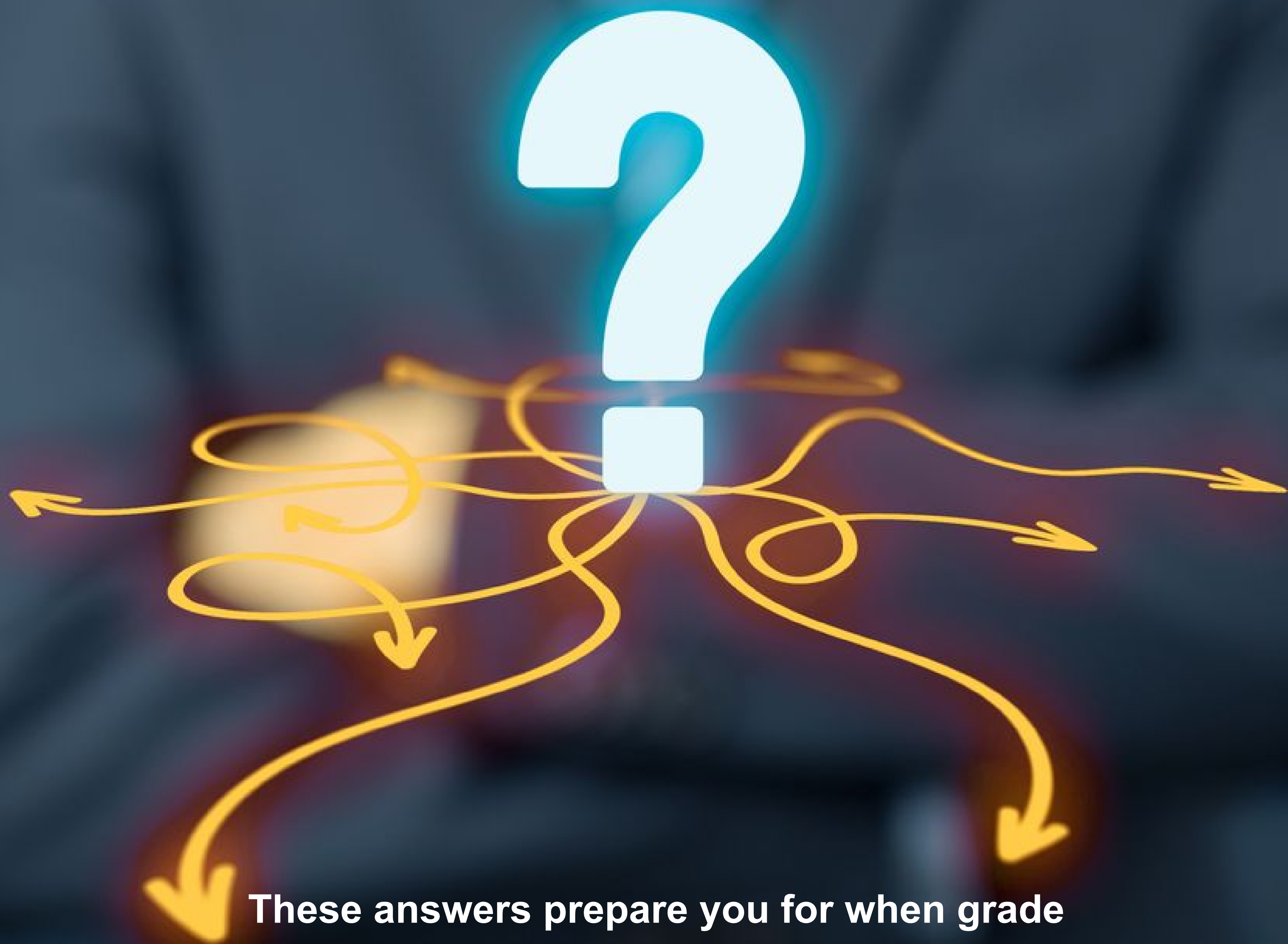
Alternative Grades: 5 Questions to Ask



These answers prepare you for when grade substitution is necessary.

RYERSON

You are sourcing material for a new project ...

The project document specifies the need for stainless steel grade 303 round bar. But your search comes up short—with limited availability of this material. It is suggested that grade 304 as a suitable alternative. Now it's your call on what to do next.

Short of those with a metallurgy degree, your knowledge on the factors that make for a suitable alternative for that 303 round bar may be limited. The truth of the matter is that in many instances there is an alternate grade that will fit your need. But it's a decision that involves a few different variables.

This is where having some help on some basic metal characteristics comes into play. Let's look at five factors that help determine grade selection.

Ultimately, the decision of substituting one grade for another comes down to its end use. But **answering five questions** can be a good starting point in your decision-making process.

Alternative Factors

In instances when your desired grade of metal is not available, there may be an alternate grade that will fit your need. Here are five factors to consider when determining alternative grade selection.

Strength
- Yield: The point at which metal shape deforms
- Tensile: The level at which metal can stretch

Machinability
- Ease at which your metal can be cut into desired final shape and size

Hardness
- Measuring metal's resistance to what is referred to as 'localized deformation'.

Tolerance
- The level of approved deviation of a piece of metal from the target measurement.

Element Content
- All metal is comprised of different elements, each of which impacts can impact the makeup of your metal in different ways.

RYERSON

1. How much stress can the metal withstand?

This is a consideration of metal **strength**. This differs from metal stiffness; in fact, all steel has approximately the same stiffness, but differing levels of strengths.

The level of strength is dependent upon the alloying elements of metal. And this is typically measured in two forms:

Yield strength: Here we are looking at the strength of a metal's shape; measuring the point at which it will begin to deform. In other words, if you apply a level of stress that is less than its yield strength, the metal will be able to return to its original shape once the stress has been eliminated. Applying stress beyond the yield strength means permanent deformation of the metal.

Tensile strength (also referred to as ultimate strength): This measures the level at which metal can be stretched before it breaks. Divide the area of the material being tested by the stress placed on it in order to determine the tensile strength. This ultimately becomes an important measure of a metal's ability to perform under the stress of its end use.

Factored together, these two measures help determine the strength of your grade. This is an important consideration. Without the required strength, you run the risk that your end product will not perform up to the standards of its intended use, resulting in catastrophe for the case of some applications.

Shape

Yield strength looks at the strength of a metal's shape, measuring the point at which it will begin to deform.

Stretch

Tensile strength (also referred to as ultimate strength) measures the level at which metal can be stretched before it breaks.

2. Can the metal can be cut into a desired final shape and size with ease?

With this question, we are talking about **machinability**. Metals that possess good machinability can be cut with little power—ultimately reducing the stress and wear on the tooling equipment—and achieve a good finish.

The machinability of the metal will depend on its physical properties and the cutting conditions. Typically, machinability will be expressed as either a percentage or normalized value.

3. How well will metal hold-up against friction?

Hardness measures a metal's resistance to what is called 'localized deformation'. This is done by running tests to induce various methods of deformation such as abrasion or indentation. Two widely used tests for hardness are:

Rockwell Hardness: This scale has been in existence since 1914 and is based on the indentation hardness of the metal. It measures the depth of penetration by an indenter into the surface. The hardness is inversely proportional to the depth of the penetration.

There are multiple versions of the Rockwell Hardness Scale, most notably Rockwell C, which is good for measuring hardened metal, and Rockwell B, which is a good measure for softer metal. These measures will be indicated by a number, accompanied by a set of letters. For example, 65 HRC (Rockwell C) or 75 HRB (Rockwell B).

Brinell Hardness: In existence since around 1900, this is considered the first widely used and standardized test for metals. In this test, a hard steel or carbide ball is used as an indenter to the piece of metal. The value is obtained by dividing the applied load (in kilograms) by the surface area (in square millimeters) of the result force.

It is important to understand the conversion between these two scales. In addition, you can also refer to ASTM A370, sections 16-19, which describes the hardness testing procedures along with descriptions of the various hardness testing equipment and equations.

Brinell *	Rockwell C##	Rockwell B^	Rockwell A#
745	65.3	-	84.1
712	-	-	-
682	61.7	-	82.2
653	60.0	-	81.2
627	58.7	-	80.5
601	57.3	-	79.8
578	56.0	-	79.1
555	54.7	-	78.4
534	53.5	-	77.8
514	52.1	-	76.9
495	51.0	-	76.3
477	49.6	-	75.6
461	48.5	-	74.9
444	47.1	-	74.2
429	45.7	-	73.4
415	44.5	-	72.8
401	43.1	-	72.0
388	41.8	-	71.4
375	40.4	-	70.6
363	39.1	-	70.0
[illegible]	[illegible]	[illegible]	[illegible]

Full list available in digital version by scrolling on this chart.
*No. 10-mm Tungsten Carbide Ball, 3,000kg Load
##Scale, 150kg Load, Brake Penetration
^Scale, 100kg Load, 1/16 inch diameter ball
Scale, 60kg, Load, Brake Penetration

4. How thick should the metal be?

Tolerance is a measure of metal thickness. Tolerance is the level of approved deviation of a piece from the target measurement. For example, if you need a carbon bar that is 1.5 thick, a tolerance level of +/- 1 means that a piece that comes one inch above or below that measurement would still meet your specs.

As you can imagine, there are multiple reasons for having tight, consistent tolerances. One in which you may not be considering is the ability to ensure that your piece of metal will be compatible with other components in use. In other words, being certain that your piece will fit together nicely with other components. Going too far outside the specified tolerance level could result in added machining work to get the parts to fit together—and ultimately, added waste on a project.

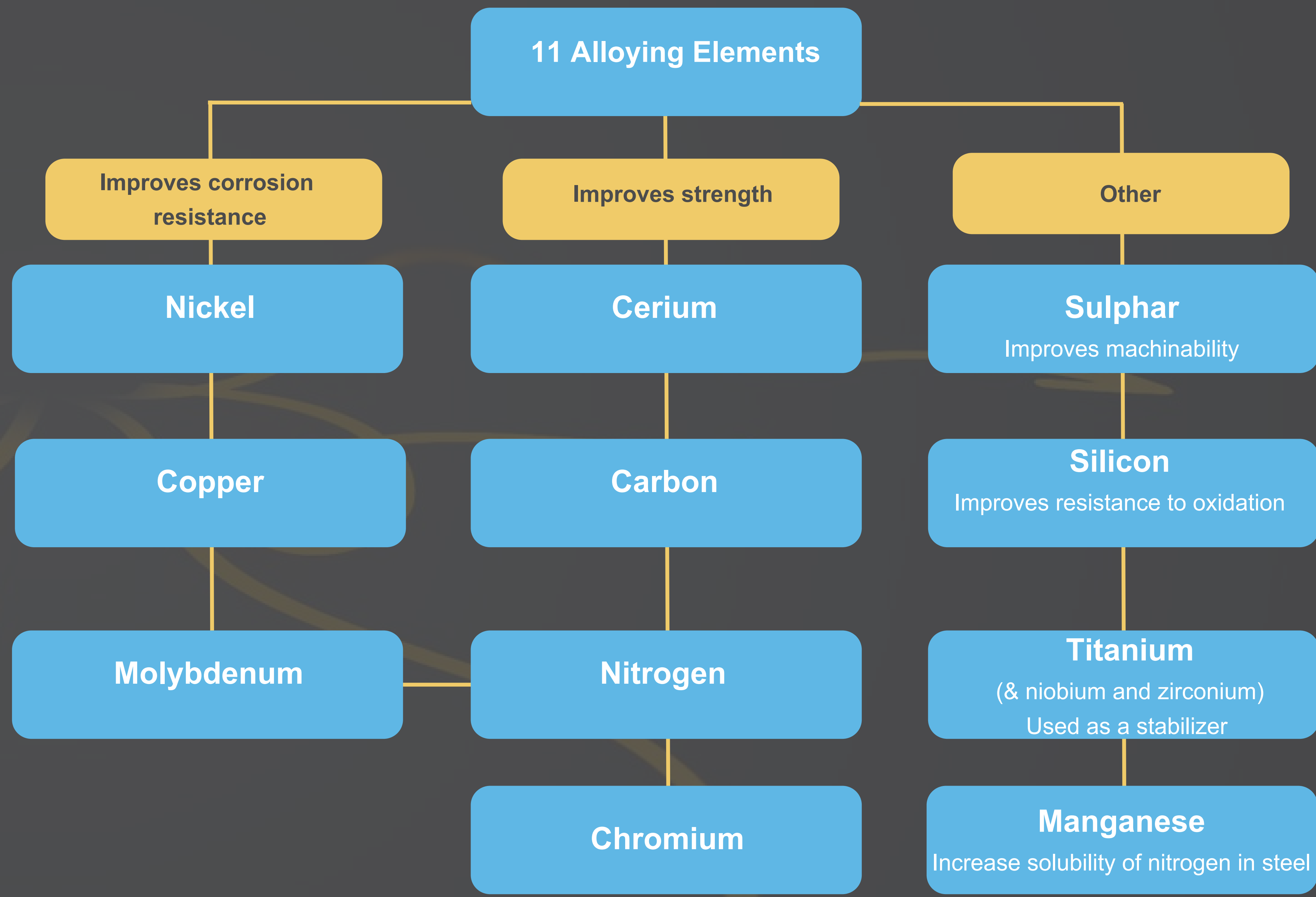
Tolerance level is necessary since metal production can often be an imperfect process. Minor deviations will occur during metal production.

5. What is the make-up of the material?

All metal is comprised of different **alloying elements**, all of which impact the material in different ways. This becomes important when you consider things like the environment in which the end application will be used. For example, those that are exposed to a high rate of moisture must exhibit a strong resistance to corrosion.

Let's look at stainless steel, for example. A basic rule of thumb says that the higher the chromium levels contained within the stainless steel, the higher the corrosion resistance. All stainless steels are iron-based alloys containing at least 10.5% chromium. The rest of the makeup is defined by various alloying elements, which control the microstructure of the alloy.

Among the five families of stainless steels, austenitic is the most resistant to corrosion. This is related to the fact it has high chromium levels. Its corrosion performance can even be adjusted to suit different environments through the adjustment of alloying elements—for example, varying the carbon or molybdenum levels. This means that should you need to make a substitution, it's advisable to stay within the austenitic stainless family in order to maintain the level of corrosion resistance.



Source: International Stainless Steel Forum