University of Portland
Donald P. Shiley School of Engineering
EGR 270 – Materials Laboratory

There are literally hundreds of thousands of different engineering materials. Standards play a critical role in materials definition. Numerous professional organizations create and maintain material standards including AISI (American Iron and Steel Institute), SAE (Society of Automotive Engineers), ANSI (American National Standards Institute) and ASTM (American Society for Testing and Materials). In addition to standardized materials, some companies have their own proprietary materials for which they hold patents. For standardized materials, "UNS" (Unified Numbering System) is also used to designate alloys, so many alloys have multiple designations. Engineered materials can be classified as follows:

Metals and alloys
    Ferrous
        Cast irons, cast steels, and powder metals
        Carbon and low alloy steels
        Stainless steels – excellent corrosion resistance in an oxidizing environment – but poor in a reducing environment. Specific alloys have excellent corrosion resistance in specific environments.
        Tool steels – very high hardness and hardenability, and are tough.
        Maraging steels - high strength steels hardened by metallurgical reactions not involving carbon. They are strengthened by precipitation hardening of intermetallic compounds.
    Nonferrous
        Aluminum alloys – poor for elevated temperature, but 1/3 the density of steel. Aluminum parts may cost between 3-10 times more than comparable steel parts.
        Titanium alloys – very good elevated temperature properties, 2/3 the density of steel, titanium parts can cost between 5-20 times more than comparable aluminum parts.
        Alloys of copper, tin, nickel, beryllium, cobalt, magnesium, zinc, lead.
        Refractory alloys: niobium (a.k.a. columbium), tantalum, molybdenum, tungsten, rhenium - excellent heat resistance with melting points over 3000ºF (1650ºC).
        Superalloys - have excellent combinations of properties. Specifically, they exhibit very high strength at high temperature and they have excellent corrosion resistance
        Shape memory alloys – plastically deformed, but return to original shape upon heating.
        Amorphous metals – non-crystalline metals, can have high modulus of elasticity, high strength, and extremely high elastic strain limit.
Ceramics (many types) - may be crystalline or amorphous, high hardness, low conductivity, high temperature.
Polymers: thermosetting, thermoplastic, elastomers
Composites: Metal matrix composites (MMC's), Ceramic matrix composites (CMC's), Fiber-reinforced-plastic composites (FRP).

Engineers must have a good understanding of relevant engineering standards. To give you familiarity with at least one material standard, your assignment for this week is to investigate SAE material standards. You will also be answering questions to help you improve your knowledge of metallurgy. Go to www.sae.org, scroll down to "TOPICS" and click on "Materials" then click on "Standards". Then search for the following standards (the "Text" line is the search line). For each of these three standards, what are their title and scope? ("cutting and pasting" is acceptable – but at least read what you are cutting and pasting). Do NOT purchase any standard. If there are multiple links select the most recent dated standard for that number (you may ignore the letter after the number, for example AMS5338G is AMS5338). As an example: AMS 6381, the title of this standard is: *Steel, Mechanical Tubing, 0.95Cr - 0.20Mo (0.38 - 0.43C) (SAE 4140)*, the scope is: *This specification covers an aircraft-quality, low-alloy steel in the form of mechanical tubing.* What is the title and scope of:
   a) AMSS 5626 (yes, AMSS not just AMS)
   b) AMS 5338

AMS stands for "Aerospace Material Specifications" published by SAE. These specifications were developed for aerospace use; however, AMS materials are not limited to aerospace applications. AMS specifications often have tighter limits on composition than equivalent non-aerospace specifications for the "same" alloy. The link on the course web page (for this week) will help you answer the following questions with respect to AMS 6529B:
   c) What does this specification cover? (Hint: see Section 1.1)
   d) In regard to hardness, what is the application of material covered by this standard?
   e) What is the allowable range for yield strength and tensile strength of this material specified in AMS 6529B? (hint, this may be a trick question).
   f) What are the alloying elements and what are their acceptable ranges?*
   g) What are the impurity elements and what are their acceptable limits?*
   h) What is detrimental about excessive amounts of phosphorous in steel?**
   i) What is detrimental about excessive amounts of sulfur in steel?**
   j) What benefit does carbon provide in steel?**
   k) What benefit does chromium provide in steel?**
   l) What benefit does the molybdenum provide in steel?**
   m) What is the heat treat condition of a steel that meets specification AMS 6529B? (eg. annealed, normalized, or other)
   n) What is meant by "normalized steel" and "fully annealed steel"?***
   o) What is meant by "decarburization"?***
   p) The ASM handbook lists the chemical compositions of many alloys. If you discover a difference in the composition listed in an SAE standard with that shown in ASM handbooks for the exact same alloy (same standard) which one would be correct and why? Hint: which one (ASM or SAE) is the original definition/standard for AMS6529B?

*Hint: typically, alloying elements are specified as a range (eg. between 0.38 and 0.43wt%C) whereas impurities are typically listed as having a maximum amount allowed (such as 0.008wt%S max).
**Hint: you will find the answer in the ASM handbook (available on line, link from course page): Volume I – Carbon and Low Alloy Steel – Classification and Designation of Carbon and Low Alloy Steels – Effects of Alloying Elements. Do NOT use other online resources.
***Hint: the answer is not in the SAE standard. It may be in the course textbook or ASM handbook, or for this, I will allow www… but you MUST cite your sources!