

## Glossary of Steel Fittings and Flanges Terms

**Alloy Steel** - All steels contain carbon and small amounts of silicon, sulfur, manganese and phosphorus. Steels which contain intentional additions of elements other than these, or which exceed 0.60% silicon, or 1.65% manganese and/or 0.60% copper, are termed alloy steels.

**Annealing** - A softening heat treatment. (See heat treatment)

**Austenite** - The FCC structure of steel, known also as gamma.

**Austenitic Stainless Steel** - Low carbon, iron-chromium-nickel stainless alloys containing sufficient nickel to provide an austenitic (FCC) structure at normal temperatures. These alloys usually cannot be hardened by heat treatment, but can be hardened by cold working. They are normally non-magnetic, but sometimes become slightly magnetic on cold working. These have 2xx or 3xx designations. There are a few precipitation hardening grades.

**Average Wall** - See dimensions.

**Bevel** - An angular cut on the I.D. or O.D. of a tube, fitting, or flange welding end.

**Billet** - As used in the manufacture of flanges, a round or RCS (Round Corner Square) bar with dimensions and other characteristics suitable for forging into flanges.

**Bloom** - A semi-finished piece of steel, resulting from the rolling or forging of an ingot. A bloom is square or not more than twice as wide as thick, and usually not less than 36 sq. in. in cross-sectional area.

**Bright Anneal** - A final anneal in a controlled atmosphere to retain a shiny cold rolled finish. (See heat treatment)

**Brinell Hardness** - A common hardness test (ASTM E10). The tensile strength of a steel (ksi) is approximately one half of the Brinell Hardness.

**Camber** - The amount of curvature or deviation from exact straightness over any specified length of tubing.

**Carbide** - A compound consisting of carbon and other elements; the most common carbides in steel are iron and chromium carbides.

**Carbide Precipitation** - A phenomenon of carbides coming out of a solid solution, occurring in stainless steel when heated into the range of 800-1600 degrees Fahrenheit. (Chromium Carbides Precipitation)

**Carbon Steel** - A steel consisting of essentially iron, carbon, manganese, and silicon.

**Carburizing** - Adding carbon to the surface of iron-base alloys by heating the metal below its melting point in contact with carbonaceous solids, liquids or gases. Desired hardness and toughness properties are developed in the high carbon "case" by quenching and tempering.

**Cementite** - Iron carbide, a constituent of steel.

**Charpy Impact Test** - A test for toughness, involving an impact test on a notched specimen (ASTM E23).

**Check Analysis** - An analysis of the metal after it has been rolled or forged into semi-finished or finished forms. It is not a check on the ladle analysis, but is a check against the chemistry ordered.

**Chloride Stress Cracking** - Cracking under a sustained stress in a chloride-containing environment. Austenitic stainless steels may be susceptible.

**Coefficient of Thermal Expansion** - A physical property value representing the change in length per unit length, the change in area per unit area or the change in volume per unit volume per one degree increase in temperature.

**Cold Drawing** - A process in which tubing is drawn at room temperature through a die and over a mandrel to achieve its final size. It may provide a better surface finish, closer tolerances, lighter walls, smaller diameters, longer lengths, or a different combination of mechanical properties than those possible through hot finishing or direct welding.

**Cold Working** - Permanent plastic deformation and work hardening of a metal below its recrystallization temperature.

**Conditioning** - The removal of surface defects (seams, laps, pits, etc.) from steel. Conditioning is usually done when the steel is in a semi-finished condition (bloom, billet, slab). It may be accomplished, after an inspection, by chipping, scarfing, grinding, or machining.

**Corrosion** - Chemical or electrochemical deterioration of a metal or alloy.

**Galvanic Corrosion** - Corrosion associated with the presence of two dissimilar metals in a solution (electrolyte). In principle, it is similar to bathtype plating in the sense that the anode surface has lost metal (corroded).

**Intergranular Corrosion** - Corrosion which occurs preferentially along the grain boundaries of the alloy.

**Pitting Corrosion** - Non-uniform corrosion usually forming small cavities in the metal surface.

**Corrosion Resistance** - The ability to resist attack by corrosion.

**Creep Strength** - The constant nominal stress that will cause a specified quantity of creep in a given time at a constant temperature. It is a measure of a product ability to withstand prolonged stress or load without significant continuous deformation.

**Critical Temperature** - The temperature that must be exceeded to transform the steel structure to austenite. It is likely to be important when metals are used above about a half of their absolute melting temperature (above about 600 Deg. C in steels).

**Decarburization** - The loss of carbon from the surface of an iron base alloy as the result of heating in an environment which removes the carbon. In medium or high carbon steels, decarburization leads to a pronounced lowering of the fatigue limit.

**Density** - The mass per unit volume of a substance, usually expressed in the steel industry in pounds per cubic inch.

## **Dimensions**

**O.D.** - Outside Diameter. Specified in inches and fractions of an inch, or inches and decimals of an inch, or in the metric system.

**I.D.** - Inside Diameter. Specified in the same units as the O.D.

**Wall** - Wall Thickness or Gage. Specified in either fractions or decimals of an inch or by a "wire gage" number, and/or "schedule" number.

**Nominal** - The stated value of the O.D., I.D., or wall dimension as used in discussion and in tables. It need not be the theoretical (actual) size. A 1.5 inch standard pipe has an O.D. of 1.61 inches.

**Maximum and Minimum** - The stated permissible dimensional limits.

**Basic Size** - The exact theoretical size.

**Minimum Wall** - Generally, the lightest wall permitted within specified tolerances. A "minimum wall tube or fitting" is one whose wall thickness is not permitted to fall below the specified nominal measurement.

**Average Wall** - A tube or fitting whose wall thickness is permitted to range over or under the specified nominal wall measurement within certain defined tolerances.

**Ductility** - The ability of a tube to deform plastically. Frequently, elongation during tensile testing is used as a measurement of this property.

**Duplex Steel** - The designation used for certain chromium/nickel/moly steels which exhibit microstructures consisting of ferrite zones in an austenitic matrix at ordinary temperatures. Duplex steels retain much of the formability of the austenitic grades but may have twice the yield strength and the chloride stress cracking resistance of the ferritic grades.

**Dye Penetrant Inspection** - A simple sensitive non-destructive test employing dye or a fluorescent chemical and sometimes black light to detect defects open to the surface.

**Eccentricity** - The displacement of the I.D. of the tube with respect to its O.D. Eccentricity results in the variation of wall thickness normal to seamless tubing.

**Eddy Current** - Non-destructive testing method using eddy current flow for the purpose of recognizing a surface or near surface defect in the piece being tested.

**Elastic Limit** - A measure of the maximum stress that may be applied to a product without leaving a permanent deformation or strain after the stress is released.

**Electric Furnace Process** - One of the common methods used for melting and refining stainless and some alloy steels. It involves the use of electric power as the sole source of heat, thereby preventing contamination of the steel by impurities in the fuel as in other melting processes.

**Electric Resistance Welded Tubing** - Tubing made from strip by electric resistance heating and pressure, the strip being part of the electrical circuit. The electric current, which may be introduced into the strip through electrodes or by induction, generates the welding heat through the electrical resistance of the strip.

**Elongation** - The amount of permanent stretch, usually referring to a measurement of a specimen after fracture in a tensile test. (ASTM E8) It is expressed as a percentage of the original gage length, which should be specified.

**Endurance Limit** - The maximum stress below which a material is presumed to endure an infinite number of stress cycles. This applies to carbon or low alloy steels. Otherwise a specific number of cycles, usually 10 is stated.

**Etch Test** - Exposure of a specimen to acid attack for the purpose of disclosing the presence of foreign matter, defects, segregation pattern, or flow lines.

**Extrusion** - Production process in which steel is forced by compression through a die into solids (round or special shape) or through a die and over a mandrel to form a tubular shape. An analogy is squeezing toothpaste from a tube.

**Fatigue Limit** - (Synonymous with Endurance Limit)

**Ferrite** - The normal room temperature structure of iron and steel, BCC; also called alpha.

**Ferritic Stainless Steels** - The designation used for straight chromium stainless steels which possess the microstructures consisting mainly of ferritic (BCC) structure at ordinary temperatures. Ferritic stainless steels are divided into two classifications; hardenable, and non-hardenable. The hardenable grades will exhibit a martensitic microstructure when rapidly cooled. These steels have 4xx designations.

**Finish** - In the steel industry, refers to the type of surface condition desired or existing in the finished product.

**Finish Machine Size** - Normally specified in terms of the maximum machined O.D. and the minimum machined I.D. as applied to tubular parts. Finish machine size represents the size of the part as it comes from the final machining operation. From this size the forging mill can calculate a forging size, which will be guaranteed to clean up upon machining.

**Forging** - A general term to describe the shaping of metal by hammering or squeezing, usually in a die, usually at hot working temperatures.

**Fracture Strength** - As usually related to the tensile test, fracture strength or true breaking strength is defined as the load on the specimen at the time of fracture.

**Fracture Toughness** - (K<sub>c</sub>) A material property, measurable in the lab, which correlates the stress needed to break a high strength material, with the size of any flaw present.

**Full Anneal** - To put in the fully soft condition. (See heat treatment)

**Gages, Gauges** - A measurement of thickness. There are various standard gages such as United States Standard Gage (USS), Galvanized Sheet Gage (GSG), Birmingham Wire Gage (BWG).

**Grain Size** - A measure of the size of individual metallic crystals usually expressed as an average. Grain size is reported as a number in accordance with procedures described in ASTM grain size specifications. (ASTM E112)

Apparent Ferrite Grain Size is the average of the size of the ferrite grains as microscopically viewed in the normalized or annealed condition.

Austenitic Grain Size, which is usually measured by the McQuaid-Ehn method, represents the austenitic grain size of a material at a prescribed temperature above the upper critical, frequently 1700 Deg. F. For austenitic stainless steels the grain size does not change upon cooling and is that observed microscopically at room temperature.

**Hardenability** - The ease of hardening a steel (obtaining martensite) as cooling from austenite.

**Hardness** - A measure of the degree of a material's resistance to indentation. It is usually determined by measuring resistance to penetration, by such tests as Brinell (ASTM E10), Rockwell (ASTM E18), and Vickers (ASTM E92).

**Heat Treatment** - A combination of heating and cooling operations applied to a metal or alloy in the solid state to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this definition. See various types below.

**Age Hardening** - Hardening by time dependent precipitation from a supersaturated solid solution, usually after rapid cooling or cold working. Naturally aged refers to atmospheric temperature and artificially aged to elevated temperatures. Aging occurs more rapidly at higher temperatures. (Synonymous with precipitation hardening) Over aging leads to softening.

**Air Hardening** - When the hardenability is high enough such that air cooling from austenite gives a martensitic structure.

**Annealing** - Annealing is a heat treatment process, which usually involves a relatively slow cooling after holding the material for some time at the annealing temperature. The purpose of the annealing treatment may include the following: (a) to induce softness; (b) to remove internal stresses; (c) to refine the grain size; (d) to modify physical and/or mechanical properties; (e) to produce a definite microstructure; (f) to improve machinability.

**Bright Anneal** - Carried out in a controlled furnace atmosphere, so that surface oxidation is reduced to a minimum and the product surface remains relatively bright.

**Drawing** - Synonymous with TEMPERING, which is preferable.

**Full Anneal** - Heating to a temperature above the critical and slow cooling.

**Isothermal Anneal** - Austenitizing a heat treatable alloy and cooling to and holding at a temperature at which austenite transforms to a relatively soft ferrite-carbide aggregate.

**Normalize** - Normalizing is a process, which consists of heating to a temperature approximately 100 Deg. F above the upper critical temperature and cooling in still air.

**Quenching** - A process of rapid cooling from an elevated temperature, by contact with liquids or gases.

**Soft Anneal** - A high temperature stress relieving anneal usually performed in the temperature range of 1250 to 1350 Deg. F. This anneal reduces hardness and strength of a cold worked steel to achieve near maximum softness.

**Solution Anneal** - Heating steel into a temperature range wherein certain elements or compounds dissolve, followed by cooling at a rate sufficient to maintain these elements in solution at room temperature. The expression is normally applied to stainless and other special steels.

**Stabilizing Anneal** - A treatment applied to austenitic stainless steels wherein carbides of various forms are deliberately precipitated. Sufficient additional time is provided at the elevated temperature to diffuse chromium into the areas adjacent to the carbides (usually grain boundaries). This treatment is intended to lessen the chance of intergranular corrosion.

**Stress Relieving** - A heat treatment, which reduces internal residual stresses that have been induced in metals by casting, quenching, welding, cold working, etc. The metal is soaked at a suitable temperature for a sufficient time to allow readjustment of stresses. The temperature of stress relieving is always below the transformation range. Finish anneal, medium anneal and soft anneal (sub-critical) describe specific types of stress relief anneals.

**Tempering** - Reheating quenched or normalized steel to a temperature below the transformation range (lower critical) followed by any desired rate of cooling.

**Hot Finished Seamless Tubing** - Tubing produced by rotary piercing, extrusion, and other hot working processes without subsequent cold finishing operations.

**Hot Rolled ERW Tubing** - As welded electric resistance welded tubing made from hot rolled strip or sheet.

**Hot Working** - The mechanical working of metal above the recrystallization temperature. The metal does not work harden.

**Huey Test** - A corrosion test for stainless steels. The weight loss per unit area is measured after each of five 48-hour boiling cycles in 65% nitric acid. The test results are calculated to and reported as the average corrosive rate of the five cycles in inches per month (ipm) corrosion rates. The test is used to determine the suitability of a material for nitric acid service. Since most of the weight loss is due to intergranular attack, the Huey test is commonly used as an indication of the resistance of a stainless steel to intergranular corrosion.

**Hydrostatic Test** - A test in which a liquid, usually water, under pressure, is used internally to detect and locate leaks in a tubular product of a fabricated structure.

**Impact Testing** - There are several methods of determining the toughness of a steel, but the Izod and Charpy notched-bar tests (ASTM E23) are used quite widely. In both tests, notched samples are cooled or heated to the desired test temperature, then struck once with a pendulum which fractures the specimen. The energy required to fracture the specimen, the impact strength, is measured in foot-pounds.

**Inclusions** - Particles of nonmetallic impurities, usually oxides, sulphides, silicates, which are mechanically held in metals and alloys during solidification.

**Induction Heating** - A process of heating by electrical induction.

**Ingot** - A cast metal shape suitable for subsequent rolling or forging.

**Intergranular Corrosion** - A type of electrochemical corrosion that progresses preferentially along the grain boundaries of an alloy, usually because the grain boundary regions contain material anodic to the central regions of the grain.

**Internal Soundness** - Refers to condition of inside of material - lack of defects, pipe, segregation, non-uniformity of composition.

**Isothermal Anneal** - See heat treatment.

**Izod Impact Test** - See Impact Strength Testing

**Jominy Test** - Hardenability test performed usually on alloy steels to determine depth and degree of hardness resulting from a standard end quenching method with cold water. (ASTM A255)

**Killed Steel** - Steel deoxidized with an agent such as silicon or aluminum used to react with (kill) the gases escaping during solidification. All continuous cast steels and other than low carbon steels are killed.

**Ladle** - A large vessel into which molten steel or molten slag is received and handled.

**Ladle Analysis** - Chemical analysis obtained from a sample taken during the pouring of the steel.

**Laminations** - Defects resulting from the presence of blisters, seams or foreign inclusions aligned parallel to the worked surface of a metal.

**Lap** - A surface defect caused from folding the surface of an ingot, bloom or bar during hot rolling operations and then rolling or forging the fold into the surface.

**Lateral Expansion** - It's a measure of the ductility of a steel as a result of the impact testing specimen examination. It's expressed as the transverse dimension of the specimen after impact fracture versus the original dimension.

**Machinability** - A measure of the relative ease with which steel may be machined. Special free machining grades have added sulfur to produce brittle chips.

**Machining** - The deliberate removal of metal by one or more of several processes.

**Macroetch** - A testing procedure for locating and identifying porosity, pipes, bursts, unsoundness, inclusions, segregations, carburization, flow lines from hot working, etc. Surface of the test piece should be reasonably smooth or even polished. After applying a suitable etching solution, the structure developed by the action of the reagent may be observed without a microscope.

**Magnullux Test (Magnetic Particles Test)** - This test is conducted by suitably magnetizing a ferrous material and applying a prepared wet or dry magnetic powder or fluid which adheres to it along lines of flux leakage. It shows the existence of surface and slightly subsurface non-uniformities.

**Malleability** - The property that determines the ease of deforming a metal when the material is subjected to rolling or hammering. The more malleable metals can be hammered or rolled into thin sheet.

**Mandrel** -

- (1) A device used to retain the cavity in hollow metal products during working.
- (2) A metal bar around which other metal may be bent, formed or shaped.

**Maraging** - A process of improving the mechanical strength of certain special high nickel steels. The name was derived from two hardening reactions; martensite and aging. The maraging strengthening mechanism is based on the age hardening (precipitation hardening) of extra-low carbon martensite.

**Martensite** - A constituent in quenched steel formed without diffusion and only during rapid cooling below the martensitic start ( $M_s$ ) temperature. Martensite is the hardest of the transformation products of austenite. The carbon is forcibly retained in solution. The more the carbon content, the harder the martensite and the more brittle the steel.

**Material Test Report** - Definition of a document released by a manufacturer reporting test results uniquely related to the product supplied for a specific purchase order.

**McQuaid - Ehn Test** - A special test for revealing the austenitic grain size of ferritic steels when the steel is heated to 1700 Deg. F and carburized. There are eight standard McQuaid•Ehn grain sizes - sizes 5 to 8 are considered fine grain and sizes under 5 are considered course grain.

**Mechanical Properties** - Those properties of a material that reveal the elastic and plastic reactions when force is applied, or that involve the relationship between stress and strain - for example, the modulus of elasticity, hardness, tensile strength and fatigue limit. These properties have often been referred to as "physical properties," but the term "mechanical properties" is correct.

**Mechanical Tubing** - Used for a variety of mechanical and structural purposes, as opposed to pressure tubing, which is used to contain or conduct fluids or gases under pressure. It may be hot finished or cold drawn. It is commonly manufactured to consumer specifications covering chemical analysis and mechanical properties.

**Metallography** - The science dealing with the constitution and structure of metals and alloys as revealed by the unaided eye or by such tools as low powered magnification, optical microscopes, electron microscopes, and diffraction or X-ray techniques.

**Metric System of Measurements** - In the metric system of measurements, the principal unit for length is the meter; the principal unit for volume, the liter; and the principal unit for weight, the gram. The following prefixes are used for sub-divisions and multiples: micro = 1/1 000,000; milli = 1/1000; centi = 1/100; deci = 1/10; deca = 10; hecto = 100; kilo = 1000; mega =, 1000000. In abbreviations, the sub-divisions are frequently used with a smaller letter and the multiples with a capital letter, although this practice is not universally followed everywhere the metric system is used. All the multiples and the subdivisions are not used commercially. Those ordinarily used for length are kilometer, meter, centimeter, and millimeter; for area, square meter, square centimeter and square millimeter; for volume, cubic meter, cubic decimeter (liter), cubic centimeter, and cubic millimeter. The most commonly used weights are the kilogram and gram. The metric system was legalized in the United States by an Act of Congress in 1966.

**Microcleanliness** - Refers to the extent or quality of nonmetallic inclusions observed by examination under a microscope.

**MicroEtch** - Micro-etching is used for the examination of a sample under a microscope. Etching solutions tend to reveal structural details because of preferential chemical attack on the polished surface.

**Minimum Wall** - Any wall having tolerances specified all on the plus side.

**Modulus of Elasticity** - The ratio of stress applied to a material and the resulting strain occurring at the stresses below the elastic limit.

**Nondestructive Testing** - Methods of detecting defects without destroying or permanently changing the material being tested. Test methods include ultrasonic, eddy current, magnetic particle, liquid penetrant, x-ray, hardness testing and all kinds of positive material identification systems.

**Notch Brittleness** - Susceptibility of a material to brittle fracture at points of stress concentration.

**Notch Sensitivity** - A measure of the reduction in strength of a metal caused by the presence of stress concentration.

**Ovality** - The difference between the maximum and minimum outside diameters of any one cross section of a tube or a fitting. It is a measure of deviation from roundness.

**Oxidation** - In its simplest terms, oxidation means the combination of any substance with oxygen. Scale developed during heat treatment is a form of oxidation.

**Oxide** - A compound consisting of oxygen and one or more metallic elements.

**Passivate** - The changing of the chemically active surface of a metal to a much less active state by the application of the proper chemical treatment or by allowing natural oxidation to occur by exposure to air. An example of chemically passivating stainless steel would be to immerse stainless in a hot solution of approximately 10 to 20 percent by volume nitric acid and water. Anodizing of aluminum is another example.

**Pearlite** - A mixture of ferrite and cementite that occur in steels.

**Photomicrograph** - A photographic reproduction of an object magnified more than ten times used to show microstructure characteristics of steel.

**Physical Properties** - Those properties not specifically related to reaction to external forces. These include such properties as density, electrical resistance, coefficient of thermal conductivity and melting point.

**Pickling** - Use of solutions, usually acids, to remove surface oxides from a steel product, may also be used to provide a desired surface finish.

**Piercing** - A seamless tube-making method in which a hot billet is gripped and rotated by rolls or cones and directed over a piercer point which is held on the end of a mandrel bar.

**Pit** - A sharp, usually small, depression in the surface of metal.

**Plane Strain Fracture Toughness** - The minimum fracture toughness of a material.

**Porosity** - Unsoundness caused in cast metals by the presence of blowholes, shrinkage cavities, or in a weld caused by gases that did not escape the molten weld metal.

**Positive Material Identification** - The definition used for any kind of non-destructive chemical analysis capable to positively identify a grade of steel.

**Pressure Tubing** - Tubing produced for the purpose of containing or conducting fluids or gases under pressure.

**Profilometer** - An instrument used for measuring surface finish. The vertical movements of a stylus as it traverses the surface are amplified electromagnetically and recorded (or indicated) as the surface roughness.

**Pyrometer** - An instrument of any of various types used for measuring temperatures.

**Quenching** - See heat treatment.

**Random Length** - Tubing produced to a permissible variation in length.

**Recrystallization** - The reversion of distorted cold worked microstructure to a new soft, strain-free structure during annealing. Typically, the required temperature is above half the melting point unless the material is very heavily cold worked.

**Reduction of Area** - A measure of ductility determined in a tensile test. It is the percentage change in cross sectional area after working.

**Rimmed Steel** - A steel that is not killed, where the gases escaping during solidification are allowed to escape. The steel froths.

**Rockwell Hardness** - A hardness test. (ASTM E18)

**Scale** - An oxide of iron which forms on the surface of hot steel.

**Seam** - A tight, but unwelded imperfection on the surface of a wrought metal product.

**Segregation** - Non-uniform distribution of alloying elements, impurities or microphases.

**Semi-Killed Steel** - Steel that is incompletely deoxidized to permit the evolution of carbon monoxide, thereby offsetting solidification shrinkage.

**Sensitization** - Sensitization of stainless steel is defined as a susceptibility to preferential grain boundary attack. Material which exhibits grain boundary carbide precipitation may or may not be sensitized.

**Shear Value** - Definition of fracture mode of an impact testing specimen. It is usually recorded as per cent of the total specimen area fractured in shear mode, rather than cleavage mode. It is an indication of the fracture propagation properties of the tested steel. The higher the shear percentage, the lower the sensitivity to fracture propagation.

**Soft Anneal** - See heat treatment.

**Specification** - A document defining the measurements, tests, and other requirements to which a product must conform -typically covering chemistry, mechanical properties, tolerances, finish, reports, marking and packaging.

**Stabilizing Elements** - Chemical elements added intentionally to a stainless steel to help prevent sensitization phenomenon due to chromium carbide precipitation. Such elements (Titanium, Columbium, Tantalum) have the function to preferentially form carbide compounds, thus preventing the formation of chromium carbides. Typical stainless steel stabilized grades are 321, 347 and 348.

**Stress Corrosion Cracking** - Cracking of metals under combined action of corrosion and stress. The stress can be either applied or residual. Austenitic stainless steels are especially susceptible to cracking in chloride containing environments. Usually, it only occurs above a particular temperature.

**Strip** - A flat-rolled steel product which serves as the raw material for welded tubing.

**Swaged** - A mechanical reduction of the cross sectional area of a metal, performed hot or cold by forging, pressing or hammering.

**Tempering** - See heat treatment.

**Tensile Strength** - The maximum load per square inch of original cross-sectional area carried during a tension test to failure of the specimen. This term is preferred over the formerly used ultimate strength. The tensile test is described in ASTM E6 and EB.

**Thermal Conductivity** - A measure of the ease with which heat is transmitted through a material.

**Tolerance** - Permissible variation.

**Torsion** - A twisting action resulting in shear stresses and strains.

**Toughness** - A measure of ability to absorb energy and deform plastically before fracturing.

**Transformation Temperature** - The temperature at which a change in phase occurs in steels. The term is sometimes used to denote the limiting temperature of a transformation range.

**Transverse Tension Test** - A tension test for evaluating mechanical properties of a material in a direction transverse to that of rolling.

**Ultimate Strength** - See tensile strength.

**Ultrasonic Testing** - The method of detecting defects in tubes or welds by passing high frequency sound waves into a material then monitoring and evaluating the reflected signals.

**Upsetting** - A metal-working operation similar to forging, generally used to thicken the ends of tubes prior to threading.

**Vickers Hardness Test** - A common hardness test. (ASTM E112)

**Work Hardening** - Hardening of a metal as a result of cold working. See cold working.

**Yield Point** - The stress in a material at which plastic deformation begins.

**Yield Strength** - The stress at which a material exhibits a specified deviation from proportionality of stress and strain. An offset of 0.2% is most frequently used.