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Glossary of terms used in iron
and steel (Heat treatment)

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ferrous alloys, heat treatment, production processes

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Iron and Steel Federation (**JISF**)/the Japanese Standards Association (**JSA**) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law. Consequently **JIS G 0201 : 1987** is replaced with this Standard.

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Glossary of terms used in iron and steel (Heat treatment)

Introduction This Japanese Industrial Standard has been made to achieve conformity between **JIS G 0201** and **ISO 4885** *Ferrous products—Heat treatments—Vocabulary* published in 1996 as far as possible. The vocabulary which was specified in both standards, except when the definition may confuse the domestic users or when the provisions were inadequate, has been specified in accordance with the provisions of **ISO**. Furthermore, the vocabulary which was specified in **JIS G 0201 : 1987** but not specified in **ISO**, is included with some modification.

The provisions of **ISO 4885** constitute Annex 1 (informative) and Annex 2 (informative).

1 Scope This Japanese Industrial Standard specifies the principal terms and their definitions related to the heat treatment of the rolled, cast or forged steels.

Remarks : The International Standard corresponding to this Standard is as follows.

ISO 4885 : 1996 *Ferrous products—Heat treatments—Vocabulary*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. If the indication of the year of coming into effect is given to these referred standards, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter are not applied. The normative references without the indication of the year of coming into effect apply limiting only to the most recent edition (including the amendment).

JIS B 6911 *Process of normalizing and annealing of iron and steel*

JIS B 6912 *Process of induction hardening and tempering of iron and steel*

JIS G 0551 *Methods of austenite grain size determination for steel*

JIS G 0552 *Methods of ferrite grain determination test for steel*

JIS G 0557 *Methods of measuring case depth hardened by carburizing treatment for steel*

JIS G 0559 *Methods of measuring case depth for steel hardened by flame or induction hardening process*

JIS G 0561 *Method of hardenability test for steel (End quenching method)*

ISO 3651-2 : 1998 *Determination of resistance to intergranular corrosion of stainless steels—Part 2 : Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels—Corrosion test in media containing sulfuric acid*

ISO 3887 : 1976 *Steel, non-alloy and low-alloy—Determination of depth of decarburization*

3 Classification The terms related to iron and steel (heat treatment) are classified as follows.

- a) Heat treatment in general
- b) Normalizing and annealing
- c) Quench hardening, tempering and aging
- d) Surface hardening treatment and surface treatment

4 Definitions The definitions of terms used in this Standard shall be as follows.

Remarks 1 When two or more terms are described together under one term number, they shall be preferentially used according to the order mentioned.

- 2 The figures in the parentheses below the term numbers indicate that the terms are specified in **ISO** and are the clause numbers of **ISO 4885**. The definitions of the terms specified in both **JIS** and **ISO** have been specified in accordance with **ISO**, and the parts underlined in the column of definition for each term mean supplementary explanation to the definition of **ISO**. Even when the terms were specified in both **JIS** and **ISO**, if the definitions were quoted from **JIS**, those portions are underlined and the definitions of **ISO** are given as "informative" in the column of definition.

a) Heat treatment in general

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1101 (3.74)	熱処理	NETUSYORI	Series of operations in the course of which a solid ferrous product is totally or partially exposed to thermal cycles to bring about a change in its properties and/or structure. Remarks : The chemical composition of the ferrous product may possibly be modified during these operations.	heat treatment
1102	光輝熱処理	KÔKI NETUSYORI	Heat treatment performed in protective atmosphere or the like to prevent the high temperature oxidation and decarburization of surface and to retain the bright surface. Remarks : This is subdivided into: bright annealing, bright normalizing, bright hardening, bright tempering, etc.	bright heat treatment
1103	雰囲気熱処理	HUN'IKI NETUSYORI	Heat treatment carried out by controlling the atmospheric gases in furnace according to the purpose for use. Remarks : The atmospheric gases are classified into oxidizing, reducing, inert, carburizing, nitriding gases, etc.	controlled atmosphere heat treatment
1104	真空熱処理	SINKÛ NETUSYORI	A generic term for heat treatment carried out by heating in a vacuum. Remarks : This treatment is classified into: vacuum annealing, vacuum hardening, vacuum tempering, etc.	vacuum heat treatment
1105	イオン衝撃熱処理	ION SYÔGEKI NETUSYORI	Surface treatment carried out by making use of glow discharge generated between the anode and the cathodic object in the atmosphere under reduced pressure.	ion bombardment heat treatment, plasma heat treatment
1106	電解熱処理	DENKAI NETUSYORI	Heat treatment in which electricity is passed in either electrolyte or a salt bath, between the anode and the object made cathodic, thereby the object is heated and then cooled.	electrolytic heat treatment

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1107	塩浴熱処理	EN'YOKU NETUSYORI	Heat treatment carried out in a salt bath.	salt bath heat treatment
1108	拡散浸透処理	KAKUSAN SINTÔ SYORI	A generic term for the heat treatment by diffusing metal element or nonmetal element over the surface. Remarks 1 It is also called the diffusion coating process or cementation. 2 There are - aluminizing or - calorizing, - galvanizing, - sulphurizing, - chromizing, - siliconizing, - sherardizing, etc.	diffusion coating
1109 (3.149)	加工熱処理	KAKÔ NETUSYORI	Forming process in which the final deformation takes place within a certain range of temperatures, producing a material condition with certain properties which cannot be obtained or repeated by heat treatment alone. Remarks : A representative method of this operation is the <u>ausforming process in which martensitic transformation is carried out after plastic working of steel within a temperature range of metastable austenite.</u>	thermomechanical treatment
1110	制御圧延	SEIGYO ATUEN	A kind of hot rolling method which aims to improve mechanical properties by the atomization of crystal structure of steel to be effected by an appropriate control of heating temperature, rolling temperature and pressure applied to steel pieces. Remarks : In the controlled rolling: a) The rolling which finishes in low-temperature austenite range mainly for Mn-Si type high-tension steels is called classical controlled rolling. b) The controlled rolling in which the rolling is largely carried out in not-yet-recrystallized range may be called thermal controlled rolling.	controlled rolling

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1111	加速冷却	KASOKU REIKYAKU	A controlled cooling method which is carried out mainly in the rolling process of thick plates and which aims at controlling the crystal structure of the steel and improving the mechanical properties by means of controlled rolling followed by cooling down through the temperature range for transformation with a greater speed than that of air-cooling. Remarks : This does not include the cooling method of quench hardening which merely cools rapidly on a rolling line using the apparatus for accelerated cooling.	accelerated cooling
1112	熱加工制御	NETUKAKÔ SEIGYO	A generic term for manufacturing methods carrying out air cooling or enforced controlled cooling subsequent to the main process of controlled rolling. Remarks 1 It includes the thermo-mechanical rolling and the accelerated rolling, but not when it is classical controlled rolling alone. 2 This is also called TMCP. Remarks : R : Under pressure, Ac : Accelerated cooling Fig. 1 Thermo-mechanical control process	thermo-mechanical control process
1113 (3.133)	安定化熱処理	ANTEIKA NETUSYORI	Heat treatment of a ferrous product intended to prevent subsequent dimensional or structural changes with time.	stabilizing

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1114 (3.134)	安定化焼きなまし	ANTEIKA YAKINAMASI	Annealing at around 850 °C with the aim of obtaining precipitation or spheroidization of compounds, for example carbides, in stabilized austenitic stainless steels.	stabilizing annealing
1115 (3.126)	均熱	KIN'NETU	The part of the thermal cycle during which the temperature is held constant. Remarks : It is necessary to stipulate whether the temperature concerned is, for example, that of the furnace, that of the surface of the product, that of the whole section of the product or that of any other particular point on the product. To keep the material at a fixed temperature for suitable duration for the principal purpose of lessening the temperature difference between the inside and the outside of material.	soaking
1116 (3.7)	オーステナイト化	ÔSUTENAITOKA	Operation during which the ferrous product is brought to a temperature such that the structure becomes austenitic. Remarks : If this transformation is incomplete, it is termed the partial austenitization.	austenitizing
1117 (3.8)	オーステナイト化温度	ÔSUTENAITOKA ONDO	The highest temperature at which the ferrous product is maintained during austenitization.	austenitizing temperature
1118	硬化	KÔKA	An operation in which hardness is increased by a treatment, such as aging, heating and cooling. Remarks : There are types such as age hardening, precipitation hardening, quench hardening, case hardening, etc.	hardening
1119	シーズニング, 枯し	SÎZUNINGU, KARASI	An operation of leaving castings as they are over a long period of time for the purpose of removing casting internal stress. Remarks : In recent years, stress relieving has been generally employed.	seasoning

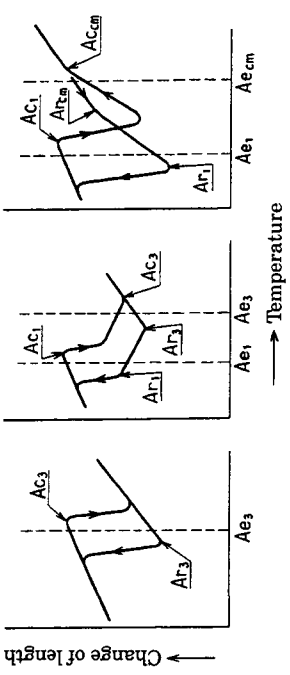
No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1201 (3.52)	拡散	KAKUSAN	A phenomenon in which atoms which constitute substance move, excited by heat energy. Remarks : Such phenomena as diffusion transformation, precipitation, recovery, recrystallization or carburizing proceed based on the diffusion of atoms. Heat treatment (or operation) intended to cause the diffusion towards the interior of the ferrous product of elements previously introduced into the surface (for example, following carburizing, boronizing or nitriding).	diffusion
1202 (3.53)	拡散処理	KAKUSAN SYORI	Surface layer formed during a thermochemical treatment containing, in solid solution or where appropriate partially precipitated, the element(s) introduced during the treatment. Remarks 1 The content of these elements diminishes continuously as the core is approached. 2 The precipitates in the diffusion zone can be nitrides, carbides, etc.	diffusion treatment
1203 (3.106)	過熱及び過均熱	KANETU OYOBI KAKINNETU*	Heating carried out under temperature conditions for a duration such that excessive grain growth is produced. Remarks : A distinction can be made between overheating, which is due to the temperature effect, and oversaking, which is due to the effect of time. An overheated and oversaked ferrous product may be retreated by an appropriate heat treatment or by hot deformation depending on the nature of the product.	overheating and oversaking
1204 (3.19)	バーニング	BĀNINGU	Irreversible change in the structure and properties brought about by the onset of fusion at the grain boundaries. Remarks : Phenomena that various properties originally possessed can not be recovered by a combined operation of later heat treatment and mechanical working or of working and heat treatment.	burning

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1205 (3.120)	再結晶	SAIKESSYÔ	A phenomenon in which, when crystals plastically strained in cold work are heated, new crystal nuclei having no internal strain begin to grow from the original crystal grains still retaining strain in the process of decreasing internal stress, and new nuclei, increasing in number and enlarging their sizes, gradually displace the original crystal grains. Remarks : The temperature at which recrystallization occurs is called recrystallization temperature. This temperature is greatly influenced by the purity or composition of metal and alloy, the degree of plastic strain in crystal and heating time, etc. Heat treatment intended to cause new grains to develop by nucleation and growth, in a work-hardened metal, without a change in phase.	recrystallization
1206 (3.68)	再結晶熱処理	SAIKESSYÔ NETUSYORI	Heat treatment intended to cause new grains to develop by nucleation and growth, in a work-hardened metal, without a change in phase.	recrystallizing
1207 (3.69)	結晶粒粗大化	KESSYÔRYÛ SODAIKA	Heat treatment of annealing carried out at a temperature well above A_{c3} for a soaking period sufficient to bring about grain growth.	grain coarsening
1207 (3.69)	結晶粒微細化	KESSYÔRYÛ BISAIKA	Heat treatment with the object of refining and eventually making uniform the grain size of a ferrous product. Remarks : Comprising heating it at a temperature slightly above A_{c3} (A_{c1} for hypereutectoid steels), without prolonged soaking at this temperature, followed by cooling at a suitable rate.	grain refining
1208 (3.45) (3.46)	脱炭	DATTAN	Depletion of carbon from the surface layer of a ferrous product. Remarks : This depletion may be either partial (partial decarburization) or nominally complete (complete decarburization). The sum of the two types of decarburization (partial and complete) is termed total decarburization (refer to ISO 3887).	decarburization
	脱炭処理	DATTAN SYORI	Thermochemical treatment intended to produce decarburization of a ferrous product.	decarburizing

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1209 (3.47)	脱炭層深さ	DATTANSŌ HUKASA	Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer depleted in carbon. Remarks 1 <u>The terms for expressing the depth of the decarburized layer are the total decarburized layer depth, the ferritic decarburized layer depth, the specific residual carbon rate decarburized depth, the practical decarburized layer depth, etc.</u> 2 This limit varies according to the type of decarburization and can be defined by reference to a structural state, a level of hardness or the carbon content of the unaltered base metal (refer to ISO 3887), or any other specified carbon content.	depth of decarburization
1210	白点	HAKUTEN	Spots with white luster generated on the fractured surface of steel products. Remarks 1 Formerly, they were often found in large forgings of low alloy steel or the like. 2 They are considered to be internal cracks induced by a transformation stress generated in the cooling process after hot working, or by an internal stress accompanying the precipitation of hydrogen or the like.	flake, white spot
1211	水素ぜい(脆)化	SUIISOZEIKA	A phenomenon in which the ductility or toughness of steel material is deteriorated by the hydrogen absorbed by the steel. Remarks : This phenomenon is usually generated when pickling, electric plating or the like is carried out, and further, with the existence of a tensile stress, often results in cracking.	hydrogen embrittlement
1212	赤熱ぜい性	SEKINETU ZEISEI	The brittleness property generated within a temperature range of hot working.	red shortness

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1213	青熱ぜい性	SEINETU ZEISEI	A property in which tensile strength and hardness of steel at temperatures around 200 to 300 °C become larger than those at ordinary temperature, and thus the steel, with its elongation and reduction of area lessened, becomes brittle. Remarks: The term "blue shortness", is derived from the fact that, blue oxidized film is formed on the surface within this temperature range.	blue shortness
1214	低温ぜい性	TEION ZEISEI	A property in which the impact value of steel rapidly decreases and the steel becomes brittle around room temperature or lower.	cold shortness
1215	σぜい性	SIGUMA ZEISEI	Embrittlement caused by the precipitation and separation of σ phase. Remarks: The σ phase is an intermetallic compound produced in the high chromium steel and high chromium-nickel steel containing not less than 20 % chromium.	sigma embrittlement
1216 (3.56)	変形	HENKEI	Any change in the shape and original dimensions of a ferrous product, occurring during heat treatment.	distortion
1217	経年変形	KEINEN HENKEI	A phenomenon in which dimensions and shape of material change at room temperature over a long period of time.	secular distortion
1218 (3.146)	熱き裂	NETU KIRETU	Fissure produced in a ferrous product by the immediate or deferred effects of heating or cooling. Remarks: Generally, the term crack is classified by an indication of the conditions under which the crack appeared, e.g. heating crack, quenching crack, etc.	thermal crack
1219	鑄鉄の成長	TYŪTETU NO SEITYŌ	An irreversible abnormal expansion generated when cast iron is repeatedly heated up and cooled down at the transformation point.	growth of cast iron
1301	変態	HENTAI	A phenomenon in which a crystal structure is changed into another crystal structure by the rise or fall of temperature. Remarks: Magnetic transformation involves no change of crystal structure.	transformation

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1302 (3.43) (3.152)	変態点 変態温度	HENTAITEN HENTAI ONDO	Transformation temperatures for a particular alloy. Temperature at which a change of phase occurs and, by extension, at which the transformation begins and ends when the transformation occurs over a range of temperatures. Remarks : The following principal transformation temperatures can be distinguished for steels: Ae₁ : equilibrium temperature defining the lower limit of existence of austenite Ae₃ : equilibrium temperature defining the upper limit of existence of ferrite Ae_m : equilibrium temperature defining the upper limit of existence of cementite in a hypereutectoid steel Ac₁ : temperature at which austenite begins to form during heating Ac₃ : temperature at which ferrite completes its transformation into austenite during heating Ac_m : temperature at which the cementite in a hypereutectoid steel dissolves completely during heating Ar₁ : temperature at which austenite completes its transformation into ferrite or ferrite and cementite during cooling Ar₃ : temperature at which ferrite begins to form during cooling Ar_m : temperature at which cementite begins to form in a hypereutectoid steel during cooling of the austenite Ms : temperature at which the austenite begins to transform into martensite during cooling Mf : temperature at which the austenite has almost completely transformed into martensite during cooling Mx : temperature at which x % of the austenite has transformed into martensite during cooling	critical points transformation temperature

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
			 a) Pure iron b) Hypo-eutectoid steel c) Hyper-eutectoid steel Fig. 2 Transformation point	
1303	磁気変態	ZIKI HENTAI	The change from ferromagnetic material to paramagnetic material or from paramagnetic material to ferromagnetic material. Remarks : This is not accompanied by a change of crystalline structure.	magnetic transformation
1304 (4.5)	α 鉄	ARUFA TETU	Stable state of pure iron at temperatures below 911 °C. Remarks 1 Its crystalline structure is body-centred cubic. 2 It is ferromagnetic at temperatures below 768 °C (the Curie point). 3 It is paramagnetic within the temperature range between 768 °C and 910 °C.	alpha iron
1305 (4.16)	δ 鉄	DERUTA TETU	Stable state of pure iron between 1 392 °C and its melting point. Remarks 1 Its crystalline structure is body-centred cubic, identical to that of alpha iron. 2 It is paramagnetic.	delta iron
1306 (4.19)	フェライト	FERAITO	Solid solution of one or more elements in alpha iron or delta iron. Remarks : The solid solution of δ iron is also called δ ferrite.	ferrite

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1307	初析フェライト	SYOSEKI FERAITO	Ferrite precipitated from austenite prior to eutectoid transformation when hypo-eutectoid steel is cooled from a high temperature.	pro-eutectoid ferrite
1308	シリコ・フェライト	SIRIKO FERAITO	Ferrite containing a great amount of silicon for example, gray cast iron and malleable cast iron.	silico-ferrite
1309 (4.21)	γ鉄	GANMA TETU	Stable state of pure iron between 911 °C and 1 392 °C. Remarks 1 Its crystalline structure is face-centred cubic. 2 It is paramagnetic.	gamma iron
1310 (4.6)	オーステナイト	ÔSUTENAITO	Solid solution of one or more elements in gamma-iron.	austenite
1311 (4.48)	固溶体	KOYÔTAI	Homogeneous, solid, crystalline phase formed by two or more elements. Remarks : A distinction is made between a substitutional solid solution in which the solute atoms are substituted for those of the solvent and an interstitial solid solution in which the solute atoms are inserted between those of the solvent.	solid solution
1312	共晶	KYÔSYÔ	A change from one solution to a structure in which not less than two solid phases are closely mixed in the process of cooling, or the structure generated as a result of the reaction. Remarks : As seen in an equilibrium diagram, when the concentration of alloying metal element is smaller than that in the eutectic solution, it is called hypo-eutectic; and when larger, hyper-eutectic.	eutectic
1313	共析	KYÔSEKI	A transformation from one solid solution to the structure in which not less than two solid phases are closely mixed in the process of cooling or the structure generated as a result of the transformation. Remarks : As seen in an equilibrium diagram, when the concentration of alloying metal element is smaller than that in the eutectoid solution, it is called hypo-eutectoid; and when larger, hyper-eutectoid.	eutectoid

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1314	析出	SEKISYUTU	A phenomenon in which a crystal of a different phase is separated from a solid solution and grows.	precipitation
1315	偏析	HENSEKI	A phenomenon in which alloying elements or impurities are unevenly distributed, or its state.	segregation
1316 (4.9)	しま状組織	SIMAZYÔ SOSIKI	Bands parallel to the direction of hot working that appear in a metallographic section. Remarks : It is observed as a band structure by the difference between the segregated zone like a band during hot working and other transformation structures.	banded structure
1317	炭化物	TANKABUTU	A compound of carbon and one or more metal elements. Remarks : Carbide having not less than two alloying elements as necessary components is called double carbide.	carbide
1318 (4.11)	セメンタイト	SEMENTAITO	Iron carbide with the formula Fe_3C .	cementite
1319	初析セメンタイト	SYOSEKI SEMENTAITO	Cementite precipitated from austenite prior to eutectoid transformation when hyper-eutectoid steel is cooled from a high temperature.	pro-eutectoid cementite
1320 (4.41)	パーライト	PÂRAITO	Aggregate of ferrite and cementite platelets formed by the eutectoid decomposition of austenite.	pearlite
1321 (4.25)	結晶粒度	KESSYÔ RYÛDO	Characteristic size of a grain revealed in a metallographic section. Remarks 1 Generally it is expressed with the grain size number obtained by either the comparison method or the cutting method. 2 The test method for the austenite grain size is specified in <u>JIS G 0551</u> and the test method for the ferrite grain size is specified in <u>JIS G 0552</u> .	grain size

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
1322 (4.51)	ウイドマンステッテン 組織	UIDOMAN- SUTETTEN SOSIKI	Structure resulting from the formation of a new phase along certain crystallographic planes in the parent solid solution. Remarks: In the case of hypoeutectoid steel, it appears in a metallographic section in the form of ferrite needles in a pearlite background. In the case of hypereutectoid steels, the needles consist of cementite.	Widmannstaetten structure
1323	双晶	SÔSYÔ	A crystal grain in which the crystal lattice is of two parts which have the same structure, forming specular symmetry with a certain fixed surface (called a twin plane) as the boundary. Remarks: The kinds of twin frequently observed in ordinary metals are a deformation twin, a transformation twin and an annealing twin.	twin
1324	焼きなまし双晶	YAKINAMASI SÔSYÔ	A kind of twin crystal often observed when recrystallization or the growth of crystal grain takes place after annealing.	annealing twin
1325	共晶黒鉛	KYÔSYÔ KOKUEN	Fine flakes of graphite having a twin shape or the graphite already existing in white cast iron before annealing malleable cast iron. Remarks: The latter is also called mottle.	eutectic graphite
1326	片状黒鉛	HENZYÔ KOKUEN	Graphite in a flaky stage generated in gray cast iron. Remarks: Graphite rosette and eutectic graphite also belong to this class.	graphite flake, flake graphite
1327	球状黒鉛	KYÛZYÔ KOKUEN	Graphite in a dense spheroidal stage generated in spheroidal graphite cast iron manufactured when it is treated with magnesium or the like.	spheroidal graphite, nodular graphite
1328	白鑄鉄, 白鉄	HAKUTYÔ TETU, HAKUSEN	Pig iron composed of eutectic cementite and pearlite, and containing no graphite.	white iron
1329	バーミキュラ黒鉛	BÂMIKYURA KOKUEN	Caterpillar type graphite of a type intermediate between spheroidal graphite and graphite flake. Remarks: This is also called compacted graphite.	vermicular graphite

b) Normalizing and annealing

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
2101 (3.102)	焼ならし	YAKINARASI	Heat treatment consisting of austenitizing followed by air cooling. Remarks : <u>The purposes of this operation are to eliminate the influence of pre-working, to render the crystal grains finer and to improve their mechanical properties. The normalizing working of iron and steel is specified in JIS B 6911.</u>	normalizing
2102 (3.3)	焼まし	YAKINAMASI	Heat treatment consisting of heating and soaking at a suitable temperature followed by cooling under conditions such that, after return to ambient temperature, the metal will be in a structural state closer to that of equilibrium. Remarks : Since this definition is very general, it is advisable to use an expression specifying the aim of the treatment (refer to bright annealing, full annealing, soft annealing, inter-critical annealing, isothermal annealing and sub-critical annealing).	annealing
2103 (3.67)	完全焼まし	KANZEN YAKINAMASI	Annealing at a temperature above A_{c3} .	full annealing
2104 (3.127)	軟化焼まし	NANKA YAKINAMASI	Heat treatment in which heating is carried out around temperatures of A_{c1} transformation point with the object of reducing the hardness of the ferrous product to a given level.	softening
2105 (3.138)	応力除去焼まし	ORYOKUZYOKYO YAKINAMASI	Heat treatment, including heating to and soaking at a suitable temperature, followed by cooling at an appropriate rate, in order to reduce the internal stresses without substantially modifying the structure.	stress relieving
2106	ひずみ取り焼まし	HIZUMITORI YAKINAMASI	An annealing in which iron and steel are heated and then maintained at a temperature not higher than the transformation point while being loaded in order to relieve the strain generated in them.	straightening annealing
2107	低温焼まし	TEION YAKINAMASI	An annealing carried out at a temperature not higher than the transformation temperature for the purpose of lowering the residual stress or softening. This is sometimes carried out at a temperature not higher than recrystallization temperature.	low temperature annealing

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
2108 (3.82)	拡散焼なまし	KAKUSAN YAKINAMASI	Prolonged high temperature annealing intended to reduce by diffusion, the heterogeneities of chemical composition due to the phenomenon of segregation.	homogenizing
2109 (3.130) (3.131)	球状化焼なまし, 球状化, 球状化処理	KYŪZYŌKA YAKINAMASI, KYŪZYŌKA, KYŪZYŌKA SYORI	Geometric development of the carbide particles, such as the cementite platelets, towards a stable spherical form. Annealing, generally involving prolonged soaking in the region of temperature A_{c1} , possibly with oscillations around this temperature, in order to bring about the spheroidization of the precipitated carbides.	spheroidizing, spherodization
2110 (3.91)	等温焼なまし	TŌON YAKINAMASI	Annealing involving austenitizing, followed by cooling which is interrupted by soaking for a period at a temperature at which the transformation from austenite into ferrite and pearlite, or cementite and pearlite, is complete.	isothermal annealing
2111	中間焼なまし	TYŪKAN YAKINAMASI	An annealing which is carried out at a suitable temperature between the recrystallization point or over up to and including point A_{c1} for the purpose of softening the steel hardened by cold working and facilitating the subsequent cold working. Or an annealing which is carried out once or several times separately before final heat during the treatment in the manufacturing process of forging. This is also called intermediate annealing.	process annealing intermediate annealing
2112 (3.17)	箱焼なまし	HAKO YAKINAMASI	Annealing carried out in a sealed container to minimize oxidation.	box annealing
2113 (3.95)	可鍛化焼なまし	KATANKA YAKINAMASI	Heat treatment intended to transform the structure of a white cast iron in order to obtain a malleable cast iron (refer to 4.53 of Annex 1) by decarburization or by graphitization of the cementite.	malleablizing
2114 (3.71)	黒鉛化焼なまし	KOKUENKA YAKINAMASI	Heat treatment applied to hypereutectoid steels in order to graphitize all or a portion of the carbide in iron and steel.	graphitizing

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
2115	第一段焼なまし	DAITIDAN YAKINAMASI	An annealing for the first stage graphitization.	first stage annealing
2116	第二段焼なまし	DAINIDAN YAKINAMASI	An annealing for the second stage graphitization.	second stage annealing
2117	予備焼なまし	YOBI YAKINAMASI	An annealing preliminarily carried out at a suitable temperature not higher than point A_{c1} for the purpose of promoting the graphitization of white iron.	pre-baking, pre-annealing
2118	脱炭焼なまし	DATTAN YAKINAMASI	An annealing for the purpose of imparting ductility by removing carbon from the surface of iron and steel.	decarburizing annealing
2201 (3.70)	黒鉛化	KOKUENKA	A phenomenon in which cementite is decomposed at a high temperature and the carbon in cementite is precipitated in the form of graphite.	graphitization
2202	第一段黒鉛化	DAITIDAN KOKUENKA	A phenomenon in which eutectic cementite is decomposed into temper carbon and austenite in the manufacturing process of malleable cast iron.	first stage graphitization
2203	直接黒鉛化	TYOKUSETU KOKUENKA	A phenomenon in which, after the first stage graphitization when austenite transforms into ferrite within the temperature range of transformation A_{c1} in the cooling process, graphite precipitates directly from austenite due to the difference of carbon solubility.	direct graphitization
2204	第二段黒鉛化	DAINIDAN KOKUENKA	A phenomenon in which eutectoid cementite is decomposed into temper carbon and ferrite in the manufacturing process of malleable cast iron.	second stage graphitization
2205 (3.119)	回復	KAIHUKU	Heat treatment intended to cause at least partial recovery of the physical or mechanical properties of a cold-worked ferrous product without apparent modification of its structure. Remarks : This treatment is carried out at a temperature below that of recrystallizing.	recovery
2301	球状炭化物	KYŪZYŌ TANKABUTU	Carbides in a globular form.	globular carbide, spheroidal carbide

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
2302	球状セメント 球状セメント	KYŪZYŌ SEMENTAITO	Cementites in a globular form.	globular cementite, spheroidal cementite
2303	焼炭素 焼炭素	YAKIMODOSI TANSO	Graphite precipitated by graphitizing white cast iron.	temper carbon

c) Quench hardening, tempering and aging

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
3101 (3.116)	焼入れ 焼入れ	YAKIIRE	Operation which consists of cooling a ferrous product more rapidly than in still air. Remarks : The use of a term specifying the cooling conditions is recommended, for example air-blast quenching, water quenching, step quenching, etc.	quenching
3102 (3.114)	焼入硬化 焼入硬化	YAKIIRE KŌKA	Hardening of a ferrous product obtained, after austenitizing, by cooling under conditions such that the austenite transforms more or less completely into martensite or into bainite.	quench hardening
3103	水焼入れ 水焼入れ	MIZU YAKIIRE	A quench hardening carried out using water as coolant.	water hardening, water quenching
3104	油焼入れ 油焼入れ	ABURA YAKIIRE	A quench hardening carried out using oil as coolant.	oil hardening, oil quenching
3105	熱浴焼入れ 熱浴焼入れ	NETUYOKU YAKIIRE	A quench hardening in which steel is rapidly cooled in a hot bath (molten metal, molten salt, oil, etc.) that is maintained at a temperature suitable for cooling, and, after kept for a suitable period of time, is drawn up to be cooled in air.	hot bath quenching
3106	塩浴焼入れ 塩浴焼入れ	ENYOKU YAKIIRE	A hot bath quench hardening using fused salt.	salt bath quenching

No.	Term (Japanese character)	Reading	Definition	English equivalent (informative)
3107	電解焼入れ	DENKAI YAKIIRE	A quench hardening which is carried out by rapidly cooling an object in an electrolyte after heating it with an electric current passed between an anode and the object as cathode.	electrolytic hardening
3108	真空焼入れ	SINKŪ YAKIIRE	A quench hardening which is carried out by rapidly cooling in gas, oil, water or the like after heating in a vacuum.	vacuum hardening
3109	空気焼入れ	KŪKI YAKIIRE	A quench hardening in which steel is cooled in air or other suitable gases. Remarks : This is carried out when quench hardening the steel having self-hardening property.	air hardening
3110	噴射焼入れ	HUNSYA YAKIIRE	A quench hardening carried out by spraying a coolant.	spray hardening
3111	噴霧焼入れ	HUNMU YAKIIRE	A quench hardening carried out in a foggy coolant.	fog hardening
3112 (3.89)	中断焼入れ	TYŪDAN YAKIIRE	Quenching carried out in a medium giving rapid cooling and interrupted before the ferrous product reaches thermal equilibrium with the quenching medium. Remarks 1 The purpose of this operation is to prevent the strain and quenching cracks generated during quenching, and to suitably control the properties to turn up after quenching. 2 This term should not be used to designate step quenching.	interrupted quenching
3113 (3.136)	階段焼入れ	KAIDAN YAKIIRE	Quenching during which the cooling is temporarily interrupted by soaking in a medium at a suitable temperature. Remarks : This term should not be used to designate interrupted quenching.	step quenching
3114	時間焼入れ	ZIKAN YAKIIRE	An interrupted quenching by a method of cooling a material in a coolant, keeping it for a suitable time and then drawing it up.	time quenching
3115	プレスクエンチ	PURESU KUENTI	A quench hardening carried out for an object placed under a pressed state. Remarks : This is applied to machine parts antipathetic to quenching distortion and is also called die quenching.	press quenching