

# TOOL STEEL GUIDE

MACTECH PORTABLE MACHINING SOLUTIONS

## Tool Steel Data

Mactech cutting machines are available with different types of tool steel cutting bits. Our most common tool steel materials are M-2 high-speed steel for general cutting, and T-15 high-speed steel for difficult to machine materials. Other tool steels are available for special applications. Contact Mactech for advice on which tooling is best for your application.

### M-2 High-speed Tool Steel

A general purpose molybdenum-type high speed steel, exhibiting well-balanced toughness, wear resistance, and red hardness properties. Commonly used in cold-cutting applications involving high speed and light cuts.

Typical Uses:

- Broaches
- Drill Bits
- Reamers
- Milling Cutters

### T-15 High-speed Tool Steel

A tungsten type super high-speed steel containing high vanadium for excellent abrasion resistance, and cobalt for good red hardness. Commonly used for difficult to machine materials where high frictional heat is present.

Typical Uses:

- Broaches
- Milling Cutters
- Shaping Cutters
- Drill Bits

## Tool Steel Terminology

Abrasive Wear	The loss of material due to hard particles moving against, and reducing softer particles	Charpy V-notch Test	A pendulum-type swing impact test in which the specimen with a V-notch is supported at both ends as a simple beam, and broken by the swinging pendulum. The energy absorbed, as determined by the subsequent rise of the pendulum, is a measure of impact toughness strength, or notch strength.
Adhesive Wear	The displacement of material resulting from two materials sliding against one another while under pressure, then redeposited on one surface, leaving pits and surface projections.	Chipping	The fracture and subsequent breakage of steel due to lack of toughness.
Alloy	A material that is dissolved into another metal in a solid solution. Also, a material that results when two or more elements combine in a solid solution.	Cold-work	Plastic deformation of steel at a temperature low enough to ensure strain hardening. Also, a group of tool steel grades chemically enhanced to perform at temperatures below 800° F.
Annealing	The heating and controlled cooling of steel for the purpose of removing stresses, softening, refining its structure, or changing ductility.	Compressive Strength	The ability of a tool steel to resist permanent deformation when a load is applied axially. When a load is applied in compression on a tool steel, the tool will compress in the longitudinal direction and expand outward. When the load is removed, the tool steel will return to its original size and shape. If the tool steel doesn't return to its original dimensions, the load has exceeded the tool steel's compressive strength.
Austenite	The metallic, non-magnetic solid solution of steel. This phase is achieved by heating the steel to above its critical transformation temperature to dissolve the alloying elements into the iron matrix.	Corrosion	The gradual chemical or electro-chemical attack on steel by atmospheric moisture or other agents, resulting in rust or tarnish.
Billet	A solid, semi-finished round or square ingot that has been hot-worked by forging or rolling.	Critical Temperature	The temperature at which austenite transforms to martensite. This is the stage of the heat-treating process when hardening of the steel occurs.
Breakage	The premature failure of a tool by cracking, or complete failure of the tool.	Inclusions	Undesirable non-metallic elements occurring in metals, such as oxides, sulphides, and silicates.
Carbide	A chemical compound combining carbon and another metallic element. Produced for the purpose of providing wear resistance in steels, such as vanadium carbide or chromium carbide.		



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Ingot	A steel casting that is formed when molten steel solidifies in a mold. The ingot is reheated and rolled into slabs, plates, blooms, or billets for processing into bars and sheets.	Reduction of Area	The percentage difference between the original cross-sectional area and that of the smallest area at the point of rupture.
Machinability	The steel's ability to be turned, milled, or shaped by mechanical means. Ratings for tool steels are based on the ease of machining W-1, indicated as a percentage of W-1 machinability.	Residual Stress	Stresses resulting from non-uniform plastic deformation or thermal gradients. Excessive cold-working, or drastic temperature differences from quenching or welding may cause residual stress.
Martensite	The resulting maximum hardness micro-structure acquired from the transformation of the softer austenite micro-structure. Steel must undergo this fully hardened stage before it can be tempered into a usable tool.	Rockwell Hardness	A measure of a hardened tool or high-speed steel, based on the steel's resistance to indentation.
Mechanical Properties	The properties of steel that include modulus of elasticity, tensile strength, elongation, hardness, and fatigue limit. These properties indicate the steel's suitability for mechanical applications.	Segregation	The chemical separation that can occur during the cooling of the molten metal into the ingot form.
Metallurgy	The science of the extraction of metals from their ores, and the application of those raw elements for their intended use.	Stainless	Designates the class of steels with the ability to resist corrosion from exposure to acids. High levels of chromium or nickel are added to the alloy to provide the necessary corrosion resistance.
Micro-structure	The arrangement of atoms in steel. A ground, highly polished and etched picture of a sample which reveals the micro-structure is referred to as a photomicrograph.	Strain	Deformation of a material produced by an outside force.
Modulus of Elasticity	The ratio within the limit of elasticity of the stress to the corresponding strain. The stress in pounds per square inch is divided by the elongation in fractions on an inch, for each inch of the original length of the test sample.	Stress Relieving	Steel is heated to a temperature below its transformation temperature for a set amount of time, and the steel is allowed to cool to room temperature to minimize the development of new stresses.
Nitriding	The process of adding nitrogen to a steel alloy by heating the metal while in contact with ammonia gas, or other nitrogenous material. This produces a surface hardness. Nitriding is performed at 935° F to 1000° F.	Tempering	The process of reheating quenched steel to a temperature below the transformation temperature for a set amount of time. The steel is allowed to cool to room temperature. This process changes the hardness, increases the toughness, and reduces stress in the steel.
Oxidation	Exposure of steel to oxygen. Staining and discoloration (rust) can result from exposure to the atmosphere. Scaling and decarburization can result from exposure to oxygen at high temperatures.	Tensile Strength	The amount of maximum amount of pressure, in pounds per square inch, that a material will carry before breaking under a slowly applied, gradually increasing load, during a tensile test.
Plastic Deformation	Deformation of a material that remains after the removal of the load which caused it.	Tool Steel	A class of steel melted in an electric furnace, to assure cleanliness and homogeneity, that includes high carbon and alloy content. These steels are characterized by high hardness and resistance to softening at elevated temperatures. These special steels are to be used as tools to form other materials.
Quenching	The process of rapidly cooling steel to obtain the fully hardened martensite micro-structure, by immersing the steel in a quenching media. Quenching media include salt brine, water, oil, or air. The intensity of the quench is determined by the temperature, volume, and velocity of the media.	Toughness	The ability of a metal to absorb energy and plastically deform before fracturing. Typically measure by the energy absorbed in a notched impact test.
Red Hardness	The steel's ability to resist softening at elevated temperatures over extended periods of time.	Transverse Toughness	The steel's ability to flex in a sideways direction, while maintaining the ability to return to its original shape, without breaking or cracking.



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