As with most building trades, (electricians, masons, carpenters,) there are time proven materials and a base line method of performing tasks which become “standard practice”. As an aircraft builder, you soon learn that there is also a time proven set of practices and building materials that are commonplace within the aviation community.

If there is one universal commonality among the countless aircraft types, it is the use of steel within the structure in some form or another. From the very earliest of aircraft to even the most current, exotic composite aircraft, there is still steel in some form or another used within the aircraft.

The FAA Aircraft Maintenance Technicians Handbook (FAA-8083-30), Chapter 05, has a great explanation of all of the different types of steels, their chemical composition, their characteristics, and usage.

The Society of Automotive Engineers (SAE) and the American Iron and Steel Institute (AISI), use a numerical index to identify the chemical compositions of the structural steels. Generally, in this system, a four-numeral series is used to designate the plain carbon and alloy steels. The first two digits indicate the type of steel, the second
digit also generally gives the approximate amount of the major alloying element, and the last two digits are intended to indicate the approximate carbon range.

Example: 1010 to 1030 Steels contain carbon in percentages ranging from 0.10 to 0.30 percent is classified as low carbon steel. And another example: 4130 alloy steel also known as Chrome-Molly contains Chromium .8 to 1.1% and Molybdenum .15 to .25% as strengthening agents. It has low carbon content .28 to .33%

Aircraft manufacturers use a wide variety of different steel alloys depending on the necessity in each particular application. Understanding the differences, between all of these types of steel alloys is very important from an aircraft maintenance technician standpoint. However, if we look at experimental aircraft, we see that the overwhelming majority utilize the 4130 chromium molybdenum alloy steel. As a result we see that the majority of suppliers for experimental aircraft only stock the 10XX series, low carbon steels and 4130 Chrome-Molly steel. 10XX series steel is used for low strength requirements at a much lower cost, And the standard for high-strength applications has become the 4130 Chrome-Molly steel. This has greatly simplified the construction applications and reduced the cost for experimental aircraft by allowing suppliers to buy material in greater quantities.

“Molybdenum is a strong alloying element. It raises the ultimate strength of steel without affecting ductility or workability. Molybdenum steels are tough and wear resistant, and they harden throughout when heat treated. They are especially adaptable for welding and, for this reason, are used principally for welded structural parts and

"Heat-treated SAE 4130 tube is approximately four times as strong as an SAE 1025 tube of the same weight and size" *

Figure: 2  1025 Low Carbon (Mild Steel)
assemblies. This type steel has practically replaced carbon steel in the fabrication of fuselage tubing, engine mounts, landing gears, and other structural parts. For example, a heat-treated SAE X4130 tube is approximately four times as strong as an SAE 1025 tube of the same weight and size.*

What this boils down to is this: the average experimental aircraft builder normally only has a couple of types of steel which they may be working with, mild steel and the 4130 chrome-molly steel. The dilemma arises when this aircraft builder is looking at a piece of steel. Is it mild steel or 4130? At first glance they may look identical. You can only imagine the potential hazards with inadvertently welding up a structural component utilizing a piece of mild steel in place of a piece of 4130.

There is a standard shop practice which is used to identify the difference between the different types of metals. We do this by using a standard test called the “Spark Test”. A Spark test is a time honored method for identifying different types of ferrous metal. (Figure: 1)

There are many on-line resources and videos which talk about this spark test method for metal identification. However, the downside is that most of these tests are designed to identify a large variety of metals found in a junkyard for metal salvage purposes. And, as you might imagine, you’re not going to find much 4130 Chrome-Molly steel at your average junkyard. As such, these on-line resources fall short for the average aircraft builder.

So let’s talk about your shop and specifically look at the differences between the 10xx series low carbon steel and 4130 steel when it comes to the spark test.

The spark test is conducted using a standard bench grinder. While applying the metal to the grinding wheel, we can observe the resulting sparks and their characteristics. Each type of metal will produce different results. With experience and knowl-
edge, you will soon become confident in your ability to identify one type of metal from another. When we observe the spark, we will be looking at the length of spark, the color of the spark, and the shape and placement of the Forks, Sprigs, and Starbursts produced by the spark.

1025 Low Carbon Steel: easily identified by the long straight shafts that emanate from the grinding wheel with a minimum of “Forks”, “Sprigs” or “Starbursts”. The spark can vary more in length, and the color of the sparks will be mostly white, and the forks will be more prevalent than sprigs or starbursts. (Figure: 2)

4130 Crome-Molly Steel: easily identified by the abundance of “Starbursts”. The “Starburst” is just as it sounds, a mini explosion of burning metal particles. In fact, this is exactly what produces that same effect in fireworks. Burning different metals and compounds causes different colors of light to be formed. The gold color is primarily from the burning iron, which makes up about 98% of the steel. 4130 has slightly more orange color in the sparks than mild steel. The sprigs or starbursts occur along the entire length of the spark pattern. (Figure: 3)

If it is simply a matter of differentiating between low carbon steel and 4130, the starbursts or the lack of the starburst is a dead giveaway. (Figure: 4)

Of course, you will find slight variations in the identification process primarily from things like the speed and diameter of the grinder, the material or coarseness of the grinding wheel, and even the material alloy or quality from one supplier to another.

Figure: 4 The “Starburst”
We recommend that anytime you purchase new material that you save a small scrap to be used as a baseline test piece. Take a magic marker and label it with the corresponding alloy. Later on, if you’re having trouble deciding what metal you are working with, you can simply go back to your selection of test pieces and match-up the material using the spark test method on both pieces.

This is a very reliable, simple process, and with a little bit of practice, you should have no trouble identifying the different ferrous metals within your shop.

References:
* The FAA Aircraft Maintenance Technicians Handbook (FAA-8083-30) chapter 05

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