INTERNATIONAL STANDARD

ISO 6208

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Nickel and nickel alloy plate, sheet and strip

Plaques, tôles et bandes en nickel et alliages de nickel

Reference number
ISO 6208:1992(E)

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.

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.

International Standard ISO 6208 was prepared by Technical Committee ISO/TC 155, *Nickel and nickel alloys*, Sub-Committee SC 2, *Wrought and cast nickel and nickel alloys*.

Annex A of this International Standard is for information only.

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Nickel and nickel alloy plate, sheet and strip

1 Scope

This International Standard specifies requirements for hot-rolled or cold-rolled nickel and nickel alloy plate, sheet and strip, for general applications in the following size ranges:

— plate over 4 mm up to and including 100 mm;

— sheet up to and including 4 mm;

— strip up to and including 4 mm.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/R 204:1961, *Non-interrupted creep testing of steel at elevated temperatures.*

ISO/R 206:1961, *Creep stress rupture testing of steel at elevated temperatures.*

ISO 6372-1:1989, *Nickel and nickel alloys — Terms and definitions — Part 1: Materials.*

ISO 6372-3:1989, *Nickel and nickel alloys — Terms and definitions — Part 3: Wrought products and castings.*

ISO 6507-1:1982, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100.*

ISO 6508:1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K).*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO/TR 7003:1990, *Unified format for the designation of metals.*

ISO/TR 9721:—[1], *Nickel and nickel alloys — Code of designation based on chemical symbols (To be published as an ISO/TR type 2).*

ISO 9722:1992, *Nickel and nickel alloys — Composition and forms of wrought products.*

ASTM E 112:1988, *Standard methods for determining the average grain size.*

3 Definitions

For the purposes of this International Standard, the definitions for nickel and nickel alloys in ISO 6372-1 and for plate, sheet and strip in ISO 6372-3 apply.

3.1 heat: The product of a furnace melt or a number of melts that are mixed prior to casting.

3.2 lot: Plate, sheet or strip of the same thickness, from the same heat, heat treated together or sequentially heat treated in a continuous furnace, but in no case for longer than 16 h of production.

4 Alloy identification

For the purposes of this International Standard, the principles for alloy identification in ISO/TR 7003 and in ISO/TR 9721 apply.

1) To be published.

5 Ordering information

Orders for plate, sheet or strip according to this International Standard shall include the following information:

5.1 The number of this International Standard.

5.2 Quantity (mass or number of pieces).

5.3 Alloy identification (see table 1).

NOTE 1 For alloy identification either the number or the description may be used.

5.4 Alloy temper (see tables 2 and 3).

NOTE 2 Precipitation-hardenable alloys are normally ordered in the non-precipitation-hardened condition.

5.5 Dimensions: thickness, width, and length (or coil dimensions in the case of strip).

5.6 Edges (see 6.7.6).

5.7 Optional requirements:

a) tensile properties of strain-hardened conditions (see table 2, footnote 4);

b) samples for product analysis (see 7.1.2);

c) determination of 1 % proof stress ($R_{p1,0}$) (see 9.2.4);

d) purchaser or third-party inspection (see clause 11);

e) declaration of conformity (see clause 12).

6 Requirements

Plate, sheet, and strip shall meet the following requirements.

6.1 Composition

Heat analysis shall meet the composition limits specified in table 1.

The composition limits do not preclude the possible presence of other elements that are not specified. If the purchaser's requirements necessitate limits for any other element that is not specified, these shall be agreed upon between the purchaser and the supplier. The percentage content of elements shown as "remainder" shall be calculated by difference from 100 %.

6.2 Tensile properties

Plate, sheet and strip shall have the tensile properties specified in table 2.

6.3 Hardness

Plate, sheet and strip shall meet the hardness requirements specified in table 2.

The type of hardness test shall be at the option of the supplier.

6.4 Grain size

Plate, sheet and strip shall meet the grain size requirements specified in table 2.

6.5 Creep or stress rupture

Plate, sheet and strip shall meet the creep or stress rupture requirements specified in table 4.

6.6 Surface quality

Plate, sheet and strip shall be clean and free from detrimental surface imperfections.

NOTE 3 Where appropriate, the acceptance criteria should be agreed upon by the purchaser and the supplier.

6.7 Dimensional tolerances

6.7.1 Thickness

The tolerance on thickness shall be as specified in tables 5 to 8. For use with table 5, hot-rolled plate shall be assumed to possess the density shown in table 1.

6.7.2 Width and length

6.7.2.1 The tolerance on width and length of hot-rolled plate shall be as specified in table 9.

6.7.2.2 For hot-rolled sheet, cold-rolled plate and cold-rolled sheet ordered in specific cut lengths, a tolerance of $^{+4}_{0}$ mm over the specified length is permitted.

6.7.2.3 For cold-rolled strip ordered in specific cut lengths, a tolerance of $^{+4}_{0}$ mm over the specified length is permitted.

For the width of cold-rolled strip, the tolerances specified in table 10 apply.

6.7.3 Straightness (edgewise curvature)

The edgewise curvature (depth of chord) of plate and sheet shall not exceed 5 mm multiplied by the length in metres.

NOTE 4 The edgewise curvature for strip should be agreed upon by the purchaser and the supplier.

6.7.4 Flatness

The flatness tolerance for hot-rolled plate shall be as specified in table 11.

6.7.5 Squareness

The adjacent sides of hot-rolled and cold-rolled sheet and cold-rolled plate shall be square within 3 mm in 1 000 mm.

6.7.6 Edges

Material shall have edges as specified in the order. When no description of any required form of edge is given, the practice of the supplier shall apply.

7 Sampling

7.1 Chemical analysis

7.1.1 Representative heat analysis samples shall be taken during pouring or subsequent processing.

7.1.2 Product analysis samples shall be taken from the finished product.

7.2 Tensile and creep or stress rupture tests

Tensile and creep or stress rupture test samples shall be taken from material in the final heat-treated condition, and tested transverse to the direction of rolling where the width permits this.

8 Number of tests

8.1 Chemical analysis, one test per heat.

8.2 Tensile test, one test per lot.

8.3 Creep or stress rupture test, one test per lot.

8.4 Hardness test, one test per lot.

8.5 Grain size determination, one test per lot.

9 Test procedures

9.1 Chemical analysis

9.1.1 The method of chemical analysis shall be at the option of the supplier, however in cases of dispute the method specified in the relevant International Standard shall be used.

If no International Standard exists, an analytical method that can be calibrated to a reference standard agreed upon by the purchaser and the supplier shall be used.

9.1.2 For a list of ISO analytical standards, see annex A.

9.2 Tensile testing

9.2.1 Testing shall be carried out in accordance with ISO 6892.

9.2.2 Test pieces to be used for sheet and strip between 0,1 mm and 3 mm thick shall be in accordance with annex B of ISO 6892:1984.

9.2.3 Test pieces to be used for plate, sheet and strip which is 3 mm or greater thick shall be in accordance with annex D of ISO 6892:1984.

9.2.4 The offset method shall be used for the determination of proof stress. An offset of 0,2 % ($R_{p0,2}$) shall be standard. However, a 1 % proof stress ($R_{p1,0}$) shall be determined and reported for information when requested by the purchaser.

9.3 Creep and stress rupture testing

9.3.1 Creep testing shall be carried out in accordance with ISO/R 204, except that only the final total plastic strain need be reported.

9.3.2 Stress rupture testing shall be carried out in accordance with ISO/R 206.

9.4 Hardness testing

9.4.1 Vickers hardness

Testing shall be carried out in accordance with ISO 6507-1.

9.4.2 Rockwell hardness

Testing shall be carried out in accordance with ISO 6508.

9.5 Grain size determination

A transverse sample representative of the full thickness shall be examined in accordance with ASTM E 112.

9.6 Rounding-off

For the purpose of determining compliance with the specified limits of the properties listed below, an observed or calculated value shall be rounded as follows

When the figure immediately after the last figure to be retained is lower than 5, the last figure to be retained remains unchanged.

When the figure immediately after the last figure to be retained is 5 or greater, the last figure to be retained is increased by one.

Composition, creep, grain size, hardness, and dimensions	Nearest unit to the last right-hand place of figures of the specified limit
Tensile strength R_m)	Nearest 10 N/mm ^{2}
0,2 % -Proof stress ($R_{p0,2}$)	Nearest 5 N/mm ^{2}
Elongation (A)	Nearest 1 %

9.7 Retests

If any one of the test pieces first selected fails to pass the specified tests, two further samples from the same lot shall be selected for testing, one of which shall be from the original product tested, unless that product has been withdrawn by the supplier. If the test pieces from both these additional samples pass the tests, the lot represented by the test samples shall be deemed to comply with the requirements of this International Standard. If the test pieces from either of these additional samples fail, the lot represented by these samples shall be deemed not to comply with the requirements of this International Standard.

10 Marking

Each piece of plate and sheet and each coil of strip shall be marked in at least one place with the number of this International Standard, the alloy identification (either the number or the description), the heat number and the manufacturer's name.

11 Purchaser and third party inspection

On-site inspection of plate, sheet and strip shall be in accordance with the agreement made between the purchaser and the supplier as part of the purchase contract.

12 Declaration of conformity

When requested by the purchaser in the contract or order, the supplier shall certify that the plate, sheet and strip were manufactured and tested in accordance with this International Standard. The declaration of conformitiy shall detail the results of all tests required by this International Standard and the order.

Table 1 — Composition and density of wrought nickel and nickel alloys (taken from ISO 9722)

Alloy identification[1)]		Composition, % (m/m)[2)]																Density[3)]
Number	Description	Al	B	C	Co[4)]	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	W	Others[5)]	g/cm³
NW2200	Ni99,0			0,15			0,2	0,4	0,3		99,0		0,010	0,3				8,9
NW2201	Ni99,0-LC			0,02			0,2	0,4	0,3		99,0		0,010	0,3				8,9
NW7263	NiCo20Cr20Mo5Ti2Al	0,3 0,6	0,005	0,04 0,08	19,0 21,0	19,0 21,0	0,2	0,7	0,6	5,6 6,1	Remainder		0,007	0,4	1,9 2,4		Ag: 0,0005(5) Bi: 0,0001(1) Pb: 0,0020(20) Ti + Al: 2,4 to 2,8	8,4
NW7090	NiCr20Co18Ti3	1,0 2,0	0,020	0,13	15,0 21,0	18,0 21,0	0,2	1,5	1,0		Remainder		0,015	1,0	2,0 3,0		Zr: 0,15	8,2
NW6617	NiCr22Co12Mo9	0,8 1,5	0,006	0,05 0,15	10,0 15,0	20,0 24,0	0,5	3,0	1,0	8,0 10,0	Remainder		0,015	1,0	0,6			8,4
NW7750	NiCr15Fe7Ti2Al	0,4 1,0		0,08		14,0 17,0	0,5	5,0 9,0	1,0		70,0		0,015	0,5	2,2 2,8		Nb + Ta: 0,7 to 1,2	8,3
NW6600	NiCr15Fe8			0,15		14,0 17,0	0,5	6,0 10,0	1,0		72,0		0,015	0,5				8,4
NW6602	NiCr15Fe8-LC			0,02		14,0 17,0	0,5	6,0 10,0	1,0		72,0		0,015	0,5				8,4
NW7718	NiCr19Fe19Nb5Mo3	0,2 0,8	0,006	0,08		17,0 21,0	0,3	Remainder	0,4	2,8 3,3	50,0 55,0	0,015	0,015	0,4	0,6 1,2		Nb + Ta: 4,7 to 5,5	8,0
NW6002	NiCr21Fe18Mo9		0,010	0,05 0,15	0,5 2,5	20,5 23,0		17,0 20,0	1,0	8,0 10,0	Remainder	0,040	0,030	1,0		0,2 1,0		8,2
NW6007	NiCr22Fe20Mo6Cu2Nb			0,05	2,5	21,0 23,5	1,5 2,5	18,0 21,0	1,0 2,0	5,5 7,5	Remainder	0,040	0,030	1,0			Nb + Ta: 1,7 to 2,5	8,3
NW6985	NiCr22Fe20Mo7Cu2			0,015	5,0	21,0 23,5	1,5 2,5	18,0 21,0	1,0	6,0 8,0	Remainder	0,040	0,030	1,0		1,5	Nb + Ta: 0,5	8,3
NW6601	NiCr23Fe15Al	1,0 1,7		0,10		21,0 25,0	1,0	Remainder	1,0		58,0 63,0		0,015	0,5				8,0
NW6633	NiCr26Fe20Co3Mo3W3			0,10	2,5 4,0	24,0 27,0		Remainder	2,0	2,5 4,0	44,0 48,0	0,030	0,030	1,5		2,5 4,0		
NW6690	NiCr29Fe9			0,05		27,0 31,0	0,5	7,0 11,0	0,5		Remainder		0,015	0,5				8,2
NW6455	NiCr16Mo16Ti			0,015	2,0	14,0 18,0		3,0	1,0	14,0 17,0	Remainder	0,040	0,030	0,08	0,7			8,6
NW6022	NiCr21Mo13Fe4W3			0,015	2,5	20,0 22,5		2,0 6,0	0,5	12,5 14,5	Remainder	0,025	0,020	0,08		2,5 3,5	V: 0,35	8,7
NW6625	NiCr22Mo9Nb	0,40		0,10	1,0	20,0 23,0		5,0	0,50	8,0 10,0	58,0	0,015	0,015	0,50	0,40		Nb + Ta: 3,15 to 4,15	8,5

Alloy identification[1]		Composition, % (*m/m*)[2]																Density[3]
Number	Description	Al	B	C	Co[4]	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	W	Others[5]	g/cm³
NW6621	NiCr20Ti			0,08 0,15	5,0	18,0 21,0	0,5	5,0	1,0		Remainder		0,020	1,0	0,20 0,60		Pb: 0,0050(50)	8,4
NW7080	NiCr20Ti2Al	1,0 1,8	0,008	0,04 0,10	2,0	18,0 21,0	0,2	1,5	1,0		Remainder		0,015	1,0	1,8 2,7		Ag: 0,0005(5) Bi: 0,0001(1) Pb: 0,0020(20)	8,2
NW4400	NiCu30			0,30			28,0 34,0	2,5	2,0		63,0		0,025	0,5				8,8
NW4402	NiCu30-LC			0,04			28,0 34,0	2,5	2,0		63,0		0,025	0,5				8,8
MW5500	NiCu30Al3Ti	2,2 3,2		0,25			27,0 34,0	2,0	1,5		Remainder	0,020	0,015	0,5	0,35 0,85			8,5
NW8825	NiFe30Cr21Mo3	0,2		0,05		19,5 23,5	1,5 3,0	Remainder	1,0	2,5 3,5	38,0 46,0		0,015	0,5	0,6 1,2			8,1
NW0276	NiMo16Cr15Fe6W4			0,010	2,5	14,5 16,5		4,0 7,0	1,0	15,0 17,0	Remainder	0,040	0,030	0,08		3,0 4,5		8,9
NW0665	NiMo28			0,02	1,0	1,0		2,0	1,0	26,0 30,0	Remainder	0,040	0,030	0,1				9,2
NW0001	NiMo30Fe5			0,05	2,5	1,0		4,0 6,0	1,0	26,0 30,0	Remainder	0,040	0,030	1,0			V: 0,2 to 0,4	9,2
NW8028	FeNi31Cr27Mo4Cu1			0,030		26,0 28,0	0,6 1,4	Remainder	2,5	3,0 4,0	30,0 34,0	0,030	0,030	1,0				8,0
NW8800	FeNi32Cr21AlTi	0,15 0,60		0,10		19,0 23,0	0,7	Remainder	1,5		30,0 35,0		0,015	1,0	0,15 0,60			8,0
NW8810	FeNi32Cr21AlTi-HC	0,15 0,60		0,05 0,10		19,0 23,0	0,7	Remainder	1,5		30,0 35,0		0,015	1,0	0,15 0,60			8,0
NW8811	FeNi32Cr21AlTi-HT	0,15 0,60		0,06 0,10		19,0 23,0	0,7	Remainder	1,5		30,0 35,0		0,015	1,0	0,15 0,60		Al + Ti: 0,85 to 1,2	8,0
NW8801	FeNi32Cr20Ti			0,10		19,0 22,0	0,5	Remainder	1,5		30,0 34,0		0,015	1,0	0,7 1,5			8,0
NW8020	FeNi35Cr20Cu4Mo2			0,07		19,0 21,0	3,0 4,0	Remainder	2,0	2,0 3,0	32,0 38,0	0,040	0,030	1,0			Nb + Ta: 8 × C to 1,0	8,1

1) For alloy identification either the number or the description may be used.

2) Single values are maximum limits, except for nickel where single values are minimum.

3) Density values are average values and are given for information only.

4) Where no limits are specified, cobalt up to a maximum of 1,5 % is allowed and counted as nickel. In this case, an indication of cobalt content is not required.

5) Values for Ag, Bi and Pb may be expressed in mass percentage [% (*m/m*)] or in parts per million (ppm).

Table 2 — Tensile properties, hardness and grain size

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm²	N/mm²	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW2200	Ni99,0	Annealed	— 1,5	1,5 —	380 380	105 105	35 40	— —	— —	— —	— —
		Hot-rolled as rolled[4]	1,5	—	380	130	30	—	—	—	—
		Cold-rolled, hard[5] Cold-rolled, half-hard[5]	1,5 1,5	— —	620 490	480 290	2 20	188 to 215 147 to 170	90 to 95 79 to 85	— —	— —
		Cold-rolled, deep drawing quality strip	— 0,25 0,5	0,25 0,5 3,0	— — —	— — —	— — —	max. 125 max. 122 max. 115	max. 70 max. 68 max. 64	7,5 6 4	max. 0,027 max. 0,045 max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25 0,5	0,5 —	— —	— —	— —	max. 122 max. 115	max. 68 max. 64	6 4	max. 0,045 max. 0,09
NW2201	Ni99,0-LC	Annealed	— 1,5	1,5 —	350 350	85 85	35 40	— —	— —	— —	— —
		Hot-rolled, as rolled[4]	1,5	—	350	85	30	—	—	—	—
		Cold-rolled, deep drawing quality strip	— 0,25 0,5	0,25 0,5 3,0	— — —	— — —	— — —	max. 117 max. 115 max. 113	max. 66 max. 64 max. 63	7,5 6 4	max. 0,027 max. 0,045 max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25 0,5	0,5 —	— —	— —	— —	max. 115 max. 113	max. 64 max. 63	6 4	max. 0,045 max. 0,09
NW7263	NiCo20Cr20Mo5Ti2Al	Solution treated	— 6	6 —	6)	6)	6)	max. 250 max. 250	— —	— —	— —
		Solution and precipitation treated	—	—	540[7]	400[7]	9[7]		—	—	—
NW7090	NiCr20Co18Ti3	Solution treated	—	—	6)	6)	6)	max. 250	—	—	—
		Solution and precipitation treated	0,3 0,5	0,5 —	1 080 1 080	— 695	15 25	— —	— —	— —	— —

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm²	N/mm²	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW6617	NiCr22Co12Mo9	Annealed	All		650	240	35	—	—	—	—
NW7750	NiCr15Fe7Ti2Al	Hot-rolled, solution treated	All		[6]	[6]	[6]	—	—	—	—
		Hot-rolled, solution and precipitation treated	4	25	1 100	720	18	—	—	—	—
		Cold-rolled, solution treated	All		[6]	[6]	[6]	—	—	—	—
		Cold-rolled solution and precipitation treated	0,1 0,4	0,4	1 100 1 170	790	18	—	—	—	—
NW6600	NiCr15Fe8	Annealed	All		550	240	30	—	—	—	—
		Hot-rolled, as rolled[4]	All		580	240	30	—	—	—	—
		Cold-rolled, hard[5] Cold-rolled, half-hard[5]	All All		860 —	620 —	2 —	min. 248 200 to 228	min. 23 HRC 93 to 98	— —	— —
		Cold-rolled, deep drawing quality strip	— 0,25 0,5	0,25 0,5 3,0	— — —	— — —	— — —	max. 179 max. 170 max. 170	max. 88 max. 85 max. 85	7,5 6 4	max. 0,027 max. 0,045 max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25 0,5	0,5 —	— —	— —	— —	max. 170 max. 170	max. 85 max. 85	6 4	max. 0,045 max. 0,09
NW6602	NiCr15Fe8-LC	Annealed	All		550	180	30	—	—	—	—
NW7718	NiCr19Fe19Nb5Mo3	Solution treated	All		[6]	[6]	[6]	—	—	—	—
		Solution and precipitation treated	— 25	25 57	1 240 1 240	1 035 1 035	12 10	— —	— —	— —	— —
NW6002	NiCr21Fe18Mo9	Annealed	— 4	4 —	690 660	275 240	35 35	— —	— —	— —	— —
NW6007	NiCr22Fe20Mo6Cu2Nb	Annealed	— 4 19	4 19 —	620 620 580	240 240 205	40 35 30	— — —	— — —	— — —	— — —

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm2	N/mm2	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW6985	NiCr22Fe20Mo7Cu2	Annealed[5]	0,5 19	19 —	620 585	240 205	45 35	— —	max. 100 max. 100	— —	— —
NW6601	NiCr23Fe15Al	Annealed	All		550	205	30	—	—	—	—
NW6333	NiCr26Fe20Co3Mo3W3	Annealed	All		550	240	30	—	75 to 95	—	—
NW6690	NiCr29Fe	Annealed	All		590	240	30	—	—	—	—
NW6455	NiCr16MO16Ti	Annealed	All		690	275	40	—	—	—	—
NW6022	NiCr21Mo14W3	Annealed	All		690	310	45	—	—	—	—
NW6625	NiCr22Mo9Nb	Hot-rolled, annealed	All		760	380	30	—	—	—	—
		Cold-rolled, annealed	All		830	415	30	—	—	—	—
		Solution treated	All		690	275	30	—	—	—	—
NW6621	NiCr20Ti	Annealed	0,3 0,5	0,5 —	640 640	230 230	25 30	— —	— —	— —	— —
NW7080	NiCr20Ti2Al	Cold-worked, solution treated			6)	6)	6)				
		Cold-worked, solution and precipitation treated	0,3 0,5	0,5 —	1 030 1 030	— 640	15 25	— —	— —	— —	— —
		Hot-worked, solution treated	—	—	6)	6)	—	max. 250	—	—	—
		Hot-worked, solution and precipitation treated	— —	— —	1 000	620	20	—	—	— —	—

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm²	N/mm²	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW4400	NiCu30	Annealed	All		480	195	35	—	—	—	—
		Hot-rolled, as rolled[4]	All		510	275	25	—	—	—	—
		Cold-rolled, hard[5]	All		680	620	2	203 to 234	93 to 98	—	—
		Cold-rolled, half-hard[4], [5]	All		550	300	25	157 to 188	82 to 90	—	—
		Cold-rolled, deep drawing quality strip	—	0,25	—	—	—	max. 140	max. 76	7,5	max. 0,027
			0,25	0,5	—	—	—	max. 140	max. 76	6	max. 0,045
			0,5	3,0	—	—	—	max. 140	max. 76	4	max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25	0,5	—	—	—	max. 140	max. 76	6	max. 0,045
			0,5	—	—	—	—	max. 140	max. 76	4	max. 0,09
NW4402	NiCu30-LC	Annealed	All		430	160	35	—	—	—	—
NW5500	NiCu30Al3Ti	Solution treated	All		6)	6)	6)	max. 200	—	—	—
		Hot-rolled	All		6)	6)	6)	max. 270	—	—	—
		Solution and precipitation treated	All		900	620	15	—	—	—	—
		Hot-rolled, precipitation treated	All		970	690	15	—	—	—	—
NW8825	NiFe30Cr21Mo3	Annealed	All		590	240	30	—	—	—	—
		Cold-rolled, deep drawing quality strip	—	0,25	—	—	—	max. 210	max. 94	7,5	max. 0,027
			0,25	0,5	—	—	—	max. 210	max. 94	6	max. 0,045
			0,5	3,0	—	—	—	max. 210	max. 94	4	max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25	0,5	—	—	—	max. 210	max. 94	6	max. 0,045
			0,5	—	—	—	—	max. 210	max. 94	4	max. 0,09

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm²	N/mm²	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW0276	NiMo16Cr15W4	Annealed	All		690	275	40	—	—	—	—
NW0665	NiMo28	Annealed	All		750	350	40				—
NW0001	NiMo30Fe5	Annealed	— 4	4 —	790 690	345 315	45 40	— —	— —	— —	— —
NW8028	FeNi31Cr27Mo3,5Cu1	Cold-rolled, solution treated	All		500	215	40	—	70 to 90	—	—
NW8800	FeNi32Cr21AlTi	Cold-rolled, as rolled	All		550	240	25	—	—	—	—
		Annealed	All		520	205	30	—	—	—	—
		Cold-rolled, deep drawing quality strip	— 0,25 0,5	0,25 0,5 3,0	— — —	— — —	— — —	max. 179 max. 170 max. 170	max. 88 max. 85 max. 85	7,5 6 4	max. 0,027 max. 0,045 max. 0,09
		Cold-rolled, deep drawing quality sheet	0,25 0,5	0,5 —	— —	— —	— —	max. 170 max. 170	max. 85 max. 85	6 4	max. 0,045 max. 0,09
NW8810	FeNi32Cr21AlTi-HC	Hot-rolled, solution treated	All		450	170	30	—	—	5	min. 0,06
		Cold-rolled, solution treated	All		450	170	30	—	—	5	min.0,06

Alloy identification[1]		Temper	Thickness mm		Tensile strength $R_{m,\ min.}$	0,2 %-Proof stress[2] $R_{p0,2,\ min.}$	Elongation[3] $A_{5,\ min.}/A_{50,\ min.}$	Hardness		Grain size	
Number	Description		over	up to and including	N/mm2	N/mm2	%	Vickers	Rockwell	Corresponding ASTM No.	Average grain diameter mm
NW8811	FeNi32Cr21AlTi-HT	Hot-rolled, solution treated	All		450	170	30	—	—	5	min. 0,06
		Cold-rolled, solution treated	All		450	170	30	—	—	5	min. 0,06
NW8801	FeNi32Cr20Ti	Annealed	All		450	170	30	—	—	—	—
NW8020	FeNi35Cr20Cu4Mo2	Annealed	All		590	275	30	—	—	—	—

1) For alloy identification either the number or the description may be used.

2) Proof stress is not applicable to thicknesses less than 0,5 mm.

3) Elongation is not applicable to thicknesses less than 0,25 mm.

The elongation values listed are based on either

— a proportional gauge length $5{,}65\sqrt{S_0} \cong A_5$, where S_0 is the original cross-sectional area, or

— a fixed gauge length of 50 mm $\cong A_{50}$.

4) As-rolled plate may be given a stress-relieving heat treatment subsequent to final rolling.

5) Acceptance is based on either tensile properties or hardness, but not both. A hardness test will be conducted for acceptance, unless tensile properties instead of hardness are specified.

6) The supplier shall demonstrate that the material will meet the fully heat-treated properties after precipitation treatment in accordance with table 3.

7) Products are supplied solution-treated. The minimum tensile properties specified are to be determined on a solution treated plus aged sample tested at 780 °C. The elongation shall be measured on a gauge length of 25 mm.

Table 3 — Heat-treatment of precipitation hardenable alloys

Alloy identification[1]		Solution treatment[2]	Precipitation heat treatment applied to test samples[3]
Number	Description		
NW7263	NiCo20Cr20Mo5Ti2Al	1 150 °C, air cool or faster.	800 °C, 8 h, air cool.
NW7090	NiCr20Co18Ti3	1 080 °C to 1 150 °C, air cool or faster.	750 ° C, 4 h, air cool. Alternatively, 700 °C, 16 h,air cool.
NW7750	NiCr15Fe7Ti2Al	980 °C to 1 100 °C, air cool or faster.	730 °C, 8 h, cool at 55 °C/h to 620 °C, hold at 620 °C for 8 h, air cool. Alternatively, cool to 620 °C at any rate and hold at 620 °C to give a total precipitation treatment time of 18 h.
NW7718	NiCr19Nb5Mo3	940 °C to 1 060 °C, air cool or faster.	720 °C, 8 h, cool at 55 °C/h to 620 °C, hold at 620 °C for 8 h, air cool. Alternatively, cool to 620 °C at any rate and hold at 620 °C to give a total precipitation treatment time of 18 h.
NW7080	NiCr20Ti2Al	1 080 °C to 1 150 °C, air cool or faster.	750 °C, 4 h, air cool. Alternatively, 700 °C, 16 h, air cool.
NW5500	NiCu30Al3Ti	870 °C min., rapid cool.	590 °C to 610 °C, 8 h to 16 h, furnace cool to 480 °C, at between 8 °C/h and 14 °C/h, air cool. Alternatively, furnace cool to 535 °C, hold at 535 °C for 6 h, furnace cool to 480 °C, hold for 8 h, air cool.

1) For alloy identification either the number or the description may be used.

2) The selected temperature shall be controlled within $\pm$ 15 °C.

3) The heat treatment of both products and test samples of precipitation hardenable alloys shall be stated on the declaration of conformity.

Table 4 — Creep or stress rupture test requirements

Alloy identification[1)]		Thickness	Temperature	Stress	Minimum time to rupture	Minimum elongation at rupture on 50 mm	Duration	Maximum total plastic strain	Condition of test sample
Number	Description	mm	°C	N/mm²	h	%	h	%	
NW7263	NiCo20Cr20Mo5Ti2Al	0,4 to 6	780	116	—	—	50	0,10	Precipitation treated as in table 3
		over 6	780	120	—	—	50	0,10	
NW7718	NiCr19Nb5Mo3	0,4 to 0,6	650	655[2)]	23	4	—	—	Precipitation treated as in table 3
		over 0,6	650	690[2)]	23	4	—	—	

1) For alloy identification either the number or the description may be used.

2) An initially higher stress may be used but shall not be changed while the test is in progress. Specified time to rupture and elongation requirements shall be met. Alternatively, stress may be increased after the minimum rupture life has been met at the specified stress. However, the specified minimum elongation shall be met.

Table 5 — Tolerance on thickness and overweight of hot-rolled plates

Values in millimetres

Thickness mm		Permissible excess, in average weight per square millimetre, of rectangular plates for widths in millimetres, expressed in percentage of nominal weights[1), 2)]						
over	up to and including	up to and including 1 200	over 1 200 up to and including 1 500	over 1 500 up to and including 2 000	over 2 000 up to and including 2 500	over 2 500 up to and including 3 000	over 3 000 up to and including 3 500	over 3 500 up to and including 4 000
4	8	9,0	10,5	12,0	15,0	16,5	—	—
8	10	7,5	9,0	10,5	13,5	15,0	18,0	—
10	15	7,0	7,5	9,0	12,0	13,5	16,5	19,5
15	20	4,5	5,5	6,0	7,5	9,0	12,0	15,0
20	25	4,0	4,5	5,5	7,0	7,5	10,5	13,5
25	50	4,0	4,0	4,5	6,0	7,0	9,0	12,0

NOTE — All plates shall be ordered according to thickness and not to weight per square millimetre. No plates shall be more than 0,3 mm under the thickness ordered, and the overweight of each lot in each shipment shall not exceed the amount given in this table. Spot grinding is permitted to remove surface imperfections and the spots should not exceed 0,3 mm under the specified thickness.

The term "lot" applied to this table means all of the plates of each group width and thickness.

1) The permissible overweight for lots of circular and irregularly shaped plates shall be 25 % greater than the amounts given in this table.

2) The weight of individual plates shall not exceed the nominal weight by more than 1,25 times the amount given in the table and footnote 1.

Table 6 — Tolerance on thickness for rectangular hot-rolled plates over 50 mm thick

Values in millimetres

Specified thickness	Tolerance on specified thickness for widths			
	up to and including 1 200	over 1 200 up to and including 1 500	over 1 500 up to and including 2 000	over 2 000 up to and including 2 500	over 2 500
Over 50 up to and including 100	+ 2,0 − 0,3	+ 2,4 − 0,3	+ 2,8 − 0,3	+ 3,2 − 0,3	+ 3,6 − 0,3

Table 7 — Tolerance on thickness of hot-rolled sheet

Values in millimetres

Thickness		Tolerance on thickness
over	up to and including	(for widths[1] up to and including 1 200 mm)
2,0	2,5	± 0,20
2,5	3,0	± 0,25
3,0	4,0	± 0,30

1) Measured 10 mm or more from either edge, except for widths under 25 mm which are measured anywhere.

Table 8 — Tolerance on thickness of cold-rolled strip, sheet and plate

Values in millimetres

Thickness		Thickness tolerance for widths	
over	up to and including	up to and including 300[1]	over 300
0,10	0,15	± 10 % of thickness	—
0,15	0,25	± 0,03	—
0,25	0,40	± 0,04	± 0,05
0,40	0,70	± 0,05	± 0,07
0,70	1,0	± 0,06	± 0,10
1,0	1,6	± 0,08	± 0,12
1,6	2,5	± 0,10	± 0,17
2,5	4,0	± 0,15	± 0,25
4,0	5,0	± 0,30	± 0,40
5,0	7,0	± 0,40	± 0,50

1) Measured 10 mm or more from either edge, except for widths under 25 mm which are measured anywhere.

Table 9 — Tolerance on width and length of sheared, plasma torch-cut, and abrasive-cut rectangular hot-rolled plate

Values in millimetres

Type	Thickness		Tolerance on width or length for widths or lengths given													
			up to and including 1 000		over 1 000 up to and including 2 000		over 2 000 up to and including 3 000		over 3 000 up to and including 6 000		over 6 000 up to and including 9 000		over 9 000 up to and including 12 000		over 12 000	
	over	up to and including	plus	minus	plus	minus	plus	minus	plus	minus	plus	minus	plus	minus	plus	minus
Sheared[1)]	4	7	5	4	7	4	10	4	15	4	15	4	20	4	—	—
	7	10	7	4	10	4	15	4	15	4	15	4	20	4	25	4
	10	20	10	4	15	4	15	4	20	4	20	4	25	4	35	4
	20	25	15	4	15	4	15	4	25	4	25	4	30	4	40	4
	25	30	15	4	20	4	20	4	25	4	30	4	35	4	—	—
Abrasive-cut[2)]	5	30	4	4	4	4	4	4	4	4	6	6	6	6	—	—
	30	70	5	4	5	4	5	4	5	4	7	6	7	6	—	—
Plasma torch-cut[3)]	4	75	15	0	15	0	15	0	15	0	15	0	15	0	15	0

1) The minimum sheared width or length is 250 mm for material 20 mm and under in thickness, and 500 mm for material over 20 mm in thickness.

2) Abrasive-cut and applicable to a minimum width or length dimension of 500 mm to 1 000 mm, depending on thickness, and a maximum dimension of 3 650 mm to 10 000 mm, depending on thickness and width ordered.

3) The tolerance spread shown for plasma-torch cutting may all be obtained on the minus side, or divided between the plus and minus sides if specified by the purchaser.

Table 10 — Tolerance on width for cold-rolled strip

Values in millimetres

Thickness		Width tolerance for widths				
over	up to and including	from 5 up to and including 100	over 100 up to and including 200	over 200 up to and including 300	over 300 up to and including 500	over 500 up to and including 1 000
0,1	1,0	± 0,1	± 0,15	± 0,2	± 0,5	± 1
1,0	2,0	± 0,2	± 0,25	± 0,5	± 1,0	± 2
2,0	2,5	± 0,25	± 0,3	± 0,5	± 1,0	± 2
2,5	3,0	± 0,3	± 0,5	± 1,0	± 1,5	± 3
3,0	4,0	± 0,3	± 0,5	± 1,5	± 2	± 3

Table 11 — Flatness tolerance for rectangular, circular, or irregularly shaped hot-rolled plates

Values in millimetres

Thickness		Flatness tolerance for widths						
over	up to and including	up to and including 1 200	over 1 200 up to and including 1 500	over 1 500 up to and including 2 000	over 2 000 up to and including 2 500	over 2 500 up to and including 3 000	over 3 000 up to and including 3 500	over 3 500 up to and including —
4	7	20	27	32	35	42	—	—
7	10	18	20	24	29	37	48	—
10	15	13	15	18	20	29	35	45
15	20	13	15	16	16	29	29	35
20	25	13	15	16	16	24	26	29
25	50	13	15	15	15	18	20	26
50	100	7	8	10	12	15	20	23

NOTES

1 The tolerances shall apply to plates up to 3 500 mm in length, or to any 3 500 mm of longer plates.

2 If the longer dimension is under 900 mm, the tolerance shall be 7 mm.

3 The shorter dimension specified is considered the width, and the flatness tolerance across the width shall not exceed the values of that dimension given in this table.

4 The maximum deviation from a flat surface does not customarily exceed the tolerance for the longer dimension specified in this table.

Annex A
(informative)

List of ISO methods of analysis

[1] ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method.*

[2] ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method.*

[3] ISO 7524:1985, *Nickel, ferronickel and nickel alloys — Determination of carbon content — Infra-red absorption method after induction furnace combustion.*

[4] ISO 7525:1985, *Nickel — Determination of sulfur content — Methylene blue molecular absorption spectrometric method after generation of hydrogen sulfide.*

[5] ISO 7526:1985, *Nickel, ferronickel and nickel alloys — Determination of sulfur content — Infra-red absorption method after induction furnace combustion.*

[6] ISO 7527:1985, *Nickel, ferronickel and nickel alloys — Determination of sulfur content — Iodimetric titration method after induction furnace combustion.*

[7] ISO 7528:1989, *Nickel alloys — Determination of iron content — Titrimetric method with potassium dichromate.*

[8] ISO 7529:1989, *Nickel alloys — Determination of chromium content — Potentiometric titration method with ammonium iron(II) sulfate.*

[9] ISO 7530-1:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: General requirements and sample dissolution.*

[10] ISO 7530-2:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 2: Determination of cobalt content.*

[11] ISO 7530-3:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 3: Determination of chromium content.*

[12] ISO 7530-4:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 4: Determination of copper content.*

[13] ISO 7530-5:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 5: Determination of iron content.*

[14] ISO 7530-6:1990, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 6: Determination of manganese content.*

[15] ISO 7530-7:—[2], *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 7: Determination of aluminium content.*

[16] ISO 7530-8:—[2], *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 8: Determination of silicon content.*

[17] ISO 7530-9:—[2], *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 9: Determination of vanadium content.*

[18] ISO 9388:—[2], *Nickel alloys — Determination of phosphorus content — Molybdenum blue molecular absorption spectrometric method.*

[19] ISO 9389:1989, *Nickel alloys — Determination of cobalt content — Potentiometric titration method with potassium hexacyanoferrate(III).*

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