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Mechanical testing of metals — Symbols and definitions in published standards

Essais mécaniques des métaux — Symboles et définitions figurant dans les normes publiées

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 25679 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*.

This first edition of ISO/TR 25679, together with ISO 23718[1)], *Metallic materials — Terms used in mechanical testing*, cancel and replace ISO/TR 12735-1:1996, *Mechanical testing of metals — Symbols used with their definitions — Part 1: Symbols and definitions in published standards*.

1) In preparation.

Introduction

This index of symbols and definitions in published standards has been prepared to provide an appropriate means for avoiding contradictions and misunderstandings and to standardize various kinds of symbols and their definitions generally used in this field. Wherever possible, the same symbol has been used to denote the same type of parameter in the different tests, but the differing types of test piece, product form and test have to be taken into account. This has not been universally possible and symbols should always be considered in the context of the specific method of test being used.

In the discussion of revising ISO/TR 12735-1:1996, common terms among the published standards were selected and a Draft International Standard covering terminology: ISO/DIS 23718, *Metallic materials — Terms used in mechanical testing,* was prepared. This Technical Report, which is an index of symbols and definitions, was separated from the terminology (ISO/DIS 23718) in order to be updated flexibly in future.

Mechanical testing of metals — Symbols and definitions in published standards

1 Scope

This Technical Report enumerates the symbols and definitions used in International Standards for specific methods of mechanical testing of metallic materials, which are the responsibility of ISO Technical Committee 164, *Mechanical testing of metals*. The data is indexed alphabetically and via a coding system. Annex A provides an additional cross-reference between the coding system and relevant International Standard numbers.

2 Designation system

To assist in indexing and cross-referencing symbols and definitions, a code number is used to identify test methods. The first digit of the code identifies the sub-committee of ISO/TC 164 that is responsible for preparing and reviewing International Standards for that test method. Subsequent digits are in ascending order of the ISO number for each International Standard or Draft International Sandard.

International Standards that relate to a common test method and which all share the same set of symbols and definitions are given a single code number.

If there existed both a valid International Standard and a document designed to replace it that had reached the DIS stage, then both the International Standard and the DIS (Draft International Sandard) or FDIS will have been assigned to the same code number.

Each test method for metallic materials is identified and designated as shown in Table 1. Annex A provides a rapid cross-reference to the coding system.

Table 1 — Identity and code of mechanical test

	Test Identity	Code	ISO standards
SC 1	Metallic materials — Uninterrupted uniaxial creep testing in tension — Method of test	1.01	204:1997 DIS 204:2005
	Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines	1.02	376:2004
	Metallic materials — Tensile testing at elevated temperature	1.03	783:1999
	Metallic materials — Tensile testing at ambient temperature	1.04	6892:1998
	Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system	1.05	7500-1:2004
	Metallic materials — Verification of static uniaxial testing machines — Part 2: Tension creep testing machines — Verification of the applied load	1.06	7500-2:1996 DIS 7500-2:2005
	Metallic materials — Calibration of extensometers used in uniaxial testing	1.07	9513:1999
	Metallic materials — Tensile testing at low temperature	1.08	15579:2000
	Metallic materials — Tensile testing in liquid helium	1.09	19819:2004

Table 1 (*continued*)

	Test Identity	Code	ISO standards
SC 2	Metallic materials — Bend test	2.01	7438:2005
	Metallic materials — Sheet and strip 3 mm thick or less — Reverse bend test	2.02	7799:1985
	Metallic materials — Wire — Simple torsion test	2.03	7800:2003
	Metallic materials — Wire — Reverse bend test	2.04	7801:1984
	*Metallic materials — Wire — Wrapping test	2.05	7802:1983
	Metallic materials — Sheet and strip — Erichsen cupping test	2.06	20482:2003
	Metallic materials — Tube (in full section) — Bend test	2.07	8491:1998
	Metallic materials — Tube — Flattening test	2.08	8492:1998
	Metallic materials — Tube — Drift-expanding test	2.09	8493:1998
	Metallic materials — Tube — Flanging test	2.10	8494:1998
	Metallic materials — Tube — Ring-expanding test	2.11	8495:1998
	*Metallic materials — Tube — Ring tensile test	2.12	8496:1998
	Metallic materials — Wire — Reverse torsion test	2.13	9649:1990
	Metallic materials — Sheet and strip — Determination of plastic strain ratio	2.14	10113:1991 DIS 10113:2005
	Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent	2.15	10275:1993
	Metallic materials — Earing test	2.16	11531:1994
	Metallic materials — Guidelines for the determination of forming-limit diagrams	2.17	12004:1997
	Metallic materials — Tube ring hydraulic pressure test	2.18	15363:2000
	Metallic materials — Strain analysis report	2.19	TR 14936:1998
SC 3	Metallic materials — Hardness test — Knoop test	3.01	4545:1993 FDIS 4545-1 to 4545-4:2005
	*Metallic materials — Hardness test — Verification of Knoop hardness testing machines	3.01	4546:1993
	*Metallic materials — Hardness test — Calibration of standardized blocks to be used for Knoop hardness testing machines	3.01	4547:1993
	Metallic materials — Brinell hardness test — Part 1: Test method	3.02	6506-1:1999 FDIS 6506-1:2005
	*Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines	3.02	6506-2:1999 FDIS 6506-2:2005
	*Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks	3.02	6506-3:1999 FDIS 6506-3:2005
	Metallic materials — Vickers hardness test — Part 1: Test method	3.03	6507-1:1997 FDIS 6507-1:2005
	*Metallic materials — Vickers hardness test — Part 2: Verification of testing machines	3.03	6507-2:1997 FDIS 6507-2:2005
	*Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks	3.03	6507-3:1997 FDIS 6507-3:2005
	Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)	3.04	6508-1:1999 FDIS 6508-1:2005

Table 1 (*continued*)

	Test Identity	Code	ISO standards
	*Metallic materials — Rockwell hardness test — Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T)	3.04	6508-2:1999 FDIS 6508-2:2005
	*Metallic materials —Rockwell hardness test — Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T)	3.04	6508-3:1999 FDIS 6508-3:2005
	*Metallic materials — Hardness testing — Tables of Knoop hardness values for use in tests made on flat surfaces	3.05	10250:1994
	Metallic materials — Instrumented indentation test for hardness and materials parameters — Part 1: Test method	3.06	14577-1:2002
	*Metallic materials — Instrumented indentation test for hardness and materials parameters — Part 2: Verification and calibration of testing machines	3.06	14577-2:2002
	*Metallic materials — Instrumented indentation test for hardness and materials parameters — Part 3: Calibration of reference blocks	3.06	14577-3:2002
	*Metallic materials — Conversion of hardness values	3.07	18265:2003
SC 4	Steel — Charpy impact test (U-notch)	4.01	83:1976
	*Steel — Charpy impact test (V-notch)	4.01	148:1983
	Metallic materials — Charpy pendulum impact test — Part 1: Test method	4.01	FDIS 148-1:2005
	Metallic materials — Charpy pendulum impact test — Part 2: Verification of test machines	4.01	148-2:1998
	Metallic materials — Charpy pendulum impact test — Part 3: Preparation and characterization of Charpy V reference test pieces for verification of test machines	4.01	148-3:1998
	*Steel — Designation of test piece axes	4.02	3785:1976 FDIS 3785:2005
	Metallic materials — Determination of plane-strain fracture toughness	4.03	12737:2005
	Steel — Charpy V-notch pendulum impact test — Instrumented test method	4.04	14556:2000
	Metallic materials — Unified method of test for the determination of quasistatic fracture toughness	4.05	12135:2002
SC 5	Metals — Axial load fatigue testing	5.01	1099:1975
	Metallic materials — Fatigue testing — Axial force controlled method	5.01	DIS 1099:2005
	Metals — Rotating bar bending fatigue testing	5.02	1143:1975
	Steel — Torsional stress fatigue testing	5.03	1352:1977
	Axial load fatigue testing machines — Dynamic force calibration — Strain gauge technique	5.04	4965:1979
	Metallic materials — Fatigue testing — Axial-strain-controlled method	5.05	12106:2003
	Metallic materials — Fatigue testing — Statistical planning and analysis of data	5.06	12107:2003
	Metallic materials — Fatigue testing — Fatigue crack growth method	5.07	12108:2002
* There are no symbols or definitions in the text of the standard.			

3 Definitions and symbols

Definitions and symbols employed in all of the International Standards and (Final) Draft International Standards prepared by ISO/TC 164, *Mechanical testing of metals* are classified under the codes listed in Table 1, *Identity and code of mechanical test*. If a standard has separate clauses for definitions and symbols, the definitions are listed first, followed by a table of symbols. Each table of symbols is re-arranged into a consistent alphabetical order. For clarity, notes, alternative definitions and conditions embodied within definitions, which are particular to the individual standard, are excluded.

3.1 Code 1.01 Metallic materials — Uninterrupted uniaxial creep testing in tension — Method of test

3.1.1 Definitions

reference length, L_r
base length used for the calculation of elongation

NOTE Examples of reference lengths for several types of test pieces are given.

original reference length, L_{ro}
reference length determined at ambient temperature before the test L_{ro}, not exceeding the parallel length L_c by more than 10 % L_c for circular test pieces, or by more than 15 % L_c for square or rectangular test pieces

final reference length, L_{ru}
reference length determined at ambient temperature after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line

original gauge length, L_o
length between gauge length marks on the piece measured at ambient temperature before the test

final gauge length after rupture, L_u
length between gauge marks on the test piece measured after rupture, at ambient temperature, the two pieces having been carefully fitted back together so that their axes lie in a straight line

parallel length, L_c
length of the parallel reduced section of the test piece

extensometer gauge length, L_e
distance between the measuring points of the extensometer; as near as possible to the reference length

original cross-sectional area, S_o
cross-sectional area of the parallel length determined at ambient temperature prior to testing

minimum cross-sectional area after rupture, S_u
minimum cross-sectional area of the parallel length determined at ambient temperature after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line

initial stress, σ_o
applied force divided by the original cross-sectional area S_o of the test piece

elongation
increase of the reference length at any moment during the test

percentage creep elongation, A_f
at any given moment t during the test, the increase in the reference length between this moment and the zero moment (ΔL_{rt}) at a specified temperature, expressed as a percentage of the original reference length

$$A_f = \frac{\Delta L_{rt}}{L_{ro}} \times 100$$

NOTE 1 The symbol A_f may have as superscript the specified temperature T, in degrees Celsius, and as subscript the stress, in megapascals, and the time t, in hours.

NOTE 2 By convention, the zero moment (start of time) is the moment at which the initial stress (σ_o) is applied to the test piece. The origin of the elongation is the value of the reference length at the zero moment.

percentage elongation after creep rupture, A_{fu}
permanent elongation of the reference length after rupture ($L_{ru} - L_{ro}$), expressed as a percentage of the original reference length:

$$A_{fu} = \frac{L_{ru} - L_{ro}}{L_{ro}} \times 100$$

NOTE The symbol A_{fu} may have as superscript the specified temperature T, in degrees Celsius, and as subscript the stress, in megapascals.

percentage reduction of area after creep rupture, Z_u
maximum change in cross-sectional area measured after rupture ($S_o - S_u$), expressed as a percentage of the original cross-sectional area (S_o):

$$Z_u = \frac{S_o - S_u}{S_o} \times 100$$

NOTE The symbol Z_u may have as superscript the specified temperature T, in degrees Celsius, and as subscript the stress, in megapascals.

creep rupture time, t_u
time required for the test piece, maintained at the specified temperature T and strained by the specified tensile force, to rupture

NOTE The symbol t_u may have as superscript the specified temperature T, in degrees Celsius, and as subscript the stress, in megapascals.

simple machine
test machine that allows the straining of only one test piece at a time

multiple machine
test machine that allows simultaneous straining of more than one test piece at the same temperature

Table 2 — Symbols designated in the International Standard, Code 1.01

Symbol	Unit	Meaning
ΔL_{rt}	mm	Increase in the reference length between a moment t and the zero moment
σ_o	MPa	Initial stress
A_f	%	Percentage creep elongation
A_{fu}	%	Percentage elongation after creep rupture
b	mm	Width of the cross-section of the parallel length of a test piece of square or rectangular cross-section
d	mm	Diameter of the cross-section of the parallel length of a cylindrical test piece
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L_r	mm	Reference length
L_{ro}	mm	Original reference length
L_{ru}	mm	Final reference length
L_u	mm	Final gauge length after rupture

Table 2 (*continued*)

Symbol	Unit	Meaning
r	mm	Transition radius
S_o	mm^2	Original cross-sectional area of the parallel length
S_u	mm^2	Minimum cross-sectional area after rupture
T	°C	Specified temperature
T_i	°C	Indicated temperature
t_u	h	Creep rupture time
Z_u	%	Percentage reduction of area after creep rupture

3.2 Code 1.02 Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines

Table 3 — Symbols designated in the International Standard, Code 1.02

Symbol	Unit	Designation
b	%	Relative reproducibility error with rotation
b'	%	Relative repeatability without rotation
f_c	%	Relative interpolation error
F_f	N	Maximum capacity of the transducer
F_N	N	Maximum capacity of the measuring range
f_o	%	Relative zero error
i_f	—	Reading [a] on the indicator after removal of force
i_o	—	Reading [a] on the indicator before application of force
r	—	Resolution of the indicator
v	%	Relative reversibility error of the force proving instrument
X	—	Deflection with increasing test force
$\overline{X_r}$	—	Average value of the deflections with rotation
$\overline{X_{wr}}$	—	Average value of the deflections without rotation
X'	—	Deflection with decreasing test force
X_a	—	Computed value of deflection
X_{max}	—	Maximum deflection
X_{min}	—	Minimum deflection
X_N	—	Deflection corresponding to the maximum capacity

[a] Reading value corresponding to the deflection.

3.3 Code 1.03 Metallic materials — Tensile testing at elevated temperature

3.3.1 Definitions

gauge length
length of the parallel portion of the test piece on which elongation is measured at any moment during the test

original gauge length, L_o
gauge length at ambient temperature before heating of the test piece and before application of force

final gauge length, L_u
gauge length after rupture, the two pieces having been carefully fitted back together so that their axes lie in a straight line, measured at ambient temperature

parallel length, L_c
parallel portion of the test piece

NOTE The concept of parallel length is replaced by the concept of distance between grips for non-machined test pieces.

extensometer gauge length, L_e
length of the parallel portion of the test piece used for the measurement of elongation by means of an extensometer

NOTE The length may differ from L_o and could have a value greater than b, d, or D but less than L_c.

extension
increase in the extensometer gauge length (L_e), at any moment during the test

elongation
increase in the original gauge length (L_o) under the action of the tensile force, at any moment during the test

percentage elongation
elongation expressed as a percentage of the original gauge length (L_o)

percentage permanent elongation
increase in the original gauge length of a test piece after removal of a specified stress, expressed as a percentage of the original gauge length (L_o)

percentage elongation after fracture, A
permanent elongation of the gauge length after fracture ($L_u - L_o$), expressed as a percentage of the original gauge length (L_o)

percentage total elongation at fracture, A_t
total elongation (elastic elongation plus plastic elongation) of the gauge length at the moment of fracture, expressed as a percentage of the original gauge length (L_o)

percentage reduction of area, Z
maximum change in cross-sectional area ($S_o - S_u$) which has occurred during the test, expressed as a percentage of the original cross-sectional area (S_o)

maximum force, F_m
greatest force which the test piece withstands during the test

stress
force at any moment during the test divided by the original cross-sectional area (S_o) of the test piece

tensile strength, R_m
stress corresponding to the maximum force (F_m)

yield strength
when the metallic material exhibits a yield phenomenon, point reached during the test at which plastic deformation occurs without any increase in the force

upper yield strength, R_{eH}
value of stress at the moment when the first decrease in force is observed

lower yield strength, R_{eL}
lowest value of stress during plastic yielding, ignoring any transient effects

proof strength, non-proportional extension, R_p
stress at which a non-proportional extension is equal to a specified proportion e of the extensometer gauge length (L_e)

Table 4 — Symbols designated in the International Standard, Code 1.03

Symbol	Unit	Designation
θ_i	°C	Indicated temperature
θ	°C	Fixed temperature
a [a]	mm	Thickness of a flat test piece or wall thickness of a tube
A [b]	%	Percentage elongation after fracture: $\frac{L_u - L_o}{L_o} \times 100$
A_t	%	Percentage total elongation at fracture
b	mm	Width of the parallel length of a flat test piece or average width of a longitudinal strip from a tube or width of flat wire
d	mm	Diameter of the parallel length of a circular test piece or diameter of round wire or internal diameter of a tube
D	mm	External diameter of a tube
F_m	N	Maximum force
k	—	Coefficient of proportionality
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L_t	mm	Total length of test piece
L_u	mm	Final gauge length after fracture
R_{eH}	N/mm^2 [c]	Upper yield strength
R_{eL}	N/mm^2	Lower yield strength
R_m	N/mm^2	Tensile strength
R_p	N/mm^2	Proof strength, non-proportional extension
S_o	mm^2	Original cross-sectional area of the parallel length
S_u	mm^2	Minimum cross-sectional area after fracture

Table 4 (*continued*)

Symbol	Unit	Designation
Z	%	Percentage reduction of area: $\frac{S_o - S_u}{S_o} \times 100$

[a] The symbol T is also used in steel-tube product standards.

[b] In the case of proportional test pieces, only if the original gauge length is other than $5{,}65\sqrt{S_o}$, $5{,}65\sqrt{S_o} = 5\sqrt{\frac{4S_o}{\pi}}$,

where S_o is the original cross-sectional area of the parallel length, shall the symbol A be supplemented by an index indicating the coefficient of proportionality used, e.g.:

$A_{11,3}$ = percentage elongation of an original gauge length (L_o) of $11{,}3\sqrt{S_o}$.

In the case of non-proportional test pieces, the symbol A shall be supplemented by a subscript designating the original gauge length used, expressed in millimetres, e.g.:

A_{80} = percentage elongation of an original gauge length (L_o) of 80 mm.

[c] 1 N/mm^2 = 1 MPa

3.4 Code 1.04 Metallic materials — Tensile testing at ambient temperature

3.4.1 Definitions

gauge length, L
length of the cylindrical or prismatic portion of the test piece on which elongation shall be measured. In particular, a distinction is made between:

original gauge length, L_o
gauge length before application of force

final gauge length, L_u
gauge length after rupture of the test piece

parallel length, L_c
parallel portion of the reduced section of the test piece

NOTE The concept of parallel length is replaced by the concept of distance between grips for non-machined test pieces.

elongation
increase in the original gauge length (L_o) at any moment during the test

percentage elongation
elongation expressed as a percentage of the original gauge length (L_o)

percentage permanent elongation
increase in the original gauge length of a test piece after removal of a specified stress, expressed as a percentage of the original gauge length (L_o)

percentage elongation after fracture, A
permanent elongation of the gauge length after fracture ($L_u - L_o$), expressed as a percentage of the original gauge length (L_o)

In the case of proportional test pieces, only if the original gauge length is other than $5{,}65\sqrt{S_o}$, where S_o is the original cross-sectional area of the parallel length, the symbol A shall be supplemented by an index indicating the coefficient of proportionality used, for example:

$A_{11,3}$ = percentage elongation of a gauge length (L_o) of $11{,}3\sqrt{S_o}$

In the case of non-proportional test pieces, the symbol A shall be supplemented by an index indicating the original gauge length used, expressed in millimetres, for example:

$A_{80\ \mathrm{mm}}$ = percentage elongation of a gauge length (L_o) of 80 mm

percentage total elongation at fracture, A_t
total elongation (elastic elongation plus plastic elongation) of the gauge length at the moment of fracture, expressed as a percentage of the original gauge length (L_o)

percentage elongation at maximum force
increase in the gauge length of the test piece at maximum force, expressed as a percentage of the original gauge length (L_o). A distinction is made between the percentage total elongation at maximum force (A_{gt}) and the percentage non-proportional elongation at maximum force (A_g)

extensometer gauge length, L_e
length of the parallel portion of the test piece used for the measurement of extension by means of an extensometer

It is recommended that, for measurement of yield and proof strength parameter, $L_e \geqslant L_o/2$.

It is further recommended that, for measurement of parameters "at" or "after" maximum force, L_e be approximately equal to L_o.

extension
increase in the extensometer gauge length (L_e) at a given moment of the test

percentage permanent extension
increase in the extensometer gauge length, after removal of a specified stress from the test piece, expressed as a percentage of the extensometer gauge length (L_e)

percentage yield point extension, A_e
in discontinuous yielding materials, the extension between the start of yielding and the start of uniform work hardening. It is expressed as a percentage of the extensometer gauge length (L_e)

percentage reduction of area, Z
maximum change in cross-sectional area ($S_o - S_u$), which has occurred during the test, expressed as a percentage of the original cross-sectional area (S_o)

maximum force, F_m
greatest force that the test piece withstands during the test once the yield point has been passed

For materials without a yield point, it is the maximum value during the test

stress
at any moment during the test, force divided by the original cross-sectional area (S_o) of the test piece

tensile strength, R_m
stress corresponding to the maximum force (F_m)

yield strength
when the metallic material exhibits a yield phenomenon, a point is reached during the test at which plastic deformation occurs without any increase in the force

upper yield strength, R_{eH}
value of stress at the moment when the first decrease in force is observed

lower yield strength, R_{eL}
lowest value of stress during plastic yielding, ignoring any initial transient effects

proof strength, non-proportional extension, R_p

stress at which a non-proportional extension is equal to a specified percentage of the extensometer gauge length (L_e). The symbol used is followed by a suffix giving the prescribed percentage, for example: $R_{p0,2}$

proof strength, total extension, R_t

stress at which total extension (elastic extension plus plastic extension) is equal to a specified percentage of the extensometer gauge length (L_e). The symbol used is followed by a suffix giving the prescribed percentage, for example: $R_{t0,5}$

permanent set strength, R_r

stress at which, after removal of force, a specified permanent elongation or extension, expressed respectively as a percentage of original gauge length (L_o) or extensometer gauge length (L_e), has not been exceeded

The symbol used is followed by a suffix giving the specified percentage of the original gauge length (L_o) or of the extensometer gauge length (L_e), for example: $R_{r0,2}$

Table 5 — Symbols designated in the International Standard, Code 1.04

Symbol	Unit	Designation
a	mm	Thickness of a flat test piece or wall thickness of a tube
A	%	Percentage elongation after fracture: $\frac{L_u - L_o}{L_o} \times 100$
A_g	%	Percentage non-proportional elongation at maximum force F_m
A_e	%	Percentage yield point extension
A_{gt}	%	Percentage total elongation at maximum force F_m
A_t	%	Percentage total elongation at fracture
ΔL_m	mm	Extension at maximum force
b	mm	Width of the parallel length of a flat test piece or average width of a longitudinal strip from a tube or width of a flat wire
d	mm	Diameter of the parallel length of a circular test piece, or diameter of round wire or internal diameter of a tube
k	—	Coefficient of proportionality
D	mm	External diameter of a tube
E	N/mm^2	Modulus of elasticity
F_m	N	Maximum force
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L'_o	mm	Initial gauge length for determination of A_g
L_t	mm	Total length of test piece
L_u	mm	Final gauge length
L'_u	mm	Final gauge length after fracture for determination of A_g
R_{eH}	N/mm^2	Upper yield strength
R_{eL}	N/mm^2	Lower yield strength
R_m	N/mm^2	Tensile strength
R_p	N/mm^2	Proof strength, non-proportional extension

Table 5 (*continued*)

Symbol	Unit	Designation
R_r	N/mm^2	Permanent set strength
R_t	N/mm^2	Proof strength, total extension
S_o	mm^2	Original cross-sectional area of the parallel length
S_u	mm^2	Minimum cross-sectional area, after fracture
Z	%	Percentage reduction of area: $\frac{S_o - S_u}{S_o} \times 100$

3.5 Code 1.05 Metallic materials — Verification of static uniaxial tensile testing machines

3.5.1 Definitions

calibration
set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

NOTE 1 The result of a calibration permits either the assignment of values of measurands to the indications or the determination of corrections with respect to indications.

NOTE 2 A calibration may also determine other metrological properties, such as the effect of influence quantities.

NOTE 3 The result of a calibration may be recorded in a document, sometimes called a calibration certificate or a calibration report.

Table 6 — Symbols designated in the International Standard, Code 1.05

Symbol	Unit	Meaning
ρ_{air}	kg/m^3	Density of air
ρ_m	kg/m^3	Density of the dead weights
a	%	Relative resolution of the force indicator of the testing machine
b	%	Relative repeatability error of the force-measuring system of the testing machine
F	N	True force indicated by the force-proving instrument with increasing test force
F'	N	True force indicated by the force-proving instrument with decreasing test force
F_c	N	True force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range which is used
$\overline{F}_i$, $\overline{F}$	N	Arithmetic mean of several measurements of F_i and F for the same discrete force
F_i'	N	Force indicated by the force indicator of the testing machine to be verified, with increasing test force
$F_{i\,max}$ $F_{i\,min}$ F_{max}, F_{min}	N	Highest or lowest value of F_i or F for the same discrete force
F_{ic}	N	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range which is used

Table 6 (*continued*)

Symbol	Unit	Meaning
F_{io}	N	Residual indication of the force indicator of the testing machine to be verified after removal of force
F_N	N	Maximum capacity of the measuring range of the force indicator of the testing machine
f_o	%	Relative zero error of the force-measuring system of the testing machine
g_n	m/s^2	Local acceleration due to gravity
q	%	Relative accuracy error of the force-measuring system of the testing machine
r	N	Resolution of the force indicator of the testing machine
v	%	Relative reversibility error of the force-measuring system of the testing machine

3.6 Code 1.06 Metallic materials — Verification of static uniaxial testing machines — Tension creep testing machines

Table 7 — Symbols designated in the International Standard, Code 1.06

Symbol	Unit	Meaning
a	%	Relative discrimination threshold
b	%	Relative repeatability error of the testing machine
d	N	Discrimination threshold
d_1	N	Discrimination threshold corresponding to 20 % of the maximum force range (F_N)
F	N	True load indicated by the force proving instrument
$\overline{F}$	N	Arithmetic mean of several measurements of F for the same discrete load
F_i	N	Load applied by the testing machine to be verified — for deadweight machines: $F_i = mg$ [a] — for lever-type machines: $F_i = mgR$ [a] — for jockey weight machines, the value of F_i is indicated on the scale of the machine
F_M	N	Force exerted by the masses on the scale pan of the machine
F_{max}, F_{min}	N	Highest or lowest value of F for the same discrete load
F_N	N	Maximum capacity of the load range of the testing machine
F_v	N	Lower limit of the verified load range
q	%	Relative accuracy error of the testing machine
R	—	Lever ratio used for the verification

[a] g = local acceleration due to gravity, in metres per second squared.

3.7 Code 1.07 Metallic materials — Calibration of extensometers used in uniaxial testing

Table 8 — Symbols used in the International Standard, Code 1.07

Symbols	Unit	Designation
E_{max}	mm	Maximum limit of calibration range
E_{min}	mm	Minimum limit of calibration range
L_e	mm	Nominal value of gauge length of extensometer
L'_e	mm	Measured value of gauge length of extensometer
l_i	µm	Displacement indicated by the extensometer
l_t	µm	True displacement given by the calibration apparatus
q	%	Relative bias error of the extensometer
q_{Le}	%	Relative gauge length error
r	µm	Resolution of extensometer

3.8 Code 1.08 Metallic materials — Tensile testing at low temperature

3.8.1 Definitions

gauge length, L
length of the cylindrical or prismatic portion of the test piece on which elongation shall be measured

original gauge length, L_o
gauge length before application of force measured at ambient temperature

final gauge length, L_u
gauge length after fracture of the test piece measured at ambient temperature

parallel length, L_c
length of the parallel portion of the reduced section of the test piece

extensometer gauge length, L_e
length of the parallel portion of the test piece used for the measurement of elongation by means of an extensometer

NOTE This length may differ from L_o and has a value greater than b or d but less than L_c.

elongation
increase in the original gauge length (L_o) at any moment during the test

percentage elongation
elongation expressed as a percentage of the original gauge length (L_o)

percentage permanent elongation
increase in the original gauge length of a test piece after removal of a specified stress, expressed as a percentage of the original gauge length (L_o)

percentage elongation after fracture, A
permanent elongation of the original gauge length after fracture ($L_u - L_o$), expressed as a percentage of the original gauge length (L_o)

NOTE In the case of proportional test pieces, only if the original gauge length is other than $5{,}65\sqrt{S_o}$, where S_o is the original cross-sectional area of the parallel length, should the symbol A be supplemented by an index indicating the coefficient of proportionality used, for example:

$A_{11.3}$ = percentage elongation of a gauge length (L_o) of $11{,}3\sqrt{S_o}$

In the case of non-proportional test pieces, the symbol A shall be supplemented by an index indicating the original gauge length used, expressed in millimetres, for example:

$A_{80\ mm}$ = percentage elongation of a gauge length (L_o) of 80 mm.

percentage total elongation at fracture, A_t
total elongation (elastic elongation plus plastic elongation) of the gauge length at the moment of fracture, expressed as a percentage of the original gauge length (L_o)

extension
increase in the extensometer gauge length (L_e) at a given moment of the test

percentage permanent extension
increase in the extensometer gauge length, after removal from the test piece of a specified stress, expressed as a percentage of the extensometer gauge length (L_e)

percentage reduction of area, Z
maximum change in cross-sectional area which has occurred during the test ($S_o - S_u$), expressed as a percentage of the original cross-sectional area (S_o)

maximum force, F_m
maximum force which the test piece withstands during the test after any yielding has taken place

NOTE For brittle materials, it is the maximum value during the test.

stress
force at any moment during the test divided by the original cross-sectional area (S_o) of the test piece

tensile strength, R_m
stress corresponding to the maximum force (F_m)

yield strength
when the metallic material exhibits a yield phenomenon, a point during the test at which plastic deformation occurs without any increase in the force

upper yield strength, R_{eH}
value of stress at which the first decrease in force is observed

lower yield strength, R_{eL}
lowest value of stress during plastic yielding, ignoring any transient effects

proof strength, non-proportional extension, R_p
stress at which the non-proportional extension is equal to a specified percentage of the extensometer gauge length (L_e)

NOTE The symbol used is followed by a suffix giving the prescribed percentage, for example: $R_{p0,2}$

Table 9 — Symbols and designations, Code 1.08

Symbol	Unit	Designation
θ	°C	Specified temperature
θ_i	°C	Indicated temperature
a	mm	Thickness of a flat test piece or wall thickness of a tube
A	%	Percentage elongation after fracture: $\frac{L_u - L_o}{L_o} \times 100$
A_t	%	Percentage total elongation at fracture
b	mm	Width of the parallel length of a flat test piece or average width of the longitudinal strip taken from a tube or width of flat wire
d	mm	Diameter of the parallel length of a cylindrical test piece or diameter of a circular wire
F_m	N	Maximum force
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
L_o	mm	Original gauge length
L_u	mm	Final gauge length after fracture
R_{eH}	N/mm^2	Upper yield strength
R_{eL}	N/mm^2	Lower yield strength
R_m	N/mm^2	Tensile strength
R_p	N/mm^2	Proof strength, non-proportional extension
S_o	mm^2	Original cross-sectional area of the parallel length
S_u	mm^2	Minimum cross-sectional area after fracture (final cross-sectional area)
Z	%	Percentage reduction of area: $\frac{S_o - S_u}{S_o} \times 100$

3.9 Code 1.09 Metallic materials — Tensile testing in liquid helium

3.9.1 Definitions

adiabatic heating
internal heating of a specimen resulting from deformation under conditions such that the heat generated by plastic work cannot be quickly dissipated to the surrounding cryogen

axial strain
average of the longitudinal strains measured at opposite or equally spaced surface locations on the sides of the longitudinal axis of symmetry of the specimen

NOTE The longitudinal strains are measured using two or more strain-sensing transducers located at the mid-length of the parallel length.

bending strain
difference between the strain at the surface of the specimen and the axial strain

NOTE The bending strain varies around the circumference and along the parallel length of the specimen

dewar
a vacuum-insulated container for cryogenic fluids

discontinuous yielding strength, R_i
peak stress at the initiation of the first measurable serration on the stress-strain curves

tensile cryostat
test apparatus for applying tensile forces to specimens in cryogenic environments

Table 10 — Symbols and designations, Code 1.09

Symbol	Unit	Designation
d	mm	Diameter of the parallel length of a cylindrical test piece or diameter of a circular wire
L_o	mm	Original gauge length
L_u	mm	Final gauge length after fracture
L_c	mm	Parallel length
L_e	mm	Extensometer gauge length
S_o	mm^2	Original cross-sectional area of the parallel length
S_u	mm^2	Minimum cross-sectional area after fracture (final cross-sectional area)
Z	%	Percentage reduction of area: $Z = \frac{S_o - S_u}{S_o} \times 100$
A	%	Percentage elongation after fracture: $A = \frac{L_u - L_o}{L_o} \times 100$
F_m	N	Maximum force
R_m	N/mm^2	Tensile strength
$R_{p0,2}$	N/mm^2	0,2 % proof strength, non-proportional extension
R_i	N/mm^2	Discontinuous yielding strength

3.10 Code 2.01 Metallic materials — Bend test

Table 11 — Symbols designated in the International Standard, Code 2.01

Symbol	Unit	Designation
α	degree	Angle of bend
a	mm	Thickness or diameter of test piece (or diameter of the inscribed circle for pieces of polygonal cross-section)
b	mm	Width of test piece
D	mm	Diameter of mandrel
l	mm	Distance between supports
L	mm	Length of test piece
r	mm	Internal radius of bend portion of test piece after bending

3.11 Code 2.02 Metallic materials — Sheet and strip 3 mm thick or less — Reverse bend test

Table 12 — Symbols designated in the International Standard, Code 2.02

Symbol	Unit	Designation
a	mm	Thickness of test piece
h	mm	Distance from top tangential plane of cylindrical supports to the bottom face of guide
N_b	—	Number of reverse bends
r	mm	Radius of cylindrical supports
y	mm	Distance from a plane defined by the axis of cylindrical supports and the nearest point of contact with the test piece

3.12 Code 2.03 Metallic materials — Wire — Simple torsion test

Table 13 — Symbols designated in the International Standard, Code 2.03

Symbol	Unit	Designation
d	mm	Diameter of round wire
D	mm	Characteristic dimension for non-circular wires [a]
L	mm	Free length between grips
N_t	—	Number of turns

[a] The characteristic dimension for non-circular wires is the maximum dimension of the cross-section and is usually specified in the relevant standard.

3.13 Code 2.04 Metallic materials — Wire — Reverse bend test

Table 14 — Symbols designated in the International Standard, Code 2.04

Symbol	Unit	Designation
a	mm	Minimum thickness of wire of non-circular section capable of being held between parallel grips
d	mm	Diameter of round wire
d_g	mm	Diameter of guide hole
h	mm	Distance from the top tangential plane of cylindrical supports to the bottom face of guide
N_b	—	Number of reverse bends
r	mm	Radius of cylindrical supports
y	mm	Distance from a plane, defined by the axes of the cylindrical supports, to the nearest point of contact with the test piece

3.14 Code 2.06 Metallic materials — Sheet and strip — Erichsen cupping test

Table 15 — Symbols designated in the International Standard, Code 2.06

Symbol	Unit	Designation
a	mm	Thickness of the test piece
b	mm	Width or diameter of the test piece
d_1	mm	Diameter of the spherical end of the punch
d_2	mm	Bore diameter of the die
d_3	mm	Bore diameter of the blank holder
d_4	mm	Outside diameter of the die
d_5	mm	Outside diameter of the blank holder
h_1	mm	Height of the inside rounded part of the die
h	mm	Depth of the cup during the test
IE	—	Erichsen cupping index
R_1	mm	Outside corner radius of the die, outside corner radius of the blank holder
R_2	mm	Inside corner radius of the die

3.15 Code 2.07 Metallic materials — Tube (in full section) — Bend test

Table 16 — Symbols designated in the International Standard, Code 2.07

Symbol	Unit	Designation
α	degree	Angle of the bend
a [a]	mm	Wall thickness of the tube
D	mm	Outside diameter of the tube
L	mm	Length of test piece before the test
r	mm	Inside radius at the bottom of the groove

[a] The symbol T is also used in steel tube standards.

3.16 Code 2.08 Metallic materials — Tube — Flattening test

Table 17 — Symbols designated in the International Standard, Code 2.08

Symbols	Unit	Designation
a [a]	mm	Wall thickness of the tube
b	mm	Inside width of flattened test piece
D	mm	Outside diameter of the tube
H	mm	Distance between platens measured under load
L	mm	Length of the test piece

[a] The symbol T is also used in steel tube standards.

3.17 Code 2.09 Metallic materials — Tube — Drift expanding test

Table 18 — Symbols designated in the International Standard, Code 2.09

Symbol	Unit	Designation
β	degree	Angle of conical mandrel
a [a]	mm	Wall thickness of the tube
D	mm	Original outside diameter of the tube
D_u	mm	Maximum outside diameter after testing
L	mm	Length of the test piece before testing
[a] The symbol T is also used in steel tube standards.		

3.18 Code 2.10 Metallic materials — Tube — Flanging test

Table 19 — Symbols designated in the International Standard, Code 2.10

Symbol	Unit	Designation
β	degree	Angle of the conical mandrel
a [a]	mm	Wall thickness of the tube
D	mm	Original outside diameter of the tube
D_u	mm	Maximum outside diameter of the flange
L	mm	Length of the test piece before the test
R	mm	Corner radius of the flanging tool
[a] The symbol T is also used in steel tube standards.		

3.19 Code 2.11 Metallic materials — Tube — Ring expanding test

Table 20 — Symbols designated in the International Standard, Code 2.11

Symbol	Unit	Designation
a [a]	mm	Wall thickness of the tube
D	mm	Original outside diameter of the tube
$D_m$max	mm	Maximum diameter of the conical mandrel
$D_m$min	mm	Minimum diameter of the conical mandrel
D_u	mm	Maximum outside diameter of the expanded part of the test piece
L	mm	Length of test piece before the test
k	mm	Length of the taper of the conical mandrel
[a] The symbol T is also used in steel tube standards.		

3.20 Code 2.13 Metallic materials — Wire — Reverse torsion test

Table 21 — Symbols designated in the International Standard, Code 2.13

Symbol	Unit	Designation
d	mm	Diameter of a round wire
L	mm	Free length between grips
N_t	—	Number of turns in one direction

3.21 Code 2.14 Metallic materials — Sheet and strip — Determination of plastic strain ratio

3.21.1 Definitions

plastic strain ratio, r
ratio of the true width strain and true thickness strain in a test piece that has been submitted to uniaxial tensile stress

Table 22 — Symbols designated in the International Standard, Code 2.14

Symbol	Unit	Meaning
Δr	—	Degree of planar anisotropy
ε_a	—	True thickness strain
ε_b	—	True width strain
b	mm	Gauge width of the test piece after straining to a specified elongation
b_o	mm	Original gauge width of the test piece
L	mm	Gauge length after straining to a specified elongation
L_o	mm	Original gauge length
r	—	Plastic strain ratio
r_m, $\overline{r}$	—	Weighted average of $r_{x/y}$ values
$r_{x/y}$	—	Plastic strain ratio in x-direction (in degrees) relative to the rolling direction at a strain level of y %

3.22 Code 2.15 Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent

Table 23 — Symbols designated in the International Standard, Code 2.15

Symbol	Unit	Meaning
α	—	Gradient of line lnσ versus lnε
ΔL	mm	Instantaneous elongation of measurement base
ε	—	True strain in test piece under action of force F: $\varepsilon = \ln\left(\frac{L}{L_e}\right)$
σ	N/mm^2	True stress in test piece under action of force F: $\sigma = F\left(\frac{L}{L_e S_o}\right)$

Table 23 (*continued*)

Symbol	Unit	Meaning
F	N	Instantaneous force applied to test piece
K	N/mm^2	Strength coefficient
L	mm	Instantaneous length of measurement base: $L = L_e + \Delta L$
L_e	mm	Extensometer gauge length
n	—	Strain hardening exponent
N	—	Number of measurements made in determining tensile strain hardening exponent
S	mm^2	Cross-sectional area of parallel-sided section of test piece under action of force F: $S = S_o\left(\frac{L_e}{L}\right)$
S_o	mm^2	Original cross-sectional area of parallel-sided section of test piece

3.23 Code 2.16 Metallic materials — Earing test

Table 24 — Symbols designated in the International Standard, Code 2.16

Symbol	Unit	Meaning
a	mm	Thickness of test piece
d_1	mm	Diameter of punch
d_2	mm	Inside diameter of die
d_b	mm	Diameter of circular blank
$\overline{h}_e$	mm	Mean ear height
$h_{e\ max}$	mm	Maximum ear height
$\overline{h}_t$	mm	Mean value of h_t
$h_{t\ max}$	mm	Maximum value of h_t
h_t	mm	Distance between outside bottom of cup to any ear peak
$\overline{h}_v$	mm	Mean value of h_v
h_v	mm	Distance between outside bottom of cup to any ear valley
$h_{v\ min}$	mm	Minimum value of h_v
R_1	mm	Corner radius of punch
R_2	mm	Inside corner radius of die
R_a	µm	Surface roughness parameter – arithmetic mean deviation of profile
Z	%	Ear height expressed as a percentage

3.24 Code 2.17 Metallic materials — Guidelines for the determination of forming-limit diagrams

Table 25 — Symbols and their meanings, Code 2.17

Symbol	Unit	Meaning
a	mm	Thickness of test piece
e_2	%	Minor strain (90° to major)
e_1	%	Major strain
FLC	—	Forming-limit curve
FLD	—	Forming-limit diagram
l_1	mm	Final length in major strain direction
l_2	mm	Final length at 90° to major strain direction
l_0	mm	Original gauge length of grid pattern

3.25 Code 2.18 Metallic materials — Tube ring hydraulic pressure test

Table 26 — Symbols designated in the International Standards, Code 2.18

Symbol	Unit	Designation
a [a]	mm	Measured tube test ring thickness
A_t	%	Specified total circumferential strain
d [b]	mm	Measured outside diameter of the tube test ring
l	mm	Length of tube test ring
P	N/mm^2	Hydrostatic pressure to produce the specified total circumferential strain
R_{At}	N/mm^2	Hoop strength at the specified total strain

a The symbol T is also used in steel tube standards.

b The symbol D is also used for this parameter in standards for steel tubes.

3.26 Code 2.19 Metallic materials — Strain analysis report

Table 27 — Symbols designated in the International Standards, Code 2.19

Symbol	Unit	Meaning
a	mm	Thickness of test piece
a_3	mm	Thickness after forming the part
e_1	%	Major strain
e_2	%	Minor strain, 90° to the direction of major strain
e_3	%	Thickness strain
L_o	mm	Original gauge length of grid pattern
l_1	mm	Final length in major strain direction
l_2	mm	Final length 90° to the direction of major strain
n	1	Strain hardening exponent (n value)
r_m	1	Plastic strain ratio, weighted average
FLD	—	Forming-Limit Diagram
FLC	—	Forming-Limit Curve

3.27 Code 3.01 Metallic materials — Hardness test — Knoop test

Table 28 — Symbols designated in the International Standards, Code 3.01

Symbol	Designation
c	Indenter constant relating projected area of the indentation to the square of the length of the long diagonal
d	Length, in millimetres, of the long diagonal
F	Test force, in newtons
HK	Knoop hardness = $\frac{\text{Test force}}{\text{Projected area of indentation}}$ $= 0{,}102 \times \frac{F}{d^2 \cdot c} = 0{,}102 \times \frac{F}{0{,}070\ 28\ d^2} = 1{,}451 \frac{F}{d^2}$
NOTE	Constant $= \frac{1}{g_\text{n}} = \frac{1}{9{,}806\ 65} \approx 0{,}102$ where g_n is the acceleration due to gravity. Indenter constant $c = \frac{\tan\frac{\beta}{2}}{2\tan\frac{\alpha}{2}}$ where α and β are the angles between the opposite edges.

3.28 Code 3.02 Metallic materials — Brinell hardness test — Part 1: Test method

Table 29 — Symbols designated in the International Standards, Code 3.02

Symbol	Unit	Designation
d	mm	Mean diameter of the indentation $\left(d = \frac{d_1 + d_2}{2}\right)$
D	mm	Diameter of the ball
d_1, d_2	mm	Indentation diameters measured at 90°
F	N	Test force
$0{,}102 \times F/D^2$	N/mm^2	Force-diameter ratio
h	mm	Depth of indentation = $\frac{D - \sqrt{D^2 - d^2}}{2}$
HBW	—	Brinell hardness = constant $\times \frac{\text{Test force}}{\text{Surface area of indentation}}$ $= 0{,}102 \times \frac{2F}{\pi D(D - \sqrt{D^2 - d^2})}$
NOTE		Constant $= \frac{1}{g_\text{n}} = \frac{1}{9{,}806\ 65} \approx 0{,}102$ where g_n is the acceleration due to gravity.

3.29 Code 3.03 Hardness test — Vickers hardness test — Part 1: Test method

Table 30 — Symbols designated in the International Standards, Code 3.03

Symbols	Designation
α	Angle between the opposite faces at the vertex of the pyramidal indenter (136°)
d	Arithmetic mean, in millimetres, of the two diagonals of length d_1 and d_2
F	Test force in newtons
HV	$\text{Vickers hardness} = \text{constant} \times \dfrac{\text{Test force}}{\text{Surface area of indentation}}$ $= 0{,}102 \dfrac{2F \sin \dfrac{136°}{2}}{d^2} \approx 0{,}189\,1 \dfrac{F}{d^2}$
NOTE	$\text{Constant} = \dfrac{1}{g_n} = \dfrac{1}{9{,}806\,65} \approx 0{,}102$ where g_n is the acceleration due to gravity.

3.30 Code 3.04 Metallic materials — Rockwell hardness test — Part 1: Test method (scales A-B-C-D-E-F-G-H-K-N-T)

Table 31 — Symbols designated in the International Standards, Code 3.04

Symbol	Unit	Designation
F	N	Total test force
F_0	N	Preliminary test force
F_1	N	Additional test force
h	mm	Permanent increase in depth of indentation under preliminary test force after removal of additional test force (permanent indentation depth)
N	mm	Number specific to the scale
S	mm	Scale unit, specific to the scale
HRA	HRA	Rockwell hardness = $100 - \dfrac{h}{0{,}002}$
HRC	HRC	Rockwell hardness = $100 - \dfrac{h}{0{,}002}$
HRD	HRD	Rockwell hardness = $100 - \dfrac{h}{0{,}002}$
HRB	HRB	Rockwell hardness = $130 - \dfrac{h}{0{,}002}$
HRE	HRE	Rockwell hardness = $130 - \dfrac{h}{0{,}002}$
HRF	HRF	Rockwell hardness = $130 - \dfrac{h}{0{,}002}$
HRG	HRG	Rockwell hardness = $130 - \dfrac{h}{0{,}002}$

Table 31 (*continued*)

Symbol	Unit	Designation
HRH	HRH	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRK	HRK	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRN	HRN	Rockwell hardness = $100 - \frac{h}{0{,}001}$
HRT	HRT	Rockwell hardness = $100 - \frac{h}{0{,}001}$

3.31 Code 3.06 Metallic materials — Instrumented indentation test for hardness and materials parameters — Part 1: Test method

Table 32 — Symbols designated in the International Standards, Code 3.06

Symbol	Unit	Designation
α	°	Angle, specific to the shape of the pyramidal indenter
η_{it}	%	Relation $W_{\mathrm{elast}}/W_{\mathrm{total}}$
$A_{\mathrm{p}}(h_{\mathrm{c}})$	mm^2	Projected area of contact of the indenter at distance h_{c} from the tip
$A_{\mathrm{s}}(h)$	mm^2	Surface area of the indenter at distance h from the tip
C_{IT}	%	Indentation creep
E_{IT}	N/mm^2	Indentation modules
F	N	Test force
F_{max}	N	Maximum test force
h	mm	Indentation depth under applied test force
h_{c}	mm	Depth of the contact of the indenter with the test piece at F_{max}
h_{max}	mm	Maximum indentation depth at F_{max}
h_{p}	mm	Permanent indentation depth after removal of the test force
h_{r}	mm	Point of intersection of the tangent c to curve b at F_{max} with the indentation depth-axis
H_{IT}	N/mm^2	Indentation hardness
HM	N/mm^2	Martens hardness
$\mathrm{HM_s}$	N/mm^2	Martens hardness determined from the slope of the increasing force/indentation depth curve
r	mm	Radius of spherical indenter
R_{IT}	%	Indentation relaxation
W_{elast}	N·m	Elastic reverse deformation work of indentation
W_{total}	N·m	Total mechanical work of indentation
NOTE 1 To avoid very long numbers the use of multiples or sub-multiples of the units is permitted.		
NOTE 2 $1N/mm^2$ = 1Mpa.		

3.32 Code 4.01 Steel — Charpy impact test (U-notch)

Table 33 — Symbols designated in the International Standards, Code 4.01

Symbol	Designation
a	Thickness of test piece
b	Width of test piece
L	Distance between supports
KU	Energy absorbed, in joules

3.33 Code 4.01 Metallic materials — Charpy pendulum impact test — Part 1: Test method

3.33.1 Definitions

actual initial potential energy (potential energy), A_P
value determined by direct verification [see ISO 148-2]

absorbed energy, K
energy value indicated by the pointer or other readout device

NOTE The letter V or U shall be added to indicate the notch geometry, that is: KV or KU. The number 2 or 8 shall be added as a subscript to indicate striker radius, that is KV_2 for example.

test piece
with the test piece placed in the test position on the supports of the machine, the following nomenclature shall apply

height, h
distance between the notched face and the opposite face

width, w
dimension perpendicular to the height that is parallel to the notch

length, l
the largest dimension at right angles to the notch

Table 34 — Symbols designated in the International Standards, Code 4.01

Symbol	Unit	Designation
A_p	J	Actual initial potential energy (potential energy)
FA	%	Shear-fracture appearance
h	mm^2	Height of test piece
KU_2	J	Absorbed energy for a U-notch test piece using a 2 mm striker
KU_B	J	Absorbed energy for a U-notch test piece using an 8 mm striker
KV_2	J	Absorbed energy for a V-notch test piece using a 2 mm striker
LE	mm	Lateral expansion
l	mm	Length of test piece
T_1	°C	Transition temperature
w	mm	Width of test piece

3.34 Code 4.01 Metallic materials — Charpy pendulum impact test — Part 2: Verification of test machines

3.34.1 Definitions

anvil
portion of the base of the machine forming a vertical plane, which restrains the test piece when it is struck by the pendulum The plane of supports is perpendicular to the plane of the anvils

base
that part of the framework of the machine located below the horizontal plane of the supports

centre of percussion
that point in a body at which, on striking a blow, the percussive action is the same as if the whole mass of the body was concentrated at that point

NOTE When a simple pendulum delivers a blow along a horizontal line passing through the centre of percussion, there is no resulting horizontal reaction at the axis of rotation.

centre of strike
that point on the striking edge of the pendulum at which, in the free hanging position of the pendulum, the vertical edge of the striker meets the upper horizontal plane of a test piece of half standard height (i.e. 5 mm) or equivalent gauge bar resting on the test piece supports

industrial machine
impact machines used for industrial, general, or most research laboratory testing of metallic materials. These machines are not used to establish reference values. Industrial machines are verified using the procedures described in ISO 148-2.

reference machine
pendulum impact testing machines used to determine the reference energy of a reference test piece. The verification requirements for this grade of machine are more stringent than those for general machines.

striker
portion of the hammer that contacts the test piece. The edge that actually contacts the test piece may have a radius of 2 mm (the 2 mm striker) or a radius of 8 mm (the 8 mm striker).

test piece supports
portion of the base of the machine forming a horizontal plane upon which the test piece rests prior to being struck by the hammer. The plane of the supports is perpendicular to the plane of the anvils.

actual absorbed energy; absorbed energy, A_V
total energy required to break a test piece when tested by a pendulum impact testing machine. It is equal to the difference in the potential energy from the starting position of the pendulum to the end of the first half swing during which the test piece is broken.

actual initial potential energy (potential energy), A_P
value determined by direct verification

indicated absorbed energy (indicated energy), A_S
energy value indicated by the pointer or other readout device

nominal indicated potential energy (nominal energy), A_N
energy assigned by the manufacturer of the machine

reference energy, A_R
absorbed energy value associated with the reference test pieces, determined from tests using reference machines

reference test pieces
impact test pieces used to verify the suitability of an industrial grade, pendulum impact testing machine by comparing the indicated energy measured by that machine to the reference energy associated with the test pieces

height
distance between the notched face and the opposite face

width
dimension perpendicular to the height that is parallel to the notch

length
largest dimension at right angles to the notch

Table 35 — Symbols designated in the International Standards, Code 4.01

Symbol	Unit	Meaning
α	degree	Angle of fall of the pendulum
β	degree	Angle of rise of the pendulum
A_N	J	Nominal initial potential energy (nominal energy)
A_P	J	Actual initial potential energy (potential energy)
A_R	J	Reference energy of a set of Charpy reference test pieces
A_S	J	Indicated absorbed energy (indicated energy)
A_V	J	Actual absorbed energy (absorbed energy)
E_2 or β_2	J or degree	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
E_3 or β_3	J or degree	Indicated energy or angle of rise after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
E_1 or β_1	J or degree	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position
F	N	Force exerted by the pendulum when measured at a distance of l_2
h	m	Height of fall of the pendulum
h_1	m	Height of rise of the pendulum
l	m	Distance to the centre of test piece (centre of striker) from the axis of rotation (length of pendulum)
l_1	m	Distance to the centre of percussion from the axis of rotation
l_2	m	Distance to the point of application of the force F from the axis of rotation
M	N·m	The moment equal to the product Fl_2
p	J	Energy loss caused by pointer friction
P_β	J	Correction of energy losses for an angle of swing β
P'	J	Energy loss caused by bearing friction and air resistance
t	s	Period of the pendulum
T	s	Total time for 100 swings of the pendulum
T_{max}	s	Maximum value of T
T_{min}	s	Minimum value of T
W	N	Weight of the pendulum

3.35 Code 4.01 Metallic materials — Charpy pendulum impact test — Part 3: Preparation and characterization of Charpy V reference test pieces for verification of test machines

Table 36 — Symbols designated in the International Standards, Code 4.01

Symbol	Unit	Meaning
A_V	J	Actual absorbed energy; absorbed energy
A_S	J	Indicated absorbed energy; indicated energy
A_R	J	Reference energy of a set of Charpy reference test pieces

3.36 Code 4.03 — Metallic materials –Determination of the plane-strain fracture toughness

3.36.1 Definitions

plane strain stress intensity factor, K_I
magnitude of the elastic stress field at the tip of a crack subjected to opening mode displacement (mode I). It is a function of applied force and test specimen size, and geometry, and has the dimensions of force time's length$^{-3/2}$.

plane-strain fracture toughness, K_{Ic}
measure, by the operational procedure of this method, of a material's resistance to crack extension when the state of stress near the crack tip is predominantly plane strain and plastic deformation is limited

NOTE It is the critical value of K_I at which significant crack extension occurs on increasing load with high constraint to plastic deformation.

crack plane orientation
method for relating the plane and direction of crack extension to the characteristic directions of the product

NOTE A hyphenated code is used wherein the letter(s) preceding the hyphen represent(s) the direction normal to the crack plane and the letter(s) following the hyphen represent(s) the anticipated direction of crack extension. For wrought metals, the letter X always denotes the principal direction of grain flow, Z the direction of principal working force, and Y the direction normal to the X-Z plane. If specimen directions do not coincide with the product's characteristic directions, then two letters are used to denote the normal to the crack plane and/or the expected direction of crack extension. If there is no grain flow direction (as in a casting), reference axes may be arbitrarily assigned but must be clearly identified.

notch opening displacement, V
displacement measured at or near the notch mouth

Table 37 — Symbols designated in the International Standards, Code 4.03

Symbol	Unit	Designation
ΔK_I	MPa·m$^{1/2}$ [a]	Difference between maximum and minimum values of K_I during any single cycle of fatigue operation
a	mm	Crack length
B	mm	Specimen thickness
E	MPa	Young's modulus
F	kN	Applied force
F_5	kN	Particular value of F
F_Q	kN	Particular value of F
K_f	MPa·m$^{1/2}$ [a]	Maximum stress intensity factor during the final stage of fatigue cracking

Table 37 (*continued*)

Symbol	Unit	Designation
K_I	MPa·m$^{1/2}$	Opening mode stress intensity factor (mode I)
K_{Ic}	MPa·m$^{1/2}$	Critical value of K_I (plane-strain fracture toughness)
K_Q	MPa·m$^{1/2}$	Provisional value of K_{Ic}
R	—	Ratio of minimum to maximum fatigue cracking force during any single cycle of fatigue operation
$R_{p0,2}$	MPa	0,2 % offset proof strength
S	mm	Span between outer loading points
V	mm	Notch opening displacement
W	mm	Width for bend specimen or effective width for compact specimen

[a] 0,031 6 MPa·m$^{1/2}$ = 1 N·mm$^{-3/2}$ = 0,031 6 MN·m$^{-3/2}$

3.37 Code 4.04 Steel — Charpy V-notch pendulum impact test — Instrumented test method

3.37.1 Definitions

general yield force, F_{gy}
force at the transition point from the linearly increasing part to the curved increasing part of the force-displacement curve

NOTE It represents a first approximation of the force at which yielding has occurred across the entire uncracked-test-piece ligament.

maximum force, F_m
maximum force in the course of the force-displacement curve

crack initiation force, F_{iu}
force at the beginning of the steep drop in the force-displacement curve

NOTE It characterizes the beginning of unstable crack propagation.

crack arrest force, F_a
force at the end (arrest) of unstable crack propagation

general yield displacement, s_{gy}
displacement corresponding to the general yield force, F_{gy}

displacement at maximum force, s_m
displacement corresponding to the maximum force, F_m

crack initiation displacement, s_{iu}
displacement at the initiation of unstable crack propagation

crack arrest displacement, s_a
displacement at the end (arrest) of unstable crack propagation

total displacement, s_t
displacement at the end of the force-displacement curve

energy at maximum force, W_m
partial impact energy from s = 0 to s = s_m

crack initiation energy, W_{iu}
partial impact energy from s = 0 to s = s_{iu}

Table 38 — Symbols designated in the International Standards, Code 4.04

Symbol	Unit	Designation
f_g	Hz	Output frequency limit
F	N	Force
F_a	N	Crack arrest force
F_{gy}	N	General yield force
F_{iu}	N	Crack initiation force
F_m	N	Maximum force
g_n	m/s^2	Acceleration due to gravity
h	m	Height of fall of the centre of strike of the pendulum (see ISO 148-2)
KV	J	Absorbed energy as defined in ISO 148-1
m	kg	Effective mass of the pendulum corresponding to its effective weight (see ISO 148-2)
s	m	Displacement
s_a	m	Crack arrest displacement
s_{gy}	m	General yield displacement
s_{iu}	m	Crack initiation displacement
s_m	m	Displacement at maximum force
s_t	m	Total displacement
t	s	Time
t_o	s	Time at the beginning of deformation of the test piece
t_r	s	Signal rise time
v_o	m/s	Initial striker impact velocity
v_t	m/s	Striker impact velocity at time t
W_a	J	Crack arrest energy
W_{iu}	J	Crack initiation energy
W_m	J	Energy at maximum force
W_t	J	Total impact energy

3.38 Code 4.05 Metallic materials — Unified method of test for the determination of quasistatic fracture toughness

3.38.1 Definitions

stress intensity factor, K
magnitude of the elastic stress-field singularity for a homogeneous, linear-elastic body

NOTE The stress intensity factor is a function of applied force, crack length, specimen size and specimen geometry.

crack-tip opening displacement, δ
relative displacement of the crack surfaces normal to the original (undeformed) crack plane at the tip of the fatigue precrack

***J*-integral**
line or surface integral that encloses the crack front from one crack surface to the other and characterizes the local stress-strain field at the crack tip

J
loading parameter, equivalent to the J-integral, specific values of which, experimentally determined by this method of test (J_c, J_i, J_u,…), characterize fracture toughness under conditions of non-negligible crack-tip plasticity

stable crack extension
crack extension which stops or would stop when the applied displacement is held constant as a test progresses under displacement control

unstable crack extension
abrupt crack extension occurring with or without prior stable crack extension

pop-in
abrupt discontinuity in the force versus displacement record, featured as a sudden increase in displacement and, generally, a decrease in force

NOTE 1 Displacement and force subsequently increase beyond their values at pop-in.

NOTE 2 When conducting tests by this method, pop-ins may result from unstable crack extension in the plane of the precrack and are to be distinguished from discontinuity indications arising from: i) delaminations or splits normal to the precrack plane; ii) roller or pin slippage in bend or compact specimen load trains, respectively; iii) improper seating of displacement gauges in knife edges; iv) ice cracking in low-temperature testing; v) electrical interference in the instrument circuitry of force and displacement measuring and recording devices.

crack extension resistance curves (*R*-curves)
variation in δ or J with stable crack extension

Table 39 — Symbols designated in the International Standards, Code 4.05

Symbols	Unit	Designation
a	mm	Nominal crack length (for the purposes of fatigue precracking, an assigned value less than a_o)
a_f	mm	Final crack length ($a_o + \Delta a$)
a_i	mm	Instantaneous crack length
a_m	mm	Length of machined notch
a_o	mm	Initial crack length
Δa	mm	Stable crack extension including blunting
Δa_{max}	mm	Crack extension limit for δ or J controlled crack extension
B	mm	Specimen thickness
B_N	mm	Specimen net thickness between side grooves
C	m/N	Specimen elastic compliance
E	GPa	Modulus of elasticity at the pertinent temperature
F	kN	Applied force
F_c	kN	Applied force at the onset of unstable crack extension or pop-in when a is less than 0,2 mm offset from the construction line

Table 39 (*continued*)

Symbols	Unit	Designation
F_f	kN	Maximum fatigue precracking force
J	MJ/m^2	Experimental equivalent to the J-integral
$J_{c(B)}$	MJ/m^2	Size-sensitive fracture resistance J at onset of unstable crack extension or pop-in when stable crack extension is less than 0,2 mm offset from the construction line (B = specimen thickness in mm)
J_g	MJ/m^2	J at upper limit of J-controlled crack extension
J_i	MJ/m^2	Fracture J at initiation of stable crack extension
$J_{m(B)}$	MJ/m^2	Size-sensitive fracture resistance J at the first attainment of a maximum force plateau for fully plastic behaviour (B = specimen thickness in mm)
J_{max}	MJ/m^2	Limit of J-R material behaviour defined by this method of test
$J_{u(B)}$	MJ/m^2	Size-sensitive fracture resistance J at the onset of unstable crack extension or pop-in when the event is preceded by stable crack extension equal to or greater than 0,2 mm offset from the construction line (B = specimen thickness in mm)
$J_{uc(B)}$	MJ/m^2	Size-sensitive fracture resistance J at the onset of unstable crack extension or pop-in when stable crack extension cannot be measured (B = specimen thickness in mm)
J_o	MJ/m^2	J uncorrected for stable crack extension
$J_{0,2BL}$	MJ/m^2	Size-insensitive fracture resistance J at 0,2 mm stable crack extension offset from the construction line
$J_{0,2BL(B)}$	MJ/m^2	Size-sensitive fracture resistance J at 0,2 mm stable crack extension offset from the construction line (B = specimen thickness in mm)
K	$MPa\sqrt{m}$	Stress intensity factor
K_f	$MPa\sqrt{m}$	Maximum value of K during the final stages of fatigue precracking
K_{Ic}	$MPa\sqrt{m}$	Plane strain fracture toughness
K_Q	$MPa\sqrt{m}$	A provisional value of K_{Ic}
q	mm	Load-point displacement
R_m	MPa	Ultimate tensile strength perpendicular to crack plane at the test temperature
$R_{p0,2}$	MPa	0,2 % offset yield strength perpendicular to crack plane at the test temperature
S	mm	Span between outer loading points in a three-point bend test
T	°C	Test temperature
U	J	Area under plot of force F versus specimen load-point displacement q at the load-line
U_e	J	Elastic component of U
U_p	J	Plastic component of U
V	mm	Notch opening displacement
V_e	mm	Elastic component of V
V_p	mm	Plastic component of V
W	mm	Width of test specimen
z	mm	For bend and straight-notch compact specimens, the initial distance of the notch opening gauge measurement position from the notched edge of the specimen, either further from the crack tip or closer to the crack tip ($-z$); or, for a stepped-notch compact specimen, the initial distance of the notch opening gauge measurement position either beyond ($+z$) or before ($-z$) the initial load-line.
W	mm	Width for bend specimen or effective width for compact specimen

Table 39 (*continued*)

Symbols	Unit	Designation
δ	mm	Crack-tip opening displacement (CTOD)
$\delta_{\mathrm{c}(B)}$	mm	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when stable crack extension is less than 0,2 mm crack offset from the construction line (B = specimen thickness in mm)
δ_{g}	mm	δ at the limit of δ-controlled crack extension
δ_{i}	mm	Fracture resistance δ at initiation of stable crack extension
$\delta_{\mathrm{m}(B)}$	mm	Size-sensitive fracture resistance δ at the first attainment of a maximum force plateau for fully plastic behaviour (B = specimen thickness in mm)
δ_{max}	mm	Limit of δ–R defined by this method of test
$\delta_{\mathrm{u}(B)}$	mm	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when the vent is preceded by stable crack extension equal to or greater than 0,2 mm offset from the construction line (B = specimen thickness in mm)
$\delta_{\mathrm{uc}(B)}$	mm	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when stable crack extension cannot be measured (B = specimen thickness in mm)
δ_{o}	mm	δ uncorrected for stable crack extension
$\delta_{0,2\mathrm{BL}}$	mm	Size-insensitive fracture resistance δ at 0,2 mm crack extension offset from construction line
$\delta_{0,2\mathrm{BL}(B)}$	mm	Size-sensitive fracture resistance δ at 0,2 mm stable crack extension offset from construction line (B = specimen thickness in mm)
ν	1	Poisson's ratio
NOTE 1 This is not a complete list of parameters. Only the main parameters are given here, other parameters are referred to in the text.		
NOTE 2 The values of all parameters used in calculations are assumed to be those measured or calculated for the temperature of the test, unless otherwise specified.		

3.39 Code 5.01 Metals — Axial load fatigue testing

Table 40 — Symbols designated in the International Standards, Code 5.01

Symbol	Definition
a	Thickness of test section of test pieces of rectangular cross-section
b	Width of test pieces of rectangular cross-section where the stress is a maximum
B	Width of test pieces of rectangular cross-section at the gripped ends
d	Diameter of the test piece where the stress is a maximum
D	Diameter of the gripped ends of the test piece if plain, or overall diameter of the threaded ends
L_{c}	Parallel length
r	Radius at the ends of the test section which starts the transition from the test diameter d or test width b to the diameter D or width B of the gripped ends; or the continuous radius between the gripped ends of the test piece

3.40 Code 5.01 Metalic materials — Fatigue testing — Axial force controlled method

Table 41 — Symbols designated in the International Standards, Code 5.01

Symbol	Designation	Definition
Stress Cycle		
σ_{max}	Maximum stress	The highest algebraic value of stress in the stress cycle.
σ_{min}	Minimum stress	The lowest algebraic value of stress in the stress cycle.
σ_m	Mean stress	Static component of the stress. It is one-half of the algebraic sum of the maximum stress and minimum stress $(\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2})$
σ_a	Stress amplitude	Variable component of stress. It is one-half of the algebraic difference between the maximum stress and the minimum stress $(\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2})$
N	Number of cycles	Number of cycles applied at any stage during the test.
R	Stress ratio	Algebraic ratio of the minimum stress to the maximum stress in one cycle, $R = \frac{\sigma_{min}}{\sigma_{max}}$
$\Delta\sigma$	Stress range	$\sigma_{max} - \sigma_{min}$
Fatigue Life and Strength		
N_f	Fatigue life or endurance	Number of stress cycles to failure in specified condition
σ_N	Fatigue strength at N cycles	Value of the stress amplitude at a stated stress ratio under which the specimen would have a life of N cycles.
σ_D	Fatigue limit	Value of the stress amplitude below which a specimen would be expected to endure an infinite number of stress cycles with a stated probability [a]
[a] Certain materials do not show a fatigue limit. Others show only a fatigue limit in certain environments.		
Specimens		
d		Diameter of the test piece where the stress is a maximum
L_c		Parallel length
r [b]		Radius at the ends of the test section which starts the transition from the test diameter d or test width b to the diameter or width of the gripped ends; or the continuous radius between the gripped ends of the specimen
a		Thickness of test section of specimens of rectangular cross-section
b		Width of specimens of rectangular cross-section where the stress is a maximum
[b] This curve need not be a true arc of a circle over the whole of the distance between the end of the test section and the start of the enlarged end for specimens of the types.		

3.41 Code 5.02 Metals — Rotating bar bending fatigue testing

Table 42 — Symbols designated in the International Standards, Code 5.02

Symbol	Definition
d	Diameter of the test piece where the stress is a maximum
D	Diameter of the gripped or loaded end of the test piece
r	Radius at the ends of the test section which starts the transition from the test diameter d

3.42 Code 5.03 Steel —Torsional stress fatigue testing

Table 43 — Symbols designated in the International Standards, Code 5.03

Symbol	Definition
d	Diameter of the test piece where the stress is a maximum
D	Diameter or width across flats of the gripped ends of the test piece. The value of D may be different for each end of the test piece
L_{c}	Parallel length of the test piece
r	Transition blending radius at the ends of the test section which starts the transition from the test diameter d to the end diameter D, or the single radius between the gripped ends

3.43 Code 5.04 Axial load fatigue machines — Dynamic force calibration — Strain gauge technique

Table 44 — Symbols designated in the International Standards, Code 5.04

Symbols	Definitions
a	Thickness of test section of a rectangular cross-section
b	Width of a rectangular cross-section where the stress is a maximum
B	Width of a rectangular cross-section at the gripped end
d	Diameter of the test piece where the stress is a maximum
D	Diameter of the gripped end of the test piece
$F_{\mathrm{a\ max}}$	Maximum force amplitude of the machine (= 1/2 $F_{\mathrm{R\ max}}$)
F_{m}	Mean force
$F_{\mathrm{m\ max}}$	Maximum mean force of the machine
F_{max}	Maximum force of the machine
F_{R}	Dynamic force range
$F_{\mathrm{R\ max}}$	Maximum dynamic force range of the machine
l	Total length of the electrical resistance strain (ERS) gauges used, i.e. the length of the gauge backing material
L_{c}	Parallel length of the test piece
r	Transition radius from the parallel length to the gripped ends

3.44 Code 5.05 Metallic materials — Fatigue testing — Axial-strain-controlled method

3.44.1 Definitions

stress
instantaneous force divided by the instantaneous cross-sectional area of the gauge length

$\sigma = F/A$

NOTE At strain values less than 10 %, the true stress is approximated by the engineering stress, F_F/A_o.

gauge length
length between extensometer measurement points

strain
true total strain

$$\varepsilon = \int_{L_o}^{L} \frac{dL}{L}$$

where L is the instantaneous length of the gauge section

NOTE At true strain values less than 10 %, ε is approximated by the engineering strain, $\Delta L/L_o$.

cycle
smallest segment of the strain-time function that is repeated periodically

maximum
greatest algebraic value of a variable within one cycle

minimum
least algebraic value of a variable within one cycle

mean
one-half of the algebraic sum of the maximum and minimum values of a variable

range
algebraic difference between the maximum and minimum values of a variable

amplitude
half the range of a variable

fatigue life, N_f
number N of cycles that have to be applied to achieve a failure

NOTE The failure criterion used shall be reported with the results.

hysteresis loop
closed curve of the stress-strain response during one cycle

Table 45 — Symbols designated in the International Standards, Code 5.05

Symbol	Unit	Designation
Specimen		
L_o	mm	Initial gauge length
L	mm	Instantaneous gauge length
A_o	mm^2	Initial gauge section
A	mm^2	Instantaneous section with $AL = A_o L_o$
A_f	mm^2	Minimum area at failure
r	mm	Transition radius (from parallel length into the grip end of the test specimen)
L_t	mm	Total length of specimen
Cylindrical		
d	mm	Diameter of cylindrical gauge section
D	mm	External diameter of specimen
L_r	mm	Length of reduced section
Flat-sheet		
B	mm	Width of gauge section
t	mm	Thickness
W	mm	Width of grip end
Fatigue testing		
E	GPa	Modulus of elasticity
E_T	GPa	Modulus for unloading following a peak tensile stress
E_C	GPa	Modulus for unloading following a peak compression stress
N_f	—	Number of cycles to failure
t_f	s	Time to failure (= N_f cycles)
σ	MPa	True stress
ε	—	True strain
Δ	—	Range of a parameter
$R_{p0,2}$	MPa	0,2 % proof stress
R_z	µm	Mean surface roughness
R_σ	—	Stress ratio (= $\sigma_{min}/\sigma_{max}$)
R_ε	—	Strain ratio (= $\varepsilon_{min}/\varepsilon_{max}$)
$\acute{\varepsilon}$	s^{-1}	Strain rate
Expression of results		
σ_y'	MPa	Cyclic yield strength [a]
n	—	Monotonic strain hardening exponent
n'	—	Cyclic strain hardening exponent
K	MPa	Monotonic strength coefficient
K'	MPa	Cyclic strength coefficient
σ_φ	MPa	Fatigue strength
b	—	Fatigue strength exponent
ε_φ	—	Fatigue ductility coefficient
c	—	Fatigue ductility exponent

[a] 0,2 % offset is typically used.

3.45 Code 5.06 Metallic materials — Fatigue testing — Statistical planning and analysis of data

3.45.1 Definitions

confidence level
value 1 – α of the probability associated with an interval of statistical tolerance

degree of freedom
number calculated by subtracting, from the total number of items of test data, the number of parameters estimated from the data

distribution function
function giving, for every value x, the probability that the random variable X is less than or equal to x

estimation
operation made for the purpose of assigning, from the values observed in a sample, numerical values to the parameters of a distribution from which this sample has been taken

population
totality of individual materials or items under consideration

random variable
variable that may take any value of a specified set of values

sample
one or more items taken from a population and intended to provide information on the population

size, n
number of items in a population, lot, sample, etc.

standard deviation, σ
positive square root of the mean squared deviation from the arithmetic mean

fatigue strength
value of stress level S, expressed in megapascals, at which a specimen would fail at a given fatigue life

specimen
portion or piece of material to be used for a single test determination and normally prepared in a predetermined shape and in predetermined dimensions

stress level, S
intensity of the stress under the conditions of control in the test

EXAMPLE Amplitude, maximum, range.

stress step, d
difference between neighbouring stress levels, expressed in megapascals, when conducting the test by the staircase method

3.46 Code 5.07 Metallic materials — Fatigue testing — Fatigue crack growth method

3.46.1 Definitions

crack length, a
linear measure of a principal planar dimension of a crack from a reference plane to the crack tip, also called crack size

cycle, N
smallest segment of a force-time or stress-time function which is repeated periodically

NOTE The terms fatigue cycle, force cycle and stress cycle are used interchangeably. The letter is used to represent the number of elapsed force cycles.

fatigue crack growth rate, $\mathrm{d}a/\mathrm{d}N$
extension in crack length per force cycle

maximum force, F_{max}
force having the highest algebraic value in the cycle; a tensile force being positive and a compressive force being negative

minimum force, F_{min}
force having the lowest algebraic value in the cycle; a tensile force being positive and a compressive force being negative

force range, ΔF
algebraic difference between the maximum and minimum forces in a cycle

$$\Delta F = F_{\mathrm{max}} - F_{\mathrm{min}}$$

force ratio, R
algebraic ratio of the minimum force or stress to maximum force or stress in a cycle

NOTE It is also called stress ratio.

stress intensity factor, K
magnitude of the ideal crack tip stress field for the opening mode force application to a crack in a homogeneous, linear-elastically stressed body where opening mode of a crack corresponds to the force being applied to the body perpendicular to the crack faces only (mode I stress condition)

maximum stress intensity factor, K_{max}
highest algebraic value of the stress intensity factor in a cycle, corresponding to F_{max}

minimum stress intensity factor, K_{min}
lowest algebraic value of the stress intensity factor in a cycle, corresponding to F_{min}

NOTE This definition remains the same, regardless of the minimum force being tensile or compressive. For a negative force ratio (R<0) there is an alternate, commonly used definition for the minimum stress intensity factor, $K_{\mathrm{min}} = 0$.

stress intensity factor range, ΔK
algebraic difference between the maximum and minimum stress intensity factors in a cycle

$$\Delta K = K_{\mathrm{max}} - K_{\mathrm{min}}$$

NOTE The force variables ΔK, R and K_{max} are related as follows: $\Delta K = (1-R)K_{\mathrm{max}}$. For a negative force ratio (R<0) there is an alternative, commonly used definition for the stress intensity factor range, $\Delta K = K_{\mathrm{max}}$.

fatigue crack growth threshold, ΔK_{th}
asymptotic value of ΔK for which $\mathrm{d}a/\mathrm{d}N$ approaches zero

NOTE For most materials, the threshold is defined as the stress intensity factor range corresponding to 10^{-8} mm/cycle. When reporting ΔK_{th}, the corresponding lowest decade of $\mathrm{d}a/\mathrm{d}N$ data used in its determination should also be included.

normalized K–gradient

$C = (1/K)\mathrm{d}K/\mathrm{d}a$

fractional rate of change of K with increased crack length, a

$$C = 1/K(\mathrm{d}K/\mathrm{d}a) = 1/K_{\mathrm{max}}(\mathrm{d}K_{\mathrm{max}}/\mathrm{d}a) = 1/K_{\mathrm{min}}(\mathrm{d}K_{\mathrm{min}}/\mathrm{d}a) = 1/\Delta K(\mathrm{d}\Delta K/\mathrm{d}a)$$

K-decreasing test

test in which the value of the normalized K-gradient, C, is negative

NOTE A K-decreasing test is conducted by reducing the stress intensity factor either by continuously shedding or by a series of steps, as the crack grows.

K-increasing test

test in which the value of C is positive

NOTE For standard specimens, a constant force amplitude results in a K-increasing test where the value of C is positive and increasing.

stress intensity factor function, $g(a/W)$

mathematical expression, based on experimental, numerical or analytical results, that relates the stress intensity factor to force and crack length for a specific specimen configuration

Table 46 — Symbols designated in the International Standards, Code 5.07

Symbols	Unit	Designation
Loading		
C	mm^{-1}	Normalized K-gradient
E	MPa	Tensile modulus of elasticity
F	kN	Force
F_{max}	kN	Maximum force
F_{min}	kN	Minimum force
ΔF	kN	Force range
K	$\mathrm{MPa{\cdot}m}^{1/2}$	Stress intensity factor
K_{max}	$\mathrm{MPa{\cdot}m}^{1/2}$	Maximum stress intensity factor
K_{min}	$\mathrm{MPa{\cdot}m}^{1/2}$	Minimum stress intensity factor
ΔK	$\mathrm{MPa{\cdot}m}^{1/2}$	Stress intensity factor range
ΔK_{i}	$\mathrm{MPa{\cdot}m}^{1/2}$	Initial stress intensity factor range
ΔK_{th}	$\mathrm{MPa{\cdot}m}^{1/2}$	Threshold stress intensity factor range
N	1	Number of cycles
R	1	Force ratio or stress ratio
R_{m}	MPa	Ultimate tensile strength at the test temperature
$R_{\mathrm{p0,2}}$	MPa	0,2 % proof strength at the test temperature
Geometry		
a	mm	Crack length or size measured from the reference plane to the crack tip
a_{cor}	mm	Crack front curvature correction length
a_{fat}	mm	Fatigue crack length measured from the notch root

Table 46 (*continued*)

Symbols	Unit	Designation
a_{n}	mm	Machined notch length
a_{p}	mm	Precrack length
B	mm	Specimen thickness
D	mm	Hole diameter for CT, SENT or CCT specimen, loading tup diameter for bend specimens
$g(a/W)$	1	Stress intensity factor function
h	mm	Notch height
W	mm	Specimen width, distance from reference plane to edge of specimen
$(W-a)$	mm	Minimum uncracked ligament
Crack growth		
$\mathrm{d}a/\mathrm{d}N$	mm/cycle	Fatigue crack growth rate
Δa	mm	Change in crack length, crack extension

4 Concordance of Keywords Scope

Certain words or phrases in use in International Standards and appearing in 3.1 to 3.46 of this document are listed in Table 47. The standards in which these keywords appear are identified by the codes included in Table 1.

Table 47 — Concordance of keywords

Keywords	Code Numbers
absorbed energy	4.01
adiabatic heating	1.09
actual absorbed energy	4.01
actual initial potential energy	4.01
amplitude	5.05
anvil	4.01
axial strain	1.09
base	4.01
bending	2.01, 5.01
bending strain	1.09
calibration	1.05
centre of percussion	4.01
centre of strike	4.01
confidence level	5.06
crack arrest displacement	4.04
crack arrest force	4.04
crack extension resistance curves (R-curves)	4.05
crack initiation displacement	4.04
crack initiation energy	4.04

Table 47 (*continued*)

Keywords	Code Numbers
crack initiation force	4.04
crack length	5.07
crack-tip opening displacement	4.05
crack plane orientation	4.03
creep rupture time	1.01
cross-sectional area after rupture	1.01
cycle	5.05, 5.07
dewar	1.09
degree of freedom	5.06
discontinuous yielding strength (R_i)	1.09
displacement at maximum force	4.04
distribution function	5.06
elongation	1.01, 1.03, 1.04, 1.08
energy at maximum force	4.04
estimation	5.06
extension	1.03, 1.04, 1.08
extensometer gauge length	1.01, 1.03, 1.04, 1.08
fatigue life, N_f	5.05
fatigue crack growth rate	5.07
fatigue crack growth threshold	5.07
fatigue strength	5.06
final gauge length	1.03, 1.04, 1.08
final gauge length after rupture	1.01
final reference length	1.01
force range	5.07
force ratio	5.07
gauge length	1.03, 1.04, 1.08, 5.05
general yield displacement	4.04
general yield force	4.04
height	4.01
hysteresis loop	5.05
indicated absorbed energy	4.01
indicated energy	4.01
industrial machine	4.01
initial stress	1.01
J	4.05
J-integral	4.05

Table 47 (*continued*)

Keywords	Code Numbers
K-decreasing test	5.07
K-increasing test	5.07
length	4.01
lower yield strength	1.03, 1.04, 1.08
maximum	5.05
maximum capacity	1.02, 1.05, 1.06
maximum force	1.03, 1.04, 1.08, 4.04, 5.07
maximum stress intensity factor	5.07
mean	5.05
minimum	5.05
minimum force	5.07
minimum stress intensity factor	5.07
multiple machine	1.01
nominal energy	4.01
nominal indicated potential energy	4.01
normalized K–gradient	5.07
original-cross-sectional area	1.01
original gauge length	1.01, 1.03, 1.08
original reference length	1.01
parallel length	1.01, 1.03, 1.04, 1.08
percentage creep elongation	1.01
percentage elongation	1.03, 1.04, 1.08
percentage permanent elongation	1.03, 1.04, 1.08
percentage permanent extension	1.08
percentage elongation after fracture	1.03, 1.04, 1.08
percentage elongation at maximum force	1.04
percentage total elongation at fracture	1.03, 1.04, 1.08
percentage reduction of area	1.03, 1.04, 1.08
percentage elongation after creep rupture	1.01
percentage permanent extension	1.04, 1.08
percentage reduction of area after creep rupture	1.01
percentage yield point extension	1.04
permanent set strength	1.04
plane strain fracture toughness	4.03
plane strain stress intensity factor	4.03
plastic strain ratio	2.14
pop-in	4.05

Table 47 (*continued*)

Keywords	Code Numbers
population	5.06
potential energy	4.01
proof strength, non-proportional extension	1.03, 1.04, 1.08
proof strength, total extension	1.04
random variable	5.06
range	5.05
reference energy	4.01
reference length	1.01
reference machine	4.01
reference test pieces	4.01
sample	5.06
simple machine	1.01
size	5.06
specimen	5.06
stable crack extension	4.05
standard deviation	5.06
strain	5.05
stress	1.03, 1.04, 1.08, 5.05
stress intensity factor	4.05, 5.07
stress intensity factor range	5.07
stress intensity factor function	5.07
stress level	5.06
stress step	5.06
striker	4.01
tensile cryostat	1.09
tensile strength	1.03, 1.04, 1.08
test piece	4.01
total displacement	4.04
upper yield strength	1.03, 1.04, 1.08
unstable crack extension	4.05
width	4.01
yield strength	1.03, 1.04, 1.08

5 Alphabetical listing of symbols

All the symbols listed in Tables 2 to 45 are given in Table 48. They are listed in a coherent alphabetical order against both the Code that identifies the International Standard and (Final) Draft International Standard in which they appear and the designation that they are given in that standard.

Table 48 — Alphabetical listing of all symbols in use

Symbols	Code	Designation
A	1.03, 1.04, 1.08, 1.09	Percentage elongation after fracture: $\frac{L_u - L_o}{L_o} \times 100$
A	5.05	Instantaneous section with $AL = A_o L_o$
A_e	1.04	Percentage yield point extension
A_f	1.01	Percentage creep elongation
A_f	5.05	Minimum area at failure
A_{fu}	1.01	Percentage elongation after creep rupture
A_g	1.04	Percentage non-proportional elongation at maximum force F_m
A_{gt}	1.04	Percentage total elongation at maximum force F_m
A_N	4.01	Nominal initial potential energy; nominal energy
A_P	4.01	Actual initial potential energy, potential energy
$A_p(h_c)$	3.06	Projected area of contact of the indenter at distance h_c from the tip
A_o	5.05	Initial gauge section
A_R	4.01	Reference energy of a set of Charpy reference test pieces
A_S	4.01	Indicated absorbed energy (indicated energy)
$A_s(h)$	3.06	Surface area of the indenter at distance h_c from the tip
A_t	1.03, 1.04, 1.08	Percentage total elongation at fracture
A_t	2.18	Specified total circumferential strain
A_V	4.01	Actual absorbed energy (absorbed energy)
a	1.03	Thickness of a flat test piece or wall thickness of a tube (The symbol T is also used for this parameter in standards for steel tubes)
a	1.04	Thickness of a flat test piece or wall thickness of a tube
a	1.05	Relative resolution of the force indicator of the testing machine
a	1.06	Relative discrimination threshold
a	1.08	Thickness of a flat test piece or wall thickness of a tube
a	2.01	Thickness or diameter of test piece (or diameter of the inscribed circle for pieces of polygonal cross-section)
a	2.02, 2.06, 2.16, 2.17, 2.19, 4.01	Thickness of test piece
a	2.04	Minimum thickness of wire of non-circular section capable of being held between parallel grips
a	2.07, 2.08, 2.09, 2.10, 2.11	Wall thickness of the tube (The symbol T is also used for this parameter in standards for steel tubes)

Table 48 (*continued*)

Symbols	Code	Designation
a	2.18	Measured tube test ring thickness (The symbol T is also used for this parameter in standards for steel tubes)
a	4.03	Crack length
a	4.05	Nominal crack length (for the purposes of fatigue precracking, an assigned value less than a_o)
a	5.04	Thickness of test section of test pieces of rectangular cross-section
a	5.07	Crack length or size measured from the reference plane to the crack tip
a	5.01	Thickness of test section of specimens of rectangular cross-section
a_{cor}	5.07	Crack front curvature correction length
a_f	4.05	Final crack length $(a_o + \Delta a)$
a_{fat}	5.07	Fatigue crack length measured from the notch root
a_i	4.05	Instantaneous crack length
a_m	4.05	Length of machined notch
a_n	5.07	Machined notch length
a_p	5.07	Precrack length
a_o	4.05	Initial crack length
a_3	2.19	Thickness after forming the part
B	4.03, 4.05	Specimen thickness
B	5.01, 5.04	Width of a rectangular cross-section at the gripped ends
B	5.05	Width of gauge section
B	5.07	Specimen thickness
B_N	4.05	Specimen net thickness between side grooves
b	1.01	Width of the cross-section of the parallel length of a test piece of square or rectangular cross-section
b	1.02	Relative reproducibility error with rotation
b	1.03, 1.04	Width of the parallel length of a flat test piece or average width of the longitudinal strip taken from a tube or width of flat wire
b	1.05	Relative repeatability error of the force-measuring system of the testing machine
b	1.06	Relative repeatability error of the testing machine
b	1.08	Width of the parallel length of a flat test piece or average width of the longitudinal strip taken from a tube or width of flat wire
b	2.01, 4.01	Width of test piece
b	2.06	Width or diameter of the test piece
b	2.08	Inside width of flattened test piece
b	2.14	Gauge width of the test piece after straining to a specified elongation
b	5.01	Width of test pieces of rectangular cross-section where the stress is a maximum
b	5.04	The width of a rectangular cross-section where the stress is a maximum
b	5.05	Fatigue strength exponent
b'	1.02	Relative repeatability without rotation
b_o	2.14	Original gauge width of the test piece

Table 48 (*continued*)

Symbols	Code	Designation
C	4.05	Specimen elastic compliance
C	5.07	Normalized K-gradient
C_{IT}	3.06	Indentation creep
c	3.01	Indenter constant relating projected area of the indentation to the square of the length of the long diagonal
c	5.05	Fatigue ductility exponent
d	1.01	Diameter of the cross-section of the parallel length of a cylindrical test piece
D	1.03, 1.04	External diameter of a tube
D	2.01	Diameter of mandrel
D	2.03	Characteristic dimension for non-circular wires
D	2.07, 2.08	Outside diameter of the tube
D	2.09, 2.10, 2.11	Original outside diameter of the tube
d	2.03, 2.04, 2.13	Diameter of a round wire
D	3.02	Diameter of the ball
D	5.01	Diameter of the gripped ends of the test piece if plain, or overall diameter of the threaded ends
D	5.02, 5.04	Diameter of the gripped or loaded end of the test piece
D	5.03	The diameter or width across flats of the gripped ends of the test piece. The value of D may be different for each end of the test piece
D	5.05	External diameter of specimen
d	1.03, 1.04	Diameter of the parallel length of a circular test piece or diameter of round wire or internal diameter of a tube
d	1.06	Discrimination threshold
d	1.08, 1.09	Diameter of the parallel length of a cylindrical test piece or diameter of a circular wire
d	2.18	Measured outside diameter of the tube test ring. The symbol T is also used in steel tube standards
d	3.02	Mean diameter of the indentation $\left(d = \frac{d_1 + d_2}{2}\right)$
d	3.03	Arithmetic mean of the two diagonals of length d_1 and d_2
d	5.05	Diameter of cylindrical gauge section
D	5.07	Hole diameter for CT, SENT or CCT specimen, loading top diameter for bend specimens
d	3.01	Length, in millimetres, of the long diagonal
d	5.01, 5.02, 5.03, 5.04	Diameter of the test piece where the stress is a maximum
$D_{\mathrm{m\ max}}$	2.11	Maximum diameter of the conical mandrel
$D_{\mathrm{m\ min}}$	2.11	Minimum diameter of the conical mandrel
D_{u}	2.09	Maximum outside diameter after testing
D_{u}	2.10	Maximum outside diameter of the flange
D_{u}	2.11	Maximum outside diameter of the expanded part of the test piece

Table 48 (*continued*)

Symbols	Code	Designation
$\mathrm{d}a/\mathrm{d}N$	5.07	Fatigue crack growth rate
d_b	2.16	Diameter of the circular blank
d_g	2.04	Diameter of guide hole
d_1	1.06	Discrimination threshold corresponding to 20 % of the maximum force range (F_N)
d_1	2.06	Diameter of the spherical end of the punch
d_1	2.16	Diameter of punch
d_1, d_2	3.02	Indentation diameters measured at 90°
d_2	2.06	Bore diameter of the die
d_2	2.16	Inside diameter of die
d_3	2.06	Bore diameter of the blank holder
d_4	2.06	Outside diameter of the die
d_5	2.06	Outside diameter of the blank holder
E	1.04	Modulus of elasticity
E	4.03	Young's modulus
E	4.05	Modulus of elasticity at the pertinent temperature
E	5.05	Modulus of elasticity, in gigapascals (GPa)
E	5.07	Tensile modulus of elasticity
E_C	5.05	Modulus for unloading following a peak compression stress, in gigapascals (GPa)
E_IT	3.06	Indentation modules
E_max	1.07	Maximum limit of calibration range
E_min	1.07	Minimum limit of calibration range
E_T	5.05	Modulus for unloading following a peak tensile stress, in gigapascals (GPa)
E_1	4.01	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position
E_2	4.01	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
E_3	4.01	Indicated energy or angle of rise after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
e_1	2.17, 2.19	Major strain
e_2	2.17	Minor strain (90° to major)
e_2	2.19	Minor strain, 90° to the direction of major strain
e_3	2.19	Thickness strain
F	1.05	True force indicated by the force-proving instrument with increasing test force
F	1.06	True load indicated by the force proving instrument
F	2.15	Instantaneous force applied to test piece
F	3.01, 3.02 3.03, 3.06	Test force
F	3.04	Total test force

Table 48 (*continued*)

Symbols	Code	Designation
F	4.01	Force exerted by the pendulum when measured at a distance of l_2
F	4.03, 4.05	Applied force
F	4.04, 5.07	Force
FA	4.01	Shear-fracture appearance
F_a	4.04	Crack arrest force
$F_{a\ max}$	5.04	Maximum force amplitude of the machine (=1/2 F_R max.)
F_c	1.05	True force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range which is used
F_c	4.05	Applied force at the onset of unstable crack extension or pop-in when a is less than 0,2 mm offset from the construction line
F_f	1.02	Maximum capacity of the transducer
F_f	4.05	Maximum fatigue precracking force
F_{gy}	4.04	General yield force
F_{ic}	1.05	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range which is used
F_{io}	1.05	Residual indication of the force indicator of the testing machine to be verified after removal of force
F_{iu}	4.04	Crack initiation force
$F_{i\ max}$, $F_{i\ min}$ F_{max}, F_{min}	1.05	Highest or lowest value of F_i or F for the same discrete force
F_i	1.06	Load applied by the testing machine to be verified — for deadweight machines: $F_i = mg$ — for lever-type machines: $F_i = mgR$ — for jockey weight machines, the value of F_i is indicated on the scale of the machine
FLC	2.17, 2.19	Forming-Limit Curve
FLD	2.17, 2.19	Forming-limit diagram
F_m	1.03, 1.04, 1.08, 1.09, 4.04	Maximum force
F_M	1.06	Force exerted by the masses on the scale pan of the machine
F_m	5.04	The mean force
$F_{m\ max}$	5.04	The maximum mean force of the machine
F_{max}	1.05	Highest value of F for the same discrete force
F_{max}	1.06	Highest value of F for the same discrete load
F_{max}	3.06	Maximum test force
F_{max}	5.04	The maximum force of the machine
F_{max}	5.07	Maximum force
F_{min}	1.05, 1.06	Lowest value of F for the same discrete load
F_{min}	5.07	Minimum force

Table 48 (*continued*)

Symbols	Code	Designation
F_N	1.02	Maximum capacity of the measuring range
F_N	1.05	Maximum capacity of the measuring range of the force indicator of the testing machine
F_N	1.06	Maximum capacity of the load range of the testing machine
F_Q	4.03	Particular value of F
F_R	5.04	The dynamic force range
$F_{R\,max}$	5.04	The maximum dynamic force range of the machine
F_v	1.06	Lower limit of the verified load range
F_0	3.04	Preliminary test force
F_1	3.04	Additional test force
F_5	4.03	Particular value of F
$\overline{F}$	1.06	Arithmetic mean of several measurements of F_i for the same discrete load
$\overline{F}_i$, $\overline{F}$	1.05	Arithmetic mean of several measurements of F_i for the same discrete force
F'	1.05	True force indicated by the force-proving instrument with decreasing test force
F_i'	1.05	Force indicated by the force indicator of the testing machine to be verified, with increasing test force
f_c	1.02	Relative interpolation error
f_g	4.05	Output frequency limit
f_o	1.02	Relative zero error
f_o	1.05	Relative zero error of the force-measuring system of the testing machine
$g(a/W)$	5.07	Stress intensity factor function
g_n	1.05	Local acceleration due to gravity
g_n	4.04	Acceleration due to gravity
H	2.08	Distance between platens measured under load
HBW	3.02	Brinell hardness = $\text{constant} \times \dfrac{\text{Test force}}{\text{Surface area of indentation}}$ $= 0{,}102 \times \dfrac{2F}{\pi D\left(D\right) - \sqrt{D^2 - d^2}}$
H_{IT}	3.06	Indentation hardness
HK	3.01	Knoop hardness = $\dfrac{\text{Test force}}{\text{Projected area of indentation}}$ $= 0{,}102 \times \dfrac{F}{d^2 \cdot c} = 0{,}102 \times \dfrac{F}{0{,}070\ 28\ d^2} = 1{,}451 \dfrac{F}{d^2}$
HM	3.06	Martens hardness
HM_s	3.06	Martens hardness determined from the slope of the increasing force/indentation depth curve
HRA	3.04	Rockwell hardness = $100 - \dfrac{h}{0{,}002}$

Table 48 (*continued*)

Symbols	Code	Designation
HRB	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRC	3.04	Rockwell hardness = $100 - \frac{h}{0{,}002}$
HRD	3.04	Rockwell hardness = $100 - \frac{h}{0{,}002}$
HRE	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRF	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRG	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRH	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRK	3.04	Rockwell hardness = $130 - \frac{h}{0{,}002}$
HRN	3.04	Rockwell hardness = $100 - \frac{h}{0{,}001}$
HRT	3.04	Rockwell hardness = $100 - \frac{h}{0{,}001}$
HV	3.03	$\text{Vickers hardness} = \text{constant} \times \frac{\text{Test force}}{\text{Surface area of indentation}}$ $= 0{,}102 \frac{2F \sin \frac{136^\circ}{2}}{d^2} \approx 0{,}189\,1 \frac{F}{d^2}$
h	2.02, 2.04	Distance from top tangential plane of cylindrical supports to the bottom face of the guide
h	2.06	Depth of the cup during the test
h	3.02	Depth of indentation: $\frac{D - \sqrt{D^2 - d^2}}{2}$
h	3.04	Permanent increase in depth of indentation under preliminary test force after removal of additional test force (permanent indentation depth)
h	3.06	Indentation depth under applied test force
h	4.01	Height of fall of the pendulum
h	4.04	Height of fall of the centre of strike of the pendulum (see ISO 148-2)
h	5.07	Notch height
h	4.01	Height of test piece
h_c	3.06	Depth of the contact of the indenter with the test piece at F_{max}
h_{max}	3.06	Maximum indentation depth at F_{max}
h_p	3.06	Permanent indentation depth after removal of the test force

Table 48 (*continued*)

Symbols	Code	Designation
h_r	3.06	Point of intersection of the tangent to curve b at F_{max} with the indentation depth-axis
h_t	2.16	Distance between outside bottom of cup to any ear peak
$h_{t\ max}$	2.16	Maximum value of h_t
h_{emax}	2.16	Maximum ear height
h_v	2.16	Distance between outside bottom of cup to any ear valley
$h_{v\ min}$	2.16	Minimum value of h_v
$\bar{h}_e$	2.16	Mean ear height
$\bar{h}_t$	2.16	Mean value of h_t
$\bar{h}_v$	2.16	Mean value of h_v
h_1	2.06	Height of the inside rounded part of the die
h_1	4.01	Height of rise of the pendulum
IE	2.06	Erichsen cupping index
i_f	1.02	Reading on the indicator after removal of force
i_o	1.02	Reading on the indicator before application of force
J	4.05	Experimental equivalent to the J-integral
$J_{0,2BL}$	4.05	Size-insensitive fracture resistance J at 0,2 mm stable crack extension offset from the construction line
$\delta_{0,2BL(B)}$	4.05	Size-sensitive fracture resistance δ at 0,2 mm stable crack extension offset from construction line (B = specimen thickness in mm)
$J_{c(B)}$	4.05	Size-sensitive fracture resistance J at onset of unstable crack extension or pop-in when stable crack extension is less than 0,2 mm offset from the construction line (B = specimen thickness in mm)
J_g	4.05	J at upper limit of J-controlled crack extension
J_i	4.05	Fracture J at initiation of stable crack extension
J_{max}	4.05	Limit of J-R material behaviour defined by this method of test
$J_{m(B)}$	4.05	Size-sensitive fracture resistance J at the first attainment of a maximum force plateau for fully plastic behaviour (B = specimen thickness in mm) Size-sensitive fracture resistance J at the first attainment of a maximum force plateau for fully plastic behaviour (B = pecimen thickness in mm)
J_o	4.05	J uncorrected for stable crack extension
$J_{u(B)}$	4.05	Size-sensitive fracture resistance J at the onset of unstable crack extension or pop-in when the event is preceded by stable crack extension equal to or greater than 0,2 mm offset from the construction line (B = specimen thickness in mm)
$J_{uc(B)}$	4.05	Size-sensitive fracture resistance J at the onset of unstable crack extension or pop-in when stable crack extension cannot be measured (B = specimen thickness in mm)
K	2.11	Length of the taper of the conical mandrel
K	2.15	Strength coefficient
K	4.05, 5.07	Stress intensity factor
K	5.05	Monotonic strength coefficient

Table 48 (*continued*)

Symbols	Code	Designation
k	1.03, 1.04	Coefficient of proportionality
KU	4.01	Energy absorbed, in joules
K_f	4.03	Maximum stress intensity factor during the final stage of fatigue cracking
K_f	4.05	Maximum value of K during the final stages of fatigue precracking
K_I	4.03	Opening mode stress intensity factor (mode I)
K_{min}	5.07	Minimum stress intensity factor
K_{max}	5.07	Maximum stress intensity factor
K_{Ic}	4.03	Critical value of K_I (plane strain fracture toughness)
K_{Ic}	4.05	Plane strain fracture toughness
K_Q	4.03, 4.05	Provisional value of K_{Ic}
KV	4.04	Absorbed energy as defined in ISO 148-1
KU_2	4.01	Absorbed energy for a U-notch test piece using an 2 mm striker
KU_8	4.01	Absorbed energy for a U-notch test piece using an 8 mm striker
KV_2	4.01	Absorbed energy for a V-notch test piece using a 2 mm striker
K'	5.05	Cyclic strength coefficient
L	2.01	Length of test piece
L	2.03	Free length between grips
L	2.07, 2.09 2.10, 2.11	Length of test piece before the test
L	2.08	Length of the test piece
L	2.13	Free length between grips
L	2.14	Gauge length after straining to a specified elongation
L	2.15	Instantaneous length of measurement base, $L = L_e + \Delta L$
L	4.01	Distance between supports
L	5.05	Instantaneous gauge length
l	5.04	The total length of the electrical resistance strain (ERS) gauges used, i.e. the length of the gauge backing material
LE	4.01	Lateral expansion
L_c	1.01, 1.03, 1.04, 1.08, 1.09, 5.01	Parallel length
L_c	5.03, 5.04	The parallel length of the test piece
L_e	1.01, 1.03, 1.04, 1.08, 1.09, 2.15	Extensometer gauge length
L_e	1.07	Nominal value of gauge length of extensometer
L_o	1.01, 1.03, 1.04, 1.08, 1.09, 2.14	Original gauge length

Table 48 (*continued*)

Symbols	Code	Designation
L_o	5.05	Initial gauge length
L_r	1.01	Reference length
L_r	5.05	Length of reduced section
L_{ro}	1.01	Original reference length
L_{ru}	1.01	Final reference length
l_t	1.07	True displacement given by the calibration apparatus
L_t	1.03, 1.04	Total length of test piece
L_t	5.05	Total length of specimen
L_u	1.01	Final gauge length after rupture
L_u	1.03, 1.08, 1.09	Final gauge length after fracture
L_u	1.04	Final gauge length
L'_e	1.07	Measured value of gauge length of extensometer
L'_o	1.04	Initial gauge length for determination of A_g
L'_u	1.04	Final gauge length after fracture for determination of A_g
l	2.01	Distance between supports
l	4.01	Distance to centre of test piece (centre of striker) from the axis of rotation (length of pendulum)
l	4.01	Length of test piece
l	2.18	Length of tube test ring
l_i	1.07	Displacement indicated by the extensometer
l_0	2.17, 2.19	Original gauge length of grid pattern
l_1	2.17, 2.19	Final length in major strain direction
l_1	4.01	Distance to the centre of percussion from the axis of rotation
l_2	2.17	Final length at 90˚ to major strain direction
l_2	2.19	Final length at 90˚ to the direction of major strain
l_2	4.01	Distance to the point of application of the force F from the axis of rotation
M	4.01	The moment equal to the product Fl_2
m	4.04	Effective mass of the pendulum corresponding to its effective weight (see ISO 148-2)
N	2.15	Number of measurements made in determining tensile strain hardening exponent
N	3.04	Number specific to the scale
N	5.01	Number of cycles applied at any stage during the test
N	5.07	Number of cycles
n	2.15	Strain hardening exponent
n	2.19	Strain hardening exponent (n value)
n	5.05	Monotonic strain hardening exponent
n'	5.05	Cyclic strain hardening exponent

Table 48 (*continued*)

Symbols	Code	Designation
N_b	2.02, 2.04	Number of reverse bends
N_f	5.01	Number of stress cycles to failure in specified condition
N_f	5.05	Number of cycles to failure
N_t	2.03	Number of turns
N_t	2.13	Number of turns in one direction
P	2.18	Hydrostatic pressure to produce the specified total circumstantial strain
p	4.01	Energy loss caused by pointer friction
P'	4.01	Energy loss caused by bearing friction and air resistance
P_β	4.01	Correction of energy losses for an angle of swing β
q	1.05	Relative accuracy error of the force-measuring system of the testing machine
q	1.06	Relative accuracy error of the testing machine
q	1.07	Relative bias error of the extensometer
q	4.05	Load-point displacement
q_{Le}	1.07	Relative gauge length error
r	1.01	Transition radius
R	1.06	Lever ratio used for the verification
R	2.10	Corner radius of the flanging tool
R	4.03	Ratio of minimum to maximum fatigue cracking force during any single cycle of fatigue operation
R	5.01	Algebraic ratio of the minimum stress to the maximum stress in one cycle, $R = \frac{\sigma_{min}}{\sigma_{max}}$
r	5.03	The transition blending radius at the ends of the test section which starts the transition from the test diameter d to the end diameter D, or the single radius between the gripped ends
r	5.04	The transition radius from the parallel length to the gripped ends
R	5.07	Force ratio or stress ratio
R_a	2.16	Surface roughness parameter: arithmetic mean deviation of profile
R_{At}	2.18	Hoop strength at the specified total strain
R_{eH}	1.03, 1.04, 1.08,	Upper yield strength
R_{eL}	1.03, 1.04, 1.08	Lower yield strength
R_i	1.09	Discontinuous yielding strength
R_{IT}	3.06	Relaxation
R_ε	5.05	Strain ratio(= $\varepsilon_{min}/\varepsilon_{max}$)
R_σ	5.05	Stress ratio(= $\sigma_{min}/\sigma_{max}$)
R_m	1.03, 1.04, 1.08 1.09	Tensile strength
R_m	4.05	Ultimate tensile strength perpendicular to crack plane at the test temperature
R_m	5.07	Ultimate tensile strength at the test temperature

Table 48 (*continued*)

Symbols	Code	Designation
R_p	1.03, 1.04, 1.08	Proof strength, non-proportional extension
$R_{p0,2}$	1.09	0,2 % proof strength, non-proportional extension
$R_{p0,2}$	4.03	0,2 % offset proof strength
$R_{p0,2}$	4.05	0,2 % offset yield strength perpendicular to crack plane at the test temperature
$R_{p0,2}$	5.05	0,2 % proof stress
$R_{p0,2}$	5.07	0,2 % proof strength at the test temperature
R_r	1.04	Permanent set strength
R_t	1.04	Proof strength, total extension
R_z	5.05	Mean surface roughness, in micrometres (µm)
R_1	2.16	Corner radius of punch
R_1	2.06	Outside corner radius of the die, outside corner radius of the blank holder
R_2	2.06, 2.16	Inside corner radius of the die
r	3.06	Radius of spherical indenter
r	1.02	Resolution of the indicator
r	1.05	Resolution of the force indicator of the testing machine
r	1.07	Resolution of the extensometer
r	2.01	Internal radius of bend portion of test piece after bending
r	2.02, 2.04	Radius of cylindrical supports
r	2.07	Inside radius at the bottom of the groove
r	2.14	Plastic strain ratio
r	5.01	Radius at the ends of the test section which starts the transition from the test diameter d or test width b to the diameter or width of the gripped ends; or the continuous radius between the gripped ends of the specimen
r	5.02	Radius at the ends of the test section which starts the transition from the test diameter d
r	5.05	Transition radius (from parallel length into the grip end of the test specimen)
r_m, $\overline{r}$	2.14	Weighted average of $r_{x/y}$ values
r_m	2.19	Plastic strain ratio, weighted average
$r_{x/y}$	2.14	Plastic strain ratio in x-direction (in degrees) relative to the rolling direction at a strain level of y %
S	2.15	Cross-sectional area of parallel-sided section of test piece under action of force F, $S = S_o\left(\frac{L_e}{L}\right)$
S	3.04	Scale unit, specific to the scale
S	4.03	Span between outer loading points
S	4.05	Span between outer loading points in a three-point bend test
S_o	1.01, 1.03, 1.04, 1.08, 1.09	Original cross-sectional area of the parallel length
S_o	2.15	Original cross-sectional area of parallel-sided section of test piece
S_u	1.01	Minimum cross-sectional area after rupture

Table 48 (*continued*)

Symbols	Code	Designation
S_u	1.03, 1.04, 1.09	Minimum cross-sectional area after fracture
S_u	1.08	Minimum cross-sectional area after fracture (final cross-sectional area)
s	4.04	Displacement
s_a	4.04	Crack arrest displacement
s_{gy}	4.04	General yield displacement
s_{iu}	4.04	Crack initiation displacement s_{iu}
s_m	4.04	Displacement at maximum force
s_t	4.04	Total displacement
T	1.01	Specified temperature
T	4.01	Total time for 100 swings of the pendulum
T	4.05	Test temperature
T_1	4.01	Transition temperature
T_i	1.01	Indicated temperature
T_{max}	4.01	Maximum value of T
T_{min}	4.01	Minimum value of T
t	4.01	Period of the pendulum
t	5.05	Thickness
t	4.04	Time
t_o	4.04	Time at the beginning of deformation of the test piece
t_r	4.04	Signal rise timet_r
t_u	1.01	Creep rupture time
t_f	5.05	time to failure (= N_f cycles), in seconds (s)
U	4.05	Area under plot of force F versus specimen load-point displacement q at the load-line
U_e	4.05	Elastic component of U
U_p	4.05	Plastic component of U
V	4.03, 4.05	Notch opening displacement
V_e	4.05	Elastic component of V
V_p	4.05	Plastic component of V
v	1.02	Relative reversibility error of the force proving instrument
v	1.05	Relative reversibility error of the force-measuring system of the testing machine
v	4.05	Poisson's ratio
v_t	4.04	Striker impact velocity at time t
v_o	4.04	Initial striker impact velocity
W	4.01	Weight of the pendulum
W	4.03, 4.05	Width for bend specimen or effective width for compact specimen
W	4.05	Width of test specimen
W	5.05	Width of grip end

Table 48 (*continued*)

Symbols	Code	Designation
W	5.07	Specimen width, distance from reference plane to edge of specimen
W_a	4.04	Crack arrest energy
W_{iu}	4.04	Crack initiation energy
W_m	4.04	Energy at maximum force
W_t	4.04	Total impact energy
W_{elast}	3.06	Elastic reverse deformation work of indentation
W_{total}	3.06	Total mechanical work of indentation
w	4.01	Width of test piece
$(W - a)$	5.07	Minimum uncracked ligament
X	1.02	Deflection with increasing test force
X'	1.02	Deflection with decreasing test force
X_a	1.02	Computed value of deflection
X_{max}	1.02	Maximum deflection
X_{min}	1.02	Minimum deflection
X_N	1.02	Deflection corresponding to the maximum capacity
$\overline{X_r}$	1.02	Average value of the deflections with rotation
$\overline{X_{wr}}$	1.02	Average value of the deflections without rotation
y	2.02	Distance from a plane defined by the axis of cylindrical supports and the nearest point of contact with the test piece
y	2.04	Distance from a plane, defined by the axes of the cylindrical supports, to the nearest point of contact with the test piece
Z	1.03, 1.04, 1.08, 1.09	Percentage reduction of area: $\frac{S_o - S_u}{S_o} \times 100$
Z	2.16	Ear height expressed as a percentage
z	4.05	For bend and straight-notch compact specimens, the initial distance of the notch opening gauge measurement position from the notched edge of the specimen, either further from the crack tip or closer to the crack tip (–z); or, for a stepped-notch compact specimen, the initial distance of the notch opening gauge measurement position either beyond (+z) or before (–z) the initial load-line.
Z_u	1.01	Percentage reduction of area after creep rupture
α	2.01, 2.07	Angle of the bend
α	2.15	Gradient of line ln σ versus ln ε
α	3.03	Angle between the opposite faces at the vertex of the pyramidal indenter (136°)
α	3.06	Angle, specific to the shape of the pyramidal indenter
α	4.01	Angle of fall of the pendulum
β	4.01	Angle of rise of the pendulum
β	2.09, 2.10	Angle of the conical mandrel
β_1	4.01	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position

Table 48 (*continued*)

Symbols	Code	Designation
β_2	4.01	Indicated energy or angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
β_3	4.01	Indicated energy or angle of rise after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
Δ	5.05	Range of a parameter
$\Delta\sigma$	5.01	$\sigma_{max} - \sigma_{min}$
Δa	4.05	Stable crack extension including blunting
Δa	5.07	Change in crack length, crack extension
Δa_{max}	4.05	Crack extension limit for δ or J controlled crack extension
ΔF	5.07	Force range
ΔK	5.07	Stress intensity factor range
ΔK_i	5.07	Initial stress intensity factor range
ΔK_I	4.03	Difference between maximum and minimum values of K_I during any single cycle of fatigue operation
ΔK_{th}	5.07	Threshold stress intensity factor range
ΔL	2.15	Instantaneous elongation of measurement base
ΔL_m	1.04	Extension at maximum force
ΔL_{rt}	1.01	Increase in the reference length between a moment t and the zero moment
Δr	2.14	Degree of planar anisotropy
δ	4.05	Crack-tip opening displacement (CTOD)
$\delta_{c(B)}$	4.05	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when stable crack extension is less than 0,2 mm crack offset from the construction line (B = specimen thickness in mm)
δ_g	4.05	δ at the limit of δ-controlled crack extension
δ_i	4.05	Fracture resistance δ at initiation of stable crack extension
$\delta_{m(B)}$	4.05	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when stable crack extension is less than 0,2 mm crack offset from the construction line (B = specimen thickness in mm)
δ_{max}	4.05	Limit of δ-R defined by this method of test
$\delta_{u(B)}$	4.05	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when the vent is preceded by stable crack extension equal to or greater than 0,2 mm offset from the construction line (B = specimen thickness in mm)
$\delta_{uc(B)}$	4.05	Size-sensitive fracture resistance δ at the onset of unstable crack extension or pop-in when stable crack extension cannot be measured (B = specimen thickness in mm)
δ_o	4.05	δ uncorrected for stable crack extension
$\delta_{0,2BL}$	4.05	Size-insensitive fracture resistance δ at 0,2 mm crack extension offset from construction line (B = specimen thickness in mm)
$\delta_{0,2BL(B)}$	4.05	Size-sensitive fracture resistance δ at 0,2 mm stable crack extension offset from construction line (B = specimen thickness in mm)
ε	2.15	True strain in test piece under action of force F, $\varepsilon = \ln\left(\frac{L}{L_e}\right)$

Table 48 (*continued*)

Symbols	Code	Designation
ε	5.05	True strain
$\dot{\varepsilon}$	5.05	Strain rate, in seconds to the power of minus one (s^{-1}).
ε_a	2.14	True thickness strain
ε_b	2.14	True width strain
ε_φ	5.05	Fatigue ductility coefficient
η_{it}	3.06	Relation W_{elast}/W_{total}
θ	1.03	Fixed temperature
θ	1.08	Specified temperature
θ_i	1.03	Indicated temperature
θ_i	1.08	Indicated temperature
ρ_{air}	1.05	Density of air
ρ_m	1.05	Density of the dead weights
σ	2.15	True stress in test piece under action of force F, $\sigma = F\left(\frac{L}{L_e S_o}\right)$
σ_D	5.01	The value of the stress amplitude below which a specimen would be expected to endure an infinite number of stress cycles with a stated probability
σ	5.05	True stress, in megapascals (MPa);
σ_a	5.01	Variable component of stress. It is one-half of the algebraic difference between the maximum stress and the minimum stress ($\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2}$)
σ_m	5.01	Static component of the stress. It is one-half of the algebraic sum of the maximum stress and minimum stress ($\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$)
σ_{min}	5.01	The lowest algebraic value of stress in the stress cycle
σ_{max}	5.01	The highest algebraic value of stress in the stress cycle
σ_N	5.01	Value of the stress amplitude at a stated stress ratio under which the specimen would have a life of N cycles
σ_o	1.01	Initial stress
σ'_y	5.05	Cyclic yield strength
σ_φ	5.05	Fatigue ductility coefficient
$0{,}102 \times F/D^2$	3.02	Force-diameter ratio

Annex A
Index

This index lists the designation codes identified in Clause 2 by ascending numerical order of International Standards which are the responsibility of Technical Committee 164, *Mechanical testing of metals.*

* There are no symbols or definitions in the text of the standard.

International Standards

ISO 12106:2003	5.05
ISO 12107:2003	5.06
ISO 12108:2002	5.07
ISO 12135:2002	4.05
ISO 12737:2005	4.03
ISO/TR 14396:1988	2.19
ISO 14556:2000	4.04
ISO 14577-1:2002	3.06
*ISO 14577-2:2002	3.06
*ISO 14577-3:2002	3.06
ISO 15363:2000	2.18
ISO 15363:2000	2.18
ISO 15579:2000	1.08
*ISO 18265:2003	3.07
ISO 19819:2004	1.09
ISO 20482:2003	2.06

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