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Standard Terminology for F16 Mechanical Fasteners¹

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1. Scope

1.1 This terminology standard provides a compilation of definitions for terminology used for mechanical fasteners.

1.2 Terms in this terminology are organized alphabetically. In Appendix X1 they are listed under fastener characteristic.

1.3 Additional definitions are shown in ANSI/ASME B18.12; IFI Glossary of Terms, IFI-139 and IFI-140; and SAE J412.

2. Referenced Documents

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

A 563 Specification for Carbon and Alloy Steel Nuts³

E 456 Terminology for Relating to Quality and Statistics⁴

2.2 ANSI/ASME Standard:

B18.12 Glossary of Terms for Mechanical Fasteners⁵

2.3 IFI Standards:

Glossary of Terms Relating to Aerospace Fasteners⁶

IFI-139 Quality Assurance Requirements for Fastener Testing Laboratories⁶

IFI-140 Carbon and Alloy Steel Wire, Rods, and Bars for Mechanical Fasteners⁶

2.4 SAE Standard:

SAE J412 General Characteristics and Heat Treatments of Steels⁷

3. Mechanical Fastener Definitions

alloy groups—an alloy group includes alloys considered to be chemically equivalent for general purpose use in specifying stainless steel bolts, hex cap screws, studs and nuts.

alloy steel—steel is considered to be alloy when the maximum range given for manganese exceeds 1.65 % or a definite minimum quantity for any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: chromium, molybdenum, nickel, or any other alloying element added to obtain a desired alloying effect.

alter—to change fastener properties such as hardness, tensile strength, surface finish, length, or other characteristics of the fastener through such processes as heat treatment, plating, and machining.

anchor bolt—a steel rod or bar, one end of which is intended to be cast in concrete while the opposite end is threaded and projects from the concrete for anchoring other material to the concrete. The end cast in concrete may be either straight or provided with an anchor, such as a bent hook, forged head, or a tapped or welded attachment to resist forces imposed on the anchor bolt as required.

annealing—a general term applied to a variety of thermal treatments applied to fasteners for the purpose of softening or homogenizing material properties. The specific types of annealing are:

full annealing—heating steel above the upper critical transformation temperature, holding it there long enough to fully transform the steel to austenite, and then cooling it at a controlled rate, in a furnace, to below a specified temperature. A full anneal refines grain structure and provides a relatively soft, ductile material that is free of internal stresses.

intercritical annealing/isothermal annealing—heating a steel above the lower critical transformation temperature, but below the upper-critical transformation temperature, to dissolve all the iron carbides, but not transform all the ferrite to austenite. Cooling slowly from this temperature, through the lower critical temperature, produces a structure of ferrite and pearlite that is free of internal stresses. In *intercritical annealing*, the steel continues to cool slowly in the furnace, similarly to full annealing. In *isothermal annealing*, cooling is stopped just below the lower critical, assuring complete transformation to ferrite and coarse pearlite, and eliminating the potential for bainite formation. The coarse pearlite structure greatly improves machinability of medium carbon steels.

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² *Annual Book of ASTM Standards*, Vol 01.01.

³ *Annual Book of ASTM Standards*, Vol 01.08.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁶ Available from Industrial Fasteners Institute, 1717 E. 9th Street, Suite 1105, Cleveland, OH 44114.

⁷ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

normalizing—a variation of full annealing in which steel is heated above the upper critical temperature and is then air cooled in air, rather than in a furnace. Normalizing relieves the internal stresses caused by previous working, and while it produces sufficient softness and ductility for many purposes, it leaves the steel harder and with a higher tensile strength than full annealing. To remove cooling stresses, normalizing is often followed by tempering.

process annealing—sometimes called subcritical annealing or stress relieving, performed at temperatures just below the lower critical temperature. Process annealing neither refines grains nor redissolves cementite, but does improve the ductility and decreases residual stress in work-hardened steel.

solution annealing—heating an austenitic stainless steel to a temperature that puts the carbides into solution. The steel is held at this temperature long enough to achieve grain growth. It is then quenched in a medium for fast cooling, which prevents most of the carbides from reprecipitating. The process achieves optimum creep strength.

spheroidize annealing—a type of subcritical annealing used to soften steel and improve machinability. Heat treating fine pearlite for a long time just below the lower critical temperature of the steel, followed by a very slow cooling, produces a spheroidal or globular form of the pearlite.

stabilization annealing—heating an austenitic stainless steel used in severe aqueous corrosion environments by first solution annealing and then reheating to about 1600°F, and holding at that temperature. The treatment causes grain boundary precipitation of carbides, but also the hold time permits the chromium remaining in the austenite solution to redistribute within the grains, restoring corrosion resistance, even adjacent to the grain boundaries.

applicable standards—those having the capability of being applied in some fashion to the host standard.

arbitration hardness location—a prescribed location on the fastener, such as at mid-radius, using 90° intervals taken through the cross section, one diameter from the threaded end for bolts and screws.

assembly lot—an assembly lot may consist of a combination of different products. As long as the products that make up the assembly are in accordance with *lot*, the quantity of assemblies determine the sample size. Example: ten assemblies consisting of a bolt, nut, and a washer would have a lot size of ten if the bolts, nuts, and washers meet the criteria of *lot*. However, if any of the components in the assembly are not in accordance with *lot* then the ten assemblies will have to be separated into lots that meet all the requirements of *lot*.

austenitic stainless alloys—steel alloys that contain a minimum of 15 % chromium and from a residual to 20 % nickel. Some alloys may contain as much as 18 % manganese. The metal is predominantly face centered cubic in structure and hardenable only by cold working. Essentially nonmagnetic in its wire form, it may become slightly magnetic from cold working. Austenitic stainless steels can be grouped into three categories: 300 series alloy, Cr-Ni-Mn alloys, and Cr-Ni-Mo-Ti.

average coating thickness—determined as either the value obtained by analytical methods or the mean value of a specified number of local thickness measurements that are evenly distributed over the significant surface.

baking duration—the time measured from when the plated product reaches a specified temperature in the baking furnace or oven until it is removed.

bar—a solid rolled or forged section that is long in relationship to its cross-sectional dimensions with a relatively constant cross-section throughout its length. Carbon and alloy steel bars are produced from hot rolled or cast billets, or from blooms rolled single strand into coils.

barrel-plating process—a fastener-coating process which employs a containment vessel called a barrel that is designed to move a given batch of fasteners together through each of the process steps, allowing ready ingress and egress of processing solutions and rinses. As the barrel moves through the process steps, it is rotated or oscillated, causing the fasteners to cascade over one another, and in the electrocleaning and electroplating steps, and electric current is applied.

batch average thickness—the calculated average thickness of a coating if it were uniformly distributed on the surfaces of the items.

bend test—various tests in which a fastener is bent through its axis or on a round mandrel to determine the toughness and ductility of the fastener.

bendable bolts—bolts furnished with an altered section at some location at which the bolt will bend.

bilateral specifications—specifications that have both an upper and a lower value.

bolt—a headed and externally threaded fastener designed to be assembled with a nut.

bolt load - elongation behavior—when tensile loaded, a bolt will elongate elastically until stressed beyond its proportional limit where it will behave plastically.

break loose torque—torque applied in a removal direction necessary to start the fastener in motion from its fully preloaded installed position.

breakaway torque—torque necessary to start a fastener in motion after the axial load of the mating components has been reduced to zero.

burst—an open break in the metal during forging located on the flats or corners of bolt and screw heads, or at the periphery of a flanged or circular headed bolt or screw, or on the flats or corners of the nut.

carbide precipitation “sensitization”—a condition which affects some austenitic stainless steels which have been subjected to temperatures in the critical range, typically 800° to 1400°F. Complex chromium carbides precipitate and reside primarily at the grain boundaries, causing deterioration of its corrosion resistance by depleting its adjacent areas of chromium.

carbon steel—steel for which no minimum content is specified or required for chromium, molybdenum, nickel, or any other element added to obtain a desired alloying effect; or steel for which maximum content specified for manganese does not exceed 1.65 %. When specified, boron may be added to

killed carbon steel with a maximum allowable of 0.003 %.

certificate of compliance—a document or electronic record, signed by an authorized party, affirming that the supplier of the fastener or related service, or both, has met the requirements of the relevant specifications, contract, or regulation.

certificate of conformance—a document or electronic record affirming that the fastener has met the requirements of the relevant specifications, contract, or regulation.

certification—the procedure and action by a duly authorized body of determining, verifying, and attesting in writing to the qualifications of personnel, processes, procedures, or items in accordance with applicable requirements.

certified quality assurance system—a system so designated officially by a recognized accrediting body as having met all of the criteria within a national or an international third party quality system standard.

check analysis—see *product analysis*.

clamp load—sometimes called preload or initial load. It is a tension on a bolt or screw, which results in equal and opposite forces which exist at the interface between two members generated through the cumulative effect of tightening one or more fasteners.

cold forming—the process of forming material below the recrystallization temperature by forcing or pressing metal into various dies.

cold heading quality material—a material that has dimensional, chemical, and residual limits such that it will successfully form a given fastener geometry when machine-applied pressure produces a metal flow that results in the desired geometry. Additionally, subsequent treatment as necessary to achieve given mechanical properties results in a fastener with freedom from internal or external imperfections that would impair its intended use.

commingling—mixing of fasteners from different lots that are of the same grade and size in the same container.

common cause—common cause variation affects all the individual values of the process output being studied. In control chart analysis, it appears as part of the random process variation.

compressible-washer-type direct tension indicator—a direct tension indicator having the capability of indicating the achievement of a required minimum bolt tension by the degree of its plastic deformation.

compression load—a load which tends to compress or shorten the member. The value for compressive strength may depend upon the degree of distortion.

cone proof load—inch series—a calculated value derived from the formula

$$CPL = (1 - 0.30D) \times f \times A_s \quad (1)$$

where:

- CPL = cone proof load (lbs),
- D = nominal diameter of nut (in.),
- f = specified proof stress of nut (psi), and
- A_s = tensile stress area of nut (in.²).

To meet the requirements of the cone proof load test, the nut shall support its specified cone proof load without stripping or rupture.

cone proof load—metric series—a calculated value derived from the formula

$$CPL = (1 - 0.012D)f \times A_s \times 0.001 \quad (2)$$

where:

- CPL = cone proof load (kN),
- D = nominal diameter of nut (mm),
- f = specified proof stress of nut (MPa), and
- A_s = tensile stress area of nut (mm²).

To meet the requirements of the cone proof load test, the nut shall support its specified cone proof load without stripping or rupture.

cone proof load test—a test performed using a conical washer and threaded mandrel to determine the influence of surface discontinuities (that is, forging cracks or seams) on the load-carrying capability of hardened steel nuts. The test includes a simultaneous dilation and stripping action of the nut.

conical washer—a washer that has a crown height that flattens under load and is partially recovered following load removal.

consensus standard—a widely available standard developed by ASTM, ASME, SAE, ISO, or any other standards-setting organization which has under its structure those parties which include users, producers, and other interested persons.

control limit—limits on a control chart which are used as criteria for signaling the need for action, or for judging whether a set of data does or does not indicate a state of statistical control.

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control plan—a written description of a system for controlling fasteners and the processes used in their manufacture. Three distinct phases are used in a control plan, including prototype, pre-launch, and production.

corrosion resistance—the ability of a fastener to resist corrosion under specified conditions.

crack—a crystalline fracture passing through or along the grain boundaries which is normally caused by overstressing the metal during manufacturing, such as forging, forming, or heat treating.

cut thread—produced by removing material from the surface with a form cutting tool.

decarburization—a loss of carbon from the surface layer of the fastener, normally associated with heat treatment.

defect—a departure of a quality characteristic from its intended level or state (or the sum of departures of different quality characteristics) that occurs with a severity sufficient to cause a fastener not to satisfy intended normal, or reasonably foreseeable, usage requirements. The term *defect* is appropriate for use when a quality characteristic is evaluated in terms of its usage.

deoxidation—a process of reducing the oxygen content from steel during the process of steel making, either by adding strong oxide forming elements, such as silicon or aluminum, or by the process of vacuum degassing to such a level that no oxidation of carbon or other elements takes place during solidification of steel.

destructive test—a test to determine the properties of a material or the behavior of an item which results in the

destruction of the sample or item.

detection process—a past-oriented strategy of quality control that attempts to identify the nonconforming product after it has been produced, and then to separate it from the conforming product.

detection system—a system which relies on final inspection as the primary means of controlling the quality of finished fasteners.

distributor—a person or organization who purchases fasteners for the purpose of reselling them. A distributor may or may not alter the fasteners prior to resale. (Significant alterations and insignificant alterations are defined separately.)

ductility of externally threaded fasteners—the ability of a fastener to deform before it fractures. Machined test specimens made from a fastener allow the measurement of elongation and reduction of area which are criteria used to evaluate the specimen. However, since yielding and fracture normally occur in the screw threads, these are impractical for the actual fastener. Hardness and the wedge tensile test are ductility indicators for the actual fastener. The lower the ratio of its specified minimum yield strength to its specified minimum tensile strength, the greater the fastener ductility.

effective case depth—the perpendicular distance from the surface of a hardened case to the furthest point where a specified level of hardness is maintained.

elongation—the increase in length of the gage length expressed as a percentage of the original gage length.

endurance limit—the maximum stress below which a bolt or screw can presumably endure an infinite number of stress cycles.

end user—the party that installs the mechanical fastener during assembly of a component or product.

environmental hydrogen embrittlement—can be “corrosion-assisted hydrogen embrittlement” caused by the liberation of hydrogen during the corrosion process, which is absorbed as atomic hydrogen, resulting in embrittlement under certain conditions of material strength and applied external stress. The end result is brittle failure. The hydrogen may also be absorbed from other external chemical sources.

extensometer—a device for sensing the elongation of fastener material while it is subjected to tensile stress, for the purpose of measuring linear deformation under controlled test conditions.

eye bolt—a bolt having a head which is a closed or open ring which as a threaded shank and has a defined breaking strength, proof load, and tensile strength.

fastener—see *mechanical fastener*.

fastener electroplating—the electro-deposition by electrolysis of an adherent metallic coating upon a fastener serving as an electrode. This coating may function as protective, decorative, or in a defined engineering function such as wearability or abrasive resistance.

fastener manufacturer—the organization or firm that procures a raw material, fabricates it into a mechanical fastener, and processes it to have certain mechanical properties.

fastener quality—the conformance of a fastener to its specification for dimensions, mechanical properties, performance requirements, and other requirements of a specification.

fastener specification—a precise statement of a set of requirements to be satisfied by a fastener, its material, or its processing. It also indicates the procedure used to determine whether the requirements given are satisfied.

fastener standard—a document which details the attributes of a finished fastener and includes such characteristics as geometry, material or chemistry, heat treatment, finish, lot size, and packaging.

fastener tensile stress area—an assumed cross sectional area of a threaded fastener through the thread, which is used when computing the load a fastener can support in tension.

fastener testing—the determination or verification that the fastener meets its specification requirements.

fatigue limit—see *endurance limit*.

fatigue strength—the maximum stress on an externally threaded fastener which can be tolerated for a specified number of repeated cycles prior to failure.

fold—a doubling over of metal which occurs during forging at or near the intersection of diameter changes which are found on the shoulders, heads, or shanks of bolts and screws, or on nuts at the intersection of diameter changes on the top face or on the bottom face.

forging cracks—occur during fastener manufacturing at the cutoff or forging operations and are located on the top of the head or on the raised periphery of indented head bolts and screws.

full size specimen—tension test specimen consisting of a completed fastener for testing in the ready to use condition without altering the configuration.

grade identification symbols—inch series standardized symbols denoting the combination of the fastener’s base material, its strength properties, its performance capabilities, and the engineering standard against which it was produced.

hardness—a measure of a material’s ability to resist abrasion or indentation, or both.

head-to-shank integrity—the assurance that a headed fastener under load is able to meet its mechanical and performance requirements without failure at the junction of the head to shank.

heat analysis—a chemical analysis of a given heat by the producer which determines the percentages of its elements.

heat resistance—the extent to which a material retains useful properties as measured during exposure of the material to a specified temperature and environment for a specified time.

high strength bolts—a term which is used commercially to denote ASTM A 325 or A 490 bolts which are primarily used in construction applications.

high temperature fastener alloys—those alloys that will maintain their anticipated strength and characteristics within the high temperature range.

high temperature for mechanical fasteners—this term is generally understood to refer to a temperature range of approximately 500°F (260°C) to 1800°F (982°C).

hot dip galvanizing—immersion of fasteners in a bath of molten zinc for a controlled time period to obtain specified coating weight or thickness.

- hot forming**—heat is applied to wire or rod to enhance metal flow into dies using machine applied pressures as opposed to metal removal by cutting for forming purposes.
- hydrogen embrittlement, internal**—see *internal hydrogen embrittlement*.
- impact strength**—often referred to as impact energy; it is the amount of energy required to fracture a fastener, usually measured by either an Izod or Charpy test.
- inch threaded Class 2A coating thickness**—a coating thickness which does not exceed $\frac{1}{8}$ of the allowance for Class 2A threads to avoid interference.
- indentation hardness**—the resistance of a material to indentation. This is the usual type of hardness test in which a pointed or rounded indenter is pressed into a surface under a substantially static load.
- in-process sampling inspection**—a random sample of product drawn from prescribed points of the processing stream (usually characteristic sensitive) and performing specific inspections and tests to determine conformance of the product at that point of the processing stream.
- inspection**—process of measuring, examining, testing, gaging, or using other procedures to ascertain the quality or state of, detect errors or defects in, or otherwise appraise materials, products, services, systems, or environments to a preestablished standard.
- inspection test**—a fastener or its selected characteristics tested in process or after manufacture to determine conformance of the fastener or its selected characteristics to the manufacturing specifications.
- inspection torque**—the torque necessary to maintain tightening motion in a fastener at its fully preloaded installed tension.
- internal hydrogen embrittlement**—embrittlement caused by residual hydrogen from fastener processing, such as cleaning, pickling, phosphating, or electroplating.
- ladle analysis**—see *heat analysis*.
- liquid medium**—a liquid used to quench a steel fastener to achieve desired mechanical properties. The selection of the medium must be compatible with the basic material and geometry to avoid quench cracks.
- local thickness**—mean of the thickness measurements of which a specified number is made within a reference area.
- locking ability**—a characteristic intentionally manufactured or added to a fastener to resist loosening.
- lot**—a quantity of product of one part number that has been processed essentially under the same conditions from the same heat treatment lot and produced from one mill heat of material and submitted for inspection at one time.
- lot sampling inspection**—a random sample drawn from a lot and performing specified inspections and tests to determine the acceptability of the lot.
- low carbon martensite**—the as-quenched phase of low carbon steels, particularly to which Boron has been intentionally added to increase the hardenability of the material, and some stainless steels.
- machined specimen**—a test specimen machined from a full-size fastener to specific dimensions to standardize test results; often specified when a full-size fastener cannot be reasonably or practically tested.
- macro-etch test**—immersion of a prepared fastener specimen into a hot acid or aggressive media followed by examination of the etched surface. The examination is done with the unaided eye or at magnification not exceeding 10 \times .
- macrograph**—a photographic reproduction of any object that has not been magnified more than ten times.
- macroscopic**—visible either with the naked eye or under low magnification (as great as about ten diameters).
- macrostructure**—the structure of metal as revealed by macroscopic examination.
- magnetic permeability**—the degree which a material becomes magnetically attractive.
- manufacturer**—see *fastener manufacturer*.
- martensitic alloys**—iron-chromium alloys with 12% to 17% chromium and sufficient carbon to permit strengthening by conventional heat treatment.
- material lap**—a longitudinal surface discontinuity extending into rod, bar, or wire, caused by doubling over of metal during hot rolling.
- material review**—an evaluation by a team of fastener experts to determine the fasteners’s fitness for general use, fitness for intended use, or fitness for specified use.
- material specification**—a proprietary or consensus standards document which defines the material, acceptable chemical limits, and other requirements used in fastener manufacturing.
- material test report**—a written document or electronic record, signed by an authorized party, attesting that the raw material is in accordance with specified requirements, including the actual results of all required chemical analyses, tests, and examinations.
- maximum hardness**—a hardness specified in fastener standards above which the fastener is considered nonconforming to the standard.
- mechanical deposition**—a coating process in which particles of the plating metal are impacted against the fastener surface such that cold welding of the plating metal to the fastener surface is accomplished.
- mechanical fastener**—a mechanical device that holds or joins two or more components in definite positions with respect to each other and is often described as a bolt, nut, rivet, screw, washer, or special formed part.
- mechanical properties**—fastener characteristics which relate to its reaction to applied loads; these properties may be those of the basic raw material or result from the manufacturing process.
- metallography**—the study of the structure of fastener metals using optical or electronic microscopes that produce a magnified image of the material structure of the fastener.
- microstructure**—the structure of a given metal revealed by microscopic observation of an etched surface.
- minimum hardness**—the hardness value of a fastener below which it is not in conformance with the specification.
- minimum local thickness**—the lowest local thickness value on the significant surface of a single article.

- modulus of elasticity**—for a given material, the ratio of unit stress to unit strain within its elastic range which may be used as a measure of stiffness. Sometimes called *Young's Modulus*.
- nick**—an indentation on the surface of a bolt, nut, screw, or stud. Also referred to as a gouge.
- nonconformance**—a fastener or fastener component which does not conform to a specification or other inspection standard.
- nonferrous alloys**—alloys that do not contain iron as their main constituent although iron may be present as an impurity. The most common nonferrous groups are copper, nickel, aluminum, and titanium alloys.
- nut**—an internally threaded product intended for use on external or male screw threads such as a bolt or a stud for the purpose of tightening or assembling two or more components.
- part identifying number (PIN)**—an alphanumeric sequence used to code B18 fasteners. The system was developed by ASME Standards Committee B18.
- passivation**—the process of forming an oxide film on the surface of stainless steel fasteners by chemical treatment, usually nitric acid solution, to improve corrosion resistance of stainless steel fasteners.
- performance properties**—design feature(s) manufactured into the fastener to achieve a specific characteristic relative to the fastener application, such as torque-tension.
- physical properties**—those properties inherent in the raw material which remain unchanged or exhibit only slight alteration in the fastener following manufacture.
- plain washer**—a fastener accessory that accepts a bolt or screw through its center hole and provides a surface to distribute bearing stress. It also serves to provide a surface for head or nut rotation during tightening.
- plastic deformation**—permanent distortion of a material under the action of applied stresses.
- plasticity**—the ability of the metal to undergo permanent deformation without rupture.
- plating**—deposition of an adherent metal onto the surface of the base metal of the fastener. A specific process should be specified; that is, electroplating, hot dip galvanizing, mechanical deposition, etc.
- precipitation hardening alloys**—a group of alloys that can be hardened by participation of second phases or intermetallic compounds by cooling during a thermal or thermal-mechanical aging treatment.
- pre-launch production plan**—a written description of the dimensional, mechanical, chemical, and performance testing that will be carried out during initial production, prior to full production.
- prevailing torque**—torque necessary to rotate a fastener relative to its mating component with the torque being measured with the fastener in motion and zero axial load in the assembly.
- prevention process**—a future-oriented strategy that, through analysis and action toward correcting the process itself, enriches quality through continuous improvement activities.
- prevention system**—a system which outlines advance quality planning, in-process inspection, process controls, and statistical methods to control the processes and seek continuous improvement.
- private label distributor**—a distributor who, by prearrangement with a manufacturer, markets fasteners identified with the distributor's unique identification marking and who assumes responsibility for the fasteners.
- process flow**—the current or anticipated sequential process steps required to produce a fastener.
- process parameters**—combination of conditions originating from people, measurement, materials, method, and environment that contribute to a given output.
- product analysis**—a chemical analysis performed on the finished fastener to verify that the chemical composition is within specified limits.
- production plan**—a complete written plan of fastener and process characteristics, process controls, tests, and acceptance procedures that will occur during full production.
- proof load**—a tension-applied load that the fastener must support without evidence of permanent deformation. (For most carbon or alloy steel fastener strength grades or property classes, proof loads are established at approximately 90% to 93% of the expected minimum yield strength.)
- property class**—a system of strength classifications used for bolts, nuts, and screws manufactured to metric standards.
- property class symbols**—metric series standardized symbols denoting the combination of the fastener's base material, its strength properties, its performance capabilities, and the engineering standard against which it was produced.
- proportional limit**—the greatest stress that the material is capable of sustaining without a deviation from the law of proportionality of stress to strain (Hooke's Law). In many cases, the elastic limit is so close to the proportional limit that no distinction is made.
- prototype plan**—a written description of the dimensional, mechanical, chemical, and performance tests that will be used to facilitate the building of a prototype.
- qualification (personal)**—the characteristics or abilities gained through training or experience, or both, that enable an individual to perform a required function.
- quality assurance**—all of the planned and systematic activities carried out for the purpose of establishing that a fastener lot is within specified tolerances, limits, and other requirements.
- quality assurance program**—the specific requirements within a quality system which serves to focus the activities of a fastener organization in pursuit of stated requirements of the quality plan.
- quality assurance system**—a manufacturing system for assuring quality that incorporates either a written control plan or employs other acceptable methods for controlling quality. This may include provisions for prototype development, initial production, and full production including advanced quality planning, continuous improvement, defect prevention, and in-process controls of dimensional, mechanical, and performance characteristics of the fastener.

quench cracks—surface discontinuities which usually transverse an irregular or erratic course on the surface of the fastener which may occur because of excessive high thermal or transformation stresses, or both, during fastener heat treatment.

rack-plating process—a fastener coating process in which individual fasteners are placed on a support called a rack which moves the fasteners together through the process steps while providing ready ingress and egress of processing solutions and rinses. In process steps which utilize an electric current, the rack serves to maintain electrical continuity.

random sampling—a method of sample selection for fasteners in a lot where each fastener has an equal and independent chance of being selected for the sample.

raw material manufacturer—an organization which manufactures rod, wire, or bar, used to produce mechanical fasteners, from raw material it manufactures and controls in terms of chemistry and mechanical properties.

reduced diameter body—a fastener having a body diameter not less than the minimum pitch diameter of its thread nor more than its minimum full body diameter.

reduction of area—the difference, expressed as a percentage, of the original cross sectional area of a tensile test specimen at its minimum cross section after fracture.

referenced standards—those which contain guidelines or nondated requirements germane to one or more elements of the host standard.

registered quality assurance system—a system that a registration body has found to be in compliance with a designated quality system standard.

registration—an evaluation of a fastener manufacturing facility's quality assurance system by an accredited registration body resulting in a certification of full compliance with a designated quality system standard; the registration body shall be accredited by a third party registration accreditation body, for example, ANSI/RAB.

related standards—those standards which possess certain relevance to the host standard in terms of understanding its concepts, but do not of necessity specify any mandated requirements.

repeatability—the variation in the values of measurement obtained when one operator uses the same gage for measuring identical characteristics of the same parts.

reprocess—the repeating of a process that has already been conducted on a fastener as part of the standard requirement.

residuals—measurable elements present in a metal or alloy which were not intentionally added to meet a specification requirement.

resilience—the tendency of a material to return to its original shape after the removal of a stress.

responsibility for the fastener—the party responsible for the fastener shall be the organization that supplies the fastener to the purchaser and certifies that the fastener was manufactured, sampled, tested, and inspected in accordance with the specification and meets all of its requirements. **A 563**

responsible party—the responsible party for the fastener shall be the organization that supplies the fastener to the purchaser

and certifies that the fasteners were manufactured, sampled, tested, and inspected in accordance with applicable specifications and meets all of the requirements.

review—a deliberately critical examination, including observation of plant operation, evaluation of audit results, procedures, certain contemplated actions, and after-the-fact investigations of abnormal conditions.

rod—produced from hot rolled or cast billets, usually rolled in a multiple strand mill to a round cross section then coiled into one continuous length.

roll thread—a thread produced by action of a form tool which, when pressed into the surface of a blank, displaces material radially.

roof and rock bolts—headed hot-rolled bars with cold-rolled or machine-cut threads at the end to be used with anchorage devices to hold up mine roofs, hold back walls, or hold down equipment or foundations.

rotational capacity test—a test in which a zinc-coated bolt is inserted in a steel joint or tension measuring device, assembled with a lubricated zinc coated nut, and initially tightened to not less than 10% of the bolt proof load. After initial tightening, the nut is rotated through specified degrees of rotation.

routine hardness locations—hardness readings made on prescribed fastener surfaces, such as wrench flats, unthreaded shank, bearing face, etc., after removal of oxide, platings, or other coating materials. Used for testing the hardness of a finished fastener.

salt spray test—a corrosion test in which the metallic fastener specimens are exposed to a fine mist of salt water solution, either continuously or intermittently.

screw—a mechanical fastener having basic design characteristics which facilitate its assembly into a tapped hole or to form its own threads during installation.

screw thread—a helical ridge generally of uniform cross section formed on a cylindrical surface used to facilitate assembly of mechanical components.

seam—a straight or smooth curved line surface discontinuity running longitudinally on the fastener thread, shank, and head.

secondary manufacturer—any entity, including the original manufacturer, that alters the fastener.

secondary processing—a process that is performed to a fastener in order to add further value, such as drilling, assembly with other fastener components, lubricating, coating, and machining. This product may already be tested (or certified when applicable, or both) in compliance with a given standard.

shall—used to denote a mandatory requirement.

shear burst—an open break in the fastener metal at approximately 45° to the product axis, usually at the periphery of fasteners having flanged or circular heads or on the side of hex heads.

shear strength—the maximum load applied normally to a fastener's axis that can be supported prior to fracture. Single shear is load occurring in one transverse plane, thus cutting the fastener into two pieces; double shear is load applied in

two planes so that, at fracture, the fastener would be cut into three pieces.

shear stress area: bolt or screw—the area perpendicular to the fastener axis which is based on the root diameter (minor diameter) of an externally threaded bolt or screw.

should—used to denote a recommendation. Not suitable for specification use to denote mandatory requirements.

significant surface—a surface area where the minimum thickness to be met shall be designated on the applicable drawing or by the provision of a suitably marked sample. However, if not designated, significant surfaces shall be defined as those normally visible, directly or by reflection, which are essential to the appearance or serviceability of the fastener when assembled in normal position, or which can be the source of corrosion products that deface visible surfaces on the assembled fastener.

significantly alter—any action which would change the mechanical or performance capabilities of the fastener following its original manufacture.

solution treat—see *annealing, solution annealing*.

special cause variation—special cause variation is intermittent, unpredictable and unstable. In control chart analysis, it is signaled by a point beyond the control limits, a run, or some other nonrandom pattern of points within the control limits.

spherical washers or seats—washers comprised of two mating washer components: one component is a washer having one flat side and a convex spherical surface on the other side. The other component is a washer having one flat side and a concave spherical depression machined into the other side. The two convex and concave spherical portions are mated and fit together to make up one spherical washer unit.

spheroidize—see *annealing, spheroidize annealing*.

stainless steel—steel which has been alloyed with chromium ranging from 10% to less than 30%. Other alloying elements may also be added.

statistical control—exists when all special causes of variation have been eliminated from a process and only common causes remain.

statistical process control—the use of statistical techniques, such as control charts, to analyze a process or its outputs so as to take appropriate actions to achieve and maintain a state of statistical control and to improve the process capability.

strain—deformation produced on a fastener by an outside force.

strain hardening—an increase in hardness and strength resulting from plastic deformation by cold working.

strength grade—a system of strength classifications used for bolts, nuts, and screws made to inch standards.

stress—force expressed in units per unit of area, which represents resistance that a fastener offers to deformation.

stress corrosion cracking—a cracking phenomena that occurs when an installed fastener under stress is exposed to a corrosive service environment.

structural bolt—a heavy hex head bolt having a controlled thread length intended for use in structural connections and assembly of such structures as buildings and bridges.

subgroup—one or more events or measurements used to analyze the performance of a process.

surface discontinuities—irregularities that occur prior to or during the manufacturing or processing of the fastener. These may include cracks, head bursts, shear bursts, seams, folds, thread laps, voids, tool marks, and nicks or gouges.

systematically selected samples—a commonly used technique whereby specimens are chosen for inspection or testing based on stated criteria of a sampling plan, such as occurs during process-control charting, during tooling changes, or at specific timed intervals.

tensile strength, fastener—see *ultimate strength*.

test report—a written document or electronic record, signed by an authorized party, which contains sufficient data and information to verify that the tested fastener properties conform to the particular specification requirements.

thread lap—a doubling over of metal on the thread which is created during roll threading operations.

threaded deformed bar—a steel bar that has a continuous hot-rolled pattern of thread-like deformations along its entire length that allows a nut and coupler to thread onto the bar.

tool marks—longitudinal or circumferential grooves of shallow depth produced by the movement of manufacturing tools over the bolt, nut, or screw surface.

torsional strength—a load, usually expressed in terms of applied torque, at which the fastener fails by being twisted off about its axis.

total case depth—the distance measured perpendicularly from the surface of a hardened case to a point where differences in chemical or physical properties of the case and core no longer can be distinguished.

toughness—the ability of a fastener to absorb energy and to deform plastically before fracture.

traceability—the ability to verify the manufacturing history, raw material, heat number, location, or application of an item by means of recorded identification.

ultimate tensile load—the maximum tensile-applied load or force a fastener can support prior to or coincidental with its fracture, and normally expressed in terms of pounds or Newtons.

user—see *end user*.

verification—an act of confirming, substantiating, and assuring that an activity or condition has been implemented in conformance with the specified requirements.

Vickers hardness test—standard method for measuring the hardness of metals, particularly those with extremely hard surfaces; the surface is subjected to a standard pressure for a standard length of time by means of a pyramid-shaped diamond. The diagonal of the resulting indentation is measured under a microscope and the Vickers hardness value is then read from a conversion table.

void—a shallow pocket or hollow on the surface of a fastener because of nonfilling of metal during forging.

warm heading or working—a forming method in which material is heated to a given temperature to improve formability before heading. The temperature used is below the recrystallization point or transformation temperature of the metal being formed.

washer-retainer crack—opening in the lip or hub of metal used to retain a washer on a nut.

weathering steels—steels having added alloying elements to enhance the resistance to atmospheric corrosion.

wedge tensile strength—the ultimate strength determined by testing with the use of a wedge with a prescribed angle.

wedge tensile test—a tensile test performed on various headed fasteners and studs using a wedge of prescribed dimensions and hardness, and in a prescribed manner for the purpose of verifying good head quality or ductility, or both.

wire—used extensively in fastener manufacturing. It is produced from hot rolled or annealed rods or bars by cold drawing. Steel sizes range from 0.062 to 1.375 in.

workmanship—the expected absence of imperfections affecting serviceability of a fastener. Often used to describe a

finish free from injurious burrs, seams, laps, or irregular surfaces.

yield strength—the tension-applied load at which the fastener experiences a specific amount of permanent deformation, that is, the bolt has been stressed beyond its elastic limit and is in the plastic zone. It is very difficult to test full size bolts for yield strength. Because of different strain rates in the threaded section, thread runout and unthreaded shank which together comprise the stressed length, a “proof load” concept was introduced.

Young’s modulus—see *modulus of elasticity*.

zero defects—a term which indicates that no deviation from the requirements of a specification are present within a statistically valid sample drawn from a given fastener lot.

APPENDIX

(Nonmandatory Information)

X1. FASTENER TERMS BY CHARACTERISTIC

X1.1 Mechanical fastener terminology may also be organized by fastener characteristics relating to coatings and finishes, inspection and related documentation, materials and manufacturing/processing, mechanical properties, performance properties, physical properties, product definition, quality assurance, and testing.

Coatings and Finishes

Average Coating Thickness
 Baking Duration
 Barrel-Plating Process
 Batch Average Thickness
 Fastener Electroplating
 Hot Dip Galvanizing
 Inch Threaded Class 2A Coating Thickness
 Local Thickness
 Mechanical Deposition
 Minimum Local Thickness
 Passivation
 Plating
 Rack-Plating Process

Inspection and Related Documentation

Applicable Standards
 Assembly Lot
 Certificate of Compliance
 Certificate of Conformance
 Certification
 Control Plan
 Detection Process
 Fastener Specification
 Fastener Standard
 Inspection
 Inspection Test
 Lot
 Lot Sampling Inspection
 Material Lap
 Prevention Process
 Process Flow
 Referenced Standards
 Related Standards
 Shall
 Shear Burst
 Should
 Special Cause Variation

Statistical Control
 Statistical Process Control
 Subgroup
 Void

Materials and Manufacturing/Processing

Alloy Groups
 Alloy Steel
 Alter
 Annealing
 Austenitic Stainless Alloys
 Carbide Precipitation “Sensitization”
 Carbon Steel
 Check Analysis
 Cold Forming
 Cold Heading Quality Material
 Crack
 Cut Thread
 Decarburization
 Deoxidation
 Effective Case Depth
 Elongation
 Forging Cracks
 Heat Analysis
 High Temperature Fastener Alloys
 Hot Forming
 Hydrogen Embrittlement, Internal
 Internal Hydrogen Embrittlement
 Ladle Analysis
 Liquid Medium
 Low Carbon Martensite
 Martensitic Alloys
 Material Specification
 Microstructure
 Nonferrous Alloys
 Precipitation Hardening Alloys
 Process Parameters
 Property Class
 Quench Cracks
 Raw Material Manufacturer
 Reprocess
 Residuals
 Rod
 Roll Thread
 Seam
 Secondary Manufacturer



Secondary Processing
Significantly Alter
Solution Treat
Spheroidize
Stainless Steel
Strain Hardening
Strength Grade
Threaded Deformed Bar
Total Case Depth
Warm Heading or Working
Weathering Steels
Wire

Mechanical Properties

Bilateral Specification
Clamp Load
Cone Proof Load-Inch Series
Cone Proof Load-Metric Series
Fastener Tensile Stress Area
Fatigue Strength
Grade Identification Symbols
Hardness
Impact Strength
Maximum Hardness
Mechanical Properties
Minimum Hardness
Modulus of Elasticity
Proof Load
Property Class Symbols
Proportional Limit
Reduction of Area
Shear Strength
Strain
Stress
Tensile Strength, Fastener
Toughness
Ultimate Tensile Load
Wedge Tensile Strength
Yield Strength
Young's Modulus

Performance Properties

Bolt Load - Elongation Behavior
Break Loose Torque
Breakaway Torque
Compression Load
Corrosion Resistance
Ductility of Externally Threaded Fasteners
Endurance Limit
Environmental Hydrogen Embrittlement
Fatigue Limit
Heat Resistance
High Temperature for Mechanical Fasteners
Inspection Torque
Locking Ability
Performance Properties
Plasticity
Prevailing Torque
Stress Corrosion Cracking
Torsional Strength

Physical Properties

Magnetic Permeability
Physical Properties
Resilience

Product Definition

Anchor Bolt
Bar
Bendable Bolts
Bolt
Compressible-Washer-Type Direct Tension Indicator
Conical Washer
Consensus Standard
Eye Bolt
Fastener
High Strength Bolts
Mechanical Fastener

Nut
Part Identifying Number (PIN)
Plain Washer
Reduced Diameter Body
Roof and Rock Bolts
Screw
Screw Thread
Shear Stress Area: Bolt or Screw
Significant Surface
Spherical Washers or Seats
Structural Bolt
Washer-Retainer Crack

Quality Assurance

Burst
Certified Quality Assurance System
Commingling
Common Cause
Control Limit
Defect
Detection System
Fastener Quality
Fold
In-Process Sampling Inspection
Material Review
Nick
Nonconformance
Pre-Launch Production Plan
Prevention System
Process Parameters
Production Plan
Prototype Plan
Qualification (Personal)
Quality Assurance
Quality Assurance Program
Quality Assurance System
Random Sampling
Registered Quality Assurance System
Registration
Repeatability
Responsibility for the Fastener
Responsible Party
Review
Surface Discontinuities
Systematically Selected Samples
Thread Lap
Tool Marks
Traceability
Verification
Workmanship
Zero Defects

Supplier/User

Distributor
End User
Fastener Manufacturer
Manufacturer
Private Label Distributor

Testing

Arbitration Hardness Location
Bend Test
Cone Proof Load Test
Destructive Test
Extensometer
Fastener Testing
Full Size Specimen
Head-to-Shank Integrity
Indentation Hardness
Machined Specimen
Macro-etch Test
Macrograph
Macroscopic
Macrostructure
Material Test Report
Metallography
Plastic Deformation
Product Analysis

Rotational Capacity Test
Routine Hardness Locations
Salt Spray Test
Test Report

Vickers Hardness Test
Wedge Tensile Test

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