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English version

Vocabulary of heat treatment terms for ferrous products

Vocabulaire du traitement thermique des produits ferreux

Begriffe der Wärmebehandlung von Eisenwerkstoffen

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
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Foreword

This European Standard has been prepared by the Technical Committee ECISS/TC 21, Vocabulary of heat treatment terms, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1994, and conflicting national standards shall be withdrawn at the latest by April 1994.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE This European Standard contains different references to definitions and different statements in notes in each language version because of different terms used in national terminology.

Contents

1 Scope

The purpose of this European Standard is:

1.1 To define the terms in the ferrous products heat treatment vocabulary.

These terms are divided into a main part (**3.2**) and a complementary section (**3.3**)

— the main part gives an alphabetical list of the terms with their definitions and, where appropriate, comments. Definitions of foreign terms for which the language in question has no equivalents are given at the end of the main part under their reference number;

— the complementary section comprises the definitions of terms necessary to understand the main part.

NOTE The comments are printed in italics in order to differentiate them from the definitions.

Any term defined in the main part of this European Standard and used elsewhere in a definition or a comment is printed in CAPITAL LETTERS.

The reference numbers given with each term are identical in all the versions and correspond to the French alphabetical order. In order to avoid any confusion, the numbers of the terms in the annex are preceded by the letter A. Clause **3.1** gives the terms in numerical order.

1.2 To facilitate translations using the tables of equivalent terms.

Table 1 gives the equivalent French and German terms for the English terms in the alphabetical list.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EU 23-71, *End quench hardenability test for steel (Jominy test).*

EU 103-71, *Micrographic determination of the ferritic or austenitic grain size of steels.*

EU 104-70, *Determination of the decarburization depth of unalloyed and low alloy structural steels.*

EU 105-71, *Determination and verification of the effective case depth after carburizing.*

EU 108-72, *Round steel wire rod for cold formed nuts and bolts — Dimensions and tolerances.*

EU 114-72, *Determination of resistance to intergranular corrosion of austenitic stainless steels. Corrosion test in a sulphate medium (Monypenny — Strauss test).*

EU 116-72, *Determination of the effective case depth after surface hardening.*

EN 10020, *Definition and classification of grades of steel.*

EN 10083-1, *Quenched and tempered steels — Part 1: Technical conditions for special steel.*

EN 10083-2, *Quenched and tempered steels — Part 2: Unalloyed quality steels.*

prEN 10083-3, *Quenched and tempered steels — Part 3: Technical delivery conditions for boron steels.*

3 Terms

3.1 List of terms in numerical order

1	Carbon activity
2	Softening
3	Grain refining
4	Aluminizing
5	Endothermic atmosphere
6	Exothermic atmosphere
7	Ausforming
8	Austenitizing
9	Auto-tempering
10	Self-quenching
11	Blueing
12	Boriding
13	Burning
14	Blacking
15	Maximum achievable hardness
16	Carbonitriding
17	Carburizing
18	Blank carburizing
19	Boost-diffuse carburizing
20	Heating
21	Heating curve
22	Heating time
23	Heating function
24	Heating schedule
25	Heating rate
26	Chromizing
27	Carbon mass transfer coefficient
28	Compound layer
29	Diffusion zone
30	Quench hardened layer

31 Carbon profile
32 Tempering curve
33 Cyaniding
34 Thermal cycle
35 Decarburization
36 Decarburizing
37 Distortion
38 Baking
39 Destabilization of retained austenite
40 Ageing treatment
41 Stress relief tempering
42 Time-temperature-transformation diagram (TTT diagram)
43 Continuous-cooling-transformation diagram (CCT diagram)
44 Equivalent ruling section
45 Diffusion treatment
46 Impulse hardening
47 Induction hardening
48 Local hardening
49 Precipitation hardening
50 Precipitation hardening treatment
51 Single quench hardening treatment
52 Quench hardening
53 Through-hardening
54 Surface hardening treatment
55 Quench hardening treatment
56 Direct hardening treatment
57 Double quench hardening treatment
58 Secondary hardening
59 Floor-to-floor time
60 Normalizing forming
61 Temper embrittlement
62 Spheroidization
63 Spheroidizing
64 Graphitization
65 Graphitizing
66 Grain coarsening
67 Homogenizing
68 Solution annealing
69 Impulse heating
70 Isoforming
71 Jominy test
72 Soaking
73 Malleablizing
74 Maraging
75 Medium
76 Solution treatment
77 Heating-up time
78 Nitrocarburizing
79 Nitriding
80 Blank nitriding
81 Two-stage nitriding
82 Normalizing
83 Operation
84 Internal oxidation
85 Patenting
86 Depth of transformation
87 Carbon potential
88 Quenching capacity
89 Preheating
90 Case depth
91 Effective case depth after carburizing
92 Depth of decarburization
93 Depth of hardening
94 Effective case depth after surface hardening
95 Depth of nitriding
96 Carbon restoration
97 Recrystallizing
98 Annealing
99 Bright annealing
100 Full annealing
101 Soft annealing
102 Inter-critical annealing
103 Isothermal annealing
104 Sub-critical annealing
105 Cooling
106 Cooling curve
107 Cooling time
108 Cooling function
109 Cooling conditions
110 Cooling schedule
111 Cooling rate
112 Critical cooling function
113 Critical cooling rate
114 Stress relieving
115 Recovery
116 Tempering
117 Sherardizing
118 Siliconizing
119 Stabilizing
120 Stabilization of retained austenite
121 Sulphidizing

122 Overcarburizing
123 Overheating and oversoaking
124 Thermal crack
125 Austenitizing temperature
126 Transformation temperature
127 Quenching temperature
128 Inter-critical treatment
129 Sub-zero treating
130 Heat treatment
131 Thermochemical treatment
132 Thermomechanical treatment
133 Hardenability
134 Quenching
135 Direct quenching
136 Step quenching
137 Austempering
138 Martempering
139 Interrupted quenching
140 Vanadizing
141 Case hardening
142 Limited ruling section
143 Stabilizing annealing
144 Term without an English definition (see definition)
145 Term without an English definition (see definition)
146 Term without an English definition (see definition)
147 Equalization
148 Term without an English definition (see definition)
149 Flame hardening

Terms in the annex

A 150 Acicular structure
A 151 Steel
A 152 Austenitic steel
A 153 Ferritic steel
A 154 Graphitic steel
A 155 Ledeburitic steel
A 156 Maraging steel
A 157 Alloy
A 158 Austenite
A 159 Retained austenite
A 160 Air-hardening steel
A 161 Bainite
A 162 Banded structure
A 163 Epsilon carbide
A 164 Cementite
A 165 Coalescence of a precipitate
A 166 Constituent
A 167 Nitrogen profile
A 168 Critical diameter
A 169 Low load hardness
A 170 Mass effect
A 171 Eutectoid transformation
A 172 Alpha iron
A 173 Gamma iron
A 174 Delta iron
A 175 Ferrite
A 176 Cast iron
A 177 Malleable cast iron
A 178 Grain
A 179 Crystallinity
A 180 McQuaid-Ehn grain size
A 181 Grain size
A 182 Grain growth
A 183 Hypereutectoid steel
A 184 Hypoeutectoid steel
A 185 Intermetallic compound
A 186 Transformation range
A 187 Grain boundary
A 188 Ledeburite
A 189 Martensite
A 190 Secondary martensite
A 191 Metastable
A 192 Microhardness
A 193 Pearlite
A 194 Phase
A 195 Parent phase
A 196 Proeutectoid constituent
A 197 Recalescence
A 198 Sensitization
A 199 Solid solution
A 200 Transformation temperature
A 201 Ageing
A 202 Widmannstatten structure

3.2 Main part

ageing treatment – 40 –

HEAT TREATMENT applied to a ferrous product after SOLUTION TREATMENT to bring its properties to the required level.

It consists of HEATING to and SOAKING at one or more specified temperatures, followed by cooling appropriately.

NOTE In English, a treatment carried out after SOLUTION TREATMENT but before the final AGEING TREATMENT and at an intermediate temperature is called Austenite conditioning or Primary hardening

aluminizing – 4 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product with the object of producing surface enrichment in aluminium.

NOTE In English, the term calorizing was formerly used to designate this treatment.

annealing – 98 –

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.

*As this definition is very general, it is advisable to use an expression specifying the aim of the treatment (see definitions **96** to **101**).*

NOTE In English, the term "box annealing" is used when the annealing is carried out in a sealed container to minimize oxidation.

atmosphere see MEDIUM – 75 –

ausforming – 7 –

THERMOMECHANICAL TREATMENT of a ferrous product which consists of plastically deforming the metastable austenite before subjecting it to the martensitic and/or bainitic transformation.

austempering – 137 –

HEAT TREATMENT involving AUSTENITIZATION followed by STEP QUENCHING, at a rate fast enough to avoid the formation of ferrite or pearlite, to a temperature above M_s and SOAKING to ensure partial or total transformation of the austenite to bainite.

The final COOLING to ambient temperature is not at any specific rate.

austenite conditioning See AGEING TREATMENT – 40 –

austenitizing – 8 –

OPERATION during which the ferrous product is brought to a temperature such that the structure becomes austenitic.

If this transformation is incomplete, the austenitization is termed partial.

austenitizing temperature – 125 –

Highest temperature at which the ferrous product is held during austenitization.

auto-tempering – 9 –

Spontaneous TEMPERING undergone by martensite during QUENCHING.

NOTE In English, the term "self-tempering" is also used to designate this phenomenon.

baking – 38 –

HEAT TREATMENT permitting the release of hydrogen occluded in a ferrous product without modifying its structure.

This treatment is generally carried out following an electrolytic plating or pickling or welding operation.

blacking – 14 –

OPERATION carried out in an oxidizing MEDIUM at a temperature such that the polished surface of a ferrous product becomes covered with a thin, continuous, adherent film of dark-coloured oxide.

blank carburizing – 18 –

Simulation treatment which consists of reproducing the THERMAL CYCLE of CARBURIZING without the carburizing MEDIUM.

This treatment makes it possible to assess the metallurgical consequences of the THERMAL CYCLE of CARBURIZING.

blank nitriding – 80 –

Simulation treatment which consists of reproducing the THERMAL CYCLE of NITRIDING without the nitriding MEDIUM.

This treatment makes it possible to assess the metallurgical consequences of the THERMAL CYCLE of NITRIDING.

blue brittleness see TEMPER EMBRITTLEMENT – 61 –

blueing – 11 –

OPERATION carried out in an oxidizing MEDIUM at a temperature such that the polished surface of a ferrous product becomes covered with a thin, continuous, adherent film of blue-coloured oxide.

NOTE In English, the term steam treatment is used when the process is carried out in superheated water vapour.

boriding – 12 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product with the aim of producing a surface layer of boride.

NOTE The medium in which boriding takes place should be specified, for example, pack boriding, paste boriding, etc.

boost-diffuse carburizing – 19 –

CARBURIZING carried out in two or more successive stages with different carbon potentials.

box annealing see ANNEALING – 98 –

bright annealing – 99 –

ANNEALING carried out in a MEDIUM that allows the original metallic surface finish to be maintained by preventing oxidation of the metal.

burning – 13 –

Irreversible change in the structure and properties brought about by the onset of fusion at the grain boundaries.

calorizing see ALUMINIZING – 4 –

carbon activity – 1 –

Ratio of the vapour pressure of carbon in a given state (for example in austenite of specific carbon concentration) to the vapour pressure of pure carbon (graphite), as a reference state, at the same temperature.

carbon mass transfer coefficient – 27 –

Mass of carbon transferred from the carburizing MEDIUM into the steel, per unit surface area per second for a unit difference between the CARBON POTENTIAL, and actual surface carbon content.

carbon potential – 87 –

Carbon content at the surface of a specimen of pure iron in equilibrium with the CARBURIZING MEDIUM considered and under the conditions specified.

carbon profile – 31 –

Carbon content as a function of distance from the surface.

carbon restoration – 96 –

THERMOCHEMICAL TREATMENT intended to restore the carbon content of the surface layer, decarburized during an earlier treatment.

carbonitriding – 16 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product heated to a temperature above Ac_1, to obtain a surface enrichment in carbon and nitrogen, which are in solid solution in the austenite.

Generally, this OPERATION is followed immediately by QUENCH HARDENING.

NOTE 1 The MEDIUM in which CARBONITRIDING takes place shall be specified, for example gas, salt bath, etc.
NOTE 2 CARBONITRIDING carried out in a bath of molten salts containing cyanides is called CYANIDING.

carburizing – 17 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in the austenitic state, to obtain a surface enrichment in carbon, which is in solid solution in the austenite.

The carburized ferrous product undergoes QUENCH HARDENING (immediately or later).

NOTE The MEDIUM in which CARBURIZING takes place shall be specified, for example gas, pack, etc.

case depth – 90 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer enriched in carbon. This limit should be specified.

Example: For the total CASE DEPTH, this limit will correspond to the carbon content of the unaltered base metal.

NOTE In English the term CASE DEPTH is used for any CASE HARDENING or SURFACE HARDENING process.

case hardening – 141 –

Treatment consisting of CARBURIZING or CARBONITRIDING followed by QUENCH HARDENING.

NOTE In English, NITRIDING, NITROCARBURIZING, etc., are also considered to be CASE HARDENING processes.

cementation see THERMOCHEMICAL TREATMENT – 131 –

chromizing – 26 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to obtain surface enrichment in chromium.

The surface layer can consist of practically pure chromium (on low-carbon steels) or of chromium carbide (on high-carbon steels).

compound layer – 28 –

Surface layer formed during a THERMOCHEMICAL TREATMENT and made up of the chemical compounds formed by the element(s) introduced during the treatment and certain elements from the base metal.

For example, the layer of nitride formed during NITRIDING, the layer of boride formed during BORIDING, the layer of chromium carbide formed during the CHROMIZING of high carbon steel.

NOTE In English the term "white layer" is improperly used to designate this layer on nitrided and nitrocarburized ferrous product.

continuous-cooling-transformation diagram (CCT diagram) – 43 –

Set of curves drawn in a semi-logarithmic coordinate system with logarithmic time/temperature coordinates and which define for each COOLING FUNCTION, the temperature at which the austenite begins and ends its transformation.

In general a complementary curve joins the points corresponding to the temperatures at which the proportion of phase transformed reaches 50 %. Information is also given about the transformation products and their proportions.

Finally, the hardness measured after return to ambient temperature is shown for each of the COOLING CURVES.

NOTE CCT diagrams may also be obtained for a given cooling period.

cooling – 105 –

Reduction of the temperature of a ferrous product.

The COOLING process may be carried out in one or more steps.

NOTE The MEDIUM in which COOLING takes place shall be specified, for example of air, water, oil, furnace, ... (see also QUENCHING – 134 –).

cooling conditions – 109 –

The conditions under which the COOLING of the ferrous product takes place: nature and temperature of the MEDIUM, relative movements, agitation, etc.

cooling curve – 106 –

Graphical representation of the COOLING FUNCTION (variation of temperature as a function of time during COOLING).

cooling function – 108 –

Successive variations of the temperature at one point in the ferrous product considered, as a function of time from the commencement of COOLING to the end of this operation.

cooling rate – 111 –

Characterizes the variation in temperature as a function of time during COOLING.

One distinguishes between:

— an instantaneous rate corresponding to a specified temperature;

— an average rate over a defined interval of temperature.

cooling schedule – 110 –

COOLING FUNCTION (variation in temperature as a function of time during COOLING), which must be followed.

core refining see DOUBLE QUENCH HARDENING – 57 –

cooling time – 107 –

The interval of time separating two characteristic temperatures of the COOLING FUNCTION. It is always necessary to specify precisely what the temperatures are.

critical cooling function – 112 –

COOLING FUNCTION corresponding to the least severe COOLING conditions which will nevertheless permit the full development of a given transformation, avoiding the appearance of an undesirable preliminary structure.

This term shall be completed by an indication of the transformation considered, for example martensitic, bainitic, etc.

critical cooling rate – 113 –

COOLING RATE corresponding to the CRITICAL COOLING FUNCTION.

critical points see TRANSFORMATION TEMPERATURE – 126 –

cyaniding – 33 –

See CARBONITRIDING (– 16 –)

decarburization – 35 –

Depletion of carbon from the surface layer of a ferrous product.

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. (See EU 104-70).

decarburizing – 36 –

THERMOCHEMICAL TREATMENT intended to produce DECARBURIZATION of a ferrous product.

deep freezing see SUB-ZERO TREATING – 129 –

depth of decarburization – 92 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer depleted in carbon. This limit differs according to the type of DECARBURIZATION (see DECARBURIZATION – 35 –) and can be defined by reference to a structural state, a level of hardness or the carbon content of the unaltered base metal (see EU 104-70), or any other prescribed carbon content.

depth of hardening – 93 –

Distance between the surface of a ferrous product and a limit characterizing the penetration of QUENCH HARDENING. This limit may be defined starting from a structural state or a level of hardness.

depth of nitriding – 95 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer enriched in nitrogen. This limit shall be specified.

NOTE When this limit is a level of hardness, the term "effective case depth" is used in English (see EU 108-72).

depth of transformation – 86 –

Development of QUENCH HARDENING from the surface of a ferrous product. The DEPTH OF TRANSFORMATION is generally measured in terms of the DEPTH OF HARDENING.

destabilization of retained austenite – 39 –

Phenomenon occurring during TEMPERING which allows the retained austenite to undergo martensitic transformation within a temperature range where it would not previously have transformed spontaneously.

diffusion treatment – 45 –

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, BORIDING or NITRIDING).

diffusion zone – 29 –

Surface layer formed during a THERMOCHEMICAL TREATMENT containing, in solid solution or where appropriate partially precipitated, the element(s) introduced during the treatment. The content of these elements diminishes continuously as the core is approached.

The precipitates in the diffusion zone can be nitrides, carbides, etc.

direct hardening treatment – 56 –

HARDENING TREATMENT of a ferrous product, by DIRECT QUENCHING.

In general this treatment is carried out after CARBURIZING and, if necessary, after cooling to the temperature most appropriate to the hardening of the product.

direct quenching – 135 –

QUENCHING carried out immediately following hot or cold rolling or after a THERMOCHEMICAL TREATMENT, etc.

distortion – 37 –

Any change in the shape and original dimensions of a ferrous product, occurring during HEAT TREATMENT.

double hardening see DOUBLE QUENCH HARDENING – 57 –

double quench hardening treatment – 57 –

HEAT TREATMENT consisting of two successive QUENCH HARDENING treatments, generally carried out from different temperatures.

In the case of carburized products, the first QUENCH HARDENING can be obtained by DIRECT QUENCHING, the second being carried out from a lower temperature.

NOTE The incorrect expression "double hardening" is used in English to designate this treatment. In the case of carburized products, when the second QUENCH HARDENING treatment is carried out from above the critical temperature of the base material, the term "core refining" is used.

effective case depth after carburizing – 91 –

Distance between the surface of a ferrous product and the position where the Vickers hardness is $HV_1 = 550$ (see EU 105-71).

EU 105 indicates equally that:

— loads other than the conventional load may be used after prior agreement, to measure this depth, these loads are between 4,9 *and* 49 N.

— the superficial Rockwell test may be similarly used, after prior agreement to define the limiting hardness value.

effective case depth after surface hardening – 94 –

Distance between the surface and the point whose Vickers hardness (HV_1) is equal to 80 % of the minimum surface hardness required for the ferrous product considered (see EU 116-72).

EU 116-72 indicates equally that:

— Loads other than the conventional load may be used after prior agreement, to measure this depth, these loads are between 4,9 N and 49 N.

— The superficial Rockwell test may be similarly used, after prior agreement, to define the limiting hardness value.

effective case depth see DEPTH OF NITRIDING – 95 –

endothermic atmosphere – 5 –

Furnace atmosphere produced endothermically and with a CARBON POTENTIAL capable of being matched to the carbon content of the ferrous product under HEAT TREATMENT in order to reduce, increase or maintain the carbon level at the surface of the ferrous product.

equalization – 147 –

The second stage of HEATING of a ferrous product whereby the required temperature at the surface is attained throughout its section.

equivalent ruling section – 44 –

Diameter (d) of the cylinder of the same steel (of length $\geq 3d$) in which the COOLING RATE at its centre would be identical to the slowest COOLING RATE recorded in the ferrous product considered, for the same COOLING conditions.

The equivalent diameter is not the same as that determined by heat treatment (see EN 10083-1 and EN 10083-2).

exothermic atmosphere – 6 –

Furnace atmosphere produced exothermically and controlled so that it does not oxidize the ferrous product.

flame hardening – 149 – See SURFACE HARDENING (– 54 –)

floor-to-floor time – 59 –

Interval of time between placing a ferrous product in a furnace and its removal.

full annealing – 100 –

ANNEALING at a temperature above Ac_3.

glow discharge nitriding see NITRIDING – 79 –

grain coarsening – 66 –

ANNEALING carried out at a temperature well above Ac_3 for a SOAKING period sufficient to bring about grain growth.

grain refining – 3 –

HEAT TREATMENT with the object of refining and eventually making uniform the grain size of a ferrous product and comprising HEATING it at a temperature slightly above Ac_3 (Ac_1 for hypereutectoid steels), without prolonged SOAKING at this temperature, followed by COOLING at a suitable rate.

graphitization – 64 –

Precipitation of carbon in the form of graphite.

graphitizing – 65 –

HEAT TREATMENT applied to cast irons or hypereutectoid steels to bring about GRAPHITIZATION.

hardenability – 133 –

Capacity of a steel to give rise to martensitic and/or bainitic transformations.

HARDENABILITY is often characterized under defined experimental conditions by the development of hardness as a function of the distance from a quenched surface (for example, the Jominy curve).

hardening temperature see QUENCHING TEMPERATURE – 127 –

heat treatment – 130 –

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.

The chemical composition of the ferrous product may possibly be modified during these OPERATIONS. (See THERMOCHEMICAL TREATMENT – 131 –)

heating – 20 –

Increasing the temperature of a ferrous product.

NOTE This temperature increase may be carried out in one or more stages.

heating curve – 21 –

Graphical representation of the HEATING FUNCTION.

heating function – 23 –

Successive variations of the temperature at one point in the ferrous product considered, as a function of time during HEATING, from the commencement of HEATING to the end of the rise in temperature.

heating rate – 25 –

Characterizes the variation of the temperature as a function of time during HEATING.

One distinguishes between:

— the instantaneous rate corresponding to a specific temperature;

— the average rate over a defined interval of temperature.

heating schedule – 24 –

HEATING FUNCTION which is to be carried out.

heating time – 22 –

Interval of time separating two characteristic temperatures of the HEATING FUNCTION.

It is always necessary to specify what these temperatures are.

heating-up time – 77 –

Time required for the temperature of a designated point of a ferrous product at a given temperature, to attain the required value.

homogenizing – 67 –

Prolonged high temperature ANNEALING, intended to reduce by diffusion, to a greater or lesser extent, the heterogeneities of chemical composition due to the phenomenon of segregation.

impulse hardening – 46 –

Hardening treatment using heating by impulses. Normally this hardening is the result of SELF-QUENCHING.

impulse heating – 69 –

Method of HEATING by short repeated bursts of energy, giving rise to a local increase in temperature.

Various sources of energy can be used, for example: condenser discharge, lasers, electron beams, etc.

induction hardening – 47 – See SURFACE HARDENING (– 54 –)

inter-critical annealing – 102 –

ANNEALING at a temperature between Ac_1 and Ac_3.

inter-critical treatment – 128 –

Treatment of a hypoeutectoid steel involving HEATING to and SOAKING at a temperature between Ac_1 and Ac_3 followed by COOLING adapted to the characteristics required.

internal oxidation – 84 –

Precipitation to a greater or lesser depth towards the interior of a ferrous product, of dispersed oxides formed by oxygen which has diffused from the surface.

interrupted quenching – 139 –

QUENCHING carried out in a MEDIUM giving rapid COOLING and interrupted before the ferrous product can reach thermal equilibrium with the quenching MEDIUM.

This expression is not to be used to designate STEP QUENCHING.

ion nitriding see NITRIDING – 79 –

isoforming – 70 –

THERMOMECHANICAL TREATMENT of a steel consisting of plastic deformation carried out during the transformation of austenite to pearlite.

isothermal annealing – 103 –

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.

Jominy test – 71 –

Standardized test which consists of austenitizing a steel test piece and then quenching it by means of a jet of water applied to one end. The variation in hardness with distance from the quenched end (Jominy curve) characterizes the HARDENABILITY of the steel (EU 23).

limiting ruling section – 142 –

Maximum diameter or thickness of a bar in which the specified properties are to be met by a given HEAT TREATMENT.

local hardening – 48 –

QUENCH HARDENING limited to part of a ferrous product.

malleablizing – 73 –

HEAT TREATMENT intended to transform the structure of a white cast iron in order to obtain a malleable cast iron by DECARBURIZATION or by GRAPHITIZATION of the cementite.

maraging – 74 –

A PRECIPITATION HARDENING TREATMENT carried out on steels, the SOLUTION TREATMENT of which, produces a soft, very low carbon martensite which can subsequently be aged to give the required mechanical properties.

martempering – 138 –

HEAT TREATMENT involving AUSTENITIZATION followed by STEP QUENCHING, at a rate fast enough to avoid the formation of ferrite, pearlite or bainite, to a temperature slightly above M_s and SOAKING for long enough to ensure that the temperature is uniform but short enough to avoid the formation of bainite.

The final COOLING, during which martensite forms practically simultaneously throughout the whole cross-section, is generally carried out in air.

maximum achievable hardness – 15 –

Maximum value of harness that can be obtained on a given ferrous product by QUENCH HARDENING, under ideal conditions.

medium – 75 –

Environment in which the ferrous product is placed during a HEAT TREATMENT OPERATION.

The MEDIUM can be solid, liquid or gaseous. It plays an important role by means of its calorific properties (heating MEDIUM, cooling MEDIUM, etc.) and by its chemical properties (oxidizing MEDIUM, decarburizing MEDIUM, etc.). The gaseous MEDIUM is often designated by the term "atmosphere".

nitriding – 79 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to produce surface enrichment in nitrogen.

If this treatment is carried out in a MEDIUM to which a certain quantity of oxygen has been added, it is called "OXYNITRIDING".

NOTE 1 The MEDIUM in which the nitriding takes place should be specified, for example: gas, plasma, etc.
NOTE 2 In English, the terms glow discharge nitriding and ion nitriding were formerly used to designate plasma nitriding.

nitrocarburizing – 78 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to produce surface enrichment in nitrogen and carbon, which forms a COMPOUND LAYER.

Beneath this COMPOUND LAYER there is a DIFFUSION ZONE enriched in nitrogen.

NOTE 1 The MEDIUM in which the NITROCARBURIZING takes place should be specified, for example salt bath, gas, plasma etc.
NOTE 2 In English the expression "soft nitriding" is improperly used to designate this treatment.

normalizing – 82 –

HEAT TREATMENT consisting of AUSTENITIZING followed by AIR COOLING.

normalizing forming – 60 –

A forming process in which the final deformation is carried out within a certain temperature range producing a material with an equivalent condition to that obtained after NORMALIZING, so that the specified values of mechanical properties are the same as those produced by NORMALIZING.

operation – 83 –

Each of the elementary actions within a HEAT TREATMENT CYCLE.

overcarburizing – 122 –

CARBURIZING until the surface carbon content exceeds the prescribed level.

NOTE In English, this term also designates excessive CASE DEPTH.

overheating and oversoaking – 123 –

HEATING carried out under temperature conditions and duration such as to produce excessive grain growth.

A distinction can be made between overheating, which is due to the temperature effect, and oversoaking, which is due to the effect of time. An overheated and oversoaked ferrous product may be retreated by an appropriate HEAT TREATMENT or by hot deformation depending on the nature of the product.

oxynitriding see NITRIDING – 79 –

patenting – 85 –

HEAT TREATMENT consisting of AUSTENITIZING followed by COOLING under conditions suitable for producing the appropriate structures for subsequent wire-drawing or rolling.

A distinction is drawn between:

— CONTINUOUS PATENTING, when the OPERATIONS of HEATING and COOLING of the unwound product are carried on continuously;

— BATCH PATENTING, when the product remains in the form of a coil or bundle during this HEAT TREATMENT.

NOTE The medium in which the PATENTING takes place should be specified, for example air, lead bath etc.

precipitation hardening – 49 –

Hardening of a ferrous product caused by the precipitation of one or more compounds from a supersaturated solid solution.

precipitation hardening treatment – 50 –

HEAT TREATMENT consisting of a SOLUTION TREATMENT followed by an AGEING TREATMENT.

preheating – 89 –

OPERATION consisting of raising the temperature of the ferrous product to one or more temperatures, intermediate between the initial and the maximum temperature, and holding it there for a certain time.

primary hardening see AGEING TREATMENT – 40 –

quench hardened layer – 30 –

Surface layer of a ferrous product, hardened by QUENCHING, the thickness of which being generally defined by the depth of QUENCH HARDENING.

quench hardening – 52 –

Hardening of a ferrous product obtained, after AUSTENITIZATION, by cooling under conditions such that the austenite transforms more or less completely into martensite and possibly into bainite.

quench hardening treatment – 55 –

HEAT TREATMENT with the object of QUENCH HARDENING and comprising AUSTENITIZATION followed by COOLING, under conditions such that the austenite transforms more or less completely into martensite and possibly into bainite.

quenching – 134 –

OPERATION which consists of COOLING a ferrous product more rapidly than in still air.

The use of a term specifying the COOLING conditions is recommended, for example air-blast quenching, water quenching, STEP QUENCHING, etc.

When the quenching of part of a ferrous product that has been heated is carried out by thermal transfer towards the unheated parts, this is called SELF-QUENCHING.

quenching capacity – 88 –

Ability of a MEDIUM to carry out a particular COOLING SCHEDULE.

This QUENCHING CAPACITY can be characterized with the aid of a quench severity index, whose definition has still to be determined.

quenching temperature – 127 –

The temperature from which QUENCHING is carried out.

NOTE In English, the term "hardening temperature" is equally used, to designate the QUENCHING TEMPERATURE of hardenable ferrous products.

recovery – 115 –

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.

This treatment is carried out at a temperature below that of RECRYSTALLIZATION.

recrystallizing – 97 –

HEAT TREATMENT intended to cause new grains to develop by nucleation and growth, in a work-hardened metal, without a change in phase.

secondary hardening – 58 –

Hardening of a ferrous product obtained after one or more TEMPERING treatments carried out after QUENCH HARDENING.

This hardening is due to the precipitation of a compound or to the formation of martensite or bainite from the retained austenite, decomposed during TEMPERING or destabilized during this process then transformed during the subsequent COOLING.

self-quenching – 10 –

See QUENCHING (– 134 –).

self tempering see AUTO-TEMPERING – 9 –

sherardizing – 117 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to produce surface enrichment in zinc.

siliconizing – 118 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to produce surface enrichment of silicon.

single quench hardening treatment – 51 –

HARDENING TREATMENT carried out in a single step after CARBURIZING and slow COOLING to ambient temperature. If the treatment is followed by isothermal ANNEALING, this is called single quench hardening with isothermal transformation.

soaking – 72 –

The part of the THERMAL CYCLE during which the temperature is held constant.

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.

soft annealing – 101 –

See SOFTENING (– 2 –).

soft nitriding see NITROCARBURIZING – 78 –

softening – 2 –

HEAT TREATMENT with the object of reducing the hardness of the ferrous product to a given level.

solution annealing – 68 –

HEAT TREATMENT applied to austenitic steels. It consists of HEATING to a high temperature followed by COOLING sufficiently rapidly to preserve a homogeneous austenitic structure on return to ambient temperature.

solution treatment – 76 –

HEAT TREATMENT intended to dissolve and retain in solution previously precipitated constituents.

spheroidization – 62 –

Geometric development of the carbide particles, such as the cementite platelets, towards a stable spherical form.

spheroidizing – 63 –

ANNEALING, generally involving prolonged SOAKING in the region of Ac_1, possibly with oscillations around this temperature, in order to bring about the SPHEROIDIZATION of the precipitated carbides.

stabilization of retained austenite – 120 –

Phenomenon which reduces or prevents the possibility of the transformation of retained austenite into martensite during COOLING to a temperature below ambient temperature.

This stabilization occurs during low temperature TEMPERING or holding at ambient temperature after QUENCHING.

stabilizing – 119 –

HEAT TREATMENT of a ferrous product intended to prevent subsequent dimensional or structural changes with time.

Generally, this treatment causes those changes to occur, which at a later date would be undesirable.

stabilizing annealing – 143 –

ANNEALING at 850 °C with the aim of obtaining precipitation or SPHEROIDIZATION of compounds, e.g. carbides, in stabilized austenitic stainless steels.

steam treatment see BLUEING – 11 –

step quenching – 136 –

QUENCHING during which the COOLING is temporarily interrupted by SOAKING in a MEDIUM at a suitable temperature.

This item is not to be used to designate INTERRUPTED QUENCHING.

stress relief tempering – 41 –

TEMPERING carried out at a temperature generally below 200 °C on totally or partially martensitic structures in order to reduce the intrinsic stresses by the onset of carbide precipitation without too much reduction in the hardness.

stress relieving – 114 –

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.

sub-critical annealing – 104 –

ANNEALING at a temperature slightly below Ac_1.

sub-zero treating – 129 –

Treatment carried out after QUENCHING to transform the retained austenite into martensite and consisting of COOLING to and SOAKING at a temperature below ambient.

NOTE In English, the term “deep freezing” is also used to designate this treatment.

sulfidizing – 121 –

NITROCARBURIZING with the voluntary addition of sulfur to the COMPOUND LAYER.

surface hardening – 54 –

QUENCH HARDENING treatment after surface heating.

NOTE It is useful to specify the method of heating, for example flame, induction, electron beam, laser beam, etc.

temper embrittlement – 61 –

Embrittlement which affects certain quenched and tempered steels after SOAKING at certain temperatures or during slow COOLING through these temperatures.

A distinction is made between:

— IRREVERSIBLE TEMPER EMBRITTLEMENT (BLUE BRITTLENESS): for temperatures of the order of 300 °C;

— REVERSIBLE TEMPER EMBRITTLEMENT: for temperatures between approximately 450 °C and 550 °C inclusive.

This embrittlement reveals itself by a displacement of the transition curve for the impact strength of the metal towards higher temperatures. It disappears after reheating at a temperature above 550 °C *followed by rapid COOLING.*

temper diagram see TEMPERING CURVE – 32 –

tempering – 116 –

HEAT TREATMENT applied to a ferrous product, generally after QUENCH HARDENING, or other heat treatment to bring the properties to the required level.

It consists of HEATING to specific temperatures ($< Ac_1$) and SOAKING, one or more times followed by COOLING at an appropriate rate.

TEMPERING generally leads to a reduction in hardness but can, in certain cases, cause an increase in hardness.

tempering curve – 32 –

Graphical representation of the relationship between mechanical properties and tempering temperature for a specific tempering time.

NOTE In English, the term "tempering diagram" is equally used.

thermal crack – 124 –

Fissure produced in the ferrous product by the immediate or deferred effects of HEATING or COOLING.

Generally, the term "crack" is completed by an indication of the conditions under which the crack appeared, for example HEATING crack, QUENCHING crack, etc.

thermal cycle – 34 –

Variation of temperature as a function of time during a HEAT TREATMENT.

thermochemical treatment – 131 –

HEAT TREATMENT carried out in a MEDIUM suitably chosen to produce a change in the chemical composition of the base metal by exchange with the MEDIUM.

NOTE In English, the term "Cementation" is used when the THERMOCHEMICAL TREATMENT is intended to impart a metallic element or a metalloid into the ferrous product.

thermomechanical treatment – 132 –

A forming process in which the final deformation takes place within a certain range of temperatures leading to a material condition having certain properties which cannot be obtained or preserved by a single HEAT TREATMENT.

through-hardening – 53 –

QUENCH HARDENING such that the DEPTH OF HARDENING is not less than the distance between the core and the surface of the ferrous product.

time-temperature-transformation diagram (TTT diagram) – 42 –

Set of curves drawn in a semi-logarithmic coordinate system with logarithmic time/temperature coordinates which define, for each level of temperature, the beginning and end of the transformation of austenite under isothermal conditions.

In general, a complementary curve joins the points corresponding to the times at which the proportion of transformed austenite reaches 50 %. *Finally, information is usually given as to the transformation products and their hardness.*

transformation temperature – 126 –

The temperature at which a change of phase occurs and by extension, the temperatures at which the transformation begins and ends when the transformation occurs over a range of temperature.

(See the commentary in the annex under term A 200.)

two stage nitriding – 78 –

NITRIDING with at least one change in the nitriding conditions (temperature and/or gas composition), intended to reduce the thickness of the COMPOUND LAYER.

vanadizing – 140 –

THERMOCHEMICAL TREATMENT applied to a ferrous product in order to produce surface enrichment in vanadium.

white layer see COMPOUND LAYER – 28 –

3.3 Complementary section

acicular structure – A 150 –

Structure whose constituents appear in the form of needles in a metallographic section.

ageing – A 201 –

Phenomenon leading to a modification in the properties of a ferrous product due to the migration of interstitial elements, which can occur at ambient temperature or at temperatures close to it.

air-hardening steel – A 160 –

Steel whose HARDENABILITY is such that COOLING in air produces a martensitic structure in objects of considerable size.

NOTE The English term "self-hardening steel" is now obsolete.

alloy – A 157 –

Product consisting of a metal and one or more elements totally soluble in it in the liquid state and capable of entering into solid solution or forming a compound.

alpha iron – A 172 –

Stable state of pure iron at temperatures below 911 °C. Its crystalline structure is body-centred cubic.

It is ferromagnetic at temperatures below 768 °C (the Curie point.

austenite – A 158 –

Solid solution of one or more elements in GAMMA IRON.

austenitic steel – A 152 –

Steel whose structure is austenitic at ambient temperature after SOLUTION ANNEALING.

However, cast austenitic steels can contain up to about 20 % *ferrite.*

bainite – A 161 –

Metastable constituent formed by the decomposition of austenite in a temperature interval between the temperature at which pearlite forms and that at which martensite starts to appear. It consists of supersaturated ferrite in which carbon has been finely precipitated in the form of carbide.

One generally distinguishes between:

— upper bainite which is formed at higher temperatures in the interval described above;

— lower bainite which is formed at lower temperatures in the interval described above.

banded structure – A 162 –

Bands parallel to the direction of hot working that appear in a metallographic section and indicate the transformations undergone by the segregated zones during hot working.

cast iron – A 176 –

Product which is essentially iron and whose carbon content is more than 2 % (the presence of large amounts of carbide-forming elements may modify the lower limit of the carbon content).

cementite – A 164 –

Carbide of iron with the formula Fe_3C.

coalescence of a precipitate – A 165 –

Geometric change of particles of a precipitate by diffusion of the constituent elements through the matrix from small (which disappear) to large particles (which grow in size).

This term shall not be considered a synonym for SPHEROIDIZING.

constituent – A 166 –

Single phase or mixture of phases appearing as an individual feature during the metallographic examination of a structure.

critical diameter – A 168 –

Diameter (d) of a bar of sufficient length ($\geq 3d$) having a structure of 50 % martensite at its centre after QUENCHING under given conditions.

crystallinity – A 179 –

Grain produced by fracturing a test piece under conditions such that there is no noticeable plastic deformation or tearing.

delta iron – A 174 –

Stable state of pure iron between 1 392 °C and its melting point. Its crystalline structure is body-centred cubic, identical to that of alpha iron.

It is paramagnetic.

epsilon carbide – A 163 –

Iron carbide with the approximate formula, $Fe_{2,4}C$.

eutectoid transformation – A 171 –

Reversible transformation of austenite into pearlite (ferrite + cementite) that occurs at a constant temperature.

ferrite – A 175 –

Solid solution of one or more elements in ALPHA or DELTA IRON.

ferritic steel – A 153 –

Steel in which the ferritic state is stable at all temperatures in the solid state.

gamma iron – A 173 –

Stable state of pure iron between 911 °C and 1 392 °C. Its crystalline structure is face-centred cubic.

It is paramagnetic.

grain – A 178 –

Elementary crystal of a polycrystalline structure.

grain boundary – A 187 –

Interface separating two grains with different crystallographic orientations.

grain growth – A 182 –

Increase in the grain size of a ferrous product as a result of HEATING to a temperature well above the Ac_3 point.

grain size – A 181 –

Characteristic size of the grain revealed in a metallographic section (see EU 103-71).

The nature of the grain should be specified, for example austenitic, ferritic, etc.

graphitic steel – A 154 –

Steel in whose structure a greater or lesser proportion of the carbon is intentionally precipitated in the form of graphite.

hypereutectoid – A 183 –

Steel containing more carbon than the eutectoid composition.

hypoeutectoid steel – A 184 –

Steel containing less carbon than the eutectoid composition.

intercritical range see TRANSFORMATION RANGE – A 186 –

intermetallic compound – A 185 –

Compound of two or more metals possessing physical properties and a crystal structure different from those of the pure metals and their solid solutions.

ledeburite – A 188 –

Structure of an iron/carbon alloy which results from a eutectic transformation and consists of austenite and cementite.

ledeburitic steel – A 155 –

A steel whose structure consists of ledeburite.

low load hardness – A 169 –

Hardness measured under a load of between 1,96 N and 49,1 N.

McQuaid-Ehn grain size – A 180 –

Size of the austenite grains formed during CARBURIZING and determined under standard test conditions.

This index is only valid for steels which have been CARBURIZED (see EU 103-71).

malleable cast iron – A 177 –

See MALLEABLIZING – 73 –

maraging steel – A 156 –

Steel whose specific properties can be obtained by a MARAGING treatment.

martensite – A 189 –

Metastable solid solution with a body-centred tetragonal structure.

It is formed by the transformation of austenite by a non-diffusional mechanism.

mass effect – A 170 –

Influence of the size of a piece on its COOLING behaviour.

metastable – A 191 –

An apparently stable state outside the conditions defined by the equilibrium diagram.

microhardness – A 192 –

Hardness measured under a load of less than 1,96 N.

nitrogen profile – A 167 –

Nitrogen content as a function of the distance from the surface.

parent phase – A 195 –

Phase from which one or more new phases are formed.

pearlite – A 193 –

Aggregate of ferrite and cementite platelets formed by the eutectoid decomposition of austenite.

phase – A 194 –

Structurally homogeneous component of a system.

NOTE The phases of a ferrous product are, for example, ferrite, austenite, cementite, etc.

proeutectoid constituent – A 196 –

Constituent formed during the decomposition of austenite prior to the eutectoid transformation.

In the case of hypoeutectoid steels, the proeutectoid constituent is ferrite; in the case of hypereutectoid steels, the proeutectoid constituent is a carbide.

recalescence – A 197 –

The increase in temperature due to the release of heat accompanying the transformation of the austenite during COOLING.

retained austenite – A 159 –

Untransformed austenite remaining, at ambient temperature, after QUENCH HARDENING.

secondary martensite – A 190 –

Martensite formed during SECONDARY HARDENING.

self hardening steel see AIR HARDENING STEEL – A 160 –

sensitization – A 198 –

Increase in the sensitivity of stainless steels to intergranular corrosion due to the precipitation of carbides at the grain boundaries.

In order to study the resistance to intergranular corrosion, a sensitizing treatment is used (see EU 114-72).

solid solution – A 199 –

A homogeneous, solid, crystalline phase formed by two or more elements.

One distinguishes 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.

steel – A 151 –

Product whose principal element is iron and whose carbon content is not more than 2 % (the presence of large quantities of carbide-forming elements may modify the upper limit of the carbon content).

The nomenclature for unalloyed steels suitable for HEAT TREATMENT and for alloyed steels is defined by EN 10020.

transformation range – A 186 –

Interval or temperature within which the product undergoes a change of phase.

NOTE In English, the term "inter-critical range" is also used.

transformation temperature – A 200 –

See the term TRANSFORMATION TEMPERATURE (126) in section **3.2**.

The following principal temperatures can be distinguished for steels:

- Ae_1: equilibrium temperature defining the lower limit of existence of austenite.
- Ae_3: 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.
- Ac_1: temperature at which austenite begins to form during HEATING.
- Ac_3: temperature at which ferrite completes its transformation into austenite during HEATING.
- Ac_m: temperature at which the cementite in a hypereutectoid steel dissolves completely.
- Ar_1: temperature at which austenite completes its transformation into ferrite or ferrite and cementite during COOLING.
- Ar_3: 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.
- M_s: temperature at which the austenite begins to transform into martensite during COOLING.
- M_f: temperature at which the austenite has almost completely transformed into martensite during COOLING.
- M_x: temperature at which x % of the austenite has transformed into martensite during COOLING.

NOTE In English the above temperatures are also termed "critical points" when referring to a particular alloy.

Widmannstatten structure – A 202 –

Structure resulting from the formation of a new phase along certain crystallographic planes in the parent solid solution.

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.

Definitions of foreign terms for which there is no English equivalent

– 144 –

QUENCH HARDENING TREATMENT followed by TEMPERING at a high temperature with the aim of obtaining the desired mechanical properties and in particular good ductility and good toughness.

– 145 –

Condition of a ferrous product which has undergone the treatment defined in term 144.

This condition is characterized by the values of the properties obtained at the various points of the section of the part.

– 146 –

The first stage of HEATING of a ferrous product bringing its surface to the specified temperature (see Figure 2).

– 148 –

HEATING of a ferrous product from its initial temperature until the specified temperature is obtained. It is a combination of terms numbers 146 and 147 (EQUALIZATION) (see Figure 2).

3.4 Graphs

Figure 1 and Figure 2 give graphical representations of some terms.

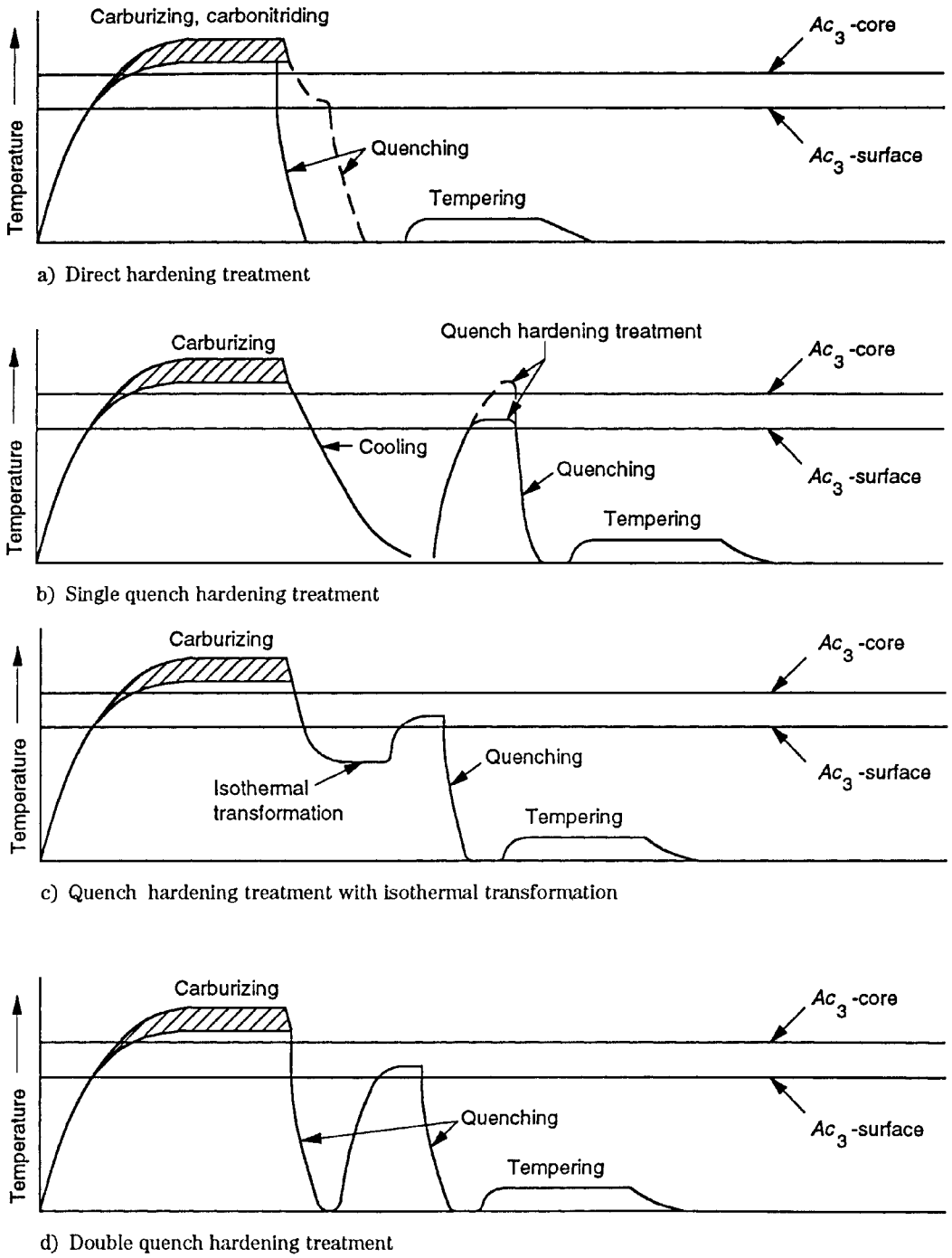

Figure 1 — Schematic representation of the possible THERMAL CYCLES of various CASE HARDENING treatments

4 Equivalent terms

Table 1 gives the alphabetical list of terms defined in this standard and their equivalents in French and German.

The following rules have been applied in preparing this table:

— one single equivalent per language has been used for one given term;

— the same equivalents have been used for a term and its synonym;

— if there are no English equivalents for the terms (left-hand column at the end of the table), reference is made to the definition of these terms using the relevant reference number.

The same applies if there are no equivalents to the English terms.

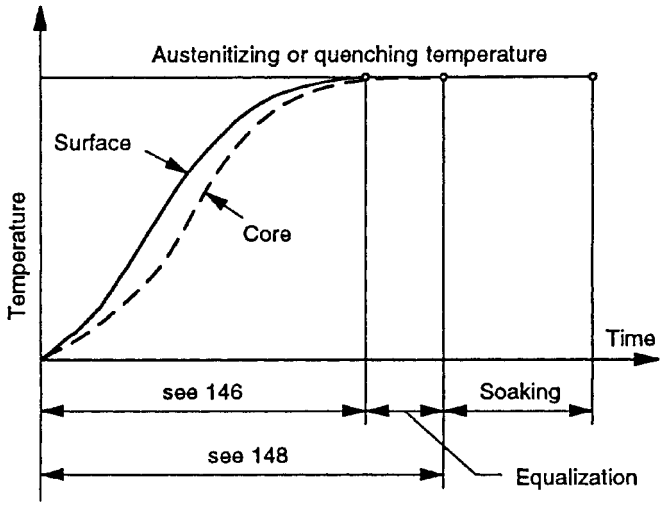

Figure 2 — Schematic representation of heating during an AUSTENITIZING treatment

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– A –			
Acicular structure	A150	Aciculaire (Structure)	Nadeliges Gefüge; Nadelförmiges Gefüge
Ageing	A201	Vieillissement	Alterung
Ageing treatment	40	Désuraturation (Traitement de)	Auslagern
Air hardening steel	A160	Auto-trempant (Acier)	Lufthärtender Stahl
Alloy	A157	Alliage	Legierung
Alpha iron	A172	Fer α	α Eisen
Aluminizing	4	Alumininsation	Aluminieren
Annealing	98	Recuit	Glühen
Atmosphere	See 75		
Ausforming	7	Austéniformage	Austenitformhärten
Austempering	137	Trempe étagée bainitique	Bainitisieren; Isothermisches Umwandeln in der Bainitstufe
Austenite	A158	Austénite	Austenit; γ-Mischkristall
Austenitic steel	A152	Acier austénitique	Austenitischer Stahl
Stahl, Austenitizing	8	Austénitisation	Austenitisieren
Austenite conditioning	See 40		
Austenitizing temperature	125	Température d'austénitisation	Austenitisiertemperatur
Auto-tempering	9	Auto-revenu	Selbstanlassen
– B –			
Bainite	A161	Bainite	Bainit
Baking	38	Deshydrogénation	Dehydrieren; Wasserstoffentzug durch Glühen
Banded structure	A162	Bandes (structure de)	Zeilengefüge; Zeilenstruktur
Blacking	14	Brunissage	Brunieren
Blank carburizing	18	Cémentation à blanc	Blindaufkohlen; Simulationsaufkohlen
Blank nitriding	80	Nitruration à blanc	Blindnitrieren; Simulationsnitrieren
Blue brittleness	See 61		
Blueing	11	Bleuissage	Bläuen
Boost-diffuse carburizing	19	Cémentation étagée	Mehrstufiges Aufkolen
Box annealing	See 98		
Boriding	12	Boruration	Borieren
Bright annealing	99	Recuit blanc	Blankglühen
Burning	13	Brûlure	Verbrennung

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– C –			
Calorizing	See 4		
Carbon activity	1	Activité du carbone	Kohlenstoffaktivität; C-Aktivität
Carbon mass transfer coefficient	27	Coefficient de transfert du carbone	Kohlenstoffübergangszahl
Carbon potential	87	Potentiel carbone	Kohlenstoffpegel
Carbon profile	31	Courbe de répartition du carbone	Kohlenstoffverlauf
Carbon restoration	96	Recarburation (Traitement de)	Wiederaufkohlen
Carbonitriding	16	Carbonitruration	Carbonitrieren
Carburizing	17	Cémentation	Aufkohlen
Case depth	90	Profondeur de cémentation	Aufkohlungstiefe
Case hardening	141	(No French equivalent)	Einsatzhärten
Cast iron	A176	Fonte	Gusseisen
Cementation	See 131		
Cementite	A164	Cémentite	Zementit
Chromizing	26	Chromisation	Chromieren
Coalescence of a precipitation	A165	Coalescence (d'un précipité)	Teilchenwachstum
Compound layer	28	Couche de combinaison	Verbindungsschicht
Constituent	A166	Constituant	Gefügebestandteil
Continuous-cooling-transformation diagram (CCT diagram)	43	Diagramme de transformation en refroidissement continu (en conditions anisothermes) (Diagramme TRC)	Zeit-Temperatur-Umwandlungsschaubild für kontinuierliches Abkühlen-; ZTU-Schaubild für kontinuierliches Abkühlen
Cooling	105	Refroidissement	Abkühlen
Cooling conditions	109	Refroidissement (Mode de)	Abkühlbedingungen
Cooling curve	106	Refroidissement (Courbe de)	Abkühlkurve
Cooling function	108	Refroidissement (Loi de)	Abkühlverlauf
Cooling rate	111	Refroidissement (Vitesse de)	Abkühlgesschwindigkeit
Cooling schedule	110	Refroidissement (Programme de)	Abkühlvorschrift; Abkühlprogramm
Cooling time	107	Refroidissement (Durée de)	Abkühldauer
Core refining	See 57		
Critical cooling function	112	Refroidissement critique (Loi de)	Kritischer Abkühlverlauf
Critical cooling rate (Vitesse de)	113	Refroidissement critique	Kritische Abkühlgeschwindigkeit
Critical diameter	A168	Diamètre critique de trempe	Kritischer Durchmesser
Critical points	See 126		
Cyaniding	33	Cyanuration	Salzbadcarbonitrieren
Crystallinity	A179	Grain de Cassure	(No German equivalent)

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– D –			
Decarburization	35	Décarburation	Entkohlung
Decarburizing	36	Décarburation (Traitement de)	Entkohlen
Deep freezing	See 129		
Delta iron	A174	Fer δ	δ-Eisen
Depth of decarburization	92	Profondeur de décarburation	Entkohlungstiefe
Depth of hardening	93	Profondeur de durcissement par trempe	Einhärtungstiefe
Depth of nitriding	95	Profondeur de nitruration	Nitriertiefe
Depth of transformation	86	Pénétration de trempe	Einhärtung
Destabilization of retained austenite	39	Destabilisation de l'austénite résiduelle	Destabilisierung des Restaustenits
Diffusion treatment	45	Diffusion (Traitement thermique ou Opération de)	Diffisionsbehandeln, Diffundieren
Diffusion zone	29	Couche de diffusion	Diffusionsschicht
Direct hardening treatment	56	Durcissement par trempe directe (Traitement de)	Direkthärten
Direct quenching	135	Tremp directe	Direktabschrecken
Distortion	37	Déformation (de traitement thermique)	Verzug (durch Wärmebehandlung)
Double hardening	See 57		
Double quench hardening treatment	57	Durcissement par double trempe (Traitement de)	Doppelhärten
– E –			
Effective case depth after curburizing	91	Profondeur conventionnelle de cémentation	Einsatzhärtungstiefe
Effective case depth after surface hardening	94	Profondeur conventionnelle de durcissement par trempe après chauffage superficiel	Einhärtungstiefe nach Randschichthärten
Effective case depth	See 95		
Endothermic atmosphere	5	Atmosphère endothermique	Endotherme Atmosphäre
Epsilon carbide	A163	Carbure ϵ	ϵ-Carbid
Equalization	147	(No French equivalent)	Durchwärmen
Equivalent ruling section	44	Diamétre équivalent (d'un produit)	Gleichwertiger Durchmesser
Eutectoid transformation	A171	Eutectoïde (Transformation)	Eutektoidische Umwandlung
Exothermic atmosphere	6	Atmosphère exothermique	Exotherme Atmosphäre

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– F –			
Ferrite	A175	Ferrite	Ferrit
Ferritic steel	A153	Acier ferritique	Ferritischer Stahl
Flame hardening	149	(No French equivalent)	Flammhärten
Floor to floor time	59	Durée d'enfournement	Verweildauer
Full annealing	100	Recuit complet	(No German equivalent)
– G –			
Gamma iron	A173	Fer γ	γ-Eisen
Grain	A178	Grain	Korn, Kristallit
Grain boundary	A187	Joint du grain	Korngrenze
Grain coarsening	66	Grossissement du grain (Recuit de)	Grobkornglühen
Glow discharge nitriding	See 79		
Grain growth	A182	Grossissement du grain	Kornwachstum; Kornvergröberung
	3	Affinage structural (Traitement d')	Umkörnen
Grain size	A181	Grosseur de grain	Korngrösse
Graphitic steel	A154	Acier graphitique	Graphitischer Stahl
Graphitization	64	Graphitisation	Graphitisierung
Graphitizing	65	Graphitisation (Traitement de)	Graphitisieren
– H –			
Hardenability	133	Trempabilité	Härtbarkeit
Hardening temperature	See 127		
Heat treatment	130	Traitement thermique	Wärmebehandlung
Heating	20	Chauffage	Wärmen
Heating curve	21	Chauffage (Courbe de)	Wärmkurve
Heating function	23	Chauffage (Loi de)	Wärmverlauf
Heating rate	25	Chauffage (Vitesse de)	Wärmgeschwindigkeit
Heating schedule	24	Chauffage (Programme de)	Wärmvorschrift; Wärmprogramm
Heating time	22	Chauffage (Durée de)	Wärmdauer
Heating-up time	77	Mise en température (Durée de)	(No German equivalent)
Homogenizing	67	Homogénéisation (Recuit de)	Diffusionsglühen
Hypereutectoid steel	A183	Hypereutectoïde (Acier)	Übereutektoidischer Stahl
Hypoeutectoid steel	A184	Hypoeutectoïde (Acier)	Untereutektoidischer Stahl
– I –			
Impulse hardening	46	Durcissement par impulsions	Impulshärten
Impulse heating	69	Impulsions (Chauffage par)	Impluswärmen
Induction hardening	47	Durcissement par induction	Induktionshärten

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
Inter-critical annealing	102	Recuit intercritique	(No German equivalent)
Inter-critical range	See A187		
Inter-critical treatment	128	Traitement intercritique	Behandeln im ($\alpha + \gamma$)-Gebiet; Teil-austenitisieren
Intermetallic compound	A185	Intermétallique (Composé)	Intermetallische Verbindung
Internal oxidation	84	Oxydation interne	Innere Oxidation
Interrupted quenching	139	Trempe interrompue	Gebrochenes Abschrecken
Ion nitriding	See 79		
Irreversible temper embrittlement	See 61		
Isoforming	70	Isoformage	Umformperlitisieren
Isothermal annealing	103	Recuit isotherme	Perlitisieren Isothermisches Umwandeln in der Perlitstufe
– J –			
Jominy test	71	Jominy (Essai)	Stirnabschreckversuch
– L –			
Ledeburite	A188	Lédéburite	Ledeburit
Ledeburitic steel	A155	Acier lédéburitique	Ledeburitischer Stahl
Limiting ruling section	142	(No French equivalent)	(No German equivalent)
Local hardening	48	Durcissement local par trempe	Örtlich begrenzte Härtung
Low load hardness	A169	Dureté sous charge réduite	Kleinlasthärte
– M –			
McQuaid-Ehn grain size	A180	Grain McQuaid Ehn (Grosseur de)	McQuaid–Ehn-Korngröse
Malleable cast iron	A177	Fonte malléable	Temperguss
Malleablizing	73	Malléabilisation (Recuit de)	Tempern
Maraging	74	Maraging (Traitement de)	Martensitaushärten
Maraging steel	A156	Acier maraging	Martensitaushärtender Stahl
Martempering	138	Trempe étagée martensitique	Warmbadhärten
Martensite	A189	Martensite	Martensit
Mass effect	A170	Effet de masse	Volumeneinfluss
Maximum achievable hardness	15	Capacité de durcissement par trempe	Aufhärtbarkeit
Medium	75	Milieu	Mittel; Medium
Metastable	A191	Métastable	Metastabil
Microhardness	A192	Microdureté	Mikrohärte

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– N –			
Nitriding	79	Nituration	Nitrieren
Nitrogen profile	A167	Courbe de répartition de l'azote	Stickstoffverlauf
Nitrocarburizing	78	Nitrocarburation	Nitrocarburieren
Normalizing	82	Normalisation (Traitement de)	Normalglühen
Normalizing forming	60	Formage normalisant	Normalisierendes Umformen
– O –			
Operation	83	Opération	Wärmebehandlungschritt
Overcarburizing	122	Surcarburation	Überkohlung
Overheating and oversoaking	123	Surchauffe	Überhitzen und Überzeiten
Oxynitriding	See 79		
– P –			
Parent phase	A195	Phase-mère	Mutterphase
Patenting	85	Patentage	Patentieren
Pearlite	A193	Perlite	Perlit
Phase	A194	Phase	Phase
Precipitation hardening	49	Durcissement par précipitation	Aushärtung
Precipitation hardening treatment	50	Durcissement par précipitation (Traitement de)	Aushärten
Preheating	89	Préchauffage	Vorwärmen
Primary hardening	See 40		
Proeutectoid constituent	A196	Proeutectoïde (Constituant)	Voreutektoidische Ausscheidung
– Q –			
Quench hardened layer	30	Couche durcie par trempe	Einhärtungsschicht
Quench hardening	52	Durcissement par trempe	Härtung
Quench hardening treatment	55	Durcissement par trempe (Traitement de)	Härten
Quenching	134	Trempe	Abschrecken
Quenching capacity	88	Pouvoir de refroidissement d'un milieu	Abkühlvermögen
Quenching temperature	127	Température de trempe	Abschrecktemperatur
– R –			
Recalescence	A197	Recalescence	Rekaleszenz
Recovery	115	Restauration (Traitement de)	Erholungsglühen
Recrystallizing	97	Recristallisation (Traitement de)	Rekristallisationsglühen
Retained austenite	A159	Austénite residuelle	Restaustenit
Reversible temper embrittlement	See 61		

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
– S –			
Secondary hardening	58	Durcissement secondaire	Sekundärhärtung
Secondary martensite	A190	Martensite secondaire	(No German equivalent)
Self hardening steel	See A160		
Self-quenching	10	Auto-trempe	Selbstabschrecken
Self-tempering	9		
Sensitization	A198	Sensibilisation	Sensibilisierung
Sherardizing	117	Shérardisation	Diffusionsverzinken; Sherardisieren
Siliconizing	118	Siliciuration	Silicieren
Single quench hardening treatment	51	Durcissement par simple trempe (Traitement de)	Einfachhärten
Soaking	72	Maintien (à température)	Halten
Soft annealing	101	Recuit d'adoucissement	Siehe Weichglühen
Softening	2	Adoucissement (Traitement d')	Weichglühen
Soft nitriding	See 78		
Solid solution	A199	Solution solide	Feste Lösung Mischkristall
Solution annealing	68	Hypertrempe	(No German equivalent)
Solution treatment	76	Mise en solution (Traitement de)	Lösungsbehandeln
Spheroidization	62	Globularisation	Einformung
Spherodizing	63	Globularisation (Recuit de)	Glühen auf kugelige Carbide
Stabilization of retained austenite	120	Stabilisation de l'austénite résiduelle	Stabilisierung des Restaustenits
Stabilizing	119	Stabilisation (Traitement de)	Stabilisieren
Stabilizing annealing	143	(No French equivalent)	Stabilglühen
Steam treating	See 11		
Steel	A151	Acier	Stahl
Step quenching	136	Trempe étagée	Gestuftes Abschrecken
Stress relief tempering	41	Détente (Revenu de)	(No German equivalent)
Stress relieving	114	Relaxation (Traitement de)	Spannungsarmglühen
Sub-critical annealing	104	Recuit subcritique	(No German equivalent)
Sub-zero treating	129	Traitement par le froid	Tieftemperaturbehandeln; Tiefkühlen
Sulfidizing	121	Sulfonitrocarburation	Sulfonitrocarburieren
Surface hardening treatment	54	Durcissement par trempe après-chauffage superficiel (Traitement de)	Randschichthärten
– T –			
Temper embrittlement	61	Fragilité de revenu	Anlass-Sprödigkeit
Temper diagram	See 32		
Tempering	116	Revenu	Anlassen

[a] Reference number of the term.

Table 1 — Equivalent terms

English	Ref. No.[a]	French	German
Tempering curve	32	Courbe de résistance au revenu	Anlass-Schaubild
Thermal crack	124	Tapure	Wärmebehandlungsriss
Thermal cycle	34	Cycle thermique	Zeit-Temperatur-Folge
Thermochemical treatment	131	Traitement thermochimique	Thermochemische Behandlung
Thermomechanical treatment	132	Traitement thermomécanique	Thermomechanische Behandlung
Through-hardening	53	Durcissement par trempe à coeur	Durchhärtung
Time–temperature-transformation diagram (TTT Diagram)	42	Diagramme de transformation en conditions isothermes (Diagramme TTT)	Zeit-Temperatur-Umwandlungsschaubild für isothermisches Umwandeln; ZTU-Schaubild für isothermisches Umwandeln
Transformation range	A186	Intervalle critique	Umwandlungsbereich
Transformation temperature	126 A200	Temperature de transformation	Umwandlungstemperatur; Umwandlungspunkt
Two stage nitriding	81	Nitruration séquencée	Mehrstufiges Nitieren
– V –			
Vanadizing	140	Vanadisation	Vanadieren
– W –			
Widmannstatten structure	A202	Widmannstaetten (Structure de)	Gefüge in Widmannstättenscher Anordnung
White layer	28		

[a] Reference number of the term.

Table 2 — Terms for which there are no English equivalents

English	Ref. No.[a]	French	German
(see definition)	144	(No French equivalent)	Vergüten
(see definition)	145	(No French equivalent)	Vergütung
(see definition)	146	(No French equivalent)	Anwärmen
(see definition)	148	(No French equivalent)	Erwärmen

[a] Reference number of the term.

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National annex NA (informative)
Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Iron and Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/32 upon which the following bodies were represented:

British Steel Industry

National Association of Steel Stockholders

National annex NB (informative)
Cross-references

Publication referred to	Corresponding British Standard
Euronorm 23	BS 4437:1987 *Method for determining hardenability of steel by end quenching (Jominy test)*
Euronorm 52	BS 6562 *Terms used in the iron and steel industry* Part 1:1985 *Glossary of heat treatment terms*
Euronorm 105	BS 6479:1984 *Method for determination and verification of the effective depth of carburized and hardened cases in steels* BS 6481:1984 *Method for determination of effective depth of hardening of steel after flame or induction hardening*
Euronorm 114	BS 5903:1980 *Method for determination of resistance to intergranular corrosion of austenitic stainless steels; copper sulphate — sulphuric acid method (Moneypenny Strauss test)*
EN 10020	BS EN 10020:1991 *Definition and classification of grades of steel*
EN 10083	BS EN 10083 *Quenched and tempered steels* Part 1:1991 *Technical delivery conditions for special steels* Part 2:1991 *Technical delivery conditions for unalloyed quality steels*