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British Standard Specification for

Nickel and nickel alloys: sheet and plate

Spécification du nickel et des alliages de nickel: feuilles et tôles

Spezifikation für Nickel und Nickellegierungen: Blech und Grobblech

BSI
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Foreword

This British Standard has been prepared under the direction of the Non-ferrous Metals Standards Policy Committee.

It incorporates Amendment No. 1 issued in 1984, together with further changes. This edition of BS 3072 replaces BS 3072 : 1983 which is withdrawn. It is one of a series for nickel and nickel alloys in various forms intended for engineering purposes. Others in the series are:

BS 3071 Specification for nickel-copper alloy castings
BS 3073 Specification for nickel and nickel alloys: strip
BS 3074 Specification for nickel and nickel alloys: seamless tube
BS 3075 Specification for nickel and nickel alloys: wire
BS 3076 Specification for nickel and nickel alloys: bar

When the standard was revised in 1983 all the alloys included in the previous edition were retained, and the same designations were used throughout the series for wrought nickel and nickel alloys. One additional nickel chromium molybdenum niobium alloy (NA 21) was included.

At the same time significant changes were made to dimensional tolerances that were included in certain foreign standards and had found support in discussions in the International Organization for Standardization (ISO) for inclusion in ISO standards, and provision was made for testing material to alternative proof stress criteria.

This edition introduces technical changes to bring the standard up-to-date but it does not reflect a full review of the standard, which will be undertaken in due course.

In this edition provision is made for the supply of material to comply with a minimum proof stress requirement at one or more specified elevated temperatures, when requested by the purchaser. Additional proof stress requirements at room temperature and at elevated temperatures have been introduced for alloy NA 21.

It is recommended that the results of elevated temperature tests together with information on the product dimensions, the room temperature tensile properties and the chemical composition of the material, should be sent to:

Secretariat of NFM/10
British Standards Institution
3 York Street
Manchester M2 2AT

so that, for future revisions of this standard, minimum elevated temperature proof stress values can be derived from a continuously updated data bank.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

British Standard Specification for

Nickel and nickel alloys: sheet and plate

Section one. General requirements

1. Scope

This British Standard specifies requirements for nickel and nickel alloys in the form of sheet and plate of the following thicknesses:

(a) sheet: over 0.25 mm up to and including 4 mm;

(b) plate: over 4 mm.

Details of information to be supplied by the purchaser are given in appendix A.

NOTE 1. Appendix B gives information on the heat treatment of NA 18. Proof stress properties of cold worked and annealed and hot worked and annealed nickel alloy sheet and plate at elevated temperatures are given in appendix C. Appendix D gives the cross-references between the alloy designations in this standard and UNS designations.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Definitions

For the purposes of this British Standard the following definitions apply.

2.1 sheet. A flat rolled product of rectangular section up to and including 4 mm in thickness.

2.2 plate. A flat rolled product of rectangular section over 4 mm in thickness.

2.3 cast. The product of a furnace melt or a number of melts that are mixed prior to casting.

2.4 batch. Sheet or plate of the same thickness from the same cast, produced in the same way and heat treated together or, in the case of continuous heat treatment, from a run of not more than 8 h.

2.5 annealing. A heat treatment of alloys for the purpose of softening.

2.6 solution treatment. The heat treatment of alloys at a suitable temperature for sufficient time to ensure adequate solution of a certain phase (or phases) followed by cooling at a suitable rate to ensure retention of the phase (or phases) in solution. The term is also associated with material in the softest condition.

2.7 precipitation treatment. The heat treatment of alloys to promote precipitation to produce optimum creep, or stress rupture and/or tensile characteristics. It may be accompanied by a change in hardness.

3. Information to be supplied by the purchaser

The purchaser shall state all his requirements, including any special purchase requirements, at the time of order (see appendix A).

NOTE. This standard provides for a choice from a number of alloys available in a range of sizes of sheet and plate.

4. Freedom from defects

Sheet and plate shall be clean, smooth and free from harmful defects.

5. Selection of samples for chemical analysis

The chemical composition of each cast of material shall be determined on a sample which shall be representative of the cast.

6. Dimensional and weight tolerances

6.1 Thickness and overweight

6.1.1 *Sheet.* The thickness of cold or hot rolled sheet shall not differ from the ordered thickness at any point by more than the appropriate tolerance given in tables 1 and 2.

Table 1. Tolerances on thickness of cold rolled sheet

(a) **NA 11, NA 12 and NA 13**

Thickness		Tolerance (plus and minus)	
Over	Up to and including	Up to and including 1000 mm wide	Over 1000 mm up to and including 1200 mm wide
mm	mm	mm	mm
0.25	0.70	0.05	0.05
0.70	1.0	0.07	0.07
1.0	1.6	0.08	0.09
1.6	2.5	0.10	0.11
2.5	4.0	0.13	0.15

(b) **NA 14, NA 15, NA 15(H), NA 16, NA 17, NA 18 and NA 21**

Thickness		Tolerance (plus and minus)	
Over	Up to and including	Up to and including 1000 mm wide	Over 1000 mm up to and including 1200 mm wide
mm	mm	mm	mm
0.25	0.70	0.05	0.05
0.70	1.0	0.07	0.07
1.0	1.6	0.09	0.10
1.6	2.5	0.11	0.12
2.5	4.0	0.14	0.15

6.1.2 *Plate.* The thickness of hot rolled plate shall be not more than 0.3 mm less than the ordered thickness at any one point.

If surface imperfections are removed by local grinding hot rolled plates, the depth of the ground areas shall be not more than 0.3 mm less than the ordered thickness.

Table 2. Tolerances on thickness of hot rolled sheet

Thickness		Tolerance (plus and minus)	
Over	Up to and including	Up to and including 1200 mm wide	Over 1200 mm wide
mm	mm	mm	mm
2.0	2.5	0.20	0.30
2.5	3.0	0.25	0.35
3.0	4.0	0.30	0.40

6.1.3 *Overweight of plates.* The overweight of any batch of plates over the theoretical weight shall be not greater than the percentage given in table 3. The theoretical weight shall be calculated as the product of the ordered thickness, width, length, and density of the relevant alloy given in table 6. The overweight of any individual plate in a batch shall be not more than 1.25 times the amount, expressed as a percentage, given in table 3.

6.2 Width and length

6.2.1 *Cold rolled sheet.* The width and length of cold rolled sheet shall not differ from that ordered by more than $^{+3}_{-0}$ mm.

6.2.2 *Hot rolled sheet and plate.* The width and length of hot rolled sheet and plate shall not differ from that ordered by more than the appropriate tolerance given in table 4.

Table 3. Tolerances on overweight of hot rolled plate

Thickness		Percentage excess in average weight of plates for widths						
From	Up to but excluding	Up to 1200 mm wide	Over 1200 mm to 1500 mm wide	Over 1500 mm to 2000 mm wide	Over 2000 mm to 2500 mm wide	Over 2500 mm to 3000 mm wide	Over 3000 mm to 3500 mm wide	Over 3500 mm to 4000 mm wide
mm	mm	%	%	%	%	%	%	%
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

Table 4. Tolerances on width and length of sheared, plasma torch-cut, and abrasive-cut hot rolled sheet and plate

Ordered thickness		Tolerances on width and length													
From	Up to but excluding	Up to 1000 mm		Over 1000 mm to 2000 mm		Over 2000 mm to 3000 mm		Over 3000 mm to 6000 mm		Over 6000 mm to 9000 mm		Over 9000 mm to 12 000 mm		Over 12 000 mm	
Sheared		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
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															
5 mm up to and including 30 mm		4	4	4	4	4	4	4	4	6	6	6	6	-	-
Over 30 mm up to and including 70 mm		5	4	5	4	5	4	5	4	7	6	7	6	-	-
Plasma torch-cut															
Over 4 mm up to and including 75 mm		15	0	15	0	15	0	15	0	15	0	15	0	15	0

6.3 Flatness of hot rolled sheet or plate. The variations from a flat surface measured across the width of a hot rolled sheet or plate shall not exceed the relevant values given in table 5, where the width is the smaller dimension.

For hot rolled sheet or plate less than 900 mm long, the deviation from flatness shall not exceed 7 mm.

7. Selection of samples for mechanical test

Sheets or plates shall be grouped into batches. One test sample shall be cut to provide one tensile and/or one grain size and/or hardness test piece from each batch. When tensile tests at elevated temperatures are to be carried out, one test sample shall be cut from each batch, of sufficient length to provide a tensile test piece for each test temperature.

Before test samples are cut they shall be marked to identify them with the batch they represent. Test samples shall be taken from material as supplied and, except in certain cases for alloy NA 18, they shall be tested in that condition.

When alloy NA 18 is supplied in other than the finally heat treated condition the hardness shall be determined on material in the condition as supplied, but the sample for the tensile test shall be either precipitation treated or solution treated and precipitation treated, using the conditions described by the supplier which shall be within the ranges given in appendix B.

8. Tests

8.1 Tensile test. For the room temperature tensile test, test pieces shall be prepared and the test carried out in accordance with BS 18.

The test piece shall be, depending on thickness, either one of the proportional, circular cross section test pieces or the rectangular cross section test piece with 50 mm gauge length specified in BS 18. All test pieces shall be transverse to the rolling direction, and rectangular test pieces shall be the full thickness of the sheet or plate.

Values of 0.2 % proof stress shall be determined.

NOTE. 0.2 % proof stress values are determined for acceptance purposes but 1 % values may be required for design purposes and should be determined by agreement between the supplier and the purchaser.

8.2 Hardness test. Hardness tests shall be determined in accordance with BS 427 : Part 1.

NOTE. The test load used should be reasonably large having regard to the condition of the test piece, and should be included in the report of the test result.

Table 6. Alloy densities for use in determining theoretical weights of plates from specified dimensions

Alloy	Density
	g/cm^3
NA 11	8.9
NA 12	8.9
NA 13	8.8
NA 14	8.4
NA 15	8.0
NA 15(H)	8.0
NA 16	8.1
NA 17	7.9
NA 18	8.5
NA 21	8.3

8.3 Grain size. When deep drawing quality sheet is required, the grain size shall be determined. The method for estimating and rules for expressing average grain size shall be as given in ASTM E 112*.

8.4 Retests. If any one of the test pieces first selected fails to comply with the test requirements, two further samples from the same batch shall be selected for testing, one of which shall be from the sheet or plate from which the original test sample was taken, unless that sheet or plate has been withdrawn by the supplier.

If the test pieces from both these additional samples comply with the test requirements, the batch represented by the test samples shall be deemed to comply with the requirements of this standard. Should the test pieces from either of these additional samples fail to comply with the test requirements, the batch represented by these samples shall be deemed not to comply with the requirements of this standard.

Table 5. Tolerances on flatness of hot rolled sheet or plate

Ordered thickness		Tolerances on flatness for plates of the stated widths (plus and minus)						
From	Up to but excluding	Up to 1200 mm wide	Over 1200 mm to 1500 mm wide	Over 1500 mm to 2000 mm wide	Over 2000 mm to 2500 mm wide	Over 2500 mm to 3000 mm wide	Over 3000 mm to 3500 mm wide	Over 3500 mm wide
mm	mm	mm	mm	mm	mm	mm	mm	mm
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

*Copies of this American Society for Testing and Materials specification are obtainable from American Technical Publishers Ltd., 68a Wilbury Way, Hitchin, Herts SG4 0TP.

8.5 Tensile tests at elevated temperatures. If specified by the purchaser at the time of the enquiry and order (see item (i) in appendix A) sheet and plate in alloys NA 11, NA 12, NA 13, NA 14, NA 15, NA 16 and NA 21, all in the annealed condition, and alloy NA 15 H in the solution treated condition, may be supplied to comply with a minimum 0.2 % or 1.0 % proof stress requirement at one or more specified elevated temperatures. In this case the elevated temperature tensile test pieces selected in accordance with clause 7, shall be prepared, and the tests carried out, in accordance with BS 3688 : Part 1 at the temperature(s) specified by the purchaser.

9. Marking

9.1 The following information shall be clearly displayed on each sheet or plate:

(a) the number of this British Standard, i.e. BS 3072*;

(b) the designation of the material (see section two);

(c) the supplier's name or trade mark;

(d) the cast or batch number.

NOTE. Any special requirements for marking should be agreed between the supplier and the purchaser.

9.2 Any material used for marking shall be free from elements deleterious to the metal.

Table 7. Chemical composition of NA 11 nickel

Element	Min.	Max.
	%	%
Carbon	-	0.15
Silicon	-	0.35
Manganese	-	0.35
Sulphur	-	0.01
Copper	-	0.25
Iron	-	0.40
Magnesium	-	0.20
Nickel (including not more than 2 % cobalt)	99.0	-
Titanium	-	0.10

Section two. Specific requirements

10. NA 11 nickel

10.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and mechanical properties.

10.2 Chemical composition. The chemical composition of the material shall be as given in table 7.

The percentage nickel content shall be determined as the difference between 100 and the sum of the contents of the other elements.

10.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed
Deep drawing-quality	

10.4 Finish

10.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

10.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

10.5 Properties

10.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 8.

10.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A),

Table 8. Tensile properties of NA 11 nickel at room temperature

Condition	Thickness		0.2 % proof stress† min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_0}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm² (=MPa)	N/mm² (=MPa)	N/mm² (=MPa)	%
Cold rolled and annealed	0.25	0.5	-	-	380	30
	0.5	1.5	105	130	380	35
	1.5	4	105	130	380	40
Hot rolled	All		130	-	380	30
Hot rolled and annealed	All		105	130	380	40

†Values of 0.2 % proof stress are normally determined for acceptance purposes (see 8.1).

*Marking BS 3072 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause 7 and 8.5 shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

10.5.3 *Properties of deep drawing quality sheet.* When deep drawing quality sheet is ordered, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 9.

Table 9. Hardness and grain size of NA 11 nickel

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	110	6 or finer
0.5	3.0	110	4 or finer

Table 10. Chemical composition of NA 12 low carbon nickel

Element	Min.	Max.
	%	%
Carbon	-	0.02
Silicon	-	0.35
Manganese	-	0.35
Sulphur	-	0.01
Copper	-	0.25
Iron	-	0.40
Magnesium	-	0.20
Nickel (including not more than 2 % cobalt)	99.0	-
Titanium	-	0.10

11. NA 12 low carbon nickel

11.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and properties.

NOTE. Under certain conditions of service, notably with fused caustic alkalis, some compositions within the range specified may be susceptible to stress corrosion cracking. When material is required for such duties, the supplier should be informed.

11.2 Chemical composition. The chemical composition of the material shall be as given in table 10.

The percentage nickel content shall be determined as the difference between 100 and the sum of the contents of the other elements.

11.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed
Deep drawing quality	

11.4 Finish

11.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

11.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

11.5 Properties

11.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 11.

Table 11. Tensile properties of NA 12 low carbon nickel at room temperature

Condition	Thickness		0.2 % proof stress* min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm^2 (=MPa)	N/mm^2 (=MPa)	N/mm^2 (=MPa)	%
Cold rolled and annealed	0.25	0.5	-	-	350	30
	0.5	1.5	85	110	350	35
	1.5	4	85	110	350	40
Hot rolled	All		85	-	350	30
Hot rolled and annealed	All		85	110	350	40

*Values of 0.2 % proof stress are normally determined for acceptance purposes (see 8.1).

11.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause **7** and **8.5** shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

11.5.3 *Properties of deep drawing quality sheet.* When deep drawing quality sheet is ordered, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 12.

Table 12. Hardness and grain size of NA 12 low carbon nickel

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	110	6 or finer
0.5	3.0	110	4 or finer

Table 13. Chemical composition of NA 13 nickel copper alloy

Element	Min.	Max.
	%	%
Carbon	-	0.3
Silicon	-	0.5
Manganese	-	2.0
Sulphur	-	0.02
Copper	28.0	34.0
Iron	-	2.5
Nickel (including not more than 2 % cobalt)	63.0	-

12. NA 13 nickel copper alloy

12.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and properties.

12.2 Chemical composition. The chemical composition of the material shall be as given in table 13.

The percentage nickel content shall be determined as the difference between 100 and the sum of the contents of the other elements.

12.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed
Deep drawing quality	

12.4 Finish

12.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

12.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

12.5 Properties

12.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 14.

12.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause **7** and **8.5** shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the

Table 14. Tensile properties of NA 13 nickel copper alloy at room temperature

Condition	Thickness		0.2 % proof stress* min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm^2 (=MPa)	N/mm^2 (=MPa)	N/mm^2 (=MPa)	%
Cold rolled and annealed	0.25	0.5	-	-	480	35
	0.5	4	195	220	480	35
Hot rolled	All		275	-	510	25
Hot rolled and annealed	All		195	220	480	35

*Values of 0.2 % proof stress are normally determined for acceptance purposes (see **8.1**).

table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

12.5.3 *Properties of deep drawing quality sheet.* When deep drawing quality sheet is ordered, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 15.

Table 15. Hardness and grain size of NA 13 nickel copper alloy

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	140	6 or finer
0.5	3.0	140	4 or finer

13. NA 14 nickel chromium iron alloy

13.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and properties.

13.2 Chemical composition. The chemical composition of the material shall be as given in table 16.

The percentage nickel content shall be determined as the difference between 100 and the sum of the contents of the other elements.

13.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed
Deep drawing quality	

13.4 Finish

13.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

Table 16. Chemical composition of NA 14 nickel chromium iron alloy

Element	Min.	Max.
	%	%
Carbon	-	0.15
Silicon	-	0.5
Manganese	-	1.0
Sulphur	-	0.015
Copper	-	0.5
Iron	6.0	10.0
Chromium	14.0	17.0
Nickel (including not more than 2 % cobalt)	72.0	-

13.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

13.5 Properties

13.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 17.

13.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause **7**

Table 17. Tensile properties of NA 14 nickel chromium iron alloy at room temperature

Condition	Thickness		0.2 % proof stress* min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm² (=MPa)	N/mm² (=MPa)	N/mm² (=MPa)	%
Cold rolled and annealed	0.25	0.5	-	-	550	30
	0.5	4	240	265	550	30
Hot rolled	All		240	-	580	30
Hot rolled and annealed	All		240	265	550	30

*Values of 0.2 % proof stress are normally determined for acceptance purposes (see **8.1**).

and 8.5 shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

13.5.3 *Properties of deep drawing quality sheet.* When deep drawing quality sheet is ordered the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 18.

Table 18. Hardness and grain size of NA 14 nickel chromium iron alloy

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	170	6 or finer
0.5	3.0	170	4 or finer

14. NA 15 and NA 15(H) nickel iron chromium alloy

14.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and mechanical properties.

14.2 Chemical composition. The chemical composition of the material shall be as given in table 19.

All the elements except iron shall be determined analytically.

Table 19. Chemical composition of NA 15 and NA 15(H) nickel iron chromium alloy

Element	NA 15		NA 15(H)	
	Min.	Max.	Min.	Max.
	%	%	%	%
Carbon	-	0.10	0.05	0.10
Silicon	-	1.0	-	1.0
Manganese	-	1.5	-	1.5
Sulphur	-	0.015	-	0.015
Aluminium	0.15	0.60	0.15	0.60
Chromium	19.0	23.0	19.0	23.0
Copper	-	0.75	-	0.75
Iron	Remainder		Remainder	
Nickel (including not more than 2 % cobalt)	30.0	35.0	30.0	35.0
Titanium	0.15	0.60	0.15	0.60

14.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
NA 15	**NA 15**
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed
Deep drawing quality	
NA 15(H)	**NA 15(H)**
Cold rolled and solution treated	Cold rolled and solution treated
Hot rolled and solution treated	Hot rolled and solution treated

Table 20. Tensile properties of NA 15 and NA 15(H) nickel iron chromium alloy at room temperature

Condition	Thickness		0.2 % proof stress* min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm^2 (=MPa)	N/mm^2 (=MPa)	N/mm^2 (=MPa)	%
NA 15						
Cold rolled and annealed	0.25	0.5	-	-	520	30
	0.5	4.0	205	235	520	30
Hot rolled	All		240	-	550	25
Hot rolled and annealed	All		205	235	520	30
NA 15(H)						
Cold rolled and solution treated	All		170	200	450	30
Hot rolled and solution treated	All		170	200	450	30

*Values of 0.2 % proof stress are normally determined for acceptance purposes (see 8.1).

14.4 Finish

14.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

14.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

14.5 Properties

14.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 20.

14.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause **7** and **8.5** shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

14.5.3 *Properties of deep drawing quality sheet.* When, for alloy NA 15, deep drawing quality sheet is ordered, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses **7** and **8** shall be as given in table 21.

14.5.4 *Grain size of alloy NA 15(H).* The grain size of alloy NA 15(H) shall be ASTM grain size number 5 or greater.

15. NA 16 nickel iron chromium molybdenum copper alloy

15.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, finish and properties.

Table 21. Hardness and grain size of NA 15 nickel iron chromium alloy

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	170	6 or coarser
0.5	3.0	170	4 or coarser

15.2 Chemical composition. The chemical composition of the material shall be as given in table 22.

15.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled and annealed	Hot rolled and annealed
Deep drawing quality	

Table 22. Chemical composition of NA 16 nickel iron chromium molybdenum copper alloy

Element	Min.	Max.
Carbon*	-	0.05
Silicon	-	0.5
Manganese	-	1.0
Sulphur	-	0.03
Aluminium	-	0.20
Chromium	19.5	23.5
Copper	1.5	3.0
Iron	Remainder	
Molybdenum	2.5	3.5
Nickel (including not more than 2 % cobalt)	38.0	46.0
Titanium*	0.6	1.2

*The titanium content shall be at least 20 times the carbon content.

Table 23. Tensile properties of NA 16 nickel iron chromium molybdenum copper alloy at room temperature

Condition	Thickness		0.2 % proof stress* min.	1.0 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm² (=MPa)	N/mm² (=MPa)	N/mm² (=MPa)	%
Cold rolled and annealed	0.25	0.5	-	-	590	30
	0.5	4.0	240	270	590	30
Hot rolled and annealed	All		240	270	590	30

*Values of 0.2 % proof stress are normally determined for acceptance purposes (see 8.1).

15.4 Finish

15.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

15.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

15.5 Properties

15.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 23.

15.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clauses 7 and 8.5 shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

15.5.3 *Deep drawing quality sheet.* When deep drawing quality sheet is ordered, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 24.

Table 24. Hardness and grain size of NA 16 nickel iron chromium molybdenum copper alloy

Thickness		Hardness max.	Grain size
Over	Up to and including		ASTM grain size number (see 8.3)
mm	mm	HV	
0.25	0.5	190	6 or finer
0.5	3.0	190	4 or finer

16. NA 17 nickel iron chromium silicon alloy

16.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition and finish.

16.2 Chemical composition. The chemical composition of the material shall be as given in table 25.

16.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and annealed	Cold rolled and annealed
Hot rolled	Hot rolled
Hot rolled and annealed	Hot rolled and annealed

Table 25. Chemical composition of NA 17 nickel iron chromium silicon alloy

Element	Min.	Max.
	%	%
Carbon	-	0.10
Silicon	1.9	2.6
Manganese	0.8	1.5
Sulphur	-	0.03
Chromium	17.0	19.0
Copper	-	0.5
Iron	Remainder	
Nickel (including not more than 2 % cobalt)	34.5	41.0
Titanium	-	0.20

16.4 Finish

16.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

16.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

17. NA 18 nickel copper aluminium alloy

17.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and properties.

17.2 Chemical composition. The chemical composition of the material shall be as given in table 26.

The percentage nickel content shall be determined as the difference between 100 and the sum of the contents of the other elements.

Table 26. Chemical composition of NA 18 nickel copper aluminium alloy

Element	Min.	Max.
	%	%
Carbon	-	0.25
Silicon	-	0.5
Manganese	-	1.5
Sulphur	-	0.01
Aluminium	2.3	3.2
Copper	27.0	33.0
Iron	-	2.0
Nickel (including not more than 2 % cobalt)	63.0	-
Titanium	0.35	0.85

17.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Sheet	Plate
Cold rolled and solution treated	Cold rolled and solution treated
Cold rolled, solution treated and precipitation treated	Cold rolled, solution treated and precipitation treated
Hot rolled	Hot rolled
Hot rolled, solution treated	Hot rolled and solution treated
Hot rolled, solution treated and precipitation treated	Hot rolled, solution treated and precipitation treated
Hot rolled and precipitation treated	Hot rolled and precipitation treated

17.4 Finish

17.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

17.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

17.5 Properties

17.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature for material obtained from test pieces selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 27.

17.5.2 *Hardness.* When material is ordered in the cold rolled and solution treated, hot rolled, or hot rolled and solution treated condition, the hardness obtained from samples selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 28.

Table 28. Hardness of NA 18 nickel copper aluminium alloy

Condition	Hardness max.
	HV
Cold rolled and solution treated	200
Hot rolled	270
Hot rolled and solution treated	200

18. NA 21 nickel chromium molybdenum niobium alloy

18.1 General. Material shall comply with the general requirements given in section one and shall comply with the following requirements for chemical composition, condition, finish and properties.

18.2 Chemical composition. The chemical composition of the material shall be as given in table 29.

Table 27. Tensile properties of NA 18 nickel copper aluminium alloy at room temperature

Condition	Thickness		0.2 % proof stress min.	Tensile strength min.	Elongation on a gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including			
	mm	mm	N/mm² (=MPa)	N/mm² (=MPa)	%
Cold rolled solution treated and precipitation treated	0.25 0.5	0.5 4.0	- 620	900 900	15 15
Hot rolled and precipitation treated	All		690	970	15
Hot rolled solution treated and precipitation treated	All		620	900	15

18.3 Condition. Sheet and plate shall be supplied in one of the following conditions (see item (d) of appendix A):

Hot rolled and annealed
Hot rolled and solution annealed
Cold rolled and annealed
Cold rolled and solution annealed
Deep drawing quality (annealed)

18.4 Finish

18.4.1 *Cold rolled sheet and plate.* Cold rolled sheet and plate shall be supplied with either a dull matt surface or a smooth bright surface.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

Table 29. Chemical composition of NA 21 nickel chromium molybdenum niobium alloy

Element	Min.	Max.
	%	%
Carbon	-	0.10
Silicon	-	0.50
Manganese	-	0.50
Phosphorus	-	0.015
Sulphur	-	0.015
Aluminium	-	0.40
Chromium	20.0	23.0
Cobalt (if determined)	-	1.0
Iron	-	5.0
Molybdenum	8.0	10.0
Nickel	58.0	-
Niobium and tantalum	3.15	4.15
Titanium	-	0.40

18.4.2 *Hot rolled sheet and plate.* Hot rolled sheet and plate shall be supplied either with a tightly adherent oxide or with the surface chemically or abrasively cleaned.

NOTE. The purchaser is responsible for informing the supplier if one in particular of the above alternatives is required (see item (h) of appendix A). In the absence of a statement of preference by the purchaser, the choice of finish is at the option of the supplier.

Table 31. Hardness and grain size of NA 21 nickel chromium molybdenum niobium alloy

Thickness		Hardness max.	ASTM grain size number (see 8.3)
Over	Up to and including		
mm	mm	HV	
0.25	0.5	250	6 or finer
0.5	3.0	250	4 or finer

18.5 Properties

18.5.1 *Tensile properties at room temperature.* The tensile properties at room temperature obtained from test pieces selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 30.

18.5.2 *Tensile properties at elevated temperatures.* When tensile tests at one or more specified elevated temperatures are required by the purchaser (see item (i) in appendix A), then the proof stress properties obtained from test pieces selected, prepared and tested in accordance with clause 7 and 8.5 shall be as given in appendix C for the specified temperature(s). For temperatures between those given in the table, the minimum proof stress values for the next higher temperature shall apply.

NOTE. The proof stress values given in appendix C for temperatures other than those specified by the purchaser for testing, are not subject to verification and are given for information purposes only.

18.5.3 *Deep drawing quality sheet in the annealed condition.* When deep drawing quality sheet is ordered, for sheet in the annealed condition, the hardness and grain size obtained from samples selected, prepared and tested as specified in clauses 7 and 8 shall be as given in table 31.

Table 30. Tensile properties of NA 21 nickel chromium molybdenum niobium alloy at room temperature

Condition	Thickness		0.2 % proof stress (min.)	1.0 % proof stress (min.)	Tensile strength (min.)	Elongation on gauge length of 50 mm or $5.65\sqrt{S_o}$ (min.)
	Over	Up to and including				
	mm	mm	N/mm²	N/mm²	N/mm²	%
Cold rolled and annealed	0.25	0.5	—	—	830	30
	0.5	4.0	415	455	830	30
Cold rolled and solution annealed	All		275	—	690	30
Hot rolled and annealed	All		380	420	760	30
Hot rolled and solution annealed	All		275	—	690	30

Appendix A

Information to be supplied by the purchaser

The purchaser should state all his requirements, including any optional or special requirements, at the time of the enquiry and order as follows:

(a) the number of this British Standard and the designation of the material required (as given for the relevant material in section two);

(b) width, thickness, and length;

(c) number of sheets or plates;

(d) the condition of the material (see section two, e.g. **10.3**);

(e) when required, whether 1.0 % proof stress values are to be determined in addition to the 0.2 % proof stress (see clause **8**);

(f) whether a test certificate is required;

(g) whether the purchaser desires to witness tests or inspections, and, if so, which tests and/or inspections are to be witnessed;

(h) the nature and detail of any special requirements, including finish (see section two, e.g. **10.4**).

(i) whether the material to be supplied shall comply with a minimum 0.2 % or 1.0 % proof stress value at one or more specified elevated temperatures (selected from appendix C), and if so, at which temperature(s) (see **8.5**).

Appendix B

Heat treatment of NA 18 nickel copper aluminium alloy

B.1 Solution treatment. The alloy is normally solution treated by maintaining it at a temperature within the range 980 °C to 1050 °C for a period up to 30 min, followed by rapid cooling.

B.2 Precipitation treatment. The alloy is normally precipitation treated within the temperature range 580 °C to 600 °C for 6 h to 16 h, followed by furnace cooling to 480 °C at a rate between 8 °C/h and 15 °C/h. The rate of cooling below 480 °C is unimportant.

The heat treatment given to the alloy for demonstrating its response to precipitation treatment for specification purposes does not necessarily give the optimum properties for any particular application. By varying the time the alloy is maintained at the temperature, the degree of precipitation hardening can be altered and the advice of the supplier should be sought for any particular service condition.

Appendix C

Minimum proof stress properties of cold worked and annealed and hot worked and annealed nickel alloy sheet and plate at elevated temperatures

Elevated temperature properties given in table 32 are not requirements of material supplied to this standard unless the purchaser specifically requests a proof stress requirement at one or more particular temperatures (see 8.5 and item (i) of appendix A). If such a request is made by the purchaser, then the minimum proof stress value appropriate to the material at the specified temperature(s) given in this appendix is to be considered a requirement of this standard.

Table 32. Minimum proof stress properties of cold worked and annealed and hot worked and annealed nickel alloy sheet and plate at elevated temperatures

Designation	Proof stress	Minimum 0.2 % or 1.0 % proof stress (in N/mm² (=MPa)) at a temperature of							
		200 °C	300 °C	350 °C	400 °C	450 °C	500 °C	600 °C	650 °C
	%								
NA 11	0.2	100	95	90	-	-	-	-	-
	1.0	125	120	115	-	-	-	-	-
NA 12	0.2	65	60	60	55	50	50	40	30
	1.0	90	85	85	80	75	70	60	50
NA 13	0.2	135	135	135	130	130	125	-	-
	1.0	155	155	155	150	150	145	-	-
NA 14	0.2	190	175	170	170	165	165	160	-
	1.0	215	200	195	190	185	185	180	-
NA 15	0.2	165	150	145	140	140	135	125	-
	1.0	195	180	175	170	165	160	150	-
NA 15(H)*	0.2	125	115	110	105	105	105	100	-
	1.0	155	145	140	135	130	130	125	-
NA 16	0.2	190	180	175	170	165	165	-	-
	1.0	220	205	200	195	190	190	-	-
NA 21 Sheet	0.2	340	330	330	330	330	330	315	—
	1.0	380	370	370	370	370	370	350	—
NA 21 Plate	0.2	310	300	300	300	300	300	285	—
	1.0	350	340	340	340	340	340	320	—

* Properties of alloy NA 15(H) are given for the solution treated condition.

Appendix D

Cross-references between the alloy designations in this standard and those given in the Unified Numbering System (UNS)

Wide use is made internationally, for procurement purposes, of the alloy designations for nickel alloys given in the Unified Numbering System (UNS). Details of this system are given in 'Metals and Alloys in the Unified Numbering System' (4th edition), published jointly by the Society of Automotive Engineers and the American Society for Testing and Materials. Cross-references between the alloy designations used in this British Standard and the UNS designations are given, for information, in table 33.

Table 33. Cross-references between the alloy designations in this standard and the UNS designations

BS alloy designation	UNS alloy designation
NA 11	N0 2200
NA 12	N0 2201
NA 13	N0 4400
NA 14	N0 6600
NA 15	N0 8800
NA 15H	N0 8810
NA 16	N0 8825
NA 17	No equivalent
NA 18	N0 5500
NA 21	N0 6625

Publications referred to

BS 18	Method for tensile testing of metals (including aerospace materials)
BS 427	Method for Vickers hardness test Part 1 Testing of metals
BS 3071†	Specification for nickel-copper alloy castings
BS 3073†	Specification for nickel and nickel alloys : strip
BS 3074†	Specification for nickel and nickel alloys : seamless tube
BS 3075†	Specification for nickel and nickel alloys : wire
BS 3076†	Specification for nickel and nickel alloys : bar
BS 3688	Methods for mechanical testing of metals at elevated temperatures Part 1 Tensile testing

*ASTM E112 Methods for determining average grain size

* Metals and Alloys in the Unified Numbering System, published jointly by the Society of Automotive Engineers and the American Society for Testing and Materials

*Copies are obtainable from American Technical Publishers Ltd., 68a Wilbury Way, Hitchin, Herts SG4 0TP.

† Referred to in the foreword only.

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The preparation of this British Standard was entrusted by the Non-ferrous Metals Standards Policy Committee (NFM/—) to Technical Committee NFM/10, upon which the following bodies were represented:

British Non-ferrous Metals Federation
British Steel Industry
Engineering Equipment and Materials Users' Association
Ministry of Defence
Nickel Development Institute
Non-ferrous Metal Stockists
Process Plant Association
Stainless Steel Fabricators' Association of Great Britain
Coopted members

Amendments issued since publication

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