The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS3506

Issued 1995-12
Reaffirmed 2001-10

Insert - Screw Thread, Thin Wall, Self-Locking UNS N07718, Silver Plated, Class: 185 ksi/1025 °F, Procurement Specification

FSC 5340

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) establishes the requirements for AS3504 and AS3505 thin wall self-locking inserts made from a corrosion and heat resistant, age hardenable nickel base alloy of the type identified under the Unified Numbering System as UNS N07718.

1.1.1 Classification: Tensile strength at room temperature 185 ksi minimum. Maximum test temperature of parts 1025 °F.

1.1.2 The method of locking the insert into parent material to resist rotation to be by means of swaging the insert knurled collar into the prebroached knurl of the parent material.

1.2 Application:

Primarily for use in aircraft engines application up to approximately 1025 °F where an insert with a self-locking feature is required at elevated temperature, having excellent tensile strength and resistance to relaxation.

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 publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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

AMS 2411	Silver Plating, For High Temperature Applications
AMS 5662	Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings, and Rings
AS1310	Fastener Torque for Threaded Applications - Definitions of
AS3504	Insert, Thin Wall, Short, Self-Locking, 1025 °F, Silver Plated, UNS N07718, UNJ Thread
AS3505	Insert, Thin Wall, Long, Self-Locking, 1025 °F, Silver Plated, UNS N07718, UNJ Thread
AS3507	Insert, Thin Wall, Short and Long Length, Self-Locking, Installation and Removal of
AS3508	Insert, Thin Wall, Short and Long, Hole Preparation For

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

ANSI/ASME B46.1 Surface Texture

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

ASTM E 112	Test Methods for Determining the Average Grain Size
ASTM E 1417	Standard Practice for Liquid Penetrant Examination
ASTM D 3951	Practice for Commercial Packaging

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

MIL-STD-1312/6	Fastener Test Methods, Method 6, Hardness
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification for

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

ISO 2859 Sampling Procedure and Tables for Inspection by Attributes

2.2 Definitions:

The following terms used in this document are defined as follows:

2.2.1 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 supplier's inspection at the same time.

2.2.2 DISCONTINUITY: An interruption in the normal physical structure or surface configuration of the part such as a crack, seam, lap, or inclusions.

2.2.2.1 CRACK: A clean crystalline fracture passing through or across grain boundaries without inclusion of foreign elements. Cracks are normally caused by overstressing the metal during forging or forming, or during heat treatment.

2.2.2.2 SEAM: Open surface imperfection that is narrow and continuous, usually straight, running generally parallel to the insert axis. Seams are generally inherent in the bar from which the insert is made.

2.2.2.3 LAP: A surface imperfection appearing as a seam or crack, caused by folding of material during such operations as forming, rolling, or drawing.

2.2.2.4 INCLUSION: Nonmetallic particles inherent in the material when it was made. These particles may be isolated or distributed in the form of longitudinal stringers.

2.2.3 TEST TEMPERATURE: Ambient temperature, unless otherwise specified.

2.2.4 FINISHED INSERTS: An insert ready for use, inclusive of any possible treatments and/or surface coatings, as specified in the dimensional standard or definition document.

2.2.5 STANDARD PARTS DRAWING: Document specifying all the requirements for insert; i.e., metallurgical, geometrical and dimensional, functional (strength and temperature class).

2.2.6 Refer to AS1310 for definitions related to fastener torque.

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

The insert furnished under this document shall be a product which has been subjected to and successfully passed the qualification tests specified in Section 4 of this document.

3.2 Material:

Shall be Inconel 718 (UNS N07718) Corrosion and Heat Resistant Nickel Alloy per AMS 5662.

3.3 Design:

Finished insert shall conform to the following requirements:

3.3.1 Dimensions: The dimensions of finished inserts, after all processing including plating, shall conform to the standard part drawing.

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

3.3.3 Threads: Screw thread UNJ profile and dimensions as specified in MIL-S-8879 prior to the thread deformation for the self-locking feature, unless otherwise specified on the standard part drawing.

3.3.3.1 Incomplete Threads: Incomplete threads are permissible at the chamfered end of the inserts.

3.3.3.2 Chamfer: The entering point of the thread shall be chamfered as specified on the standard part drawing.

3.3.4 Geometric Tolerances: Insert feature shall be within the geometric tolerances specified on the standard part drawing.

3.4 Fabrication:

Inserts may be manufactured by machining or forming.

3.4.1 Heat Treatment: The heat treatment medium or atmosphere shall not cause any surface contamination. Any scale which will not be removed by subsequent machining shall be removed by abrasive blasting. After final heat treatment, the hardness shall be as specified on AS3504 and AS3505.

3.4.2 Solution and Precipitation Heat Treatment: The semi-finished blanks shall be solution treated at a temperature of 1775 °F ± 75 °F, holding at the selected temperature within ±25 °F for at least 1 h, then air cooling. The solution treated blanks shall be precipitation heat treated at a temperature of 1325 °F ± 10 °F, holding at heat for 8 h, then furnace cooling down to 1150 °F ± 10 °F with a rate of 100 °F ± 10 °F per hour, holding at the 1150 °F for 8 h followed by air cooling. Instead of the 100 °F ± 10 °F per hour cooling rate to 1150 °F, inserts may be furnace cooled at any rate provided the time at 1150 °F is adjusted to give a total precipitation time of 18 h ± 30 min.

3.4.3 Threads Forming: Threads may be produced either by machining, grinding, or fully formed by single rolling process. Threads in locking area may be displaced in any manner which enables the insert to meet the requirements of this document.

3.4.4 Surface Plating: All inserts shall be silver plated per AMS 2411, .0002 thickness minimum, or as specified on AS3504 and AS3505.

3.4.5 Surface Discontinuities: Prior to surface plating, insert shall be subjected to penetrant inspection per ASTM E 1417, Type I, Sensitivity Level 2. Insert showing discontinuities equal to or exceeding the limitations of Table 1 shall be rejected.

3.5 Performance:

The insert shall be capable of the performance requirements specified as follows:

3.5.1 Rotational Resistance: Insert shall be installed into test block shown in Figure 1 by the method given in AS3507.

The test block shall be tested with a counterclockwise rotational direction of the torque wrench as shown in Figure 2. The rotational resistance torque values shall not be less than those in Table 2.

3.5.2 Reusability:

3.5.2.1 Test bolt shall be of Inco 718 per AMS 5662, 180 ksi UTS minimum, lubricated with engine oil per MIL-L-7808 at each cycle. Test bolt threads shall be UNJ profile per MIL-S-8879 with maximum pitch diameter .0004 above the standard minimum pitch diameter.

3.5.2.2 Spacer shall be of Inco 718 per AMS 5662, 180 ksi UTS minimum, uncoated.

3.5.2.3 After testing, insert threads shall not show any indications of distortion, galling, or scratches of such depth as to prevent reassembly of the insert freely with the fingers up to the self-locking device.

3.5.2.4 Self-Locking Torque (15 Cycles, Unloaded) as Received:

a. Insert shall be installed into test block shown in Figure 1 by the method given in AS3507.

b. Bolt shall be seated on spacer located on top of the test block and tightened to the seating torque in Table 3, Column 5. The bolt shall be of sufficient length to extend beyond the locking feature a minimum of 2 pitches.

c. The self-locking torque shall be measured and recorded and shall not be less than the values specified in Table 3, Column 1 (cycles 1 to 15) or greater than the values specified in Table 3, Column 3 (cycles 2 to 15).

d. The breakaway torque shall be measured and recorded for each cycle on removal of the bolt and shall not be less than the values specified in Table 3, Column 1.

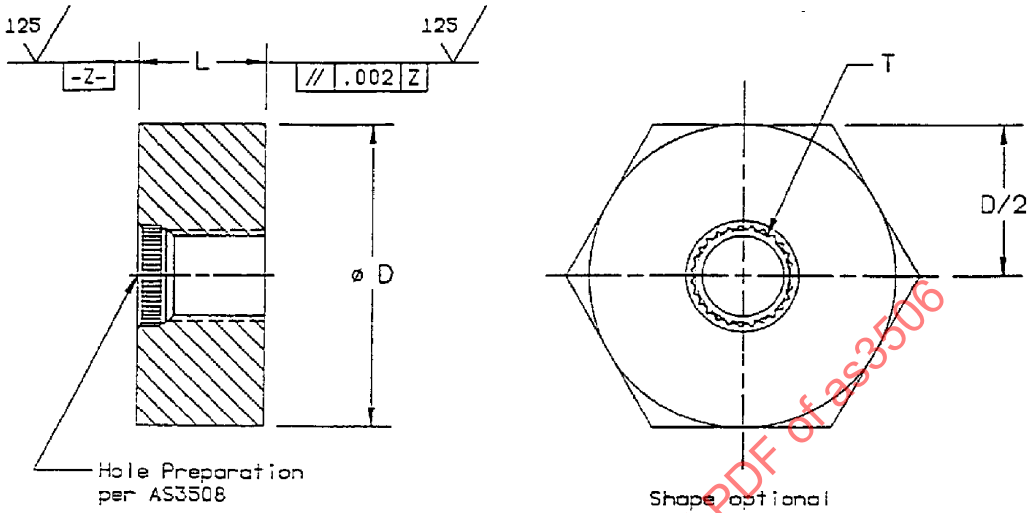
3.5.2.5 Self-Locking Torque (25 Cycles, Loaded, 1025 °F):

a. Insert shall be installed into test block shown in Figure 1 by the method given in AS3507.

b. The self-locking torque shall be measured and recorded and shall not be less than values specified in Table 3, Column 1 nor exceed values in Column 4.

c. Bolt shall be seated on spacer located on top of the test block and tightened to the seating torque specified in Table 3, Column 5.

d. Heat the assembly in furnace at 1025 °F ± 10 °F and hold at this temperature for 6 h ±15 min.



NOTES:
1. Material: INCO 718 per AMS 5662, 180 KSI UTS min.
2. Dimensions:
   T = Nominal diameter of insert external thread
   D = 4 x T
   L = Insert length

FIGURE 1 - Test Block

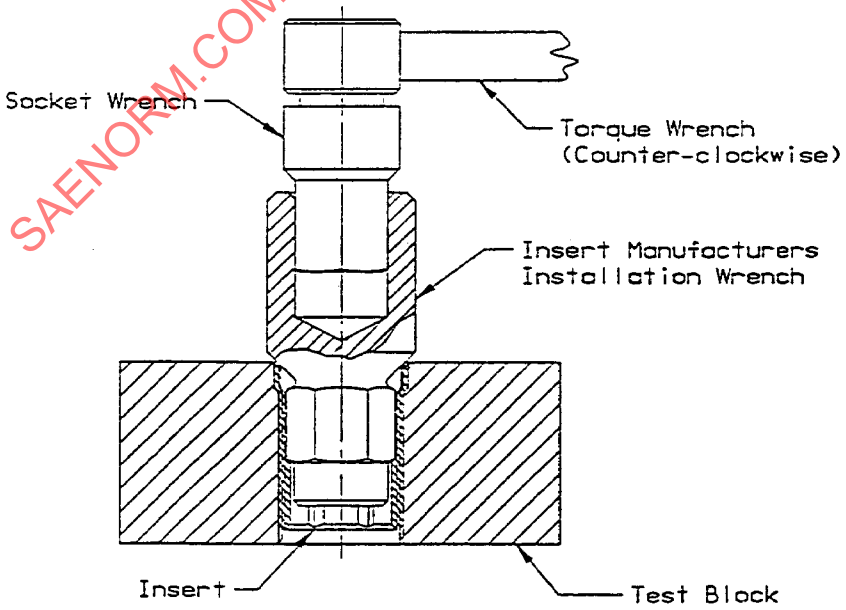


FIGURE 2 - Rotational Resistance Test Fixture

TABLE 1 - Maximum Depth of Permissible Discontinuities

Insert-Short Identification Number	Insert-Long Identification Number	Insert Internal Thread, Ref	Depth in
AS3504-01	AS3505-01	.1900-32	.0047
AS3504-02	AS3505-02	.2500-28	.0051
AS3504-03	AS3505-03	.3125-24	.0051
AS3504-04	AS3505-04	.3750-24	.0059
AS3504-05	AS3505-05	.4375-20	.0059
AS3504-06	AS3505-06	.5000-20	.0059

TABLE 2 - Torque Values for Rotational Resistance Test

Insert-Short Identification Number	Insert-Long Identification Number	Insert Internal Thread, Ref	Rotational Resistance Minimum lbf.in
AS3504-01	AS3505-01	.1900-32	75
AS3504-02	AS3505-02	.2500-28	120
AS3504-03	AS3505-03	.3125-24	200
AS3504-04	AS3505-04	.3750-24	260
AS3504-05	AS3505-05	.4375-20	350
AS3504-06	AS3505-06	.5000-20	450

TABLE 3 - Values for Breakaway Torque, Self-Locking Torque, and Seating Torque

Insert-Short Identification Number	Insert-Long Identification Number	Insert Internal Thread, Ref	Breakaway Torque and Self-Locking Torque Minimum lbf.in (1)	Breakaway Torque and Self-Locking Torque Minimum lbf.in 2(a)	Breakaway Torque and Self-Locking Torque Minimum lbf.in 2(b)	Breakaway Torque and Self-Locking Torque Minimum lbf.in 2(c)	Self-Locking Torque Maximum lbf.in (3)	Self-Locking Torque Maximum lbf.in (4)	Seating Torque lbf.in (5)
AS3504-01	AS3505-01	.1900-32	2.2	5.0	3.9	2.7	15.0	30.0	55.0
AS3504-02	AS3505-02	.2500-28	3.5	8.0	6.2	4.4	30.0	60.0	135.0
AS3504-03	AS3505-03	.3125-24	6.6	15.0	11.5	8.4	60.0	120.0	285.0
AS3504-04	AS3505-04	.3750-24	9.7	22.0	17.3	11.9	80.0	160.0	495.0
AS3504-05	AS3505-05	.4375-20	14.2	32.0	24.8	16.8	100.0	200.0	670.0
AS3504-06	AS3505-06	.5000-20	18.6	40.0	31.0	22.1	150.0	300.0	1070.0

NOTES:

(1) Minimum self-locking torque and breakaway torque for 15 cycles (as received) test and 25 cycles after 1025 °F bake test.
(2a) Minimum self-locking torque and breakaway torque for first cycle of 3 cycles test.
(2b) Minimum self-locking torque and breakaway torque for second cycle of 3 cycles test.
(2c) Minimum self-locking torque and breakaway torque for third cycle of 3 cycles test.
(3) Maximum self-locking torque for 15 cycles as received test and cycles 2 and 3 of 3 cycles test.
(4) Maximum self-locking torque for 25 cycles after 1025 °F bake test.
(5) Seating torque for 15, 25 cycles and 3 cycles tests.

3.5.2.5 (Continued):

e. Remove the assembly from furnace and cool to ambient temperature.

f. Release load by unscrewing 1/2 turn of bolt.

g. Then continue to unscrew to measure and record the breakaway torque, which shall not be less than value specified in Table 3, Column 1.

h. Remove the bolt from the insert.

The above procedure shall be repeated until 25 cycles have been completed.

3.5.2.6 Self-Locking Torque (3 Cycles) as Received:

a. Insert shall be installed into test block shown in Figure 1 by the method given in AS3507.

b. The self-locking torque shall be measured and recorded and shall not be less than values specified in Table 3, Column 2a, 2b, and 2c (cycles 1 to 3) nor greater than the values specified in Table 3, Column 3.

c. Bolt shall be seated on spacer located on top of the test block and tightened to the seating torque specified in Table 3, Column 5 (cycles 2 and 3).

d. Unscrew the bolt and measure and record the breakaway torque for each cycle. Torque values shall not be less than those specified in Table 3, Column 2a, 2b, and 2c (cycles 1 to 3).

3.6 Marking:

Each insert shall be identification marked as specified by the standard part drawing. Unless otherwise specified, the markings may be formed by stamping or machining, raised or depressed .015 maximum.

3.7 Workmanship:

Insert 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 performances.

3.7.1 Microscopic Examination: Specimen cut from insert shall be polished and etched in a suitable etchant, and examined at 100X magnification minimum to determine conformance to the following requirements:

3.7.1.1 Microstructure: Insert shall have microstructure of completely recrystallized material prior to thread deformation.

3.7.1.2 Grain Size: Grain size shall be 5 or finer as determined by comparison of the specimen with the chart in ASTM E 112. Isolated grains not exceeding a mean diameter or .009 are acceptable.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all test and inspection requirements as specified herein. Except as otherwise specified, the supplier may use his/her or any commercial laboratory acceptable to the purchaser. The purchaser reserves the right to perform any inspection set forth in the document whenever it is deemed necessary to assure that the insert conforms to prescribed requirements.

4.2 Responsibility for Compliance:

The manufacturer's system for insert 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., statistics process control - SPC) shall be established, subject to the approval of the purchaser, and used during production of inserts.

4.3 Classification of Tests:

The inspection or test requirements specified herein are classified as follows:

4.3.1 Qualification Tests: Tests (or inspection) to determine conformance to all technical requirements of this document and applicable standard part drawing are classified as qualification tests and shall be performed on the first production inspection lot of product scheduled for a purchaser, and when purchaser deems confirmatory testing to be required due to changes in material or processing. See Table 4.

4.3.2 Acceptance Tests: Tests (or inspection) to determine conformance to requirements for hardness, microstructure, grain size, plating, dimensions, material identification, threads, product identification, three cycle locking feature test, surface texture, surface discontinuities, package marking, and packaging shall be performed on each production lot. See Table 4.

4.4 Sampling:

Shall be in accordance with the following:

4.4.1 Acceptance Tests: Acceptance tests shall be performed on each production inspection lot.

4.4.1.1 Nondestructive Tests, Visual and Dimensional: A random sample shall be selected from each production inspection lot, the size of the sample to be as specified in Tables 5 and 6.

TABLE 4 - Summary of Tests - Qualification and Production Acceptance

Characteristic	Qualification Required Paragraph	Qualification Sample Size	Production Acceptance Required Paragraph	Production Acceptance Sample Size	Test Method
Dimensions, tolerances of form and position, thread gauging and quality	3.3.1	10	3.3.1	Tables 5 and 6	Conventional measuring methods
Surface Texture	3.3.2	3	3.3.2	Tables 5 and 6	ANSI/ASME B46.1
Surface plating	3.4.4	3	3.4.4	Tables 5 and 6	AMS 2411
Rotational resistance	3.5.1	5			3.5.1
Reusability:					
15 cycles "as received"	3.5.2.4	10			3.5.2.4
25 cycles after 1025 °F bake	3.5.2.5	10			3.5.2.5
3 cycles "as received"			3.5.2.6	Table 7 Col B	3.5.2.6
Hardness	3.4.1	5	3.4.1	Table 7 Col A	MIL-STD-1312, Test 6
Microstructure	3.7.1.1	2	3.7.1.1	Table 7 Col B	Microscopic Examination X100
Grain size	3.7.1.2	2	3.7.1.2	Table 7 Col B	ASTM E 112
Surface discontinuities	3.4.5	3	3.4.5	Penetrant Tables 5 and 6	ASTM E 1417, Type I, Sensitivity Level 2
				Microstructure Table 7 Col B	Microscopic examination X100
Material identification	3.2	33	3.2	100%	3.2
Product identification	5.1	33	5.1	Table 6	Visual examination
Delivery, packaging and labeling			5.1	100%	Visual examination

TABLE 5 - Classification of Defects

Category No.	AQL	Characteristic
Major 'A'		
101	0.065%	Presence of locking element
102		Fluorescent penetrant inspection
Major 'B'		
201	1.0%	Thread size
202		Coating
203		Depth of counterbore
204		Serrations
205		Surface texture
Minor 'A'		
301	2.5%	Burrs and sharp corners
Minor 'B'		
401	4.0%	Other dimensional characteristics not listed above

TABLE 6 - Sampling Plans for Visual Inspections and Dimensional Characteristics

Batch Size	Sample Size	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable AQL Ac	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable 0.065% LQ %	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable AQL Ac	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable 1% LQ %	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable AQL Ac	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable 2.5% LQ %	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable AQL Ac	Acceptance Number (Ac) and Limiting Quality (LQ) in Accordance with the Acceptable 4% LQ %
51 to 90	13	0	1.2	0	16	1	18	1	27
91 to 150	20	0	1.2	0	16	1	18	2	25
151 to 280	32	0	1.2	1	7.6	2	16	3	20
281 to 500	50	0	1.2	1	7.6	3	13	5	18
501 to 1 200	80	0	1.2	2	6.5	5	11	7	14
1 201 to 3 200	125	0	1.2	3	5.4	7	9.4	10	12
3 201 to 10 000	200	0	1.2	5	4.6	10	7.7	14	10
10 001 to 35 000	315	0	1.2	7	3.7	14	6.4	21	9
35 001 to 150 000	500	1	0.5	10	3.1	21	5.6	21	9
150 001 to 500 000	800	1	0.5	14	2.5	21	5.6	21	9

NOTE:

The data given in Table 6 are based on single sampling plans for a standard inspection, as specified in ISO 2859/1 (Tables 2-A and 6-A). A 100% inspection should be performed when the sample size is as large or larger than the batch size.

As regards those manufacturers who carry out an inspection during the manufacturing process (inspection on a machine and/or inspection between operations), the sampling plan for the final inspection shall be in such a way that the overall inspection plan shall guarantee an equivalent quality level.