.9.2.1.4.

3.9.2 Microscopic Examination: Specimens cut from parts shall be polished, etched with a suitable etchant and examined at a magnification not lower than 100X to determine conformance to the requirements of 3.9.2.1.

3.9.2.1 Threads:

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

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

3.9.2.1.3 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 non-pressure flank (one lap at any cross-section through the thread) provided that it extends toward the crest and generally parallel to the flank (see Figure 7).

3.9.2.1.4 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 5) as measured from the thread crest when the 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 5 may be increased by one-half of the difference between the minimum major diameter and the actual major diameter as measured on the part.

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 Responsibility for Compliance:

The manufacturer's system for parts production shall be based on preventing product defects, rather than detecting the defects at final inspection and then requiring corrective action to be invoked. An effective manufacturing in-process control system (e.g. Statistical Process Control - SPC) shall be established, subject to the approval of the purchaser, and used during production of the inserts.

4.3 Classification of Tests:

The inspection and testing of inserts shall be classified as either qualification tests or acceptance tests.

4.3.1 Qualification Tests: Qualification tests shall be performed on inserts selected from the first lot of each size produced by a manufacturer and shall be repeated whenever a significant change is made in the manufacturing process. The qualification tests shall consist of those tests and inspections defined in Table 6.

4.3.2 Acceptance Tests: Acceptance tests shall be performed on each inspection lot. The acceptance tests shall consist of those tests and inspections defined in Table 7.

4.4 Test Sampling:

4.4.1 Material: Raw material chemical analysis certification may be accepted in lieu of test data.

4.4.2 Destructive Tests: A random sample shall be selected from each inspection lot; the size of the sample to be as specified in Table 8 and classified as in Tables 6 and 7. The sample units inspected may be selected from those that have been subjected to and passed the non-destructive tests and the fluorescent penetrant and magnetic particle inspection, with additional units selected from the manufacturing lot.

4.4.3 Fluorescent Penetrant Inspection: A random sample shall be selected from each inspection lot; the size of the sample to be as specified in Table 9. The sample units inspected 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 manufacturing lot as necessary.

4.4.4 Non-Destructive Tests - Visual and Dimensional: A random sample of parts shall be taken from each inspection lot; the size of the sample to be as specified in Table 9 and classified as in Table 10. All dimensional characteristics are considered defective when out of tolerance.

4.4.5 Acceptance Quality: Of random samples tested, acceptance quality shall be based on zero defectives.

4.5 Test Materials:

4.5.1 Test Blocks: Test blocks shall be fabricated in accordance with Figure 2 as applicable. The aluminum alloy used to prepare the test blocks shall be tested (by heat lot), to determine the ultimate shear strength. The 6061 (UNS A96061) T6 and T651 tempers, in accordance with QQ-A-225/8 and QQ-A-250/11 respectively, shall have a minimum shear strength of 27 ksi. Three shear test specimens, per heat lot, of aluminum material shall be made and tested in conformance with NASM 1312, test method 13. Raw material shear test certification may be accepted in lieu of test data.

4.5.2 Test Specimens: Test specimens shall consist of inserts installed in conformance with AS4724 in test blocks specified in 4.5.1 (see Figure 2).

4.5.3 Test Bolts: Bolts for use in all tests shall have Class 3A threads in conformance with AS8879.

4.5.3.1 Ultimate Tensile Strength of Test Bolts: Bolts used for tests specified in 3.8.1 and 3.8.3 shall have a minimum ultimate tensile strength of 200 ksi. No specific finish or material is required.

4.6 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 tensile strength, and stating that the parts conform to the other technical requirements. This report shall include the purchase order number, lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.7 Rejected Lots:

If a manufacturing lot is rejected, the vendor of parts may perform corrective action to screen out or rework the defective parts, and resubmit for acceptance tests inspection as in Table 7. Resubmitted lots shall be clearly identified as re-inspected lots.

5. PACKAGING:

5.1 Packaging shall be in accordance with ASTM D 3951.

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 not less than the following information:

FASTENERS, INSERT, SCREW THREAD, NON-LOCKING, LOCKED IN, KEY-LOCKED
AS4976
PART NUMBER
LOT 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 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.

6. ACKNOWLEDGMENT:

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 modifications authorized by the purchaser, will be subject to rejection.

8. NOTES:

8.1 Key Words:

Heavy duty insert, non-locking insert, locked in insert, locking keys, extra heavy duty insert, key locked insert

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

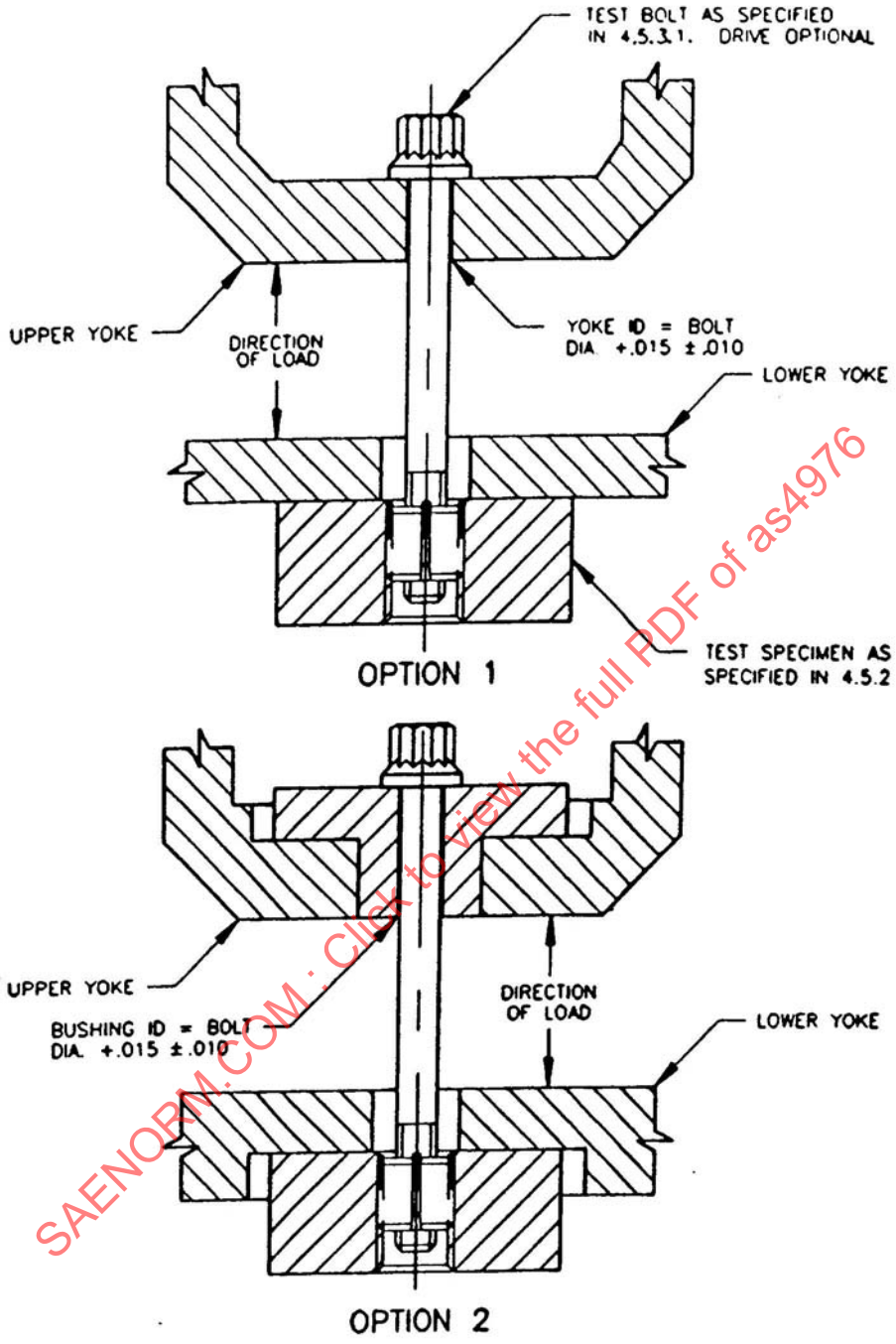
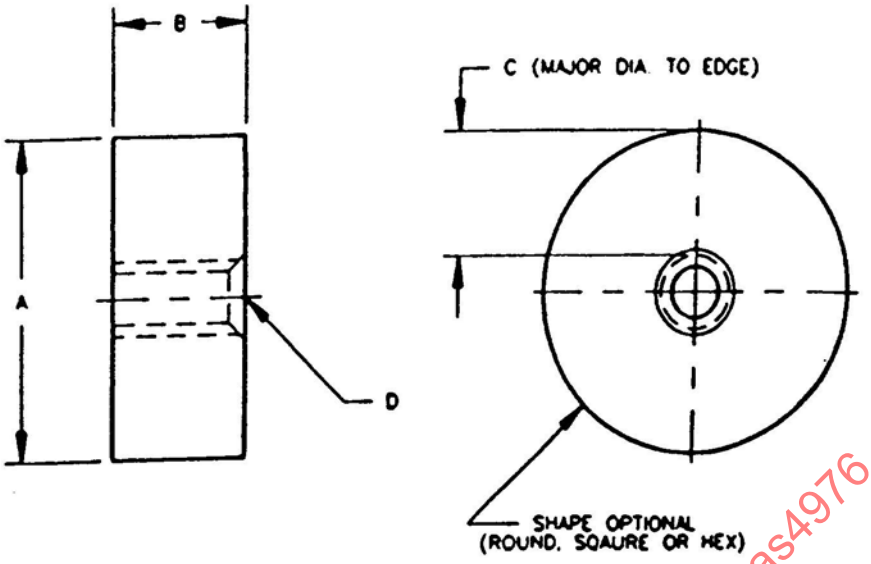


FIGURE 1 - Tensile and Pullout Fixture (Options)



Note 1. Dimensions:

A = To be 1.00", 2.00", 3.00" or larger, as required.
B = Length of applicable insert plus .063" minimum.
C = To be a minimum of 1/2 D.
D = Nominal external thread diameter of applicable insert tapped per AS4724.

Note 2. Material:

Aluminum Alloy, 2024-T4 or 2024-T351 per QQ-A-225/6 or QQ-A-250/4 (3.7.1)

Aluminum Alloy, 6061-T6 or 6061-T651 per QQ-A-225/8 or QQ-A250/11 (3.7.3)

FIGURE 2 - Test Block (Coupon)

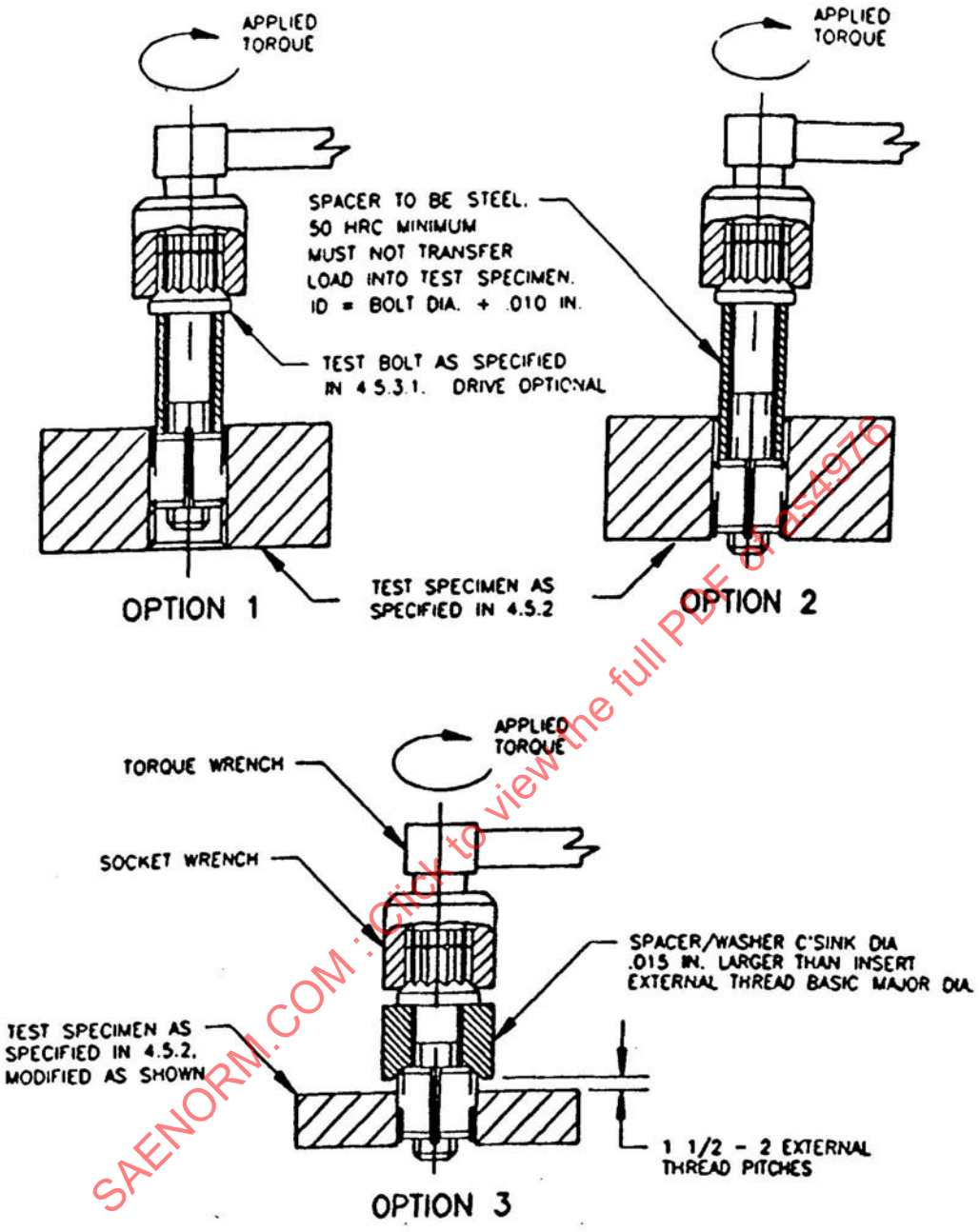


FIGURE 3 - Rotational Resistance Fixture (Options)

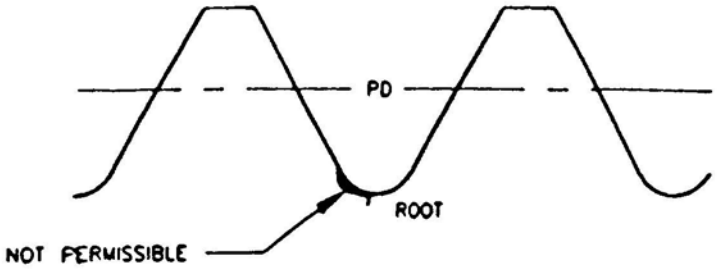


FIGURE 4 - Root Defects, Rolled Thread

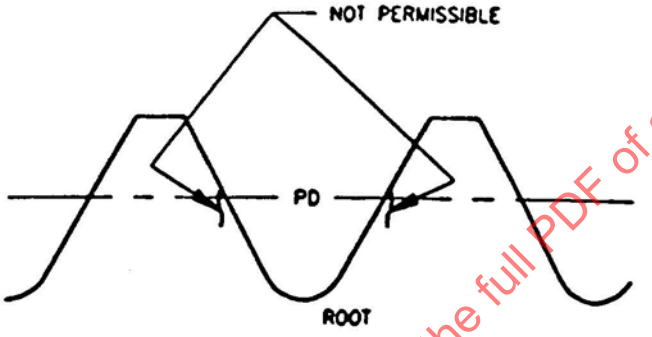


FIGURE 5 - Laps Below PD Extending Toward Root, Rolled Thread

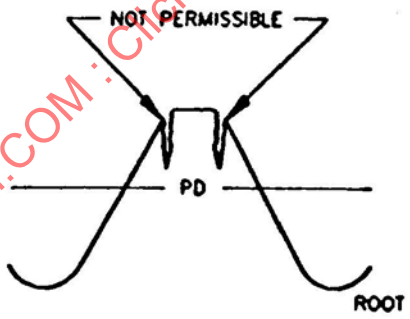


FIGURE 6 - Laps Above PD Extending Toward Root, Rolled Thread

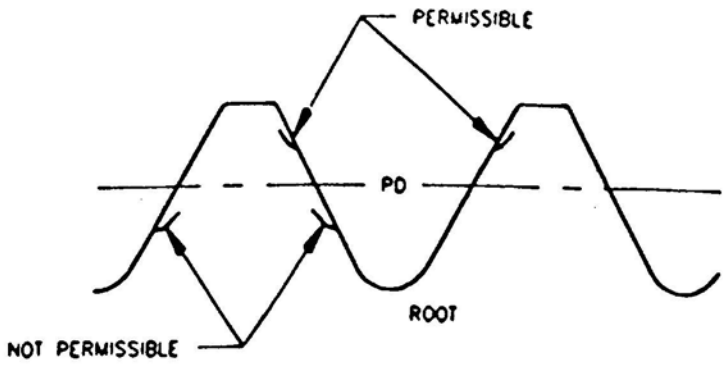
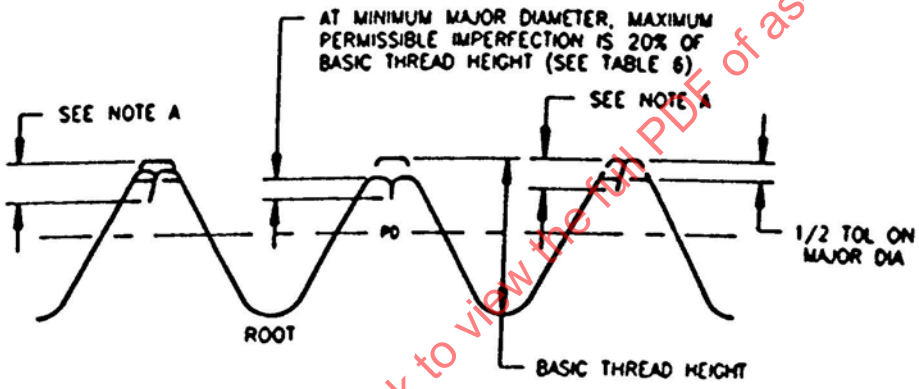


FIGURE 7 - Laps Extending Toward Crest, Rolled Thread



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

FIGURE 8 - Crest Craters and Crest Laps, Rolled Thread

TABLE 1 - Minimum Tensile Strength

Basic Internal Thread Size UNJF	Tensile Stress Area in^2	Inserts Per AS3572 Tensile Load - lbf	Inserts Per AS3573 Tensile Load - lbf
.1900	.0200	3 200	4 000
.2500	.0364	5 824	7 280
.3125	.0580	9 280	11 600
.3750	.0878	14 048	17 560
.4375	.1187	18 992	23 740
.5000	.1599	25 584	31 980
.5625	.2030	32 480	40 600
.6250	.2560	40 960	51 200
.7500	.3730	59 680	74 600
.8750	.5090	81 440	101 800
1.0000	.6630	106 080	132 600

Note 1. Area upon which stress for ultimate tensile strength test load requirements is based is calculated from the equation:

$$A = 0.7854 [D - (0.9743/n)]^2 \quad \text{(Eq.1)}$$

where:

A = area
D = basic major diameter
n = number of thread pitches per inch

Note 2. Tensile load for AS3572 inserts = Tensile stress area x 160 ksi (Eq.2)
Tensile load for AS3573 inserts = Tensile stress area x 200 ksi (Eq.3)

TABLE 2 - Resistance to Pullout for AS3572 Heavy-Duty Inserts

Basic Internal Thread Size	Minimum Shear Engagement Area in^2 (1)	Minimum Pullout Load lbf (2)
.1900	.1901	5 132
.2500	.2842	7 673
.3125	.3588	9 687
.3750	.4975	13 432
.4375	.7172	19 364
.5000	.8884	23 986
.5625	1.2493	33 731
.6250	1.4866	40 138
.7500	2.4901	67 232
.8750	3.1370	84 699
1.0000	3.8381	103 628

Note 1. Shear engagement area is an unassembled dimensional value measured parallel to the axis of the fastener for the overall engaged area of the mating thread member. It does not represent a dimension of either of the members in an unassembled condition.

Note 2. Pull-out load = Shear engagement area x 27 ksi (Eq.4)

To compute minimum pullout load in other materials, multiply shear engagement area by the applicable minimum ultimate shear strength of the material.

TABLE 3 - Resistance to Pullout for
AS3573 Extra Heavy-Duty Inserts

Basic Internal Thread Size	Minimum Shear Engagement Area in^2 (1)	Minimum Pullout Load lbf (2)
.1900	.2299	6 207
.2500	.2997	8 091
.3125	.4163	11 240
.3750	.5584	15 076
.4375	.8000	21 600
.5000	1.0293	27 791
.5625	1.3761	37 154
.6250	1.6420	44 334
.7500	2.7966	75 508
.8750	3.4652	93 560
1.0000	4.2374	114 409

Note 1. Shear engagement area is an unassembled dimensional value measured parallel to the axis of the fastener for the overall engaged area of the mating thread member. It does not represent a dimension of either of the members in an unassembled condition.

Note 2. Pull-out load = Shear engagement area x 27 ksi (Eq.5)

To compute minimum pullout load in other materials, multiply shear engagement area by the applicable minimum ultimate shear strength of the material.

TABLE 4 - Minimum Rotational Resistance Requirements

Basic Internal Thread Size	Inserts Per AS3572 Torque lbf·in	Inserts Per AS3573 Torque lbf·in
.1900	110	180
.2500	180	360
.3125	360	480
.3750	480	600
.4375	600	900
.5000	900	1200
.5625	1200	1800
.6250	1800	2400
.7500	2400	3600
.8750	3600	4800
1.0000	4800	6000