



Standard; 101 Aero Version- Exploring the World of Aerospace and Defense Fastener Standard;


Created for:
Industrial Fastener Institute
Member Only Training- Release 2.1 2026

For further technical
information and assistance
contact techinfo@indfast.org

Copyright 2026- NNI Training and Consulting

1

1




Part 1: Introduction- What Would the World Look Like Without Standards?

Copyright 2026- NNI Training and Consulting



8

8



What are common examples of standardization?

- Language
- Currency
- DNA (Genetic code)
- Measurement units and systems
- Industrial Standards
 - Threads
 - Beta versus VHS
 - Operating systems
 - Cell phone formats

Copyright 2026- NNI Training and Consulting

9

9



What do standards provide?

- Order
- Instruction
- Commonality
- Consistency



Copyright 2026- NNI Training and Consulting

10

10



What do aerospace fastener standards provide to customers?

- A system where they know what they are purchasing
- A system where they can order parts from multiple suppliers with confidence that they are going to receive the same part
- A system where multiple customers can purchase the same part without having to invest in new design activities



Copyright 2026- NNI Training and Consulting

(11)

11



History of Standardization

Copyright 2026- NNI Training and Consulting

(12)

12



History of Fastener Standardization

- Fasteners are known to exist in antiquity
 - Ancient Egypt
 - Ancient Assyria
- Screws and nails became commonplace in the Middle Ages
 - Clocks
 - Armor
 - Weapons
- All fasteners are handmade by craftsmen
 - Unique
 - No interchangeability




Example of Middle Ages Fasteners

Copyright 2026- NNI Training and Consulting


13

13



History of Fastener Standardization- Joseph Whitworth

- Early 1800's railroad development gathering steam
- Steam engines had many fasteners but lack of commonality between manufacturers plagued the industry and caused problems every time a screw needed replacement
- 1840 Sir Joseph Whitworth surveyed screw and bolt manufacturers
 - Discovered product was generally interchangeable from the same manufacturer
 - Discovered that product was NOT interchangeable between manufacturers
- 1841 Presented his paper "A Uniform System of Screw Threads" to Great Britain's Institution of Civil Engineers creating the first standardized thread



Copyright 2026- NNI Training and Consulting

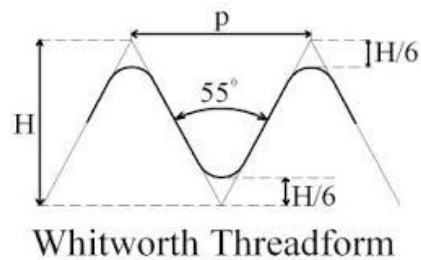
14

14



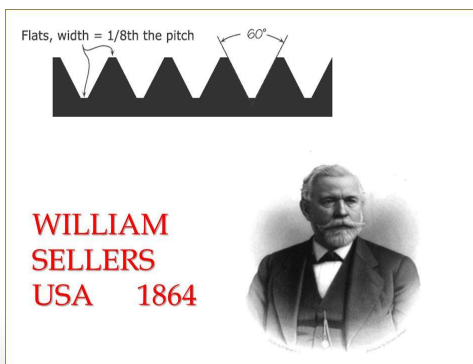
History of Fastener Standardization- Joseph Whitworth

- Whitworth Thread
 - 55° thread profile
 - Radius at top and bottom equal to 1/6 of the thread depth



History of Fastener Standardization- William Sellers

- 1864-William Sellers proposes an American Standard
 - 60° thread profile
 - Flat top and bottom
 - 1/8 pitch truncation of top and bottom



Adopted in US about
1868 as the National
Standard

Adopted in Europe in
1898



War Time Dilemma

- Lack of interchangeability arose between Allies in WWI
 - US- Sellers Thread
 - Britain- Whitworth Thread
 - Field repairs were exceptionally problematic
- 1918- National Screw Thread Commission to address thread standardization issues. Disbanded before reaching any international agreements
- Outbreak of WWII raised the lack of a unified international standard to even greater levels than in WWI
 - US providing much of Britain's war machine
 - Eventually adopted "American War Standard for Screw Threads of Truncated Whitworth Form"



M4 Tank, HQ Company, 37th Tank Battalion, 4th Armored Division, Lorraine, September 1944

Copyright 2026- NNI Training and Consulting

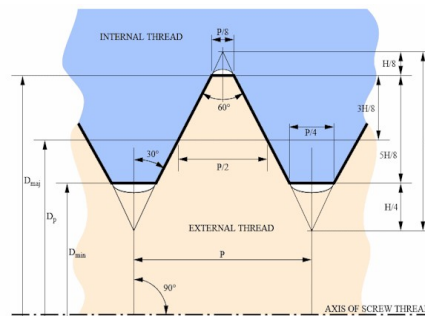
17

17



Unification After WWII

- 1945- Agreement made to use 60° thread and most of the sizes and pitches of the Sellers Coarse and Fine Series
- 1948- Declaration of Accord with Respect to the Unification of Screw Threads
 - Combined best features of Whitworth and Sellers
 - Added radius in roots for highly stressed applications



Result was the Unified Thread Series

Copyright 2026- NNI Training and Consulting

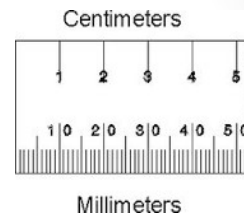
18

18



Metric Standards

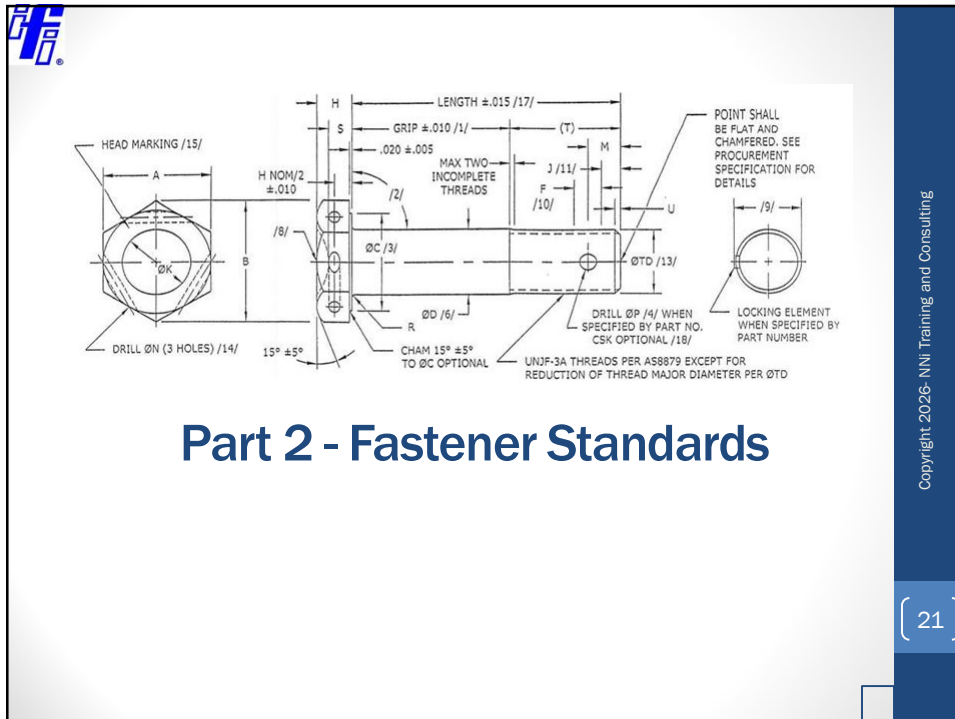
- Work on metric thread standards began in 1948
- In 1964 ISO reached agreement on ISO Inch and ISO Metric threads.
 - ISO Inch was same as Unified and eventually dropped
- In 1980s US standards organizations starting creating US metric standards
 - Many of these were near equivalents to an ISO Standard
- In the last 7 or 8 years the primary US fastener standards organizations have been withdrawing their metric fastener standards in favor of ISO standards
 - Where no ISO equivalent exists, they have been maintaining these standards



Aerospace Standards

- 18th and 19th Centuries- US and French armies were early adopters and advocates of interchangeability and standardization
- 1918 Congress passed a law establishing the "National Screw Thread Commission"
- By WWII Allied nations were standardizing and cataloging parts
 - US AN Standards (Army-Navy Standards)
 - British DEF-STAN Standards (British Defense Standards)
- NASC began developing Standards in 1941
- 1994 "Perry Memorandum" encouraged "deregulation" of Military Standards and many of these were canceled and transferred to other organizations like NASC and SAE.





Part 2 - Fastener Standards

Copyright 2026- NNI Training and Consulting

21

21

What are Fastener Standards?

- **Fastener standards** are documents created by an organization that contain information regarding:
 - Dimensional characteristics
 - Mechanical properties
 - Materials to use
 - Testing to conduct
 - Other specified information
- Standards provide a consistent framework to gauge product and/or performance against.

Copyright 2026- NNI Training and Consulting

22

22



What is a Consensus Standard?

- **Consensus Standard** - A standard that has been developed by a Consensus Standard Organization utilizing a process that seeks to gain the input and consensus of a variety of independent industry experts



What is a Non-Consensus Standard?

- **Non-Consensus Standard (Company Standard/Proprietary Standard)**- A standard developed for a more limited use, like a specific company or its suppliers, that is NOT governed by a Consensus Standards Organization and does not utilize a consensus development process.

	WORLDWIDE ENGINEERING STANDARDS	Material Specification Fasteners	GMW25		
Mechanical Properties and Material Requirements for Externally Threaded Fasteners					
<p>1 Scope This specification specifies the mechanical properties and material requirements for externally threaded fasteners in nominal thread diameters of M39 in addition to the other specified details in G33 399 (1998). This specification is based upon ISO 888-1 but it (GMW25) does not include 8.8, 12.9 and 12.9 property classes of ISO 888-1.</p> <p>1.1 Material Description: Table 1 specifies details for different property classes of fasteners covered by this standard.</p> <p>1.2 Cross-Reference of Related Specifications:</p> <table border="1"> <tr> <td>10000</td> <td>10000A</td> </tr> </table>		10000	10000A	<p>mechanical composition requirements specified in Table 1.</p> <p>1.1.2 Mechanical Requirements: Bolt, screw and stud shall meet the mechanical property and physical requirements specified for that product in Table 2 when applied per ISO 888-1. However, those special head bolts and screws with special configurations, such as rolled heads, which make the heads weaker than the threaded section, and short bolt/screw length greater than 2.0 (diameter) shall be excluded from tensile testing unless otherwise specified on the part drawing.</p> <p>1.1.2.1 Mechanical and Physical Properties Test Requirements: Test (2) test programs, A and B, for mechanical and physical properties of bolts.</p>	
10000	10000A				



Why is a Consensus Standard Better?

- Created by diverse group of experts
- Process to achieve consensus
- Bound by strict By-Laws that dictate rigid balloting procedures
- Can lead the way



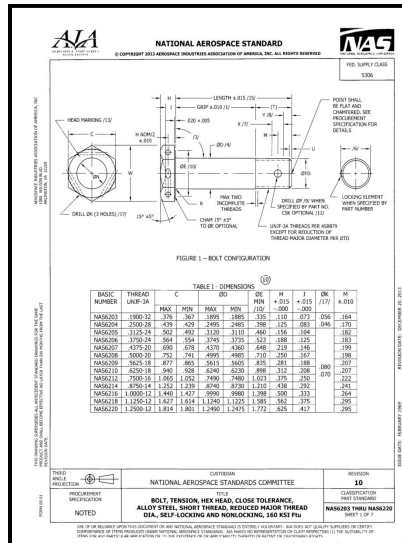
Copyright 2026- Nni Training and Consulting

25




5 Primary Types of Fastener Standards

- Product Standards
- Material Standards
- Testing Standards
- Procurement Standards
- System Standards



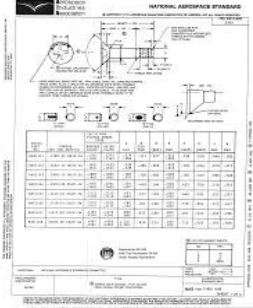
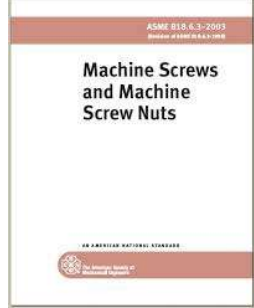
Copyright 2026- Nni Training and Consulting

26



Terminology


- **Product (Dimensional) Standard:** A standard that has been developed to describe all that is needed to know about a product.
 - In US:
 - Aerospace: NAS, NASM, NA, NAM, AN, MS, AS, AMS
 - Industrial: ASME

Copyright 2026- NNI Training and Consulting

27

27



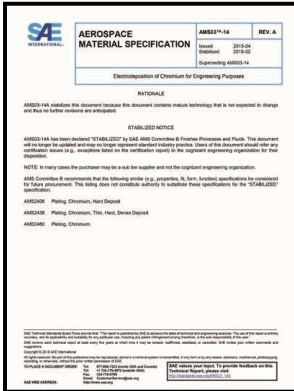
Terminology

- **Material Standard:** A standard that clearly defines the properties and desired performance criteria of specific materials
 - In US:
 - Aerospace: SAE AMS Standards
 - Industrial: ASTM, SAE, ISO

Copyright 2026- NNI Training and Consulting

28

28



SAE AEROSPACE MATERIAL SPECIFICATION

AMS2774-04	REV. A
Issued: 2016-02	
Revised: 2016-02	
Engineering Activity No.	

Electrodeposition of Chromium for Engineering Purposes

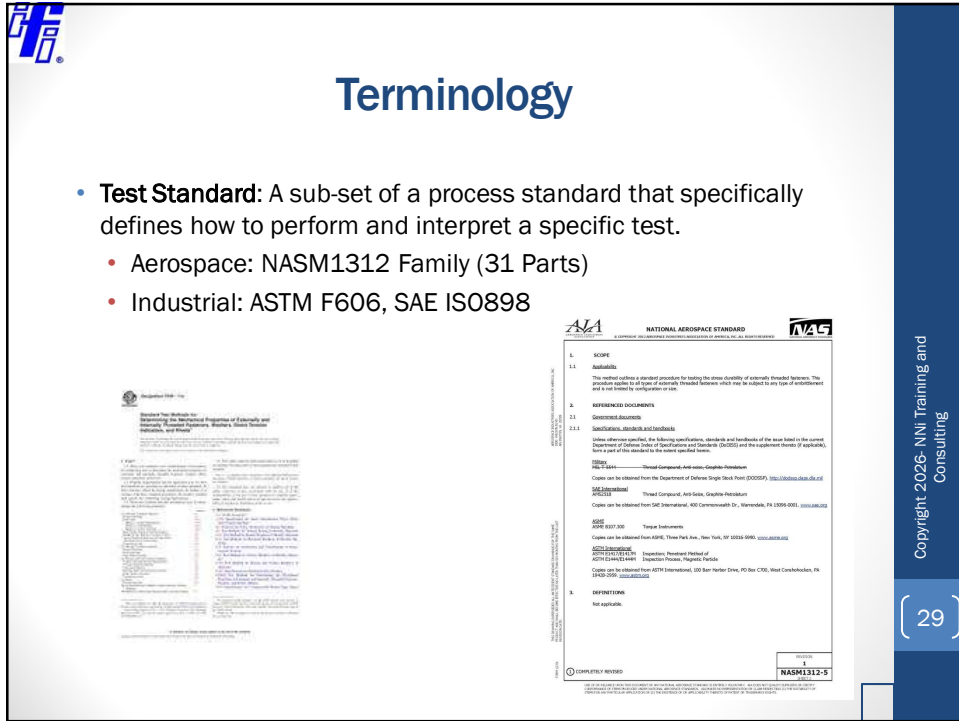
RATIONALE
AMS2774-04 certifies this document because this document contains mature technology that is not expected to change and thus has sufficient evidence and acceptance.

STABILIZED NOTICE
AMS2774-04 has been declared "STABILIZED" by SAE AMS Committee B Finalize Processes and Plans. This document will no longer be updated and there may be minor updates to the title page. Users of this document should refer any confirmation issues (e.g., inclusion based on the certification report) to the cognate engineering organization for final disposition.

NOTE: In many cases the purchaser may be a sub for supplier and not the cognate engineering organization.


AMS Committee B recommends that the following order (e.g., properties, M, Form, finish) specifications be incorporated in the procurement. The following are not intended to be included in the procurement specifications for the "STABILIZED" condition.

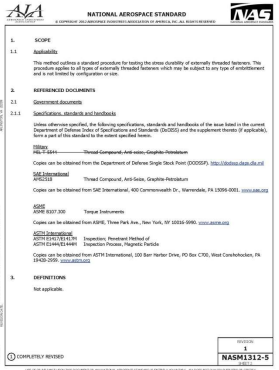
AMS2774-04 Plating, Chromium, Hard Deposit
AMS2774-04 Plating, Chromium, Thin, Hard, Dense Deposit
AMS2774-04 Plating, Chromium



Terminology

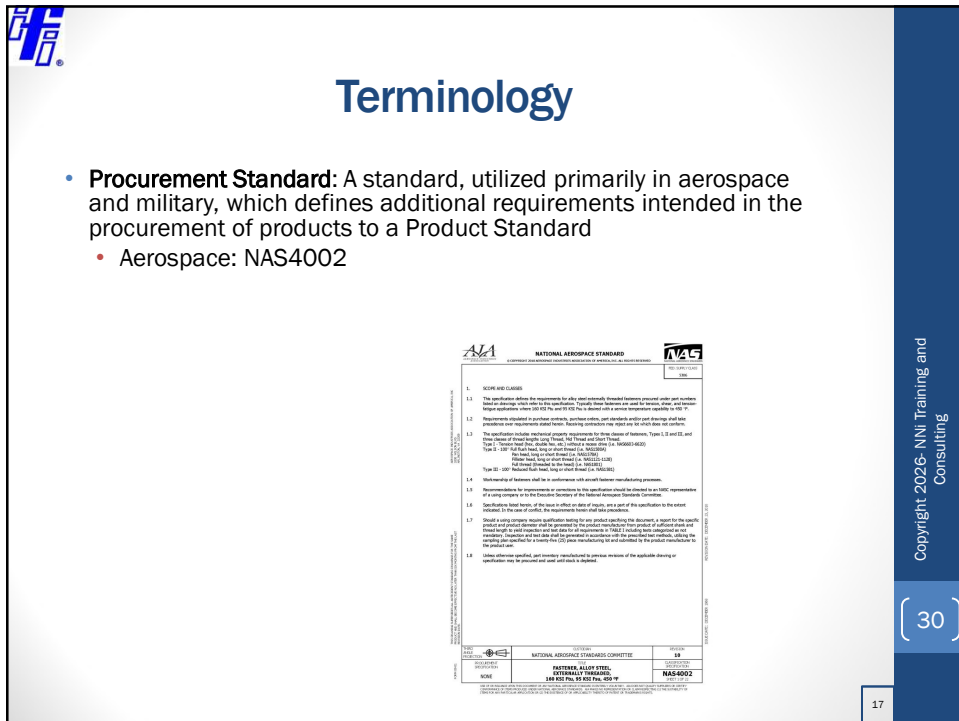
- **Test Standard:** A sub-set of a process standard that specifically defines how to perform and interpret a specific test.
 - Aerospace: NASM1312 Family (31 Parts)
 - Industrial: ASTM F606, SAE ISO898





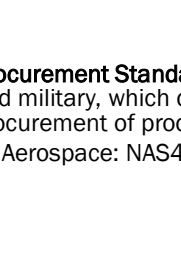
Copyright 2026- NNI Training and Consulting

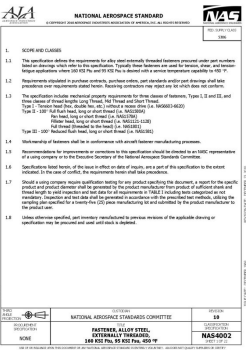
29



Terminology


- **Procurement Standard:** A standard, utilized primarily in aerospace and military, which defines additional requirements intended in the procurement of products to a Product Standard
 - Aerospace: NAS4002





Copyright 2026- NNI Training and Consulting

30



Terminology

- **System Standard:** A standard that describes the requirement of an entire system, such as a Quality Management System
- Aerospace: AS9100, AS9120
- Industrial: ISO9001, IATF 16949

SAE INTERNATIONAL AEROSPACE STANDARD	AS9100™	REV. D
	Issued 1998-11	
	Revised 2016-09	
	Superseding AS9100C	
	Technically equivalent settings indicated in all ISO2 sectors.	
(P) Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations		

RATIONALE

This standard has been revised to incorporate the new clause structure and content of ISO 9001:2015. In addition, industry requirements, definitions, and notes have been revised in response to both ISO 9001 revisions and stakeholder needs.

FOREWORD

To assure customer satisfaction, aviation, space, and defense organizations must provide, and continually improve, safe and reliable products and services that meet or exceed customer and applicable statutory and regulatory requirements. The globalization of the industry and the resulting diversity of regional and national requirements and expectations have complicated this objective. Organizations face the challenge of purchasing products and services from external providers throughout the world and at all levels of the supply chain. External providers face the challenge of delivering products and services to multiple customers having varying quality requirements and expectations.

Industry has established the International Aerospace Quality Group (IAQG), with representatives from aviation, space, and defense companies in the Americas, Asia/Pacific, and Europe, to implement initiatives that make significant improvements in quality and reductions in cost throughout the value stream. This standard has been prepared by the IAQG.

This document standardizes quality management system requirements to the greatest extent possible and can be used at all levels of the supply chain by organizations around the world. Its use should result in improved quality, cost, and delivery performance through the reduction or elimination of organization-unique requirements, effective implementation of the quality management system, and better application of good practices. While primarily developed for the aviation, space, and defense industry, this standard can also be used in other industry sectors where a quality management system with additional requirements over an ISO 9001 system is needed.

This standard includes ISO 9001:2015 quality management system requirements and specifies additional aviation, space, and defense industry requirements, definitions, and notes as shown in bold, italic text.

With the permission of the International Organization for Standardization (ISO), the complete ISO 9001 standard can be obtained from any ISO member or from the ISO Central Secretariat, 1, rue de Van Clieff, Case postale 56, CH-1211 Geneva 20, SWITZERLAND, or sold on-line using Copyright services with ISO.

SAE International Standards Institute (SAE) provides this "Terminology" as a reference to SAE to enhance the state of technical and engineering education. The use of this report in other publications, which is prohibited and subject to any applicable laws, without the prior permission of SAE, is strictly prohibited. If you need a technical report or other SAE publication, please contact SAE at the address below.

Copyright © 2016 SAE International
All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7326 (toll free in USA and Canada) / 724-776-4844 (outside USA) Fax: 724-776-0001 Email: CustomerSupport@sae.org

SAE welcomes your input. To provide feedback on this Technical Report, please visit: <http://www.sae.org/standards/submit-feedback>

Copyright 2026- NNI Training and Consulting

31

17



US Fastener Consensus Standards Organizations (CSO)

- Aerospace:
 - AIA NASC (National Aerospace Standards Committee)
 - SAE International
- Industrial:
 - American Society of Mechanical Engineers (ASME)
 - American Society for Testing and Materials (ASTM)
 - The Society of Automotive Engineers (SAE)
 - Industrial Fasteners Institute (IFI)
 - Research Council on Structural Connections (RCSC)

Copyright 2026- NNI Training and Consulting

32



AIA NASC

- AIA NASC:
- Items Covered:
 - NAS Parts (Mainly airframe fasteners and components)
 - Safety management Systems
 - Nondestructive Test Personnel Certification
 - Hazardous Materials Management
 - Foreign Object Debris (FOD) Prevention
 - Cutting Tools
 - Airport Operations
 - Trade Compliance Standards
- Fastener TC is NASC
 - Main Committee
 - Steering Committee
 - Task Groups
- Oversight Committee
 - Oversees the process
 - Makes sure standards are released within Guidelines
- Serves as Secretariat for ISO TC 20 (Aircraft and Space Vehicles)




Copyright 2026- NNI Training and Consulting

33

33



ASME Fastener Related Committees

- B18- Fasteners
 - SC1- Solid Rivets
 - SC2- Externally Driven Fasteners
 - SC3- Socket Head, Cap, and Set Screws
 - SC4- US TAG to ISO/TC2 International Liaison
 - SC6- Recessed Head Screws
 - SC7- Tubular and Split Rivets
 - SC8- Machine Pins
 - SC12- Glossary of Terms
 - SC13- SEMS
 - SC16- Nuts
 - SC18- Inspection and Quality Assurance for Fasteners
 - SC20- Self Locking Screws
 - SC24- Industry/Government Liaison
 - SC27- Retaining Rings and Retaining Clips
 - SC29- Threaded Inserts
 - SC30- Blind Fasteners
 - SC31- Studs, Lifting Eyes, and Bent Bolts
- B1- Screw Threads



Copyright 2026- NNI Training and Consulting

34

34



ASTM Fastener Related Committees

- ASTM Example
- Technical Committees
 - ~160 Different TCs
 - ~12000 Standards
 - ~31000 Volunteers
- Fastener TC is F16
 - Main Committee
 - Multiple Sub-Committees
 - Task Groups
- Committee on Standards
 - Oversees the process
 - Makes sure standards are released to ASTM By-Laws



Copyright 2026- NNI Training and Consulting

35

35



ASTM Fastener Related Committees

- F16- Fasteners
 - F16.01 Test Methods
 - F16.02 Steel Bolts, Nuts, Rivets and Washers
 - F16.03 Coatings on Fasteners
 - F16.04 Nonferrous Fasteners
 - F16.05 Driven and Other Fasteners
 - F16.90 Executive
 - F16.91 Editorial
 - F16.93 Quality Assurance Provisions for Fasteners
 - F16.95 Long Range Planning
 - F16.96 Bolting Technology
 - F16.97 Coordination with North American TAGs to ISO TC 2 on Fasteners
- A01- Steel, Stainless Steel, and Related Alloys
- B08- Metallic and Inorganic Coatings
- E07- Non-Destructive Testing
- E28- Mechanical Testing
- F07- Aerospace and Aircraft
- G01- Corrosion of Metals



Copyright 2026- NNI Training and Consulting

36

36



ASTM Fastener Related Committees

- F07- Aerospace and Aircraft
 - F07.04 Hydrogen Embrittlement
 - F07.07 Qualification Testing of Aircraft Cleaning Materials
 - F07.08 Transparent Enclosure and Materials
 - F07.90 Executive



Copyright 2026- NNI Training and Consulting

37

37



SAE Fastener Related Committees

- SAE Fastener Committee
- SAE Ship Systems Committee
- Aerospace Materials Division is responsible for AMS (Aerospace Material Specifications)
 - Metals Group
 - Non-Destructive Testing Group
 - Non-metals Group
 - SAE E-25 (Engine and Accessories)
 - SAE G-3 (Fluid System Components)
- National Aerospace and Defense Contractors Accreditation Program (NADCAP)
 - AS7113- NADCAP Requirements for Fastener Manufacturing
 - Special Processes (Heat Treat, Plating, NDT...)
- Performance Review Institute (PRI)
 - Established to accredit companies to NADCAP certifications
 - Founded in 1990 by SAE



Copyright 2026- NNI Training and Consulting

38

38



Other Fastener Related Committees

- Industrial Fasteners Institute
 - IFI Standards
 - Inch Fastener Standards Book
- Research Council on Structural Connections (RCSC)
 - *Specification for Structural Joints Using High Strength Bolts*
- National Association of Corrosion Engineers (NACE)
 - NACE02107
 - NACE 11164
 - NACE MR0175
- American Petroleum Institute
 - API 6A
 - API 20E






Copyright 2026- NNI Training and Consulting

39

39



The Most Common International Fastener Consensus Standards Organizations (CSO)

- International Organization for Standardization (ISO)
- Deutsches Institut fuer Normung eV. (DIN)
- Japanese Industrial Standards (JIS)






Copyright 2026- NNI Training and Consulting

40

40




Non-Consensus Standards

- Non-Consensus Standards
 - Any fastener user can write a standard
 - Some non-consensus standards are broadly accepted by many users- even outside the generators immediate sphere of influence
- Common standards utilized outside the generators immediate sphere of influence
 - MIL Standards (MS and AN variants)
 - FED and other government standards
 - Boeing

41

Copyright 2026- NNI Training and Consulting

41




MIL Standards

Acronym	Type	Description
MIL-HDBK	Defense Handbook	Provides standard procedural, technical, engineering, or design information about materials, processes, practices, or methods. Example: MIL-HDBK-57 Fastener Manufacturer's Insignia
MIL-SPEC	Defense Specification	Describes the essential technical requirements for military unique material or substantially modified commercial items. Example: MS35307 Hex Cap Screws
MIL-STD	Defense Standard	Establishes uniform engineering and technical requirements for military-unique or substantially modified commercial processes, procedures, practices and methods. Example: MIL-STD-1515 Fastener Systems for Aerospace Applications
MIL-PRF	Performance Specification	Provides requirements and criteria for verifying and meeting compliance without stating the methods for achieving such results. Example: MIL-PRF-5038J Tests for Protective Equipment (Including Hook and Loop fastener performance)
MIL-DTL	Detail Specification	States specific design requirements, such as materials to be used, how the requirement is to be achieved, or how an item is to be fabricated. Example: MIL-DTL-1222 Studs, Bolts, Screws, and Nuts for Applications Where a High Degree of Reliability is Required

42


Copyright 2026- NNI Training and Consulting

42



Who uses the different standards?

- Loaded question
 - Anyone can use them
 - Different interests and market segments tend to gravitate to specific standards
- Some of the standards are targeted to specific users or market segments
 - Ex. AMS or NAS Specs for aerospace
 - Ex. MS or AN Specs for defense contractors
 - Ex. RCSC for iron workers
 - Ex. API for subsea oil and gas



Copyright 2026- NNI Training and Consulting

43

43



Who uses the different standards?

- Aerospace
 - NA, NAM, NAS, NASM
 - AN and MS
 - AMS
 - AS
 - NADCAP
- Construction/Structural Bolting
 - ASME
 - ASTM
 - RCSC




Copyright 2026- NNI Training and Consulting

44

44



Who uses the different standards?

- Industrial and Industrial Distribution
 - ASME
 - ASTM
 - ISO
 - GM, Ford, FCA
 - MIL

- Automotive
 - GM, Ford, FCA
 - Toyota, Nissan, Honda, et al.
 - Bosch
 - Most refer to ISO



45





Who uses the different standards?

- Defense Supply
 - AN and MS
 - NA, NAM, NAS, NASM
 - AMS
 - ASTM
 - ASME
 - SAE
 - NADCAP

- Oil and Gas
 - ASTM
 - NACE
 - API



46




Part 3: How Consensus Standard Process Works

Copyright 2026- NNI Training and Consulting

(47)

47




How Consensus Works- An Exercise

1. The first 10 minutes you will conduct this exercise on your own. Consider why you are ranking the items where you are on your list.
2. Now break up into groups of 5 or 6. Take 15 minutes, as a group, to re-rank the items. This time, however, the entire group **MUST** agree to the ranking order. Determine a way to verify that each member of the group agrees to the ranking order. You **CANNOT** move on until everyone agrees.
3. Review the answers and see which group is most likely to survive this ordeal.

Copyright 2026- NNI Training and Consulting

(48)

48



SURVIVAL A Simulation Game

You and your companions have just survived the crash of a small plane. Both the pilot and co-pilot were killed in the crash. It is mid-January, and you are in Northern Canada. The daily temperature is 25 below zero, and the night time temperature is 40 below zero. There is snow on the ground, and the countryside is wooded with several creeks criss-crossing the area. The nearest town is 20 miles away. You are all dressed in city clothes appropriate for a business meeting. Your group of survivors managed to salvage the following items:


- A ball of steel wool
- A small ax
- A loaded .45-caliber pistol
- Can of Crisco shortening
- Newspapers (one per person)
- Cigarette lighter (without fluid)
- Extra shirt and pants for each survivor
- 20 x 20 ft. piece of heavy-duty canvas
- A sectional air map made of plastic
- One quart of 100-proof whiskey
- A compass
- Family-size chocolate bars (one per person)

Your task as a group is to list the above 12 items in order of importance for your survival. List the uses for each. You **MUST** come to agreement as a group.

Copyright 2026- NNI Training and Consulting

49

49



EXPLANATION

Mid-January is the coldest time of year in Northern Canada. The first problem the survivors face is the preservation of body heat and the protection against its loss. This problem can be solved by building a fire, minimizing movement and exertion, using as much insulation as possible, and constructing a shelter.

The participants have just crash-landed. Many individuals tend to overlook the enormous shock reaction this has on the human body, and the deaths of the pilot and co-pilot increases the shock. Decision-making under such circumstances is extremely difficult. Such a situation requires a strong emphasis on the use of reasoning for making decisions and for reducing fear and panic. Shock would be shown in the survivors by feelings of helplessness, loneliness, hopelessness, and fear. These feelings have brought about more fatalities than perhaps any other cause in survival situations. Certainly the state of shock means the movement of the survivors should be at a minimum, and that an attempt to calm them should be made.

Before taking off, a pilot has to file a flight plan which contains vital information such as the course, speed, estimated time of arrival, type of aircraft, and number of passengers. Search-and-rescue operations begin shortly after the failure of a plane to appear at its destination at the estimated time of arrival.

The 20 miles to the nearest town is a long walk under even ideal conditions, particularly if one is not used to walking such distances. In this situation, the walk is even more difficult due to shock, snow, dress, and water barriers. It would mean almost certain death from freezing and exhaustion. At temperatures of minus 25 to minus 40, the loss of body heat through exertion is a very serious matter.

Once the survivors have found ways to keep warm, their next task is to attract the attention of search planes. Thus, all the items the group has salvaged must be assessed for their value in signaling the group's whereabouts.

The ranking of the survivors items was made by Mark Wanvig, a former instructor in survival training for the Reconnaissance School of the 101st Division of the U.S. Army. Mr. Wanvig currently conducts wilderness survival training programs in the Minneapolis, Minnesota area. This survival simulation game is used in military training classrooms.


How to score

Each team should list its top 5 choices in order prior to seeing the answer sheet. To award points, look at the ranking numbers on this answer sheet. Award points to each team's top choices according to the numbers here. For example, the map would earn 12 points, while the steel wool would earn 2 points. Lowest score wins (and survives).

Copyright 2026- NNI Training and Consulting

50

50




RANKINGS

- 1. Cigarette lighter (without fluid)**
The gravest danger facing the group is exposure to cold. The greatest need is for a source of warmth and the second greatest need is for signaling devices. This makes building a fire the first order of business. Without matches, something is needed to produce sparks, and even without fluid, a cigarette lighter can do that.
- 2. Ball of steel wool**
To make a fire, the survivors need a means of catching the sparks made by the cigarette lighter. This is the best substance for catching a spark and supporting a flame, even if the steel wool is a little wet.
- 3. Extra shirt and pants for each survivor**
Besides adding warmth to the body, clothes can also be used for shelter, signaling, bedding, bandages, string (when unraveled), and fuel for the fire.
- 4. Can of Crisco shortening**
This has many uses. A mirror-like signaling device can be made from the lid. After shining the lid with steel wool, it will reflect sunlight and generate 5 to 7 million candlepower. This is bright enough to be seen beyond the horizon. While this could be limited somewhat by the trees, a member of the group could climb a tree and use the mirrored lid to signal search planes. If they had no other means of signaling than this, they would have a better than 80% chance of being rescued within the first day.
There are other uses for this item. It can be rubbed on exposed skin for protection against the cold. When melted into an oil, the shortening is helpful as fuel. When soaked into a piece of cloth, melted shortening will act like a candle. The empty can is useful in melting snow for drinking water. It is much safer to drink warmed water than to eat snow, since warm water will help retain body heat. Water is important because dehydration will affect decision-making. The can is also useful as a cup.
- 5. 20 x 20 foot piece of canvas**
The cold makes shelter necessary, and canvas would protect against wind and snow (canvas is used in making tents). Spread on a frame made of trees, it could be used as a tent or a wind screen. It might also be used as a ground cover to keep the survivors dry. Its shape, when contrasted with the surrounding terrain, makes it a signaling device.
- 6. Small ax**
Survivors need a constant supply of wood in order to maintain the fire. The ax could be used for this as well as for clearing a sheltered campsite, cutting tree branches for ground insulation, and constructing a frame for the canvas tent.
- 7. Family size chocolate bars (one per person)**

Copyright 2026- NNI Training and Consulting

51

51




Chocolate will provide some food energy. Since it contains mostly carbohydrates, it supplies the energy without making digestive demands on the body.

- 8. Newspapers (one per person)**
These are useful in starting a fire. They can also be used as insulation under clothing when rolled up and placed around a person's arms and legs. A newspaper can also be used as a verbal signaling device when rolled up in a megaphone-shape. It could also provide reading material for recreation.
- 9. Loaded .45-caliber pistol**
The pistol provides a sound-signaling device. (The international distress signal is 3 shots fired in rapid succession). There have been numerous cases of survivors going undetected because they were too weak to make a loud enough noise to attract attention. The butt of the pistol could be used as a hammer, and the powder from the shells will assist in fire building. By placing a small bit of cloth in a cartridge emptied of its bullet, one can start a fire by firing the gun at dry wood on the ground. The pistol also has some serious disadvantages. Anger, frustration, impatience, irritability, and lapses of rationality may increase as the group awaits rescue. The availability of a lethal weapon is a danger to the group under these conditions. Although a pistol could be used in hunting, it would take an expert marksman to kill an animal with it. Then the animal would have to be transported to the crash site, which could prove difficult to impossible depending on its size.
- 10. Quart of 100 proof whiskey**
The only uses of whiskey are as an aid in fire building and as a fuel for a torch (made by soaking a piece of clothing in the whiskey and attaching it to a tree branch). The empty bottle could be used for storing water. The danger of whiskey is that someone might drink it, thinking it would bring warmth. Alcohol takes on the temperature it is exposed to, and a drink of minus 30 degrees Fahrenheit whiskey would freeze a person's esophagus and stomach. Alcohol also dilates the blood vessels in the skin, resulting in chilled blood being carried back to the heart, resulting in a rapid loss of body heat. Thus, a drunk person is more likely to get hypothermia than a sober person is.
- 11. Compass**
Because a compass might encourage someone to try to walk to the nearest town, it is a dangerous item. Its only redeeming feature is that it could be used as a reflector of sunlight (due to its glass top).
- 12. Sectional air map made of plastic**
This is also among the least desirable of the items because it will encourage individuals to try to walk to the nearest town. Its only useful feature is as a ground cover to keep someone dry.

Copyright 2026- NNI Training and Consulting

52

52



Beginning of a Standard- SAE Example

SAE
INTERNATIONAL

AEROSPACE MATERIALS SYSTEMS
GROUP
ORGANIZATION AND OPERATING GUIDE

Issued: June 1978
Revised: October 2017

SAE International
400 Commonwealth Drive
Warrendale, PA 15096-0001 USA

1

Copyright 2026- NNI Training and Consulting

53

53




Beginning of a Standard- SAE Example

- Aerospace Material Systems Group is broken into (4) Technical Areas:
 - Metals and related processes (Metals Committees)
 - Non-metals and related processes (Non-Metals Committees)
 - Non Destructive Testing
 - Additive Manufacturing

Copyright 2026- NNI Training and Consulting

54

54




Beginning of a Standard- SAE Example

- Each Technical Area has one or more Technical Committees:
 - Metals and related processes (Metals Committees)
 - B- Finishes, Processes, and Fluids
 - D- Nonferrous Alloys
 - E – Carbon and Low Alloy Steels
 - F – Corrosion and Heat Resistant Alloys
 - G – Titanium, Beryllium, and Refractory Materials
 - Non-metals and related processes (Non-Metals Committees)
 - CACRC-ATA/IATA/SAE Commercial Aircraft Composite Repair Committee
 - CE – Elastomers
 - G-8 – Organic Coatings
 - G-9 – Aerospace Sealing
 - J – Aircraft Maintenance Chemicals and Materials
 - M – Aerospace Greases
 - P – Polymeric and Composite Materials
 - P-17 – Polymer Matrix Composites
 - Non Destructive Testing
 - K – Nondestructive methods and processes
 - Additive Manufacturing
 - Additive Manufacturing Committee (AMS-AM)

Copyright 2026- NNI Training and Consulting

55

55



Beginning of a Standard- SAE Example

Let's Use A286 as an Example- Currently AMS 5731, 5732, and 5733

- Starts with a “Need”
 - Brought to the TC (F) by an interested party(s)
 - Does not need to be a Committee Member (although this helps)
- Common Actions Brought to a TC
 - New Standard
 - Revision of an existing standard
 - 5 Year Review

10. New Business/Committee Correspondence


1. Change of Scope update
2. New Terminology Proposal- "Conversion Finish"- Kevin Menke
Proposed: "The conversion of the surface of a metal into a superficial coating by a chemical or electrochemical process in which compounds of the metal in question become part of the coating, or both."
3. Update- Request by Mr. Padfield to update/revise multiple terminology in F1789
 - i. Inspection Torque
 - ii. Magnetic Permeability
 - iii. Martensitic Alloy
 - iv. Microstructure
 - v. Resilience
 - vi. Strain
 - vii. Stress
 - viii. Torsional Strength
 - ix. Ultimate Tensile Load
 - x. Vickers Hardness Test
4. Discussion- Request for Guidance on "Certification" vs "Test Reports"- Kevin Menke
 - i. Is this an editorial issue?
 - ii. Should a Guidance document be created on this issue?

Example Agenda

Copyright 2026- NNI Training and Consulting

56

56

 **Beginning of a Standard- SAE Example**


Let's Use A286 as an Example- Currently AMS 5731, 5732, and 5733

- Committee Chair
 - Either places the item on the agenda prior to a meeting, or,
 - Issue gets raised from the “floor” during New Business
 - Committee Chair leads discussion
 - May call for a straw poll or vote to take up a new work item
 - Committee may be unanimous in interest and work item is taken up
- Work Item
 - Number assigned
 - Task Group is chosen (if applicable), and Leader assigned (Voluntarily)


Copyright 2026- NNI Training and Consulting

57

57

 **Beginning of a Standard- SAE Example**


- Task Group
 - Normally 3-6 individuals
 - Does the hard work
 - Usually between TC Meetings
 - Develops a draft standard
- Draft Standard
 - Discussed in Task Group
 - Advances to Ballot, or,
 - Back for more work



Copyright 2026- NNI Training and Consulting

58

58




Beginning of a Standard- SAE Example

- Technical Committee
 - Voting Members
 - Member-User
 - Member- Producer
 - Member – General Interest
 - Non-Voting Members
 - Balance of Committee
- Technical Committee Ballot- Vote
 - Approve – With or without comments
 - Disapprove – MUST present a technical argument for disapproval
 - Waive – With or without comments

Copyright 2026- NNI Training and Consulting

59

59




Beginning of a Standard- SAE Example

- Technical Committee Ballot
 - Ballot sent to TC members for vote when TG feels it is ready
 - If NO Disapprovals received- released from committee
 - If Disapprovals are received – TC and/or Task Group must work to resolve all Disapprovals
 - Find persuasive, change, and re-ballot
 - Get voter to withdraw
 - Find “nonpersuasive”
- Aerospace Council
 - Ballots are reviewed and voted on by Aerospace Council
 - Normally to assure that all procedural requirements were upheld
 - If favorable ruling, Document goes to Publication

Copyright 2026- NNI Training and Consulting


60

60



What happens when a negative vote is cast?


- Every organization has slightly different policies
 - This is what the system was designed for
 - Goal is to achieve consensus
- A negative vote should be cast:
 - When there is a significant technical problem with the standard
 - When it is clear that the document isn't ready yet
- A negative vote should not be cast:
 - Because of personal feelings toward someone on the task group
 - For simple editorial fixes
 - Without a logical explanation and solution to address the negative concern



Copyright 2026- NNI Training and Consulting

61

61




Beginning of a Standard- NAS Example

- National Aerospace Standards Committee (Division of AIA)
 - Member (OEM, Big Companies, and Very Interested Companies) [Voting Rights]
 - Associate Members (Suppliers) [Voting Rights]
 - Technical Advisors (Interested Parties) [Comments but no Voting Rights]
 - AFSAC (Aerospace Fastener Standards Advisory Committee) (Group of Technical Advisors) [Single Proxy Vote to the Group]
- Standards
 - NAS
 - NASM (Former MS Standards)
 - NA (Metric)
 - NAM (Former MS Standards- Metric)

Copyright 2026- NNI Training and Consulting

62

62




Beginning of a Standard- NAS Example

- Action is requested on a project
 - May be initiated by a member
 - May be initiated by an outside request to the committee or to a member
- Action request is reviewed by 5 member Steering Committee
 - Determines if a Work Item should move forward
 - Grants a project number for approved Work Items
- Technical Committee
 - Assigns work items granted by Steering Committee
 - Works through technical issues and ballot replies on open work items
- Work Items
 - Assigned to a Project Leader
 - Project Leader may work on it solo or form a Task Group
 - Red-line version of the standard is produced
 - Work Item goes to Ballot
 - Agree
 - Disagree
 - Waive

Copyright 2026- NNI Training and Consulting

63

63



Beginning of a Standard- NAS Example

- Ballots
 - Project Leader/Task Group has to resolve ALL comments
 - Often Work Items go through several iterations
 - If a negative CANNOT be resolved, it gets elevated to the Steering Committee for arbitration
 - Once everything is resolved, the document is released from the TC
- Oversight Committee
 - Reviews and approves all documents released from TC before they are published

Copyright 2026- NNI Training and Consulting

64

64





Part 4: Finding the Standard You Want

Copyright 2026- NNI Training and Consulting

65

65



Finding the Right Standard

- Often directly on print or purchasing information
- Use readily available references such as:
 - Indexes in print and electronic volumes of standards
 - IFI Fastener Standards (ASTM, SAE, IFI, and ASME Only)
 - ASSIST Quicksearch
- Other Methods
 - Internet
 - IHS



When you don't know the standard number your search may require patience and creativity.

Copyright 2026- NNI Training and Consulting

66

66

Format of a NAS Standard

Aerospace Standards call out Procurement Specification or documents that specify testing, special processes, packaging requirements, etc... In this case, the Procurement Specification is given in the Notes.

NAS Standards do NOT have any scope, but the Title clearly describes the part to be covered in the standard

Part/Standard Number

NATIONAL AEROSPACE STANDARD
 © COPYRIGHT 2012 AIRBORNE INDUSTRIES ASSOCIATION OF AMERICA, INC. ALL RIGHTS RESERVED

TABLE 1 - DASH NUMBERS AND DIMENSIONS

DASH NUMBER	NOMINAL THREAD SIZE UNF-3B	O/A MAX	END HDN	C HDN	H HDN	H MAX	H HDN	O/D	J HDN	J MAX	H ₁ (H)	W	
												MAX	MIN
3	1800-32	339	299	274	180	250	180	263	262	233	231	243	
4	2500-20	434	394	379	250	320	250	327	327	217	213	305	
5	3125-24	532	492	477	312	382	312	392	392	221	216	367	
6	3750-24	631	591	576	375	445	375	452	452	226	222	430	
7	4375-20	729	689	674	438	508	438	516	516	234	229	453	
8	5000-20	828	788	773	500	571	500	581	581	234	229	453	
9	5625-18	926	886	871	562	634	562	642	642	242	237	479	
10	6250-18	1024	984	969	625	697	625	704	704	242	237	479	
12	7500-16	1221	1181	1166	750	814	750	824	824	250	245	504	
14	8750-14	1418	1378	1363	875	947	875	957	957	250	245	504	
16	10000-12	1615	1575	1560	1000	1073	1000	1083	1083	250	245	504	
18	11250-12	1812	1772	1757	1125	1198	1125	1208	1208	250	245	504	
20	12500-12	2010	1970	1955	1250	1323	1250	1343	1343	250	245	504	
22	13750-12	2207	2167	2152	1375	1448	1375	1468	1468	250	245	504	
24	15000-12	2404	2364	2349	1500	1523	1500	1553	1553	250	245	504	
26	17500-12	2802	2762	2747	1750	1823	1750	1853	1853	250	245	504	
32	20000-12	3200	3160	3145	2000	2073	2000	2103	2103	250	245	504	

TITLE
 NUT, SELF-LOCKING, EXTENDED WASHER, DOUBLE HEXAGON, CRCS, 180 KSI, 450 °F AND 800 °F

REVISION
 4
 NAS1805
 SHEET 1 OF 3

Format of a NAS Standard

Material Information- Normally refers to AMS Specifications or Unified Numbering System (UNS)

Plating/Finish Information- Note Letter Codes are used to distinguish the different variations in the part description known as the "Dash Number"

MATERIAL:

FINISH:

NATIONAL AEROSPACE STANDARD
 © COPYRIGHT 2012 AIRBORNE INDUSTRIES ASSOCIATION OF AMERICA, INC. ALL RIGHTS RESERVED

TABLE 1 - DASH NUMBERS AND DIMENSIONS (CONTINUED)

DASH NUMBER	(V)	TOLERANCE X	MAXIMUM WEIGHT
			LB/100
3	.015	.006	41
4	.020	.006	42
5	.025	.006	71
6	.030	.010	1.27
7	.035	.010	2.14
8	.040	.010	3.01
9	.045	.010	4.13
10	.050	.010	5.41
12	.060	.010	10.20
14	.070	.015	15.20
16	.080	.015	21.90
18	.090	.015	32.30
20	.100	.015	43.30
22	.110	.015	55.30
24	.120	.015	70.40
26	.130	.015	87.00
32	.150	.015	117.00

MATERIAL:
 A306 (UNS S66286) CRCS PER AMS5737, NICKEL ALLOY 718 (UNS N07718) PER AMS6562
 OPTIONAL FOR NUT SIZE: 7500-16 AND LARGER.

FINISH:
 NO CODE LETTER AND F - A286, PASSIVATE PER AMS2700, METHOD 1, TYPE 2, 6 OR 8, CLASS 2 AND 718 PASSIVATE PER AMS2700, METHOD 1, TYPE 1
 OPTIONAL, CLASS 4


CODE LETTER L -
 CADMIUM PLATE PER AMS-QQ-P-416, CLASS 2, TYPE OF PLATING
 OPTIONAL, IF NUTS MEET SALT SPRAY REQUIREMENTS OF AMS-QQ-P-416, TYPE II

CODE LETTER H -
 CADMIUM PLATE PER AMS-QQ-P-416, TYPE II, CLASS 2


CODE LETTER P -
 SILVER PLATE PER AMS2410, .0002 MINIMUM THICKNESS ON SURFACES WHICH CAN BE TOUCHED WITH A # 75 BALL. THICKNESS SHALL SHOW COMPLETE COVERAGE BUT THICKNESS REQUIREMENT IS WAIVED.

LUBRICATION
 NO CODE LETTER - SOLID FILM LUBRICANT PER AMS272, TYPE I AND HYDRAULIC FLUID RESISTANCE WHEN TESTED PER ASTM D2530 USING SAE AS12M1 PHOSPHATE ESTER HYDRAULIC FLUID
 CODE LETTER F - SOLID FILM LUBRICANT PER AMS272, TYPE I. LUBRICANT SHALL BE SPACE COMPATIBLE. OIL-GARD TM ONLY
 CODE LETTER L - SOLID FILM LUBRICANT MEETING THE REQUIREMENTS OF NAS3330 AND HYDRAULIC FLUID RESISTANCE WHEN TESTED PER ASTM D2530 USING SAE AS12M1 PHOSPHATE ESTER HYDRAULIC FLUID.
 CODE LETTER N - CETYL ALCOHOL (NON-SOLID FILM LUBRICANT) PER AMS7132, TYPE I, GRADE A.
 CODE LETTER P - NO LUBRICANT.

REVISION
 4
 NAS1805
 SHEET 2



Format of a NAS Standard



MARKING: MANUFACTURER'S SYMBOL PER MIL-HDBK-57 PLUS PREFIX (OPTIONAL), BASIC PART NUMBER, FOR -3 SIZE, ONLY MANUFACTURER'S SYMBOL IS REQUIRED. LOCATION AS NOTED ON SHEET 1. IN ADDITION, CADMIUM PLATED, SOLID FILM LUBRICATED NUTS CODE LETTER "L" SHALL BE IDENTIFIED WITH A PERMANENT SPOT, DAB OR PATCH OF WHITE PAINT, DYE OR LACQUER. CODE LETTER "T" SHALL BE IDENTIFIED WITH A PERMANENT SPOT, DAB OR PATCH OF YELLOW PAINT, DYE, OR LACQUER.

COATING: BASIC PART NUMBER DESIGNATES UNPLATED, PASSIVATED NUT WITH SOLID FILM LUBRICANT. ADD "T" AFTER DASH NUMBER FOR CADMIUM PLATED NUT, WITH CETYL ALCOHOL LUBRICANT. ADD "P" AFTER DASH NUMBER FOR SILVER PLATED NUT WITH NO LUBRICANT. ADD "L" AFTER DASH NUMBER FOR CADMIUM PLATED NUT WITH SOLID FILM LUBRICANT. ADD "F" AFTER DASH NUMBER FOR UNPLATED, PASSIVATED NUT WITH KAL-GARD™ "FA" SOLID FILM LUBRICANT.

EXAMPLE OF PART NUMBER:

NAS1805-4-	2500-28 UNF-38 THREAD, PASSIVATED, SOLID FILM LUBRICANT, 450 °F.
NAS1805-4H	2500-28 UNF-38 THREAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICANT, 450 °F.
NAS1805-4P	2500-28 UNF-38 THREAD, SILVER PLATED, NO LUBRICANT, 450 °F.
NAS1805-4L	2500-28 UNF-38 THREAD, CADMIUM PLATED, SOLID FILM LUBRICANT, 450 °F.
NAS1805-4F	2500-28 UNF-38 THREAD, PASSIVATED, SOLID FILM SPACE COMPATIBLE, KAL-GARD™ "FA" LUBRICANT, 450 °F.

NOTES:

- (1) THREADS PER ASB79 BEFORE LUBRICATION.
- (2) DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
- (3) DIMENSIONS "C", "D", "E" AND "W" APPLY PRIOR TO DEFORMATION OF SELF-LOCKING DEVICE.
- (4) UPPER THREADED PORTION, ABOVE BRANCHING FEATURE, DEFORMED TO PROVIDE SELF-LOCKING FEATURE. DEFORMATION SHALL PERMIT FREE ENGAGEMENT WITH WRENCHES CONFORMING TO ISO 638-638. TOOL MARKS PERMISSIBLE IN LOCKING AREA.
- (5) DIMENSIONS IN INCHES AND APPLY AFTER FINISH AND PRIOR TO THE APPLICATION OF LUBRICATION UNLESS OTHERWISE SPECIFIED.
- (6) THIS STANDARD TAKES PRECEDENCE OVER DOCUMENTS REFERENCED HEREIN.
- (7) UNLESS OTHERWISE SPECIFIED HEREIN, REFERENCED DOCUMENTS SHALL BE THE ISSUE IN EFFECT ON DATE OF MANUFACTURE. HOWEVER, EXISTING MATERIAL INVENTORY CERTIFIED TO A PREVIOUS EDITION OF THE APPLICABLE MATERIAL SPECIFICATION(S) IS ACCEPTABLE FOR USE UNTIL DEPLETION.
- (8) FOR CRIS, MAGNETIC PERMEABILITY SHALL BE LESS THAN 2.0 (AIR = 1.0) FOR A FIELD STRENGTH H = 200 OERSTEDS USING A MAGNETIC PERMEABILITY INDICATOR PER ASTM A242A.201, TEST METHOD 3.
- (9) UNLESS OTHERWISE SPECIFIED, PART INVENTORY MANUFACTURED TO PREVIOUS REVISIONS OF THE APPLICABLE DIMENSIONING AND TOLERANCING STANDARD IS ACCEPTABLE FOR USE UNLESS OTHERWISE SPECIFIED.

PROCUREMENT SPECIFICATION: NAS2350, CLASS 30A, EXCEPT AS NOTED, NAS1805-() AND NAS1805-() IF (ASB8 CRIS PASSIVATED, AS3372, TYPE 1, SOLID FILM LUBRICANT) REUSABILITY TEST TO FIVE (5) CYCLES, RECORD MAXIMUM INSTALLATION AND BREAKAWAY TORQUE ON THE FIRST (1), THIRD AND FIFTH (5) CYCLES.


REVISION
4
NAS1805
SHEET 1

COMPLETELY REVISED


Guidance on how to designate or interpret the part number with the right dash codes.

Procurement Specification- Normally these are located in the lower left corner on the first page.

71



NAS Part Numbering and Size



- NAS Standards relate Part Number and Size in one of two ways:
- Method 1:
 - A single NAS part number provides guidance on multiple sizes in the same document. It does this using one or more “Dash Numbers” to distinguish the appropriate size combination.
- Method 2:
 - A single NAS part number represents only one primary size. For example, a 1/4-28 screw has a uniquely different part number than the next size up, 5/16- 24. There may, however, still exist “Dash Numbers” to designate different length variations. In parts utilizing this method, normally the Part Number on the print displays a range of numbers, for example: NAS 8602-8616

72



NAS Part Numbering and Size

- Size References
 - Sizes may be given in fractions, i.e. 1/4-28, or,
 - Decimal equivalents, i.e. .2500-28
- Dash Numbers
 - May be used to give the thread size and pitch
 - May be used to give the threaded length
 - May be used to give options for material, recess type, locking features, holes, or other geometric configurations

Copyright 2026- NNI Training and Consulting



NAS Part Numbering and Size- Method 1

TABLE 1 - DASH NUMBERS AND DIMENSIONS

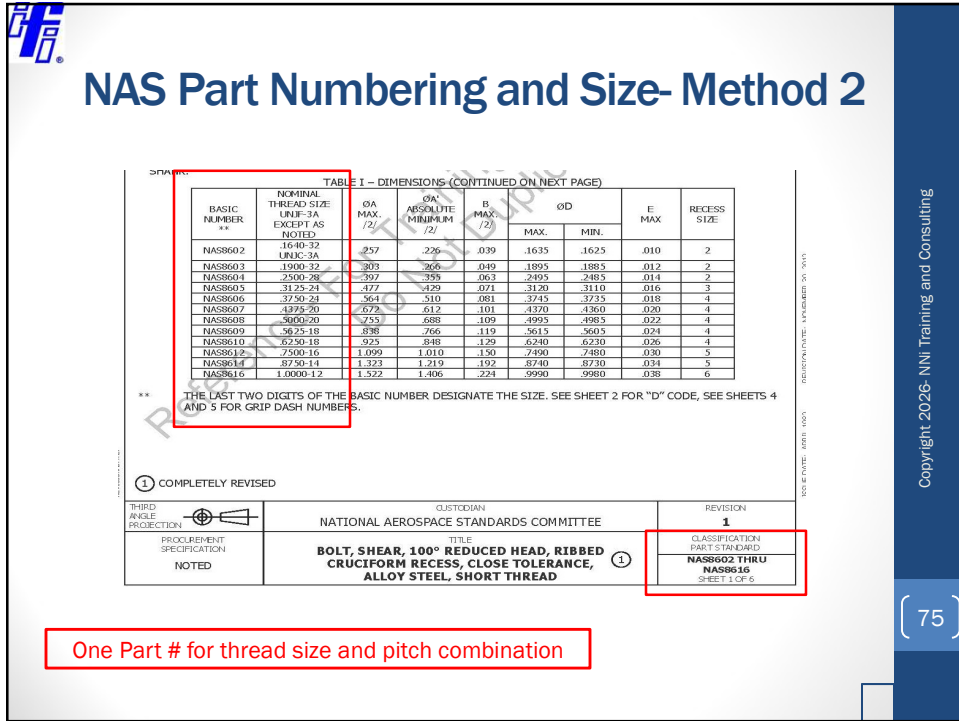
DASH NUMBER	T NOMINAL THREAD SIZE UNF-36 /3/	ØA		ØB		C		H		ØD		J		ØK (M)		W /3/	
		MAX	MIN	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MAX	MIN		
3	.1900-32	.339	.299	.277	.190	.220	.190	.065	.262	.013	.251	.243					
4	.2500-28	.434	.394	.349	.250	.280	.250	.082	.327	.017	.313	.305					
5	.3125-24	.532	.492	.418	.312	.342	.312	.120	.392	.021	.376	.367					
6	.3750-24	.631	.591	.490	.375	.405	.375	.129	.458	.026	.439	.430					
7	.4375-20	.729	.689	.611	.438	.473	.438	.156	.588	.034	.564	.553					
8	.5000-20	.828	.788	.702	.500	.535	.500	.190	.694	.038	.677	.666					
9	.5625-18	.926	.886	.775	.562	.597	.562	.230	.720	.042	.690	.679					
10	.6250-18	1.024	.984	.846	.625	.660	.625	.250	.784	.047	.752	.741					
12	.7500-16	1.221	1.181	1.059	.750	.785	.750	.310	.900	.060	.840	.828					
14	.8750-14	1.418	1.378	1.200	.875	.910	.875	.350	1.110	.068	1.064	1.052					
16	1.0000-12	1.625	1.575	1.344	1.000	1.035	1.000	.400	1.241	.077	1.190	1.177					
18	1.1250-12	1.822	1.772	1.557	1.125	1.160	1.125	.450	1.436	.090	1.377	1.364					
20	1.2500-12	2.019	1.969	1.699	1.250	1.285	1.250	.500	1.565	.098	1.502	1.489					
22	1.3750-12	2.216	2.166	1.842	1.375	1.410	1.375	.550	1.695	.107	1.627	1.614					
24	1.5000-12	2.412	2.362	1.986	1.500	1.535	1.500	.600	1.825	.117	1.752	1.739					
28	1.7500-12	2.820	2.770	2.332	1.750	1.785	1.750	.750	2.150	.138	2.064	2.050					
32	2.0000-12	3.200	3.150	2.687	2.000	2.040	2.000	.900	2.474	.155	2.377	2.363					

COMPLETED REVISED

THIRD ANGLE PROJECTION	QUOTED BY NATIONAL AEROSPACE STANDARDS COMMITTEE	REVISION 4
PROCUREMENT SPECIFICATION NOTED	TITLE NUT, SELF-LOCKING, EXTENDED WASHER, DOUBLE HEXAGON, CRES, 180 KSI, 450 °F AND 800 °F	CLASSIFICATION PART STANDARD NAS1805 SHEET 1 OF 3

One Part # and multiple Dash Numbers for different thread sizes and pitch combinations

Copyright 2026- NNI Training and Consulting



NAS Part Numbering and Size-Method 2

TABLE I - DIMENSIONS (CONTINUED ON NEXT PAGE)

BASIC NUMBER **	NOMINAL THREAD SIZE UNJF-3A EXCEPT AS NOTED	ØA	ØA	R	ØD		E MAX	RECESS SIZE
		MAX. /2/	ABSOLUTE MINIMUM /2/		MAX.	MIN.		
NAS8602	.1640-32 UNJC-3A	.257	.226	.039	.1635	.1625	.010	2
NAS8603	.1900-32	.303	.266	.049	.1895	.1885	.012	2
NAS8604	.2500-28	.397	.355	.063	.2495	.2485	.014	2
NAS8605	.3125-24	.477	.429	.071	.3120	.3110	.016	3
NAS8606	.3750-24	.564	.510	.081	.3745	.3735	.018	4
NAS8607	.4375-20	.679	.612	.101	.4370	.4360	.020	4
NAS8608	.5000-20	.755	.688	.109	.4995	.4985	.022	4
NAS8609	.5625-18	.838	.766	.119	.5615	.5605	.024	4
NAS8610	.6250-18	.925	.848	.129	.6240	.6230	.026	4
NAS8612	.7500-16	1.099	1.010	.150	.7490	.7480	.030	5
NAS8614	.8750-14	1.323	1.219	.192	.8740	.8730	.034	5
NAS8616	1.0000-12	1.522	1.406	.224	.9990	.9980	.038	6

** THE LAST TWO DIGITS OF THE BASIC NUMBER DESIGNATE THE SIZE. SEE SHEET 2 FOR "D" CODE, SEE SHEETS 4 AND 5 FOR GRIP DASH NUMBERS.

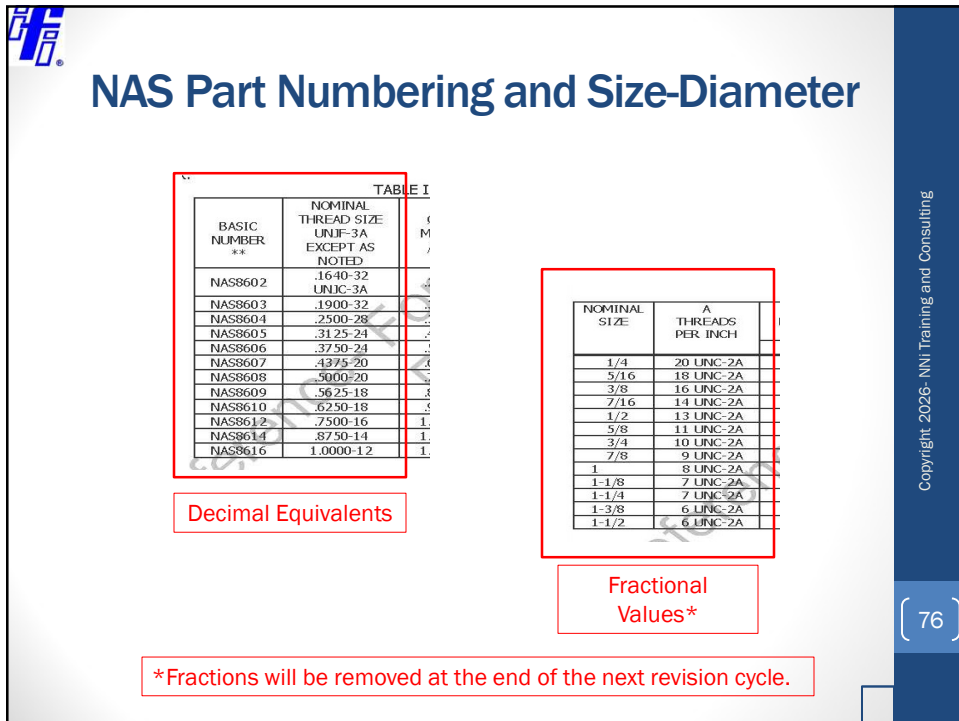
① COMPLETELY REVISED

THIRD ANGLE PROJECTION	CUSTODIAN NATIONAL AEROSPACE STANDARDS COMMITTEE	REVISION 1
PROCUREMENT SPECIFICATION NOTED	TITLE BOLT, SHEAR, 100° REDUCED HEAD, RIBBED CRUCIFORM RECESS, CLOSE TOLERANCE, ALLOY STEEL, SHORT THREAD	CLASSIFICATION PARTS TO SERIES NAS8602 THRU NAS8616 SEE TABLES

One Part # for thread size and pitch combination

75

75



NAS Part Numbering and Size-Diameter

TABLE I

BASIC NUMBER **	NOMINAL THREAD SIZE UNJF-3A EXCEPT AS NOTED	M
NAS8602	.1640-32 UNJC-3A	.4
NAS8603	.1900-32	.4
NAS8604	.2500-28	.4
NAS8605	.3125-24	.4
NAS8606	.3750-24	.4
NAS8607	.4375-20	.4
NAS8608	.5000-20	.4
NAS8609	.5625-18	.4
NAS8610	.6250-18	.4
NAS8612	.7500-16	.4
NAS8614	.8750-14	.4
NAS8616	1.0000-12	.4

Decimal Equivalents

NOMINAL SIZE	A THREADS PER INCH
1/4	20 UNC-2A
5/16	18 UNC-2A
3/8	16 UNC-2A
7/16	14 UNC-2A
1/2	13 UNC-2A
5/8	11 UNC-2A
3/4	10 UNC-2A
7/8	9 UNC-2A
1	8 UNC-2A
1-1/8	7 UNC-2A
1-1/4	7 UNC-2A
1-3/8	6 UNC-2A
1-1/2	6 UNC-2A

Fractional Values*

*Fractions will be removed at the end of the next revision cycle.

76

76

NAS Part Numbering and Size-Dash Numbers

The Standard provides a "map" which supplies how the Dash Numbers develop the part number.

NATIONAL AEROSPACE STANDARD

© COPYRIGHT 2012 AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. ALL RIGHTS RESERVED

NAS NATIONAL AEROSPACE STANDARD

EXAMPLE OF PART NUMBER:

NAS 1189 V 08 T 12 & B

- LOCKING MATERIAL AND TYPE (NO CODE LETTER, NYLON, OPTIONAL LOCKING TYPE, SEE CODE)
- FINISH (INCLUDE "A", "H" OR "W" CODE BEFORE LOCKING MATERIAL AND TYPE CODE)
- LENGTH DASH NUMBER IN .0625 INCREMENTS (SEE TABLE II AND CODE)
- RECESS (SEE CODE)
- DIA DASH NUMBER (SEE PART NUMBER IN TABLE I AND CODE)
- MATERIAL OF SCREW (SEE CODE)
- BASIC PART NUMBER

77

77

Copyright 2026- NNI Training and Consulting

NAS Part Numbering and Size-Dash Numbers

NATIONAL AEROSPACE STANDARD

© COPYRIGHT 2012 AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. ALL RIGHTS RESERVED

NAS NATIONAL AEROSPACE STANDARD

TABLE I - DIMENSIONS AND STRENGTH VALUES

DIA DASH NO.	THREAD (1/2)	DIA MIN	DIA MAX	DIA MIN	DIA MAX	DRH	DRH	DRH	DRH	TENSILE STRENGTH (MIN)	
										CRES (440-HSS)	ALLOY STEEL CRES (T)
02	Ø.0800	.078	.082	.080	.080	.010	.010	.010	.010	300	435
04	Ø.1300	.125	.135	.130	.130	.015	.015	.015	.015	665	765
06	Ø.1800	.175	.185	.180	.180	.020	.020	.020	.020	590	820
08	Ø.2300	.225	.235	.230	.230	.025	.025	.025	.025	990	1,390
10	Ø.2800	.275	.285	.280	.280	.030	.030	.030	.030	1,480	2,890
12	Ø.3300	.325	.335	.330	.330	.035	.035	.035	.035	3,990	5,520
14	Ø.3800	.375	.385	.380	.380	.040	.040	.040	.040	9,200	9,200
16	Ø.4300	.425	.435	.430	.430	.045	.045	.045	.045	9,600	14,000

NATIONAL AEROSPACE STANDARDS COMMITTEE

REVISION: 14

DATE: 11/15/12

NAS 1189

SCREW, SELF-LOCKING, FLAT 100 DEG. HEAD, CRUTCHFORM AND OFFSET CRUTCHFORM RECESS, FULL THREAD

78

First Dash # gives the material-codes found on pg. 2

Second Dash number gives the thread diameter

Ex: NAS 1189-08 = #8-32 thread with alloy steel

Ex: NAS 1189-E-4 = .2500-28 thread of CRES material


Dash Codes for Materials

.. AFTER BASIC PART NUMBER DESIGNATES ALLOY STEEL WITH TYPE II CADMIUM PLATING.
 "C" IN LIEU OF FIRST DASH DESIGNATES CRES (440-HSS).
 "E" IN LIEU OF FIRST DASH DESIGNATES CRES (150 KSI).
 "T" IN LIEU OF FIRST DASH DESIGNATES TITANIUM ALLOY.

78

78

Copyright 2026- NNI Training and Consulting



NAS Part Numbering and Size-Dash Numbers

LENGTH DASH NUMBER INDICATES LENGTH IN .0625 INCREMENTS (CONVERTED TO THREE DECIMAL PLACES PER ANSI/ASME Y14.5M). INTERMEDIATE OR LONGER LENGTHS MAY BE SPECIFIED BY USE OF WHOLE DASH NUMBER ONLY. USE OF .25 INCH INCREMENTS IS RECOMMENDED FOR SCREWS OVER 3 INCHES LONG.

TOLERANCE + .000 - .031		TOLERANCE + .000 - .062		TOLERANCE + .000 - .094	
LENGTH DASH NO.	LENGTH	LENGTH DASH NO.	LENGTH	LENGTH DASH NO.	LENGTH
3	.188	18	1.125	34 TO 96	2.125 TO 6.000
4	.250	20	1.250		
5	.312	22	1.375		
6	.375	24	1.500		
7	.438	26	1.625		
8	.500	28	1.750		
10	.625	30	1.875		
12	.750	32	2.000		
14	.875				
16	1.000				

Third Dash # gives the Recess Type-codes found on pg. 2

Fourth dash number gives the length (# x .0625) - Codes found on pg. 4

Ex: NAS 1189-08-T-8 = #8-32 thread with alloy steel, Offset Cruciform and ½" long

Ex: NAS 1189-E-4-T-24 = .2500-28 thread of CRES material, Offset Cruciform and 1.5" long

USE "P" FOR CRUCIFORM RECESS PER NASM3006 OR "T" FOR OFFSET CRUCIFORM RECESS PER NASM33781 OR "R" FOR RIGGED OFFSET CRUCIFORM RECESS PER NASM14191 BETWEEN DIA AND LENGTH DASH NUMBERS; "R" CODE, APPLIES TO SIZES 06 THRU 5 INCLUSIVE ONLY.

Dash Codes for Recess Choices

79

Copyright 2026- NNI Training and Consulting





Part 6: Using Material Standards-AMS Example

80

Copyright 2026- NNI Training and Consulting

Format of an AMS Standard

Standard from SAE International by Norm I. Tandy, May 17, 2016 Page 2 of 15

SAE INTERNATIONAL **AMS-QQ-P-416**

1. SCOPE
This specification covers the requirements for electroplated cadmium plating.

1.1. SCOPE NOTES
Custom plating shall be of the following types and classes, as specified (see Ordering Information):

1.1.1 Types

- I - As plated
- II - With supplementary chromate treatment (see 3.2.2.1)
- III - With supplementary phosphate treatment (see 3.2.2.2)

1.1.2 Classes

- 1 - 0.0005 inch, minimum
- 2 - 0.0002 inch, minimum
- 3 - 0.0002 inch, minimum

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to the requirements of a document unless a specific document issue is specified. When the referenced document title has been cancelled after its superseding document has been specified, the last published issue of the document shall apply.

2.1 SAE Publications
Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4010 (outside USA) www.sae.org

AMS2076 Pyrometry
Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4010 (outside USA) www.sae.org

2.2 ASTM Publications
Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19380-2055, Tel: 610-832-9885 www.astm.org

ASTM B17 Operating Salt Spray (Fog) Apparatus

ASTM B244 Measurement of Thickness of Anodic Coatings on Aluminum and of other Nonconductive Coatings on Nonmagnetic Base Metals with Edley Current Instruments

ASTM B487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B489 Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Base Metals

ASTM B504 Measurement of Thickness of Metallic Coatings by the Coulometric Method

ASTM B567 Measurement of Coating Thickness by the Beta Backscatter Method

Scope: This is important because it tells what the standard covers and often what it does not.

Definition of the types and classes- in this case tells thickness and type of plating

Other documents referenced in this standard

81

81

Format of an AMS Standard

Standard from SAE International by Norm I. Tandy, May 17, 2016 Page 3 of 15

SAE INTERNATIONAL **AMS-QQ-P-416**

ASTM B568 Measurement of Coating Thickness by X-Ray Spectrometry

ASTM B571 Qualitative Adhesion Testing of Metallic Coatings

ASTM E29 Using Significant Digits to Express Conformance with Specifications

ASTM E376 Measuring Coating Thickness by Magnetic-Field or Edley Current (Electromagnetic) Testing Methods

ASTM F1919 Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

2.3 U.S. Government Publications
Copies of these documents are available online at <http://pubssearch.dau.edu>

TT-C-460 Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings

ML-DTL-002 Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems

ML-STD-1916 DOD Preferred Methods of Acceptance of Product

2.4 AA Publications
Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-261-1900 www.aiaa.org

NASM1312-1 Fastener Test Methods - Method 1, Salt Spray

NASM1312-5 Fastener Test Methods - Method 5, Stress Corrosion Cracking

NASM1312-12 Fastener Test Methods - Method 12, Thickness of Metallic Coatings

NASM1312-16 Fastener Test Methods - Method 16, Stress Durability, Internally Threaded

3. REQUIREMENTS

3.1 MATERIAL

The materials used shall be suitable to produce coatings that meet the requirements of this specification.

3.1.1 Inventory
Items in inventory on the date of the issuance of this amendment may be used until the supply is exhausted.

3.2 General Requirements

Unless otherwise specified (see Ordering Information) parts having an ultimate tensile strength of greater than 200 ksi (or 1400 MPa) shall not be hardened in accordance with this specification.

3.2.1 Provisions for Stress Relief

Steel parts which have been machined, ground, cold-formed, or cold-straightened after heat treatment, shall be stress relieved in accordance with Table 1 or Table 2, as applicable. Stress relief shall precede and passivation, cleaning, and plating for steel of hardening structural tensile stresses. Stress relief is not required for fasteners if all cold working is limited to cold working of the head-to-shank fillet and thread coating after heat treatment.

Body of Document: Section 3 tells of the requirements

82

82

Format of an AMS Standard

Body of Document: Section 4 tells of the quality requirements- including testing and sampling requirements

SAE INTERNATIONAL
AMS-QQ-P-418™E Page 6 of 18

3.3.2 Adhesion
The adhesion of the plating shall be such that when examined at a magnification of 4.10X, the plating shall not show separation from the basis metal nor from any underplating at the interface, nor shall any underplate show separation from the basis metal at the interface when subjected to the tests described in 4.6.2 and Table 2. The interface between the underplate and the basis metal is the surface before plating. The formation of cracks in the plating caused by rupture of the basis metal, the underplate or combination of both which do not result in flaking, peeling or blistering of the plating shall not be considered as nonconformance to this requirement.

3.3.3 Corrosion Resistance
Type II areas required to be covered (see 3.3.1) shall not show white corrosion products of cadmium, zinc, or basis metal corrosion products at the end of 96 hours when tested by continuous exposure to the salt spray in accordance with 4.6.2 and Table 2. The appearance of corrosion products visible to the unaided eye shall be cause for rejection, except that white corrosion products at the edges of specimens (see 4.6.2) shall not constitute failure.

3.3.4 Hydrogen Embrittlement Relief Test
Hydrogen embrittlement testing is required for parts heat treated to 150 ksi (or 10.345 GPa) or above, but is not required for bearings, steel nut and bearing sleeves, track roller bearing studs, and end supports on needle track roller bearings. Unless otherwise specified in the product specification or drawing, testing shall be in accordance with 4.6.4 as specified in 4.4.2.3 and 4.4.2.3.1. Stud and bearing sleeves, track roller bearing studs and end supports of needle track roller bearings shall be tested as specified in 4.6.4.3.

3.4 Environmental Requirements
All cadmium plating facilities and equipment shall comply with all applicable Federal, State, and local guidelines (see 5.7).

3.5 Workmanship
3.5.1 Basis Metal
The basis metal shall be free from visible conditions detrimental to the appearance or protective value of the plating.

3.5.2 Appearance
The cadmium plating shall be smooth, uniform, and free from appearance, free from blisters, pits, nodules, burning, and other defects when examined visually without magnification. The plating shall show no indication of contamination or improper operation of equipment, including, but not limited to, cadmium deposits, such as: unnecessary powdered or dulled plating; superficial staining, which has been determined as resulting from rinsing, or slight discoloration resulting from any drying or baking operation; or chemical etching for cause for rejection.

3.5.2.1 Appearance after application of supplementary treatments (3.2.8) shall be essentially uniform in color and shall not comprise areas which has been determined as resulting from rinsing, or slight discoloration resulting from the above or surface conditions shall not be cause for rejection.

4. QUALITY ASSURANCE PROVISIONS

The purchaser is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the processor may use the level of any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the purchaser. The purchaser reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

Copyright 2026- NNI Training and Consulting


83

Part 7: Using Procurement Standards – NASM Example



Copyright 2026- NNI Training and Consulting

84



Procurement Standard- Example NAS4002

Sampling of Requirements

TABLE I – BASIC REQUIREMENTS


CHARACTERISTICS	ENGINEERING REQUIREMENTS	TESTING REQUIREMENTS (SEE 3.1)	
		TEST METHOD	SAMPLING PLAN
MATERIAL	Alloy Steel per; AMS6322 (SAE 8740) AMS6415 (SAE 4340)	Verify material alloy type or grade using any one of the following methods: x-ray fluorescence, optical emission spectrometry or similar methods. Trace elements analysis is not required.	Manufacturer shall verify, or contract for verification, a sample of each heat of raw material utilized for the production of fasteners specifying NAS4002 and shall retain documentation of such verification results.

- Specifies material options per AMS specification
- Specifies allowable test methods
- Specifies verification with each heat lot

Copyright 2026- NNI Training and Consulting

87

87



Procurement Standard- Example NAS4002

Sampling of Requirements

THREADS	Shall be rolled subsequent to all thermal treatment (see "Grain Flow" below) except bake after plating. Size per drawing. Unless otherwise specified, form, dimensions and processing per AS8879 except major diameter may be limited by part standard. Incomplete threads per FIGURES 1A, 2 and 3. Surface irregularities per FIGURE 1 and 1A.	See FIGURES 1, 1A, 2 and 3.	Per TABLE XII, 0.65% AQL.
---------	---	-----------------------------	---------------------------

- Specifies rolling after heat treatment
- Specifies thread runout condition and allowable thread laps
- Specifies acceptance per .65% AQL

Copyright 2026- NNI Training and Consulting

88

88



Procurement Standard- Example NAS4002


Explanation of Requirements

- 100% inspection by human eye/touch = costly/inefficient and **ineffective**
- Automatic screening/sorting methods are becoming the norm



Copyright 2026- NNI Training and Consulting

89



Procurement Standard- Example NAS4002

Explanation of Requirements

- AQL = Acceptable Quality Level- An inferential statistical method employed to test a smaller sampling of a larger population of parts
- Traditional sampling method for Aerospace product
- Acceptance limits assessed by feature functional criticality: 'Critical', 'Major A', 'Major B', 'Minor A', 'Minor B'
- Large sample sizes, certain amount of defects allowable


TABLE XII – ATTRIBUTE SAMPLING FOR NON-DESTRUCTIVE INSPECTION /a/

LOT SIZE	0.15% AQL			0.65% AQL			1.0% AQL			2.5% AQL			4.0% AQL		
	SAMPLE SIZE	Ac	R	SAMPLE SIZE	Ac	R	SAMPLE SIZE	Ac	R	SAMPLE SIZE	Ac	R	SAMPLE SIZE	Ac	R
Under 26	ALL		1	20	0	1	13	0	1	5	0	1	3	0	1
26 thru 50	ALL		1	20	0	1	13	0	1	5	0	1	13	1	2
51 thru 90	80	0	1	20	0	1	13	0	1	20	1	2	13	1	2
91 thru 150	80	0	1	20	0	1	13	0	1	20	1	2	20	2	3
151 thru 280	80	0	1	20	0	1	50	1	2	32	2	3	32	3	4
281 thru 500	80	0	1	80	1	2	50	1	2	50	3	4	50	5	6
501 thru 1,200	80	0	1	80	1	2	80	2	3	80	5	6	80	7	8
1,201 thru 3,200	80	0	1	125	2	3	125	3	4	125	7	8	125	10	11
3,201 thru 10,000	315	1	2	200	3	4	200	5	6	200	10	11	200	14	15
10,001 thru 35,000	315	1	2	315	5	6	315	7	8	315	14	15	315	21	22
over 35,000	500	2	3	500	7	8	500	10	11	500	21	22	315	21	22

Note: /a/ Sample sizes listed above are based on single sampling plans for normal inspection in ASQ Z1.4. It is permissible to use other sampling plans, per ASQ Z1.4, which provide the same quality protection. When sample equals or exceeds the lot size, 100% inspection is required.

Copyright 2026- NNI Training and Consulting

90



Procurement Standard- Example NAS4002


Explanation of Requirements

- **C=0:** In inferential statistical method where one Accepts at 0 (zero) defects and rejects at 1 (one) defect
- Defect detected = 100% sort or scrap lot
- Premise for above: Process is under Statistical Control
- Sample size is smaller than for AQL method for same statistical significance
- This philosophy is replacing traditional AQL methods

Copyright 2026- NNI Training and Consulting

91

91



Procurement Standard- Example NAS4002

Sampling of Requirements

HEAD TO SHANK FILLET AREA	Unless otherwise specified, on .1900 Dia. and larger fasteners, head to shank fillet radius shall be cold worked subsequent to all thermal treatment except bake after plate. The fillet radius shall conform to the applicable drawing. Threaded to the head fasteners do not require fillet cold working. The fillet area may be distorted per FIGURE 6 and TABLE VII.	Comparator measurement a minimum of two places using 10X to 50X.	TABLE XI.
------------------------------	--	--	-----------

Reference

- Specifies fillet rolling after heat treatment on sizes above .1900 diameter (except threaded to the head fasteners)
- Specifies allowable distortion limits
- Specifies measurement technique

Copyright 2026- NNI Training and Consulting

92

92



Procurement Standard- Example NAS4002


Explanation of Requirements



Copyright 2026- NNI Training and Consulting

93

93



Procurement Standard- Example NAS4002

Explanation of Requirements

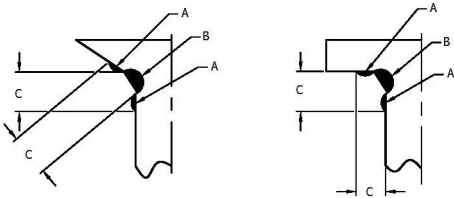


FIGURE 6 – FILLET COLD WORKING DISTORTION
Note: Permissible distortion limits per TABLE VII.

TABLE VII – PERMISSIBLE FILLET DISTORTION LIMITS /a/ ¹⁰

NOMINAL SIZE	Under .3125	.3125 to .3750	.4375 to .6250	.7500 to 1.0000	Over 1.0000
	C MAX	.062	.094	.125	.156
	REDUCED HEAD TYPE III ONLY				
	.031	.047	.062	.078	.094

Note: /a/ Cold working of head to shank fillet may cause distortion of the fillet area. Distortion shall not exceed .002 inch above (A) or below (B) contour shown on fastener drawing. Distorted area shall not extend beyond "C" as illustrated above.

¹⁰

Copyright 2026- NNI Training and Consulting

94

94

**Procurement Standard- Example
NAS4002**

Sampling of Requirements

FATIGUE TEST	Fasteners shall meet the test cycle requirements per TABLE X when subjected to the loads per TABLE IV.	MIL-STD-1312-11	TABLE X.
--------------	--	-----------------	----------

• Specifies requirement for Fatigue Test

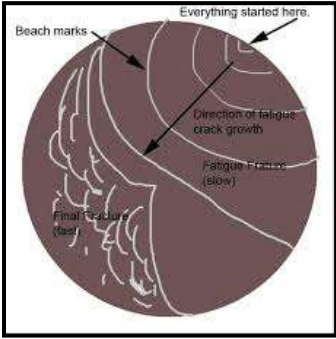
95

Copyright 2026- NNI Training and Consulting

95

**Procurement Standard- Example
NAS4002- Explanation of Requirements**


- **Progressive Failure**
 - Repetitive or fluctuating stress application
 - May take many cycles prior to failure
 - Failure may occur at stresses lower than tensile strength
 - Occurs without any plastic deformation (i.e. without notice)
- **Stages of Failure**
 - Initiation
 - Crack Propagation
 - Fast Failure



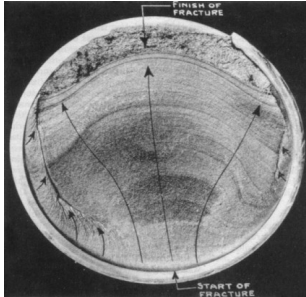
96

Copyright 2026- NNI Training and Consulting

96

 **Procurement Standard- Example
NAS4002- Explanation of Requirements**


- **Initiation**
 - Normally initiates at surface-site of maximum stress
 - Site of a flaw
 - Thread lap
 - Crack
 - Fold
 - Inclusion
 - Site of a stress riser
 - Sharp filet
 - Hole
 - Notch




Copyright 2026- NNI Training and Consulting

(97)

97

 **Procurement Standard- Example
NAS4002- Explanation of Requirements**

- **Crack Propagation**
 - Stage 1
 - Crack propagates along slip planes
 - Normally featureless surface
 - Stage 2
 - Crack propagates in direction perpendicular to maximum tensile stress
 - Shows up on surface as fatigue striations
- **Fast Failure**
 - When crack reaches sufficient length that remaining cross section cannot support applied load



Copyright 2026- NNI Training and Consulting

(98)

98



Procurement Standard- Example NAS4002- Explanation of Requirements

- **High Cycle (low strain) Fatigue**
 - Cyclic rate is very high (meaning many load cycles per unit of time)
 - Amplitude is low and totally elastic (meaning that the strain or displacement of the part as a result of the applied stress is very low)
 - Characteristic of most servo-hydraulic fatigue test frames used for fatigue testing (apply many cycles in a short period of time)



This is the Fatigue test called out in NASM 1312-11

Copyright 2026- NNI Training and Consulting

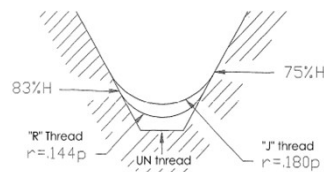
99

99



Procurement Standard- Example NAS4002- Explanation of Requirements


- **Change Bolt-Joint Spring Rate**
 - Increase joint hardness
 - Reduce bolt shank dia.
 - Increase bolt length
 - Replace large bolts with more smaller bolts
- **Reduce tensile stress concentration**
 - Roll threads hard
 - Add a radiused root thread (MJ or UNJ)
 - Control squareness and concentricity



Copyright 2026- NNI Training and Consulting

100

100




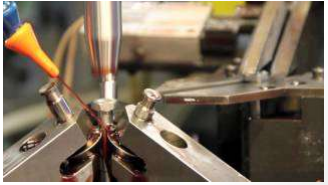
Procurement Standard- Example NAS4002- Explanation of Requirements

Copyright 2026- NNI Training and Consulting

- **Reduce tensile Stress Concentration (cont.)**
 - Increase fillet radii
 - Roll underhead fillet radius
 - Control shot peen surface
 - Eliminate surface finishes that are in tension, i.e. electroless nickel


- **Material and Process**
 - Use fine grain, alloy steels
 - Magnaflux or dye penetrant parts for cracks
 - Meet surface discontinuity standards





101

101



Procurement Standard- Example NAS4002

Copyright 2026- NNI Training and Consulting


Sampling of Requirements

METALLURGICAL	No cracks permitted in any location. A crack is a clean crystalline break passing through the grain or grain boundary. Other discontinuities permitted only as described in TABLE V. See Table I, Note /b/. Fasteners shall not be marked for magnetic inspection.	Magnetic inspect by longitudinal & circular method per ASTM E 1444. Apply magnetic inspection after plating except as stated in Note /b/. Magnetic inspection is not required for sizes smaller than .1900-32.	Sample per TABLE XII, .15% AQL. Increase to 100% if any indications which exceed permissible discontinuity limits are found in samples during the inspection process.
---------------	--	--	---

- Specifies that no cracks are permitted
- Specifies verification via NDT- Magnetic particle Inspection
- Specifies sampling and AQL of .15% , increasing to 100% if indications are found that exceed limits

102

102



Procurement Standard- Example NAS4002

Explanation of Requirements

Magnetic particle Inspection (MPI) is a non-destructive testing (NDT) process for detecting surface and shallow subsurface discontinuities in ferromagnetic materials such as iron, nickel, cobalt, and some of their alloys. The process puts a magnetic field into the part. The piece can be magnetized by direct or indirect magnetization. Direct magnetization occurs when the electric current is passed through the test object and a magnetic field is formed in the material. Indirect magnetization occurs when no electric current is passed through the test object, but a magnetic field is applied from an outside source. The magnetic lines of force are perpendicular to the direction of the electric current, which may be either alternating current (AC) or some form of direct current (DC) (rectified AC).

The presence of a surface or subsurface discontinuity in the material allows the magnetic flux to leak, since air cannot support as much magnetic field per unit volume as metals.

To identify a leak, ferrous particles, either dry or in a wet suspension, are applied to a part. These are attracted to an area of flux leakage and form what is known as an indication, which is evaluated to determine its nature, cause, and course of action, if any.

Copyright 2026- NNI Training and Consulting

103

103



Procurement Standard- Example NAS4002

Explanation of Requirements




Copyright 2026- NNI Training and Consulting

104

104

Procurement Standard- Example NAS4002

Sampling of Requirements

CHARACTERISTICS	ENGINEERING REQUIREMENTS	TESTING REQUIREMENTS (SEE 3.1)	
		TEST METHOD	SAMPLING PLAN
PACKAGING	Package to prevent nicking, scratching of threads or ground surfaces, or other damage during handling, transportation or storage. Unit packages must contain fasteners of one part number from one inspection lot only. Assortment of unit packages may be in larger packages. Packaging must allow for economical transportation and conform to consolidated freight classification rules.	Visual examination.	Not applicable.

- Specifies that package must prevent any damage during handling and transportation

105

105

Procurement Standard- Example NAS4002

Sampling of Requirements

- Specifies required inspection report and inspection classification of each characteristic

The screenshot shows the following table:

DIMENSIONAL CLASSIFICATION	CHARACTERISTICS
0.075% AQL	Threads, Protrusion, Undercuts and Grinding per note (N) under Figure 2, with sample size per TABLE III, 6.6.6.6 AQL, Conical measurement per note under Figure 2 and measurement, with sample size per TABLE XI.
1.0% AQL	Length Part/Item gauging for each head style. Separation of head bearing surface to chamfer for protruding heads. chamfering head angle for bush heads. Concentricity of head and threads to shank.
2.5% AQL	Concentricity of chamfer. Protruding head size and thickness. Radius to head (per applicable specification).
5.0% AQL	Hex head - Chamfer and washer face (diameter and thickness). Conventional head - Head C/D, head and angle. Cauldron and outer profile (diameter and location). Other dimensional characteristics not noted above.

106

106





Part 8: Aerospace and Defense Specific Certifications and Accreditations

Copyright 2026- NNI Training and Consulting


(107)

107



GIFWG

- GIFWG: Government Industry Fastener Working Group
 - Work group that allows Industry and Defense Department to work together on improving and maintaining MIL standards
 - Meets in conjunction with NASC
 - Chaired by DLA and NAVAIR



Copyright 2026- NNI Training and Consulting

(108)

108



QSLD / QSLM

- Qualified Suppliers List – Distributors
- Qualified Suppliers List – Manufacturers
- Required for any business that wishes to sell to US Govt. or an entity that sells to the US Govt. (In other words, a distributor supplying US Govt. contracts likely will need to purchase product from a QSLM supplier.)
- Certifications are administered and maintained by DLA (Defense Logistics Agency) out of Philadelphia
- Fastener Categories: Class 2A/2B Threads and Class 3A/3B Threads



Copyright 2026- NNI Training and Consulting

109

109



CAGE Code and MIL-HDBK-57

- CAGE Code: Commercial and Government Entity
 - Assigned by DoD/DLA
 - Required to supply to US Government and Military Agencies
 - CAGE Codes assigned by location (i.e. more than 1 CAGE per supplier is possible)
 - 5 Digit Alpha Numeric
- MIL-HDBK-57
 - Listing that includes all Manufacturer's ID plus Cage Code

MIL-HDBK-57G (IS)

ALCO MACHINE CO. 27 BEARING AVENUE HARRISON, NJ 07009 CAGE code: 27918 2/	ALEXANDER MANUFACTURING COMPANY INC. DBA METRO TOOL & MANUFACTURING CO. 2402 ARKANSAS LANE GRAND PRAIRIE, TX 75052-7203 MT CAGE code: 2M919 2/
ALCOA FASTENING SYSTEMS 3076 WEST LOMITA BLVD. TORRANCE, CA 90505 plants: *** CAMLOG PRODUCTS *** HUCK INDUSTRIAL PRODUCTS *** HUCK AEROSPACE PRODUCTS *** KAYNAR PRODUCTS *** KEL-DIX/MICRODOT PRODUCTS *** MESAERO PRODUCTS *** RAM PRODUCTS *** ROSAN PRODUCTS *** SIMMONDS PRODUCTS *** TRISHAR PRODUCTS *** VOI-SHAN PRODUCTS CAGE code: 15553 1/	ALL AUTOMATICS 8222 SORRENSEN AVENUE SANTA FE SPRINGS, CA 90670 A CAGE code: 055Y5 1/
ALCOA GLOBAL FASTENERS INC 13001 EAST TEMPLE AVE LA PUENTE, CA 91746-1417 O CAGE code: 06950 2/	ALL MANUFACTURERS INC. DBA HARPER AEROSPACE FASTENERS 2900 PALMADRES DR CORONA, CA 92880 - 9429 AOL CAGE code: 57472 2/
ALCOA-KOFEM KFT AFS NEMESZVAMOS OPERATIO H-8248 NEMESZVAMOS DOCSIA CYORGY U. 2/A HUNGARY CAGE code: 0725V 1/	ALL PINS MANUFACTURING P.O. BOX 137 WILSEYVILLE, CA 95257 plant 5048 POOR MANS WAY WILSEYVILLE, CA 95257 CAGE code: 06CZ5

1/ Information published in this revision was verified by direct contact with manufacturers.
 2/ Information not verified to be current, as reported from manufacturer. Information identical to that published in MIL-HDBK-57, Revision 5.

Copyright 2026- NNI Training and Consulting

110

Example Page from MIL-HDBK-57

110



Qualifications

- Qualification:
 - Documentation completed by the manufacturer the FIRST time a part is produced
 - Includes verification of dimensions and tests to demonstrate the manufacturer is capable of producing the part (similar to PPAP process used in automotive)
 - May be self-certified or require a 3rd party witness
 - Qualification test report must be on file and available for review
- Requalification is required...
 - When a significant process change occurs
 - If the location changes
 - Part has not been manufactured in the last 18 months

Copyright 2026- NNI Training and Consulting

111

111



Qualification Versus Acceptance

Qualification is usually more stringent than everyday acceptance requirements.

QUALIFICATION (first time produced)

NASM25027 [13 tests, 168 h SE]

Test	Requirement paragraph	Test method paragraph	Sample Size
Examination of product	3.7 - 3.5	4.5.1 - 4.5.1.2	All
Stability of titanium coating	3.7 - 3.7.2	4.5.2 - 4.5.2.6	7
Axial tensile strength	3.8.1	4.5.3.1	10
Bench torque	3.8.2.1	4.5.3.2	2
Locking torque	3.8.2.2 - 3.8.2.2.2	4.5.3.3 - 4.5.3.3.5	20 #1
Permanent set	3.8.2.2.3	4.5.3.3.4	1
Torque out	3.8.2.3	4.5.3.4	5
Push out	3.9	4.5.3.5	5
Vibration	3.10	4.5.3.6 - 4.5.3.6.3	10
Discontinuing	3.11	4.5.4 - 4.5.4.2	All
168-hour stress embrittlement	3.12	4.5.5.2	10
Stress corrosion	3.13	4.5.6	5
Hydrogen permeability	3.14	4.5.7	All

1/ For locking torque (10) of the (20) samples shall be used for tests at room temperature and (10) for conditioning tests.
 2/ Torque out and push out are not applicable to right angle plate nut and wrenchable nuts.

ACCEPTANCE (each subsequent production lot)

NASM25027 [8 tests, 23h SE]


Test	Requirement paragraph	Test method Paragraph
Examination of product	3.4 - 3.5.2	4.5.1 - 4.5.1.2
Axial tensile strength	3.8.1	4.5.3.1
Locking torque 1/	3.8.2.2 - 3.8.2.2.3	4.5.3.3 thru 4.5.3.3.4.1
Torque out (not applicable to right angle plate and wrenchable nuts)	3.8.2.3	4.5.3.4
Push out (not applicable to right angle plate wrenchable nuts)	3.9	4.5.3.5
Discontinuing	3.11	4.5.4
168-hour stress embrittlement	3.12	4.5.5.1
Hydrogen permeability	3.14	4.5.7

2/ Except paragraphs 3.8.2.2.3 and 4.5.3.3.4.


Copyright 2026- NNI Training and Consulting

112

112



QMS Philosophy




All modern Quality Management Systems (QMS) fundamentally approach "quality" as a system or approach that should be embraced as part of the company culture.

- Universally these systems promote:
 - Involvement by all employees, but particularly by top management
 - That quality cannot be "inspected" in, but rather must be developed through robust processes
 - Customer service
 - Continual improvement
 - Problem solving
 - Statistical techniques

Copyright 2026- NNI Training and Consulting

113

113



AS9100D

- A QMS developed exclusively for the aerospace industry
- Uses ISO9001 as its foundation
 - This means that AS9100 adapts the process control philosophy of ISO
 - This means that all of the requirements of ISO9001 are built into AS9100
- AS9100 is meant to be adaptable to many different types of companies in the supply chain
- AS9120 was developed for distributors that do no rework or part modification
- When AS9100 went to its C revision it adopted an auditing practice more similar to the automotive standard TS16949 than previous revisions. In its D revision it mirrors the structure of ISO 9001

Copyright 2026- NNI Training and Consulting

114

114



AS9100D


- AS9100 is developed and maintained by International Aerospace Quality Group
 - AS9100- Americas
 - EN9100- Europe
 - JIS Q9100 – Japan and Asia



Copyright 2026- NNI Training and Consulting


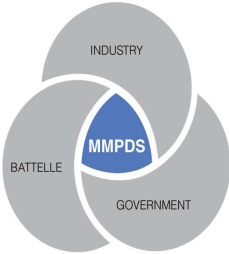
115

115



MMPDS


- MMPDS: Metallic Materials Properties Development and Standardization
 - Source for metallic materials and fastener systems allowed by FAA, DoD, and NASA
 - Replaced MIL-HDBK-5
 - Custodian is Battelle Memorial Institute

Copyright 2026- NNI Training and Consulting

116

116



NADCAP


- NADCAP (National Aerospace and Defense Contractors Accreditation Program) is an industry cooperative accreditation program
- Established by SAE in 1990 is administered by PRI (Performance Review Institute)
- They audit and accredit QMS, Special Processes, and Products
- There was a Fastener Product/Manufacturing NADCAP accreditation, but this never seemed to catch on
- Other Fastener related accreditations are Coatings, Heat Treatment, NDT, Testing and Dimensional Inspection, and QMS.



Copyright 2026- NNI Training and Consulting

117

117



NADCAP

- NADCAP Task Groups Include:
 - Aerospace Quality Systems (AQS)
 - Aero Structure Assembly (ASA)
 - Chemical Processing (CP)
 - Coatings (CT)
 - Composites (COMP)
 - Conventional Machining as a Special Process (CMSP)
 - Fluid Distribution Systems (FLU)
 - Heat Treating (HT)
 - Materials Testing Laboratories (MTL)
 - Measurement & Inspection (M&I)
 - Metallic Materials Manufacturing (MMM)
 - Nonconventional Machining and Surface Enhancement (NMSE)
 - Nondestructive Testing (NDT)
 - Welding (WLD)

Copyright 2026- NNI Training and Consulting

118

118



DFARS - Specialty Metals

- This is a Defense Federal Acquisition Regulation Supplement
- The part that is relevant to fasteners is in regards to the Berry Amendment (10USC 2533b) regarding preference for domestically produced product
- The DFAR regulation 48CFR 252.227-7009 originally stipulated that all Specialty Metals were subject to the Berry Amendment.
- This meant that many alloy steels and specialty metals used by the fastener industry had to have their melt source in the US or one of several approved NATO Qualifying Countries
- Some relief has been given and suppliers may choose to use exclusively DFARS compliant material or self certify that they employ a “market basket” approach, meaning that they purchase no less than 50% of their annual material buy from US or Qualifying Country sources going across all of their commercial product.

Copyright 2026- NNI Training and Consulting

(119)

119



DFARS - Specialty Metals

"Specialty Metals" means: (a) **Steel** with a maximum **alloy** content exceeding one or more of the following limits: **manganese**, 1.65%, **silicon**, 0.60%, or **copper**, 0.60%, or containing more than 0.25% of any of the following elements: **aluminum**, **chromium**, **cobalt**, **columbium**, **molybdenum**, **nickel**, **titanium**, **tungsten**, or **vanadium**.

DFARS qualifying countries (Per DFARS 225.872-1): **Australia, Austria, Belgium, Canada, Denmark, Egypt, Finland, France, Germany**, Greece, Israel, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. Jul 12, 2011

Copyright 2026- NNI Training and Consulting

(120)

120



ITAR

- ITAR refers to International Traffic in Arms Regulations
- Formerly any part that was included on the US Munitions List might be controlled under ITAR. This meant that there were requirements regarding export restrictions and information regarding these products could only be viewed by US citizens. This often placed a burden on organizations with ITAR requirements on how they managed employees, vendors, visitors etc.
- As of October 2013, most fasteners have been excluded from the US Munitions List greatly reducing the burden on the fastener manufacturing supply chain

Copyright 2026- NNI Training and Consulting

121

121



FAA TSO C148

- TSO: Technical Standard Order
 - TSO C148 is applicable to all in-house designed fasteners sold for use in commercial and private aircraft
 - This TSO does not apply to Standard Fasteners



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C148

Date: 9/26/97

Technical Standard Order

Subject: TSO-C148, AIRCRAFT MECHANICAL FASTENERS

- PURPOSE.** This technical standard order (TSO) prescribes the minimum performance standards that aircraft mechanical fasteners must meet to be identified with the applicable TSO marking.
- APPLICABILITY.** The standards of this TSO apply to specialized types of mechanical fasteners described in Appendix 1, Aircraft Mechanical Fastener Property Test Requirements, intended for review and their applications in the manufacture and maintenance of aircraft products. The standards are also adaptable to fasteners of proprietary design. This TSO shall not be used for standard parts.
- REQUIREMENTS.** Aircraft mechanical fasteners that are to be identified with this TSO and that are manufactured on or after the date of this TSO must meet the minimum performance standards specified in the applicant's part drawing and applicable part specification(s) submitted with the fastener manufacturer's application for TSO authorization.
 - Test Requirements.** The required performance shall be demonstrated by accomplishing the tests specified for each property in the part drawing and applicable part specification(s) in accordance with the test procedures specified in Appendix 1.
 - Deviations.** Alternative test procedures that produce an equivalent level of safety may be used if specified at the time of TSO application and approved in accordance with 14 CFR §21.609.
- MARKING.**
 - In addition to the marking specified in 14 CFR §21.607(d), the fastener type and the manufacturer's inspection lot number shall be permanently and legibly marked on each package or container.
 - Each individual fastener that is manufactured under this TSO must be permanently and legibly marked with at least the name or symbol of the manufacturer and part identification. When this is not practical, marking may be accomplished in a manner acceptable to the Administrator.

DISTRIBUTION: FVS-126, A-WB013, A-MF315, A-MCD14, A-FPS-12.7, RLTD;
A-FAC-0MAX, AVN-1 (2 copy)

Copyright 2026- NNI Training and Consulting

122

122




Part 10: Helpful Tips

Copyright 2026- NNI Training and Consulting


(123)

123



Understanding the Standards


- Important Terms:
 - “Shall” Indicates a requirement
 - “Should” Indicates a recommendation
 - “May” indicates a permission
 - “Can” indicates a possibility or capability
 - “Note” indicates information intended to clarify or give guidance



Copyright 2026- NNI Training and Consulting

(124)

124



Helpful Hints

- If you are not sure whether it is the right standard
 - Read the scope carefully (this will often tell what the standard encompasses and what it does not)
 - Read the Title carefully- NAS Standards do not have a scope but their titles are full of detail
 - Make sure all the pieces fit
- When obtaining the standard
 - With the exception of the MIL standards, which are free, all other standards are copy written and must be purchased
 - Do not bother trying to locate or trust a copy that has been posted online. If you need it, purchase it.
 - Beware of the revision dates- standards, especially the commonly used ones, get revised often. If you need the latest revision make sure you know what that is and obtain it. In some cases individuals need older versions- if this is the case, make sure you obtain the right one

Copyright 2026- NNI Training and Consulting

(125)

125



Helpful Hints

- When obtaining the standard
 - Many companies keep up-to-date libraries of standards- be sure to check what your company has available before purchasing a new copy
 - Keep standards on subscription, when possible. This will assure they are available and up-to-date. Many organizations have subscription models- a few include IFI and ASTM.
- When using a standard
 - Read it all thoroughly and carefully- it is easy to miss small but important details
 - Carefully read the requirements in the Procurement Standard
 - Always read the footnotes
 - Remember the Purchase Order supersedes the Procurement Standard

Copyright 2026- NNI Training and Consulting

(126)

126