

# ***The Critical Fastener Facts Every Fastener Supplier and User Should Know***



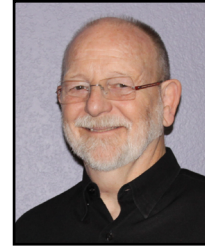
Industrial Fasteners Institute, [www.indfast.org](http://www.indfast.org)

© 2015 INDUSTRIAL FASTENERS INSTITUTE

All rights reserved, in particular rights of translation into other languages. No part of this publication may be reproduced or transmitted in any form or by any means, electronic, microfilm, mechanical, photocopying, recording, or otherwise without the prior written permission of the publisher.

## About the Author:

Joe Greenslade is the Director of Engineering Technology of the Industrial Fasteners Institute. He has been in the fastener industry in a variety of capacities since 1970. Joe held positions in one of the leading fastener companies in the United States in sales, engineering, and management before starting his own firm to provide products and services to fastener manufacturers around the world.



He has served on the fastener related committees of the American Society of Mechanical Engineers (ASME), the American Society of Materials and Testing (ASTM), SAE International, The Research Council for Steel Construction (RCSC) and the International Standards Organization (ISO) since the mid-1980's.

Joe has published over 300 articles on a wide variety of fastener related subjects. He has a dozen patents on fastener related products and measurement instruments. In 2007 he sold his company to become the third Director of Engineering Technology for the Industrial Fasteners Institute.

Joe has been writing and teaching mechanical fastener technology for 45 years. He has answered thousands of fastener technology questions from around the world. As in most things in life, a relatively small body of knowledge provides the answers to the majority frequently asked questions. This book contains the most frequently asked questions and their answers about the specifying, inspecting, and installing of mechanical fasteners. This small book is truly the "Reader's Digest" or "Cliff Notes" of fastener technology.

## DISCLAIMER

Both the author and the Industrial Fasteners Institute ("IFI") have taken reasonable measures to ensure the quality of the data and the other information included in this publication. However, the author and IFI do not guarantee, and assume no responsibility for, the accuracy, correctness, efficacy, or completeness of any information provided herein. The use of and reliance on any information contained herein is voluntary should only be undertaken after an independent analysis of the fastening requirements for the particular application.

TO THE MAXIMUM EXTENT ALLOWED BY LAW, THE INFORMATION CONTAINED HEREIN IS PROVIDED WITHOUT ANY WARRANTIES OF ANY KIND INCLUDING WARRANTIES OF ACCURACY OR REASONABLENESS OF FACTUAL OR SCIENTIFIC ASSUMPTIONS, STUDIES, OR CONCLUSIONS, OF MERCHANTABILITY, OR OF FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL THE AUTHOR OR IFI BE LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING ANY DIRECT, INDIRECT, SPECIAL, CONSEQUENTIAL OR OTHER DAMAGES ARISING OUT OF THE USE, REFERENCE TO, OR RELIANCE ON THE INFORMATION CONTAINED IN THIS PUBLICATION, WHETHER BASED ON WARRANTY, CONTRACT, TORT OR ANY OTHER LEGAL THEORY AND WHETHER OR NOT THE AUTHOR OR IFI ARE ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Reference herein to any specific commercial product, process, or service by trade name, trademark, service mark, manufacturer, or otherwise does not constitute or imply endorsement or recommendation by the author or IFI.

## Table of Contents:

	<b>Page</b>
<b>Introduction</b>	4
<b>Thread Technology</b>	5
<b>Bolt and Cap Screw Technology</b>	8
<b>Socket Head Products Technology</b>	11
<b>Nut Technology</b>	13
<b>Structural Bolting Technology</b>	15
<b>Screw Technology</b>	19
<b>Washer Technology</b>	20
<b>Tightening Technology</b>	21
<b>Fastener Inspection</b>	23
<b>Failure Analysis</b>	25
<b>Index</b>	28

## Introduction

The technology of mechanical fasteners is much more complex and varied than most people understand until they embark on a career where they either supply or specify the use of mechanical fasteners. The standards books that cover the detailed requirements of inch and metric mechanical fasteners cover thousands and thousands of pages from several different standard making organizations.

The 90 questions and answers in this book cover the fastener technology specifics that address approximately 90% of the common questions that arise on a daily basis concerning mechanical fasteners used in the industrial market place. Both mechanical fastener suppliers and users should keep this book within reach if not committed to memory.

Using this as a foundation of fastener knowledge, suppliers and users can launch themselves into becoming a true fastener expert by gathering first hand use of this information over a period of years.

**Technical resources from which the information in this book was taken:**

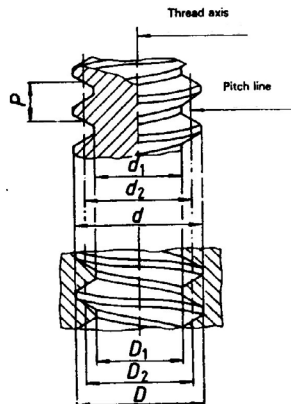
**Industrial Fasteners Institute online store, <http://www.indfast.org/shop/>**

- **9th Edition Inch Fastener Standards Book,**  
[http://www.indfast.org/shop/product\\_detail.asp?cat=8&m=0&id=536](http://www.indfast.org/shop/product_detail.asp?cat=8&m=0&id=536)
- **TORQUE Book for Fasteners,**  
[http://www.indfast.org/shop/product\\_detail.asp?cat=2&m=0&id=523](http://www.indfast.org/shop/product_detail.asp?cat=2&m=0&id=523)
- **IFI Technology Handbook,**  
[http://www.indfast.org/shop/product\\_detail.asp?cat=2&m=0&id=110](http://www.indfast.org/shop/product_detail.asp?cat=2&m=0&id=110)
- **Mechanical Fastening and Joining by Bengt Blendulf,**  
[http://www.indfast.org/shop/product\\_detail.asp?cat=2&m=0&id=524](http://www.indfast.org/shop/product_detail.asp?cat=2&m=0&id=524)
- **IFI Technology Connection,**  
[http://www.indfast.org/shop/display\\_products.asp?cat=4](http://www.indfast.org/shop/display_products.asp?cat=4)

**ISO Metric Fastener Standards Collection,**  
[http://www.indfast.org/shop/product\\_detail.asp?cat=8&m=0&id=191](http://www.indfast.org/shop/product_detail.asp?cat=8&m=0&id=191)

Research Council on Structural Connections, [www.boltcouncil.org](http://www.boltcouncil.org)

## Thread Technology



1. What ASME standard covers inch thread geometry?

***ASME B1.1 is the standard that covers thread geometry for inch standards.***

2. What ASME standard covers thread gages and thread gaging practices for inch threads?

***ASME B1.2 is the standard that covers thread gages and thread gaging practices for inch threads.***

3. What ASME thread standard covers metric thread geometry?

***ASME B1.13M is the standard that covers thread geometry for metric threads.***

4. What ASME standard covers thread gages and thread gaging practices for metric threads?

***ASME B1.16M is the standard that covers thread gages and thread gaging practices for metric threads.***

5. What ASME standard covers inch and metric thread acceptability?

***ASME B1.3 is the standard that covers thread acceptability for both inch and metric threads.***

6. What standard provides the torque values that can be used when going into a 3A or 6h threaded ring gage?

***ASTM F788/788M and ISO 6157-3 are the standards that provide the torque values that can be used when going into a 3A or 6h threaded ring gage.***

7. When 0.0001 inch of plating is applied to an externally threaded fastener how much does the pitch diameter increase?

***The pitch diameter of an externally threaded fastener increases by 0.0004 inches when 0.0001 inch of plating is applied.***

8. When nuts are electroplated up to 0.0003 inches, how much does the pre-plate thread size need to be changed?

***The pre-plate thread size of nuts electroplated up to 0.0003 inches does not need to be changed because electroplating does not “throw” inside holes as much as it covers external surfaces.***

9. What is the standard and rule used when two different thread gages do not agree such that one properly calibrated gage rejects the part and a gage of the same or a different gage type rejects the same parts?

***When two different thread gages do not agree such that one properly calibrated gage rejects the part and a gage of the same or a different gage type rejects the same parts, accept the parts per ASME B1.3, Section 6b.***

10. What thread gaging system is required to use on most industrial grade bolts, screws, and nuts?

***ASME B1.3, System 21 is the thread gaging system that is required for use on most industrial grade bolts, screws, and nuts.***

11. What thread characteristics are inspected when using ASME B1.3, System 21 gaging?

***The thread characteristics that are inspected when using ASME B1.3, System 21 gaging for external threads are the major diameter and functional diameter and for internal threads are the minor diameter and the functional diameter.***

12. What thread characteristics are inspected when using ASME B1.3, System 22 gaging?

***The thread characteristics that are inspected when using ASME B1.3, System 22 gaging for external threads are the major diameter, functional diameter, and pitch diameter and for internal threads are the minor diameter, functional diameter, and pitch diameter.***

13. How many complete turns can a screw or bolt screw into a NOT GO thread gage and be acceptable?

***A screw or bolt can screw into a NOT GO thread gage three complete turns and be acceptable.***

14. How many complete turns can a NOT GO threaded plug gage enter a nut thread and be acceptable?

***A NOT GO threaded plug gage can enter a nut thread three complete turns and be acceptable.***

15. How far can a NOT GO cylindrical plug gage enter a nut thread and be acceptable?

***A NOT GO cylindrical plug gage may not enter a nut thread and be acceptable.***

16. What gage class(es) are used on industrial grade nuts before and after plating:

***The gage classes used on industrial grade nuts before and after plating are 2B for inch nuts and 6H for metric nuts.***

17. What gage class(es) are used on industrial grade screws and bolts before and after plating:

***a. The gage classes used on inch industrial grade screws and bolts before plating is 2A GO/NOT GO and after plating is 3A GO and 2A NOT GO.***

***b. The grade classes used on metric industrial grade screws and bolts before plating is 6g GO/NOT GO and after plating is 6h GO and 6g NOT GO.***

18. What is the difference between a fixed limit gage and an indicating gage, and give an example of each.

***There are two different types of thread gages. They are "fixed limit" and "indicating" gages. An example of a fixed limit thread gage is a threaded ring gage, and an example of an indicating thread gage is a tri-roll thread gage.***

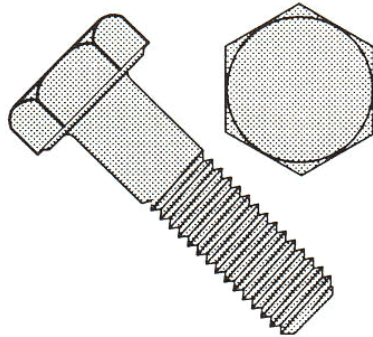
19. What is the length of thread engagement that can generally be used before lead error may cause thread interference during assembly even though both the internal and external threads gage properly?

***The length of thread engagement that can generally be used before lead error may cause thread interference during assembly even though both the internal and external threads gage properly is 1.5 d.***

20. What are the three things that can be tried to stop the galling of stainless bolt and nut threads?

***Three things that can be tried to stop the galling of stainless bolts and nuts are using a different grade of stainless for the mating components, slow down the installation RPMs, and lubricate the bolt and/or nut with thread lubricant.***

## Bolt and Cap Screw Technology



21. What is the standard covering inch bolt and screw Grades 2, 5, and 8?

***SAE J429 is the standard that covers inch bolt and screws Grades 2, 5, and 8.***

22. What is the ISO standard covering metric bolt and screw Property Classes 4.8 ...12.9?

***ISO 898-1 is the standard that covers metric bolt and screws Property Classes 4.8, 8.8, 10.9, and 12.9.***

23. What is the inch standard covering stainless steel hex head cap screws and what are the two most commonly supplied grades?

***ASTM A593 is the inch standard covering stainless steel hex head cap screws with the most commonly supplied grades being Group 1 CW (304) and Group 2 CW (316).***

24. What is the ISO bolt standard covering Property Classes A2 and A4?

***ISO 3506-1 is the ISO bolt standard that covers Property Classes A2 and A4.***

a. What types of stainless materials are designated A2 and A4?

***The types of stainless materials that are designated A2 and A4 are 304 SS and 316 SS respectively.***

b. What does the "-70" represent in the designation A2-70?

***The "-70" in the designation A2-70 represents the minimum tensile strength of 700 MPa.***

25. What is the most commonly used inch standard covering bolts and various cap screws?

***ASME B18.2.1 is the most commonly used inch standard covering bolts and various cap screws.***

26. What are the major differences between hex bolts and hex cap screws?

***The differences between hex bolts and hex cap screws are cap screws have washer faces, Lb dimensions, and chamfered point, whereas bolts do not.***

27. What is the ISO metric standard covering partially threaded hex cap screws?

***ISO 4014 is the ISO metric standard that covers partially threaded hex cap screws.***

28. What is the ISO metric standard covering fully-thread metric hex cap screws?

***ISO 4017 is the ISO metric standard that covers fully-threaded metric hex cap screws.***

29. What is a "Tap Bolt"?

***A "Tap Bolt" is a fully-threaded hex bolt.***

a. What standard specifies its dimensions for tap bolts?

***IFI-199 is the standard that specifies the dimensions for tap bolts.***

b. Most common material grade used for tap bolts?

***ASTM A307 is the most common material grade used for tap bolts.***

30. What is the most commonly used standard and grade used to assemble pipe flanges and what is the material tensile strength?

***The studs and nuts most commonly used for assembling pipe flanges are ASTM A193/A193M, Grade B7 studs and ASTM A194/A194M, Grade 4 or Grade 2H heavy hex nuts.***

31. What dimensional standard covers studs for flange bolting?

***ASME B18.31.2 is the dimensional standard that covers studs for flange bolting.***

32. How do studs for flange bolting length designations and locations differ from other types of studs?

***The difference between the length designations and locations for studs for flange bolting and other types of studs is studs for flange bolting are measured from the first full thread and other studs are measured end to end.***

33. Threaded rods:

a. What dimensional standard covers threaded rod?

***ASME B18.31.3 is the dimensional standard that covers threaded rods.***

b. What is the most common threaded rod material?

***ASTM A307 is the most common threaded rod material.***

c. Where can you find the list of material standards that threaded rods can be made from?

***ASME B18.31.3 has a list of materials that threaded rods can be made from.***

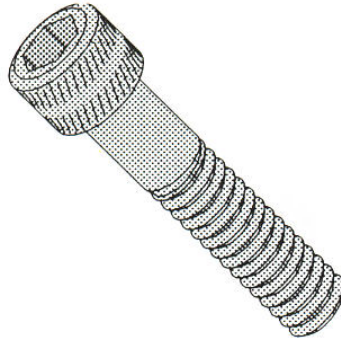
d. What is the one distinguishing difference between a threaded rod and a stud of any style regarding the points?

***The one distinguishing difference between a threaded rod and a stud of any style is that a threaded rod has non-chamfered (sheared) ends and all studs have chamfered points.***

34. What additional process step is required when producing carriage bolts (round head square neck bolts) and special screws and bolts with heads or collars having minimum thickness of 0.5d made of ASTM A307 material?

***Stress relief (875 F min.) is the additional process step that is required when producing carriage bolts (round head square neck bolts) and special screws and bolts with heads or collars having minimum thickness of 0.5d made of ASTM A307 material.***

## Socket Head Products Technology



35. What is the standard covering inch socket head caps screws:

- a. For dimensions?

***ASME B18.3 is the dimensional standard that covers inch socket head cap screws.***

- b. For alloy Steel material standard?

***ASTM A574 is the standard that covers inch alloy steel socket head cap screws.***

36. Where would you look to find the applicable material standards for button heads, flat heads, set screws, and shoulder screws?

***ASME B18.3 refers to the specific ASTM applicable material standards for button heads, flat heads, set screws, and shoulder screws.***

37. When zinc plating socket head cap screws:

- a. What is the inherent danger?

***The inherent danger in zinc plating socket head cap screws is Hydrogen Embrittlement.***

- b. What can be done to lessen the risk of hydrogen embrittlement?

***To lessen the probability of failure from Hydrogen Embrittlement when zinc plating socket head cap screws, bake after plating at 400° F for 14-24 hours and test.***

38. Which socket screw product should be used for fully preloading applications?

***Socket head cap screws are the screw product that should be used for fully preloading applications. Button, flat, and low head socket screws should not be used in fully preloaded (tightened) applications.***

39. Why shouldn't socket button heads and low socket head cap screws be used in applications where pre-loading is required?

***Socket button heads and low socket head cap screws should not be used in applications where fully pre-loading is required because the recess is too small to tighten properly and due to the small head height, they may fail through the recess and head instead of through threads if heavily loaded.***

40. Why should plated or coated socket products never be used in an application outside or in a damp environment?

***Plated or coated socket products should never be used in an application outside or in a damp environment because their hardness is over HRC 39 which makes them susceptible to stress corrosion failure, also referred to as environmental hydrogen failure (EHE).***

## Nut Technology



41. What standard covers grades 2, 5, and 8?

***SAE J995 covers nuts for grades 2, 5, and 8.***

42. What is the inch dimensional standard covering non-locking industrial nuts?

***ASME B18.2.2 is the inch dimensional standard covering non-locking industrial nuts.***

43. What is the inch dimensional standard covering locking nuts?

***ASME B18.16.6 is the inch dimensional standard covering locking nuts.***

a. What are the two types of locking nuts?

***All-metal and Nylon insert are the two types of locking nuts.***

b. Why should all types of stainless steel lock nuts be avoided?

***All types of stainless steel lock nuts have a tendency to gall, preventing proper installation. Consider the use of thread adhesives for locking instead.***

44. What are the two most commonly used material standards for inch stainless nuts?

***ASTM F594 and ASTM A194/A194M are the two most commonly used material standards for inch stainless nuts.***

45. ISO metric nuts:

a. What is the standard for metric steel nut property classes?

***ISO 898-2 is the standard for metric steel nut property classes.***

b. What are the metric nut property classes for hex nuts?

***The metric nut property classes for hex nuts are 4, 5, 6, 8, 10, and 12.***

- c. What do the property class number roughly represent?

***Property class numbers roughly represent proof load capabilities in MPa (PC 8 is 800 MPa proof load rating).***

- d. What is the ISO metric material standard covering stainless nuts?

***ISO 3506-2 is the ISO metric standard that covers stainless nuts.***

46. How do you select a nut grade to match with the bolt or screw it will be used with?

***In order to select a nut grade to match the bolt or screw it will be used with, select a nut with a proof load strength equal to or greater than the minimum bolt tensile strength.***

47. What should be suggested when customers report that the nylon rings are coming out of nylon insert lock nuts while being assembled?

***If a customer reports that the nylon rings are coming out of nylon insert lock nuts while being assembled, tell them do not use impact wrenches, install at 1200 RPM or less and use a bolt or stud with a chamfered point.***

## Structural Bolting Technology



48. What are the four most commonly used structural bolt material standards and what material strength levels are they associated with?

***The most commonly used structural bolt material standards are ASTM A325 and F1852 which are 120 ksi tensile strength, and A490 and F2280 which are 150 ksi tensile strength. These grades are covered in ASTM F3125.***

49. What is the difference between Type 1 and Type 3 structural bolts?

***Type 1 structural fasteners are made from carbon or carbon alloy steels and require coating and/or painting to avoid rusting. Type 3 structural fasteners are made from “weathering steel” that oxidizes to a point and stops, eliminating the need to coat or paint to avoid further rusting.***

50. What is the dimensional standard covering inch structural bolts?

***ASME B18.2.6 is the dimensional standard that covers inch structural bolts.***

51. What are the two styles of structural bolts:

a. Styles?

***The two styles of structural bolts are Heavy Hex and Tension Control (TC).***

b. Which is the most popular and why?

***Tension Control (TC) is the most popular structural bolt because of faster assembly and visual inspection.***

52. “Rocap” test:

a. How is it performed?

***A “Rocap” test is performed using exact bolts, nuts, and washers tightened in a Skidmore (hydraulic) tester, tightening the nut to 10% of the target bolt tension. Then rotate the nut the number of degrees designated in the ASTM F3125 standard. The bolts must not break and once the nut is broken loose, the nut must unscrew by hand.***

- b. What is its primary purpose?

***The primary purpose of a “Rocap” test is to determine if adequate nut lubrication is present to enable proper fastener tightening without failure.***

***According to ASTM F3125, Table 3, Note A, the “Rocap” testing of galvanized assemblies is mandatory. “Rocap” testing may be required by the purchaser by specifying Supplementary Requirement S.4 at the time of enquiry and order for plain or assemblies having other coatings. The test must be conducted using the exact lots of bolts, nuts, and washers, if any, that will be used on the job site.***

- c. Why should all of the exact fastening components be shipped to the job site by the same supplier?

***According to the RCSC standard, when performing a “Rocap” test, all of the fastening components shall be shipped to the job site by the same supplier to assure the exact mating parts will work on the job site.***

53. What is the applicable washer standard for structural bolting?

***ASTM F436 is the applicable washer standard for structural bolting.***

54. What is a “direct tension indicating washer (DTI)”?

***A DTI is a very precisely manufactured washer-like fastener with bumps protruding from one side. When the bolt or nut they are on is tightened, the bumps crush in a controlled fashion that indicates how much tension is in the mating bolt. A feeler gage is inserted between the bumps of the DTI periodically as the bolt is tightened to determine when the proper bolt tension is achieved. The proper tension is indicated when the majority, but NOT all of the gaps between the bumps prohibit the feeler gage from entering.***

- a. What dimensional standard covers them?

***ASME B18.2.6 is the dimensional standard covering “direct tension indicating washer (DTI)”.***

- b. What material standard covers them?

***ASTM F959 is the material standard covering “direct tension indicating washer (DTI)”.***

- c. When installing direct tension indicating washers, how does the assembler know when they are properly installed?

***When installing direct tension indicating washers, the assembler knows when they are properly installed by using a feeler gage more than half.***

55. Structural hex nuts:

- a. What style of nut is used with structural bolts?

**Heavy Hex Nuts are used with structural bolts.**

- b. What is the material standard that covers structural nuts?

**ASTM A563 is the material standard that covers structural nuts.**

- c. What is the most commonly used grade?

**DH is the most commonly used grade of heavy hex nuts used with structural bolts.**

- d. What standard and grade can be substituted for the most commonly used structural nut?

**ASTM A194/194M Grade 2H nut can be substituted for the most commonly used structural nut.**

- e. What dimensional standard covers structural nuts?

**ASME B18.2.6 is the dimensional standard that covers structural nuts.**

- f. What dimensional characteristic must be altered when plating or coating structural nuts? When does this occur in the manufacturing sequence?

**When hot dip galvanizing structural nuts, threads must be tapped oversized after coating and mechanical zinc tapped oversized before plating.**

56. What is the specification that governs structural steel assembly?

**Research Council on Structural Connections (RCSC) is the specification that governs structural steel assembly.**

- a. What is the most commonly used tighten technique used when installing hex structural bolts?

**Turn of nut is the most commonly used tightening technique used when installing hex structural bolts.**

- b. What is a "pre-installation test"?

**A "pre-installation test" is a test performed on a job site using the exact components and assembly technique specified for the structure.**

1. Why is it required?

***A “pre-installation test” is required to demonstrate that the bolts, nuts, and washers on the job site will assemble properly when constructing the structure prior to actual assembly starting.***

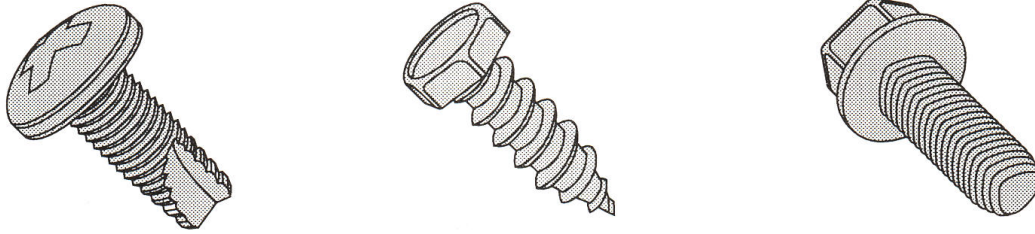
2. Who is required to do the test and when is the test required?

***A “pre-installation test” must be performed and documented by the assembly crew doing the installation.***

c. What should be the relationship of an assembled bolt end to the top surface of a nut in structural bolting?

***An assembled bolt end should be at least flush to the top surface of a nut in structural bolting.***

## Screw Technology



57. What is the dimensional and material standard covering inch machine and tapping screws?

***ASME B18.6.3 is the dimensional and material standard covering inch machine and tapping screws.***

58. What is the most common material and strength of inch machine screws?

***The most common material for inch machine screws is carbon steel with the most common strength of 60,000 PSI.***

59. What must be part of the machine screw description if the user wants a steel machine screw stronger than the common machine screw?

***According to ASME B18.6.3, the term "hardened" must be part of the machine screw description if the user wants a steel machine screw stronger than the standard non-heat treated machine screw.***

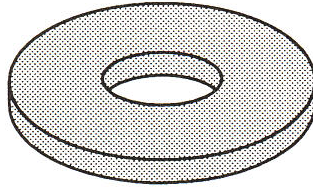
60. List the various types of inch tapping screws:

***The various types of inch tapping screws include thread forming screws Types A, AB, B, C; thread cutting screws Types T (23), BT (25), D (1), F, BF; and thread rolling screws Type TRS.***

61. What two standards cover self-drill screws and what is the difference?

***There are two styles of self-drilling screws covered by both SAE J78 and IFI-113. They are types BSD having spaced tapping screw threads and CSD which have machine screw series threads. The BSD account for approximately 90% of all self-drilling screws.***

## Washer Technology



62. What inch standard covers the requirements for both plain (flat) and over-the-threads lock washers?

***ASME B18.21.1 is the standard that covers non-structural washer requirements and ASTM F436 covers structural washer requirements.***

63. What are the various types of commonly used washers?

***Flat (plain), toothed, and helical (split-lock) are the various types of commonly used washers.***

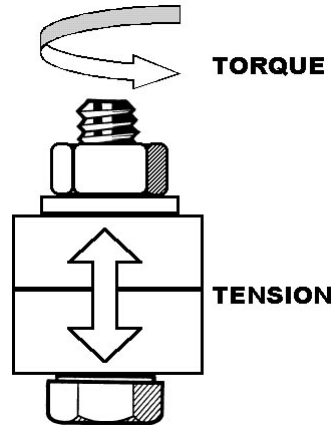
64. What is the most commonly referenced DIN standard covering washers?

***DIN 125 is the most commonly referenced DIN standard covering washers.***

65. Why should suppliers not supply hardened spring lock washers with electroplating?

***Suppliers should not supply hardened spring lock washers with electroplating because they all exceed HRC 39 and are susceptible to hydrogen embrittlement failures.***

## Tightening Technology



66. What is the commonly used formula for calculating tightening torque?

*For Inch pounds use  $T=KDP$   
For Foot pounds use  $T= (KDP)/12$   
For Nm use  $T=(KDP)/1000$*

67. What does each letter in the formula represent

*T= Torque  
K= Friction (nut) Factor  
P= Clamp load (75% of yield strength of bolt)  
D= Nominal diameter of fastener*

68. How are inch pounds converted to foot pound?

*To convert inch pounds to foot pounds, divide inch pounds by 12.*

69. Where do you find “K” factor values?

*“K” factor values can be found in the IFI TORQUE Book for Fasteners or IFI Technology Connection.*

70. What is a reasonable seating torque for most tapping screws?

*A reasonable seating torque for most tapping screws is its torsional strength. If thread stripping or screw breakage occurs, the seating torque should be determined by experimentation.*

71. What is a simple test procedure that can be performed to make a torque recommendation for a given application?

***A simple test procedure that can be performed to make a torque recommendation for a given application is to use exact components and drive 10 pieces to failure. Then, calculate average value and set target at 60% of average failure value.***

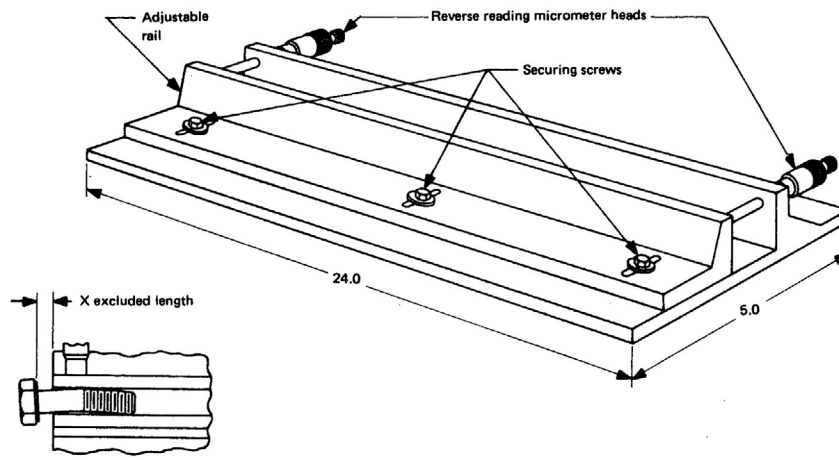
72. What is the answer to the question, “I have a 1/2-13 hex nut, grade 5, zinc plated. How much torque should I apply when seating?”

***When asked how much torque should be applied when seating a 1/2-13 hex nut, grade 5, zinc plated, the answer is that tightening values are based on the strength and finish of the bolt or screw and never the nut.***

73. What is the simplest design change that can be adopted to improving the torque – tension relationship?

***The simplest design change that can be adopted to improving the torque – tension relationship is to seat turning the member on a hardened washer instead of on a softer component surface.***

## Fastener Inspection



74. What is the most commonly used testing standard for inch and metric fasteners bolts, cap screws, nuts, and tension indicating washers?

***ASTM F606 is the most commonly used testing standard for inch and metric fasteners bolts, cap screws, nuts, and tension indicating washers.***

75. What are the two ISO testing procedures for ISO bolts and nuts?

***ISO 898-1 and ISO 898-2 are the two ISO standards covering testing procedures for ISO bolts and nuts.***

76. What are the three most common mechanical tests performed on bolts and cap screws?

***The three most common mechanical tests performed on bolts and cap screws are the hardness test, the wedge tensile test and the proof load test.***

77. What are the two most common tests performed on nuts?

***The two most common tests performed on nuts are the hardness test and the proof load test.***

78. What standards are referenced for test procedures and requirements for locking nuts?

***ASME B18.16.6 is the inch standard referenced for test procedures and requirements for locking nuts. For metric locking nuts, refer to ISO 2320.***

79. What standard covers test requirements and procedures for inch tapping screws?

***ASME B18.6.3 is the inch standard that covers the requirements and procedures for inch tapping screws.***

80. What are the four common tapping screw tests?

***The four common tapping screw tests are torsional strength, ductility, hardness, and hydrogen embrittlement.***

81. What is the primary test used to qualify self-drilling screws?

***The drill-drive time test is the primary test used to qualify self-drilling screws.***

## Failure Analysis



82. When a customer reports fastener failures, what information should be gathered immediately before starting to try to remedy the problem?

***When a customer reports fastener failures the information that should be gathered immediately before starting to try to remedy the problem is:***

***Exact part number***

***Exact lot number***

***Precise description of failure and/or pictures of failed parts***

***Where parts are used***

***How parts are driven and how is tightening controlled***

***A sample of broken and unused parts for analysis***

83. How effective is it usually to propose failure remedies before a definitive “root cause” of the failure is determined?

***It is worthless to propose failure remedies before a definitive “root cause” of the failure is determined. A root cause needs to be discovered before an effective remedy can be proposed.***

84. When a bolt failure has a “necked down” area in the threads:

- a. What is the most likely cause of the failure?

***When a bolt failure has a “necked down” area in the threads, the most likely cause of the failure is tensile overload due to over tightening or the bolt has insufficient strength for the load requirements of the design.***

- b. What is the most likely remedy?

***The most likely remedy is to reduce torque if failure occurs during installation or increase bolt strength if failure is during product use. Check tightening calculation and/or do tightening experiment.***

85. When the fracture surface of a failed bolt exhibits a “shoreline” pattern:

- a. What is the most likely cause of the failure?

***When the fracture surface of a failed bolt exhibits a “shoreline” pattern, the most likely cause of the failure is fatigue.***

- b. What is the most like remedy?

***The most likely remedy is to increase the tightening value.***

86. When a bolt or screw has an intergranular fracture surface immediately under the head or at the first unengaged thread of the bolt or screw:

- a. If the failure occurred within 48 hours of installation, what is the most likely cause?

***When a bolt or screw has an intergranular fracture surface immediately under the head or at the first unengaged thread of the bolt or screw within 48 hours of installation, the most likely cause is hydrogen embrittlement.***

- b. What is a likely remedy?

***This can be remedied by baking the parts at 400° F for 14 or more hours, better yet, change to a finish not subject to hydrogen embrittlement.***

- c. If the failure occurs weeks or months after installation what is the most likely cause?

***When a bolt or screw has an intergranular fracture surface immediately under the head or at the first unengaged thread of the bolt or screw weeks or months after installation, the most likely cause is stress corrosion, also called environmental hydrogen EHE failures.***

- d. What is the most likely remedy?

***This can be remedied by using fasteners with a core hardness less than HRC 39, or paint, coat, or otherwise protect fasteners from the moist environment, redesign joint to prevent fasteners in standing moisture, or do not use dissimilar materials in joint construction.***

87. When a customer complains about bolts and/or nuts vibrating loose:

- a. What is the most likely cause?

***The most likely cause of bolts and/or nuts vibrating loose is insufficient tightening.***

- b. What is the most likely effective remedy for each different cause?

***The most effective remedy is to use correctly calculated higher tightening torque or better determine the correct tightening value experimentally using extra components.***

88. What is the critical hardness above which hydrogen induced failures can occur?

***HRC 39 is the critical hardness above which hydrogen induced failures can occur.***

89. Why should designers avoid applications where dissimilar materials come in contact with one another?

***Designers should avoid applications where dissimilar materials come in contact with one another to avoid potential galvanic corrosion.***

90. What are the two approaches that can be taken to avoid failures when dissimilar materials must be mated with one another?

***The two approaches that can be taken to avoid failures when dissimilar materials must be mated with one another is to select fastener materials that are closer to the component materials on the "galvanic scale", and/or coat/paint the joint to keep moisture away from joint.***

## Index

ASME B1.1	5		
ASME B1.2	5	heavy hex	15
ASME B1.3	5, 6	heavy hex nuts	16
ASME B1.13	5	hydrogen induced	
ASME B1.16	5	failures	27
ASME B18.2.1	8		
ASME B18.2.2	13	IFI-113	19
ASME B18.2.6	15-17	IFI-199	9
ASME B18.3	11	inspection	23
ASME B18.6.3	19, 24	intergranular fracture	
ASME B18.16.6	13, 23	surface	26
ASME B18.21.1	20	ISO 898-1	8, 23
ASME B18.31.2	9	ISO 898-2	13, 23
ASME B18.31.3	9, 10	ISO 2320	23
ASTM A193/193M	9	ISO 3506-1	8
ASTM A194/194M	9, 13, 17	ISO 3506-2	14
ASTM A307	9, 10	ISO 4014	9
ASTM A325	15	ISO 4017	9
ASTM A490	15	ISO 6157-3	5
ASTM A563	17		
ASTM A574	11	"K" factor	21
ASTM A593	8		
ASTM F436	16	nut	13, 17, 23
ASTM F594	13		
ASTM F606	23	pitch diameter	5
ASTM F788/788M	5	pre-installation test	17
ASTM F959	16	Property Class A2	8
ASTM F1852	15	Property Class A4	8
ASTM F2280	15	Property Class 4.8	8
ASTM F3125	15	Property Class 8.8	8
		Property Class 10.9	8
bolt	8, 23	Property Class 12.9	8
cap screw	8, 23	Research Council	
		on Structural	
DIN 125	20	Connections	
direct tension		(RCSC)	17
indicating washer	16	Rocap	15
DTI	16		
failure analysis	25	SAE J78	19
		SAE J429	8
Grade 2	8	SAE J995	13
Grade 5	8	socket head products	11
Grade 2H	17	stress relief	10
Grade 8	8	studs for flange bolting	9
Grade DH	17	System 21 gaging	6
		System 22 gaging	6

T=KDP	21
tap bolt	9
tension control (TC)	15
thread	5
thread acceptability	5
thread inspection	6, 7
threaded rods	9
tightening	21
torque	21
turn of nut	17
Type 1	15
Type 3	15
washer	16, 20
weathering steel	15