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A PRIMER ON FASTENER MARKING

A number of years ago I owned an old John Deere tractor that was clearly showing its age. As I tooled around my yard cutting the grass I noticed that the engine was laboring more and more and it was consistently blowing oily blue smoke from the exhaust. I knew it was time to either retire the tractor or rebuild the engine. Although I had never done it before, I decided I would try my hand at rebuilding the engine.

For anyone that has ever committed to such a project, you know that this is not a simple task. Just about everything has to come off the engine to be able to get inside to the cylinder bore to hone it and replace the cylinder rings. Needless to say, by the time I reached this point I had a collection of components, many of them fasteners spread out across the garage floor.

As it would turn out, this happened to be one of those projects that I quickly realized I was outside my comfort zone. As a result I had to put it aside for a while to regroup and figure out exactly how to best proceed. By the time I got back to it several months had passed since I started. When I finally reached the point that I could put it all back together, I discovered there were several fasteners that had gone AWOL.

What does one do in such a situation? There are several courses of action, the best, perhaps, is to review the parts manual to get an exact description of the needed part and replace it with a genuine replacement part ordered from the original equipment manufacturer. The more expedient method, and the one I dare say most home warriors like myself are apt to employ, is to review any other identical system parts (if they exist) and use the sample to find a suitable replacement. This is where the fastener industry's observance of standards and following head marking requirements is so beneficial. How does one know, however, that they have found a suitable replacement? One of the best ways is to review the head markings of a similar or existing part and replace it with an identical part.

This is not an entirely bad strategy because the head markings convey some critical information. They immediately inform us about critical part information. In the case of standard automotive and industrial fasteners, we can quickly discern the difference between a low and high strength bolt. In the case of aerospace fasteners we usually are provided a part number that we can easily reference to find out a great deal of information about the part. Regardless of the use or industry, therefore, head markings provide a vital role in the functionality of fasteners.

Generally speaking there are two varieties of markings, those that communicate something about the strength, material, or performance capabilities of the fasteners and those that identify the manufacturer or private label distributor who last significantly altered the part. Manufacturer's insignia are unique for each company and often, although not always, a registered trademark promoting brand identity. The performance or strength markings relate to Consensus Standards (standards published by organizations like SAE, ASTM, and ISO). It is so critical that these markings represent the actual strength or performance of the part that in 1990 President George Bush signed the Fastener Quality Act into law making it illegal to falsely represent a part with counterfeit head marking.

There are so many different Consensus Standards out there that the average individual can quickly become overwhelmed with what all these different symbols and head markings mean. To try to cover all the standards out there would be an insurmountable task, but it is certainly feasible to understand what some of the most commonly used standards require regarding head markings, especially those that you interact with on a regular basis. The rest of this article will take a look at a number of the primary Consensus Standards commonly utilized here in North America and consider what they teach us about properly marking fasteners made to conform to them.

SAE J429

SAE J429 is likely the most commonly utilized material standard for inch bolts, screws, and studs. It is from this standard that the terms "Grade 2, Grade 5, and Grade 8" are derived. Grade 2 are low strength fasteners, Grade 5 are medium strength (120,000 psi) and Grade 8 are high strength (150,000 psi). The standard teaches that no internal drive screws or those under ¼ inches in diameter are required to be marked. All fasteners produced to this standard that are 1/4 inch and above require both the grade mark and a manufacturer's identification mark. Typically parts will receive the mark on the top of the head, although provisions exist for certain parts to alternately be marked on the side of the head. Studs are marked on the ends.

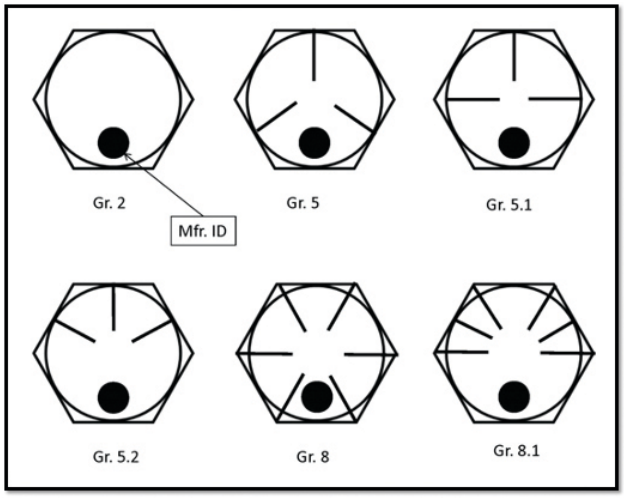

FIGURE 1: SAE J429 HEAD MARKINGS

There are also provisions in this standard for marking of special parts at the option of the manufacturer or if the part is decorative for the marking to be waived entirely by the purchaser.

Figure 1 shows the marking schemes for Grade 5 and Grade 8 variants. Grade 2 may receive a manufacturer's identification but will not receive a grade mark. Grade 5 variations utilize 3 lines and Grade 8 variations utilize 6 lines.

SAE J995

SAE J995 is the companion to SAE J429 and covers the internally threaded product. The nut marking is a little more complicated because there are three different styles depending on either size or how the parts are made. Normally the marking is on the top, although there are exceptions where the mark may be on the side or the flange. Grade 2 does not require either a grade mark or the manufacturer's identification mark. Grades 5 and 8 require both grade and manufacturer's identification marking on hex and hex flange products from 1/4 inch to 1-1/2 inch. Hex jam, heavy hex jam, hex slotted, heavy hex slotted, hex thick slotted, hex thick, and heavy hex do not require either a grade or manufacturer's identification mark.

Figure 2 illustrates the marking for SAE J995 Style A. Style A is applicable to all types and styles of nuts. Style B is applicable only to hex nuts 5/8 inch and larger and places dots (or circumferential lines) in the corners 120° apart for Grade 5 and 60° apart for Grade 8. Style C applies only to nuts fabricated from hex bar and places distinguishing notches in the side face corners of Grade 5 and Grade 8 nuts.

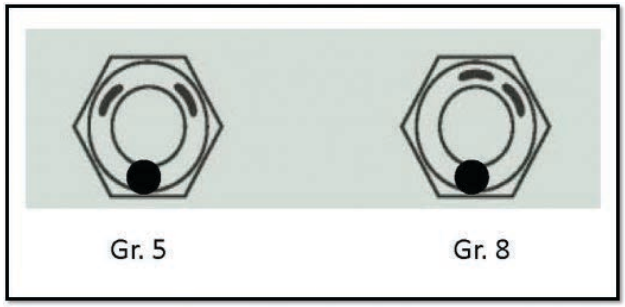

FIGURE 2: SAE J995 STYLE A MARKING (BLACK DOT REPRESENTS MFR. ID)

SAE J1237

SAE J1237 is a standard for metric thread rolling screws. Although this specification provides guidance on a small niche of fasteners, I wanted to point it out as an example of how different standards can and often do use similar methods of referring to and marking parts. In this case, the standard is for metric product but refers to different variants as "Grades" rather than the more typical reference to "Property Class" for metric fasteners. It also contains a "Grade 2" variant that must not be confused with the Grade 2 of SAE J429. In fact a Grade 2 fastener under this standard is case hardened providing very different performance than the through hardened Grade 2 of SAE J429. Figure 3 illustrates the marking scheme for this standard. Grade 2 does not require a grade marking, although it is optional at the choice of the manufacturer. Grades 9 and 10 equal to or above 3mm must be marked with the grade marking on all hex, non-recessed, and non-slotted head styles.

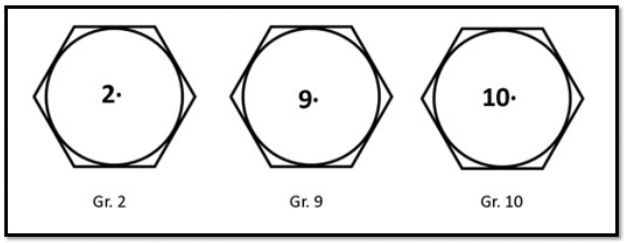

FIGURE 3: SAE J1237 HEAD MARKING

ASTM A307

ASTM A307 is a material standard for carbon steel bolts, studs, and threaded rod achieving a minimum 60,000 psi tensile strength. There are two different grades, A and B. Grade A is for general applications and applies to parts exhibiting a minimum 60,000 psi tensile strength. Grade B is for flanged joint applications and applies to parts that have a tensile strength between 60,000 psi and 100,000 psi. ASTM A307 parts require manufacturer's identification and grade markings on bolts and studs greater than or equal to 3/8" diameter. Figure 4 illustrates a sample grade marking. Grade A is marked "A307A" and Grade B is marked "A307B".

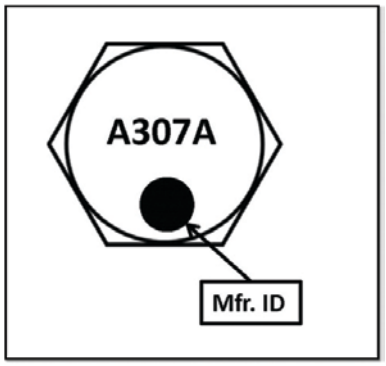

FIGURE 4: EXAMPLE OF ASTM A307 HEAD MARKING

ASTM A449

ASTM A449 is the standard for general use hex cap screws, bolts, and studs. There are two types of materials that can be used to manufacture these parts. Type 1 uses plain carbon, carbon boron, alloy, or alloy boron steel. Type 3 uses weathering steel. Parts equal to or above 3/8 inch diameter require both the manufacturer's identification and grade marking. If the part is a screw or bolt the marks should appear on the top of the head and if they are a stud the grade mark should appear on one end. Figure 5 illustrates a sample A449 marking. Type 1 receives 'A449' and Type 3 'A449'.

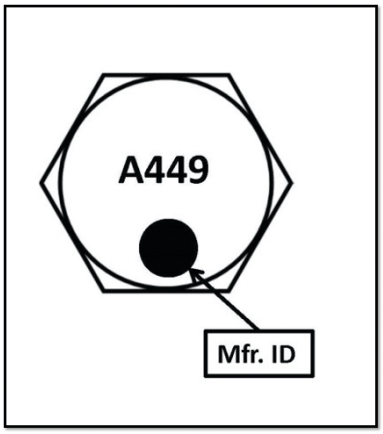

FIGURE 5: EXAMPLE OF ASTM A449 HEAD MARKING

ASTM A354

ASTM A354 is a standard for alloy steel bolts and studs. All products are to receive a manufacturer's identification and a grade mark. Figure 6 illustrates an example of ASTM A354 marking. Grade BC is roughly equivalent to an SAE Grade 5 with strength of 120,000 psi.

It will be marked 'BC'. Grade BD is roughly equivalent to a SAE Grade 8 with strength of 150,000 psi. These will be marked 'BD'.

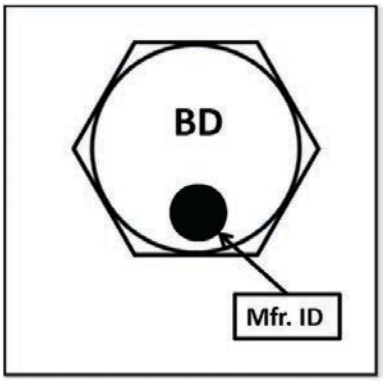

FIGURE 6: EXAMPLE OF ASTM A354 GRADE BD HEAD MARKING

ASTM A574

ASTM A574 is the inch material standard for socket head cap screws. All screws greater than or equal to ¼ inch shall display a manufacturer's identification mark. The 'A574' mark is optional and some manufacturers like to include this in the marking scheme. This may be located either on the side or top of the head at the manufacturer's option. Figure 7 illustrates an example of the marking.

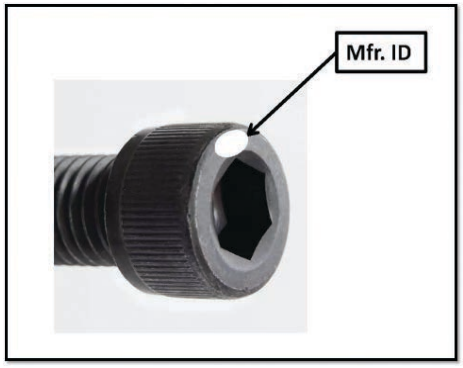

FIGURE 7: EXAMPLE OF ASTM A574 HEAD MARKING (ALSO MAY HAVE A574 OR BE LOCATED ON SIDE)

ASTM F3125/F3125M

ASTM F3125/F3125M is a combination of six previous individual standards, all different variants of high strength structural bolts and structural bolt assemblies. For ease, the new standard adopted the previous standard's identification system and simply refers to them now as "grades". Like the A449 standard, these come in two types, Type 1 bolts are made of carbon and alloy steels and Type 3 are made of weathering steels. Both manufacturer's identification and grade markings are applied to the top of the head. Figure 8 shows an example of how a bolt would be marked. Table 1 shows the different variations. There are two special exceptions; 1. For parts that are short and threaded all the way to the head, a 'T' is added at the end of the grade marking, so that a Grade A325 part that is fully threaded would be marked 'A325T'. 2. For special exceptions such as modified heads or special length an 'S' is added to the end, so that a Grade A490 with a special head would be marked 'A490S'.

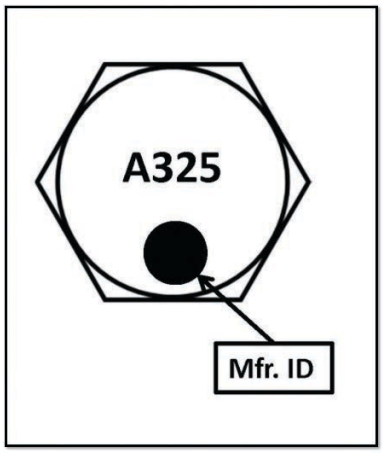

FIGURE 8: EXAMPLE OF ASTM F3125/F3125M HEAD MARKING

Grade	Strength	Type 1 Grade Marking	Type 3 Grade Marking
A325	120,000 psi	A325	A325
A325M	830 MPa	A325M	A325M
A490	150,000 psi	A490	A490
A490M	1040 MPa	A490M	A490M
F1852	120,000 psi	A325TC	A325TC
F2280	150,000 psi	A490TC	A490TC

TABLE 1: ASTM F3125/F3125M GRADE MARKINGS

ASTM A563

ASTM A563 is a standard for carbon and alloy steel nuts. This standard incorporates eight different grades that are a mix of heat treated and non-heat treated varieties. The unheat treated varieties, Grades O, A, and B, are not required to be marked with a manufacturer's identification mark or any distinguishing grade marks unless specified in the order.

Grades C, C3, D, DH, DH3 and hex nuts made to DH3 shall all display a manufacturer's identification mark and the appropriate grade marks. Marks shall be placed on one of the two nut faces. Figure 9 illustrates the marking scheme and Table 2 lists the variations.

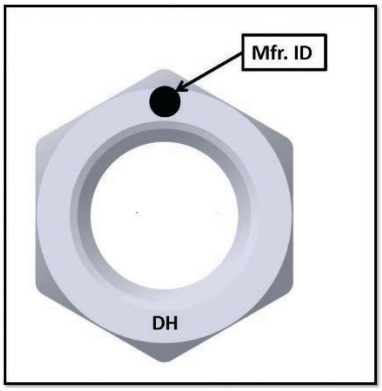

FIGURE 9: EXAMPLE OF ASTM A563 GRADE DH NUT MARKING

Grade	Thermal Treatment	Grade Marking
O	None	None
A	None	None
B	None	None
C	HT	3 Circumferential Marks 120° Apart
C3	HT + Temper	3 Circumferential Marks 120° Apart + Numeral 3
D	HT	D
DH	HT + Temper	DH
DH3	HT + Temper	Heavy Hex = DH3 Hex = HX3

TABLE 2: ASTM A563 GRADE MARKINGS

ASTM A193/A193M

ASTM A193/A193M is for alloy steel and stainless steel bolting options for high temperature service. The marking requirements for this standard get very complicated quickly because there are so many different variations. In fact, this standard has eighty-three different marking variations. Table 4 displays all the different variations.

The standard addresses Ferritic Stainless Steel and Austenitic Stainless Steel varieties. The Austenitic Stainless Steel variants are categorized into eight different classes. Each class represents a slightly different heat treating process. Table 3 describes the differences between the Class Categories.

In this standard a manufacturer's identification and grade mark are required on all sizes of bolt heads and stud ends. For bolts less than ¼ inch, studs less than 3/8 inch (10mm) and ¼ inch (6mm) studs that require more than 3 symbols, the markings shall be agreed to between purchaser and manufacturer.

Grade	Thermal Treatment	Grade Marking
O	None	None
A	None	None
B	None	None
C	HT	3 Circumferential Marks 120° Apart
C3	HT + Temper	3 Circumferential Marks 120° Apart + Numeral 3
D	HT	D
DH	HT + Temper	DH
DH3	HT + Temper	Heavy Hex = DH3 Hex = HX3

TABLE 3: ASTM A193/A193M AUSTENITIC STAINLESS STEEL CLASS CATEGORIES

Grade	Grade Marking
Ferritic SS	
B5	B5
B6	B6
B6X	B6X
B7	B7
B7M	B7M or B7M
B16	B16
B16+	B16R
Austenitic SS	
Class 1	
B8	B8
B8C	B8C
B8M	B8M
B8P	B8P
B8T	B8T
B8LN	B8F or B8LN
B8MLN	B8G or B8MLN
B8CLN	B8Y or B8CLN
B8CLNCuB	B8CLNCuB
B8ML4CuN	B8YY or B8ML4CuN
Class 1A	
B8A	B8A
B8CA	B8B or B8CA
B8MA	B8D or B8MA
B8PA	B8H or B8 PA
B8TA	B8J or B8TA
B8LNA	B8K or B8MLNA
B8NA	B8V or B8MA
B8MNA	B8W or B8MNA
B8MLCuNA	B9K or B8MLCuNA
B8CLNA	B8Z or B8CLNA
B8CLNCuBA	B8ZA or B8CLNCuBA
B8ML4CuNA	B8ZZ or B8MLCuNA
Class 1B	
B8N	B8N
B8MN	B8Y or B8MN
B8MLCuN	B9J or B8MLCuN

TABLE 4: ASTM A193/A193M AUSTENITIC STAINLESS STEEL MARKINGS

Class 1C	
B8R	B9A or B8R
B8RA	B9B or B8RA
B8S	B9D or B8S
B8SA	B9F or B8SA
Class 1D	
B8	B94
B8M	B95
B8P	B96
B8LN	B97
B8MLN	B98
B8N	B99
B8MN	B100
B8R	B101
B8S	B102
B8CLN	B103
B8ML4CuN	B104
B8CLNCuB	B105
Class 2	
B8	B8SH
B8C	B8CSH
B8P	B8PSH
B8T	B8TSH
B8N	B8NSH
B8M	B8MSH
B8MN	B8YSH
B8MLCuN	B8JSH
Class 2B	
B8MZ	B96 or B8MZ
B8	B9
Class 2 C	
B8M3	B9H or B8M3

TABLE 4 CONTINUED: ASTM A193/A193M AUSTENITIC STAINLESS STEEL MARKINGS

ASTM A194/A194M

ASTM A194/A194M is the companion standard to ASTM A193/A193M and is for carbon steel, alloy steel, and stainless steel nuts for high temperature service. Nuts shall be marked on one face representative of the grade type and manufacturing process. Table 5 provides all the variations.

Grade and Type	Hot or Cold Forged	Machined from Bar	Hot or Cold Forged or Machined from Bar and Solution Heat Treated
1	1	1B	-
2	2	2B	-
2H	2H	2HB	-
2HM	2HM	2HMB	-
3	3	3B	-
6	6	6B	-
6F	6F	6FB	-
7	7	7B	-
7L	7L	7BL	-
7M	7M	7MB	-
7ML	7ML	7MLB	-
8	8	8B	8A
8C	8C	8CB	8CA
8CLNCuB	8CLNCuB	8CLNCuBB	8CLNCuBA
8CLN	8CLN	8CLNB	8CLNA
8M	8M	8MB	8MA
8T	8T	8TB	8TA
8F	8F	8FB	8FA
8P	8P	8PB	8PA
8N	8N	8NB	8NA
8MN	8MN	8MNB	8MNA
8R	8R	8RB	8RA
8S	8S	8SB	8SA
8LN	8LN	8LNB	8LNA
8MLN	8MLN	8MLNB	8MLNA
8MLCuN	8MLCuN	8MLCuNB	8MLCuNA
8ML4CuN	8ML4CuN	8ML4CuNB	8ML4CuNA
9C	9C	9CB	9CA
16	16	16B	-

TABLE 5: ASTM A194/A194M MARKING VARIATIONS

ASTM A320/A320M

ASTM A320/A320M is a specification for alloy and stainless steel bolts for low temperature service. Like similar standards, grade and manufacturer's identification marks are required for bolts ¼ inches (6mm) diameter and above and studs 3/8 inches (10mm) and above. The top of the head is the preferred location but the sides can be used as long as the markings don't interfere. Studs can be marked on the ends.

This standard has materials broken into different classes. Class 1 parts are solution heat treated, Class 1A are solution heat treated in the finish state and Class 2 are solution heat treated from strain hardened materials. Table 6 provides all the different marking variations.

Type and Grade	Grade Marking
Ferritic Steels	
L7	L7
L7A	L7A
L7B	L7B
L7C	L7C
L70	L70
L71	L71
L72	L72
L73	L73
L43	L43
L7M	L7M or L7M
L1	L1
Austenitic Steels	
Class 1	
B8	B8
B8C	B8C
B8M	B8P
B8F	B8F
B8T	B8T
B8LN	B8LN
B8MLN	B8MLN
Class 1A	
B8A	B8A
B8CA	B8CA
B8MA	B8MA
B8PA	B8PA
B8FA	B8FA
B8TA	B8TA
B8LNA	B8LNA
B8MLNA	B8MLNA
Class 2	
B8	B8
B8C	B8C
B8P	B8P
B8F	B8F
B8T	B8T
B8M	B8M

TABLE 6: ASTM A320/A320M MARKING VARIATIONS

ISO 898 Part 1

ISO 898 Part 1 is the primary standard used to define mechanical properties of bolts, screws and studs for metric externally threaded fasteners. Whereas the inch standards refer to the different strength categories as "grades", this standard introduces a new term, "Property Class, to describe the different strength categories. The Property Class designation consists of two numbers separated by a decimal point. This nomenclature actually communicates some information for those that know the system. The first number represents 1/100 of the nominal minimum tensile strength and the second number (to the right of the decimal point) is the minimum yield strength determined as a percentage of the nominal tensile strength. The number represents 1/10 of the percentage to be used. Taking Property Class 8.8 as an example, therefore, the nominal tensile strength is 800 MPa and the yield strength is 80% of that or 640 MPa.

ISO 898 Part 1 requires that the manufacturer's identification mark accompany all fasteners exhibiting a Property Class mark. Figure 10 shows an example of a part marked to this standard. The standard also recommends that the manufacturer's Identification number be used on parts that do not exhibit a property class. Hex head parts should be marked if they are 5mm or greater in diameter. The top of the head is the preferred location but the sides or on a flange are also alternatives. Socket head cap screws require marking on 5mm diameter screws and above. The marking may be located on either the top of the head or the side of the head. Studs greater than or equal to 5mm diameter shall be marked if they are Property Class 5.6, 8.8, 9.8, 10.9 and 12.9/12.9. They may be marked on an unthreaded section or on one end. Table 7 shows all the different marking options for full loadability products.

FIGURE 10: EXAMPLE OF ISO 898/1 5.8 HEAD MARKING (BLANK DOT IS MFR. ID)

Property Class	Marking
4.6	4.6
4.8	4.8
5.6	5.6
5.8	5.8
6.8	6.8
8.8	8.8
9.8	9.8
10.9	10.9
12.9	12.9
12.9	12.9

TABLE 7: ISO 898 PART 1 FULL LOADABILITY PROPERTY CLASS MARKINGS

Property Class	Marking
4.6	04.6
4.8	04.8
5.6	05.6
5.8	05.8
6.8	06.8
8.8	08.8
9.8	09.8
10.9	010.9
12.9	012.9
12.9	012.9

TABLE 8: ISO 898 PART 1 REDUCED LOADABILITY PROPERTY CLASS MARKINGS

Some standards, this one included, provide an alternate method of marking. In the case of ISO 898 Part 1 there is an alternate "clock face method" of marking for property classes 8.8, 10.9, and 12.9. Figure 11 shows the alternate method for these three property classes. Essentially the method has the manufacturer's identification mark in the 12:00 position and a second mark in one of the clock face positions. In these three examples, Property Class 8.8 has a dash at the 9:00 position, Property Class 10.9 has a dash at the 10:00 position, and Property Class 12.9 has a second dot at the 12:00 position.

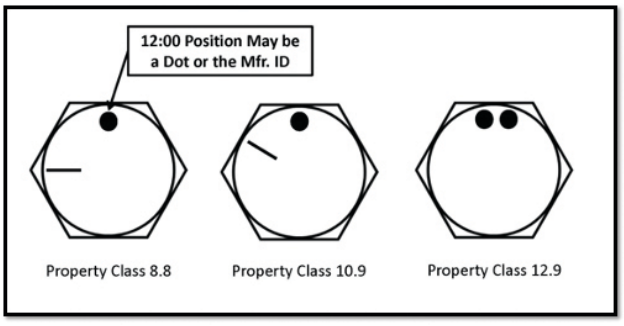

FIGURE 11: ISO 898 PART 1 ALTERNATE CLOCK FACE MARKINGS

ISO 898 Part 1 also has provisions for fasteners with reduced loadability. These are fasteners that are designed in such a way that either the head or the shank is unable to bear the same load as a full loadability fastener. Table 8 shows the different marking options for these parts.

ISO 898 Part 2

ISO 898 Part 2 is the companion standard to ISO 898 Part 1 and is for carbon and alloy steel nuts. The standard requires that all nuts made to the standard display a Property Class symbol and the manufacturer's identification mark. Small nuts may use the alternate clock face marking method. Figure 12 illustrates an example of a nut manufactured to this standard. Table 9 provides the standard marking scheme. Figure 13 shows the clock face alternative method. In this method each nut has either a dot or the manufacturer's identification mark at the 12:00 position and a second symbol (usually a dash) located in a specific clock face position. Take for example a Property Class 10 nut; the dash is located at the 10:00 position on the clock face.

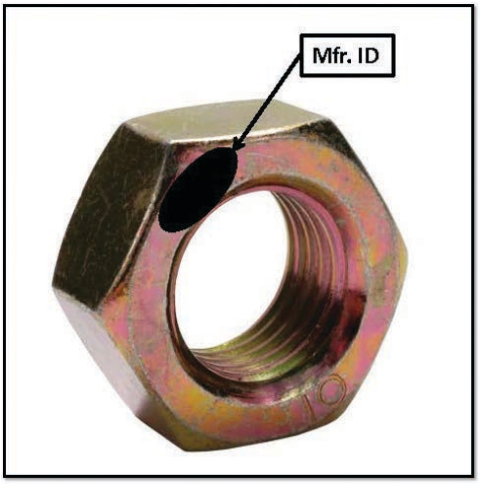

FIGURE 12: EXAMPLE OF ISO 898/2 PROPERTY CLASS 10 NUT MARKING

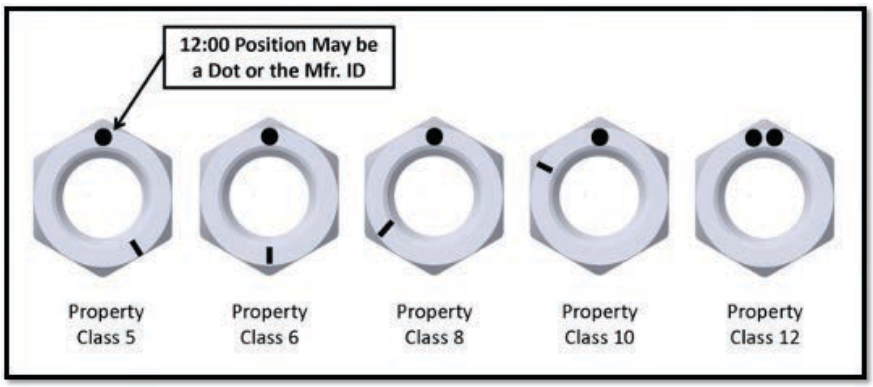

FIGURE 13: ISO 898 PART 2 ALTERNATE CLOCK FACE MARKING

Markings may be indented on the side or bearing surface or embossed on the chamfer or top of the nut. If the part has a flange the markings may also appear on the flange. Other, less often used, symbols such as left handed threads or thin styled nuts are provided for in this standard.

Aerospace Markings

Aerospace parts take marking to an entirely different level than industrial standards. Unlike the examples discussed above which display some combination of strength performance and manufacturer's identification, aerospace and defense parts usually display both the manufacturer's identification and the actual part number. Aerospace part numbers can be quite complex and usually incorporate a base part number and then a series of dash codes and numbers which provide details to diameters, length, material, platings, coatings, recess styles, and a variety of other information. Often the part number marked in to the fastener is only a partial, but still incorporates sufficient information for a user to be able to aptly identify and describe the subject part.

There are a variety of different part numbering strategies in aerospace fasteners. For this reason thorough coverage would require an entire article all on its. Figures 14 and 15, however, illustrate two common examples of aerospace marking.

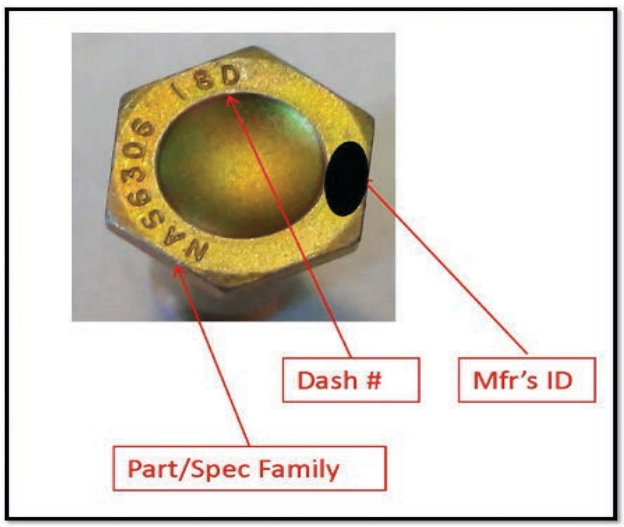

FIGURE 14: EXAMPLE OF AEROSPACE PART NAS6306 HEAD MARKING

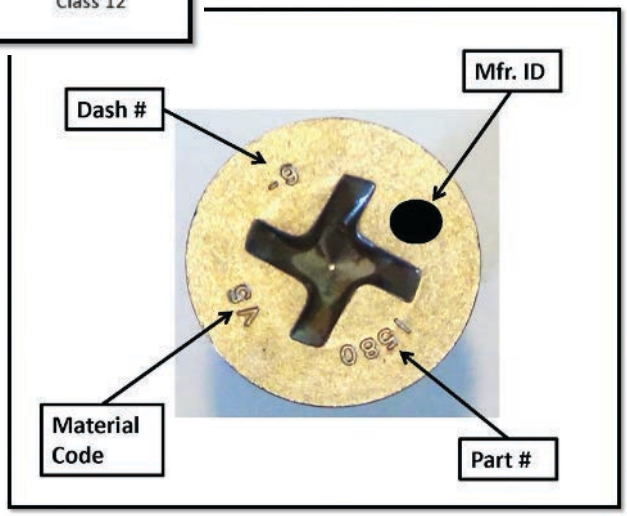

FIGURE 15: EXAMPLE OF AEROSPACE PART NAS 1580 HEAD MARKING

How Do You Identify Markings

Quite often individuals will seek to understand what the markings on the fasteners mean. They may want to confirm that the part is the proper material, desired strength grade, or simply be curious about who made the parts. If one doesn't recognize or know the meaning of a mark, however, how do they find this information out? The answer, of course, is to obtain the right standard or reference resources to find out.

When it comes to strength marks, the seeker will have to look into the standards. This, of course, presupposes that they know something about the standard that the mark is representative of. For many in the fastener industry who work with these standards everyday that might not be a huge challenge but what about someone that knows nothing about standards and fasteners? For example, how does someone who picks up a Grade 8 bolt, sees the six radial lines, figure out their significance? Unfortunately, the only answer is that they have to do some research to figure it out. Hopefully, this article can be a resource to save some of the time that might be associated with trying to find out what a marking represents.

Manufacturer's identification marks pose a different issue. There is no single repository of such marks nor a requirement that all manufacturers register their mark. The closest that we come in the United States is a registry of manufacturer's identification marks with the United States Patent and Trademark Office under the requirements of the Fastener Quality Act. To access a .pdf file of this registry you can go uspto.gov/trademark/laws-regulations/fastener-quality-act-fqa/fastener-quality-act-fqa. Unfortunately this registry is limited and is unlikely to include many of the international marks. Another resource is MIL-HDBK-57. This is a compilation of all fastener suppliers that have been issued a Cage Code for doing business with the US Government. Although this document is probably the most complete resource you will find on manufacturer's identification marks, it is maintained and used by the US Department of Defense and, therefore, is once again going to be without many of the international manufacturers. A free copy can be found from the Defense Logistic Agency's online resource "Assist On-line" website at quicksearch.dla.mil. In past years other organizations have created compilations of manufacturer's identification marks, although I am not aware that any of these are currently up-to-date and actively maintained.

Conclusion

Fastener marking is extremely important to the fastener industry and the users of the product. Users rely on these marks being accurate to assure that the right fastener is being used in their products and assemblies. As this article illustrates, however, there are many different marks and keeping them all straight can be a complicated and daunting task. Knowledge of the proper marking requirements of the fasteners that you manufacture or distribute is, however, an important obligation to your customer and the industry as a whole, since so much is riding on correct and accurate fastener marking.