Designation: A 644 – 98 (Reapproved 2003)

Standard Terminology Relating to Iron Castings[1]

This standard is issued under the fixed designation A 644; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ausferrite, *n*—a cast iron matrix microstructure, produced by a controlled thermal process, which consists of predominantly acicular ferrite and high carbon austenite. (See **austempered ductile iron**.)

austempered ductile iron, *n*—a ductile cast iron that has been produced by a controlled thermal process which results in a matrix microstructure consisting of predominately acicular ferrite and high carbon austenite.

austenitize, *vt*—to convert the matrix of a ferrous alloy to austenite by heating above the transformation temperature.

batch, *n*—the component raw materials properly weighed, proportioned, and mixed for delivery to a processing unit. Also, the product output from a processing unit in which there is essentially no product output until all component materials are charged and processed.

brittle fracture, *n*—fracture that occurs without appreciable plastic deformation of the material.

brittle fracture area, *n*—The fraction or percent of the fracture surface that formed by brittle fracture. (When observed with no or low magnification, brittle fracture appears whiter and shinier than ductile fracture.)

capability index (C_p), *n*—for a stable process, the specification range divided by six times the standard deviation.

$$C_p = \frac{(USL - LSL)}{6 \times s}$$

capability index (C_{pk}), *n*—for a stable process, the smaller of the upper capability index (CPU) or the lower capability index (CPL).

carbide, primary, *n*—carbide precipitated in cast iron during solidification.

cast iron, *n*—a generic term for a series of alloys primarily of iron, carbon, and silicon in which the carbon is in excess of the amount which can be retained in solid solution in austenite at the eutectic temperature.

cementite, *n*—a very hard and brittle compound of iron and carbon corresponding to the empirical formula Fe_3C, commonly known as iron carbide.

cementite, primary, *n*—cementite precipitated in cast iron during solidification. Also known as primary carbide. (See **cementite**.)

chill, *n*—an object, usually metal, imbedded in a portion of the mold to accelerate the local rate of heat removal from the metal being cast.

chill, *v*—to accelerate the freezing rate of cast iron, usually in a localized region, to refine the graphite structure or cause formation of primary carbides.

chill, microstructural, *n*—a localized region of primary carbides in a casting made from a cast iron that would normally solidify free of primary carbides.

chilled iron, *n*—a cast iron that would normally solidify free of primary carbide which is purposely caused to solidify as white cast iron, locally or entirely, by accelerated cooling.

compacted graphite iron, *n*—a cast iron that has been treated in the liquid state so as to cause its graphitic carbon to occur in the compacted graphite shape in the as-cast condition. (See **graphite, compacted** and **graphite, spheroidal**.)

confidence level, *n*—the probability, or expected percent of the times, that the selected percent (P %) of the actual population lies within the tolerance interval calculated from the data sample.

direct reduced iron, *n*—iron ores that have been reduced to essentially metallic iron by heat and reducing agents, but without melting, and processed into suitable shapes (typically pellets) for use as a charge material in a melting operation.

dual metal, *n*—two metals of different composition that are fusion bonded at all interfacial surfaces by casting metal of one composition against metal of a second composition.

ductile fracture, *n*—fracture that occurs with appreciable plastic deformation of the material.

ductile fracture area, *n*—The fraction or percent of the fracture surface that formed by ductile fracture. (When observed with no or low magnification, ductile fracture appears grayer and duller than brittle fracture.)

ductile iron, *n*—a cast iron that has been treated in the liquid state so as to cause substantially all of its graphitic carbon to occur as spheroids or nodules in the as-cast condition.

[1] This terminology is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.91 on Editorial Matters and Nomenclature.

Current edition approved Dec. 10, 1998. Published January 1999. Originally approved in 1971. Last previous edition approved in 1998 as A 644 – 98.

ferritize, *vt*—to increase the quantity of ferrite in the matrix of a ferrous casting through an appropriate heat treatment.

ferritizing anneal, *n*—the process of producing a predominantly ferritic matrix in cast iron through an appropriate heat treatment.

graphite, compacted, *n*—a graphite shape that is intermediate between flake graphite and nodular graphite that typically appears in a polished section as thick flakes with blunt (compacted) ends.

graphite flake, *n*—an irregularly shaped particle of graphite, usually appearing in a polished section as curved plates, such as found in gray cast irons.

graphite, nodular, *n*—spheroidal shaped graphite typically found in ductile irons and compact clusters of graphite typically found in malleable irons. (See **graphite, spheroidal**, and **temper carbon**.)

graphite, primary, *n*—graphite precipitated in cast iron during solidification.

graphite rosette, *n*—arrangement of graphite flakes in which the flakes extend radially from centers of crystallization in gray cast iron.

graphite, spheroidal, *n*—spheroidal shaped graphite having a polycrystalline radial structure, usually found in ductile iron and to a controlled, limited extent in compacted graphite iron.

graphitize, *vt*—to precipitate graphite in an iron-carbon alloy.

gray iron, *n*—cast iron that has a relatively large proportion of the graphitic carbon present in the form of flake graphite. The metal has a gray fracture.

heat, *n*—the total molten metal output from a single heating in a batch melting process or the total molten metal output from essentially a single heating in a continuous melting operation using basically constant charge and processing conditions and targeted at a fixed metal chemistry at the furnace spout. A heat can also be defined as a fixed time period for a continuous melting operation provided that it is shorter than the time period covered by the above definition.

inoculated iron, *n*—cast iron, either liquid or solid, to which one or more inoculating alloys have been added while the iron was in the molten state.

inoculated iron, fully, *n*—cast iron, either liquid or solid, to which all molten metal additions, including all inoculating alloys, have been added.

inoculating alloy, *n*—an alloy added to molten iron for the principle purpose of nucleating a primary phase such as graphite. Inoculating alloys are frequently used to avoid the formation of primary carbide by enhancing the nucleation of graphite.

lot, *n*—a finite quantity of a given product manufactured under production conditions that are considered uniform.

lower capability index (CPL), *n*—the difference between the sample mean ($\bar{x}$) and the lower specification limit divided by three times the standard deviation.

$$CPL = \frac{(\bar{x} - LSL)}{3 \times s}$$

lower specification limit (LSL), *n*—the lowest specified value.

M, *n*—the number of standard deviations, mutually concurred by the supplier and purchaser, to be used for calculations of statistical conformance to such items as minimums, maximums, specification ranges, and process capability indices.

DISCUSSION—*M* values of three or less were used in establishing initial ASTM specification limits; higher values of *M* result in reduced allowable variability for actual values when the property of interest is bounded on both sides; in the case of a minimum or maximum, a high value of *M* can result in the need for excessively high or low mean property values ($\bar{x}$).

malleable, ferritic, *n*—a ferrous alloy that is cast as white iron but which is converted by an appropriate heat treatment to a microstructure of temper carbon embedded in a ferritic matrix essentially free of pearlite and carbide.

malleable iron, *n*—a cast iron of such composition that it solidifies as white iron, which upon proper heat treatment is converted to a metallic matrix with nodules of temper carbon.

malleable, pearlitic, *n*—a ferrous alloy that is cast as white iron but which is converted by an appropriate heat treatment to a microstructure of temper carbon embedded in a matrix containing a controlled quantity, form, and distribution of pearlite or tempered martensite.

malleableize, *vt*—to convert white iron into malleable iron through an appropriate graphitizing heat treatment.

maximum (non-statistical), *n*—the highest acceptable actual test result; any valid individual test result above the maximum is cause for rejection of the component or material lot being tested.

$$\text{All } x_i \leq \text{Maximum} = USL$$

maximum (statistical), *n*—the highest acceptable statistical test result; for compliance, the sample mean ($\bar{x}$) plus *M* standard deviations(s), where *M* is a matter of agreement between the supplier and purchaser, must be less than, or equal to, the upper specification limit.

$$\bar{x} + M \times s \leq \text{Maximum} = USL$$

DISCUSSION—1—A normal data distribution is assumed for the population from which the data sample was drawn.

DISCUSSION—2— *M* values of three or less were used in establishing initial ASTM specifications limits. Higher values of *M* result in reduced allowable variability for actual values when the property of interest is bounded on both sides. In the case of a minimum or maximum, a high value of *M* can result in the need for excessively high or low mean property values ($\bar{x}$).

mean ($\bar{x}$), *n*—the sum of the individual data points (*x*'s) divided by the number of data points (*n*).

$$\bar{x} = \frac{\Sigma x_i}{n}$$

melt, *n*—the total molten metal produced in a single heat.

merchant pig iron, *n*—pig iron produced for commercial sale to foundries.