
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

Contents

	Page		Page
Foreword	1	7. Chemical composition of NA 11 nickel	5
Committees responsible	Back cover	8. Tensile properties of NA 11 nickel at room temperature	5
Specification		9. Hardness and grain size of NA 11 nickel	6
Section one. General requirements		10. Chemical composition of NA 12 low carbon nickel	6
1. Scope	2	11. Tensile properties of NA 12 low carbon nickel at room temperature	6
2. Definitions	2	12. Hardness and grain size of NA 12 low carbon nickel	7
3. Information to be supplied by the purchaser	2	13. Chemical composition of NA 13 nickel copper alloy	7
4. Freedom from defects	2	14. Tensile properties of NA 13 nickel copper alloy at room temperature	7
5. Selection of samples for chemical analysis	2	15. Hardness and grain size of NA 13 nickel copper alloy	8
6. Dimensional and weight tolerances	2	16. Chemical composition of NA 14 nickel chromium iron alloy	8
7. Selection of samples for mechanical test	4	17. Tensile properties of NA 14 nickel chromium iron alloy at room temperature	8
8. Tests	4	18. Hardness and grain size of NA 14 nickel chromium iron alloy	9
9. Marking	5	19. Chemical composition of NA 15 and NA 15(H) nickel iron chromium alloy	9
Section two. Specific requirements		20. Tensile properties of NA 15 and NA 15(H) nickel iron chromium alloy at room temperature	9
10. NA 11 nickel	5	21. Hardness and grain size of NA 15 nickel iron chromium alloy	10
11. NA 12 low carbon nickel	6	22. Chemical composition of NA 16 nickel iron chromium molybdenum copper alloy	10
12. NA 13 nickel copper alloy	7	23. Tensile properties of NA 16 nickel iron chromium molybdenum copper alloy at room temperature	10
13. NA 14 nickel chromium iron alloy	8	24. Hardness and grain size of NA 16 nickel iron chromium molybdenum copper alloy	11
14. NA 15 and NA 15(H) nickel iron chromium alloy	9	25. Chemical composition of NA 17 nickel iron chromium silicon alloy	11
15. NA 16 nickel iron chromium molybdenum copper alloy	10	26. Chemical composition of NA 18 nickel copper aluminium alloy	12
16. NA 17 nickel iron chromium silicon alloy	11	27. Tensile properties of NA 18 nickel copper aluminium alloy at room temperature	12
17. NA 18 nickel copper aluminium alloy	11	28. Hardness of NA 18 nickel copper aluminium alloy	12
18. NA 21 nickel chromium molybdenum niobium alloy	12	29. Chemical composition of NA 21 nickel chromium molybdenum niobium alloy	13
Appendices		30. Tensile properties of NA 21 nickel chromium molybdenum niobium alloy at room temperature	13
A. Information to be supplied by the purchaser	14	31. Hardness and grain size of NA 21 nickel chromium molybdenum niobium alloy	13
B. Heat treatment of NA 18 nickel copper aluminium alloy	14	32. Minimum proof stress properties of cold worked and annealed and hot worked and annealed nickel alloy sheet and plate at elevated temperatures	15
C. Minimum proof stress properties of cold worked and annealed and hot worked and annealed nickel alloy sheet and plate at elevated temperatures	15	33. Cross-references between the alloy designations in this standard and the UNS designations	16
D. Cross-references between the alloy designations in this standard and those given in the Unified Numbering System (UNS)	16		
Tables			
1. Tolerances on thickness of cold rolled sheet	2		
2. Tolerances on thickness of hot rolled sheet	3		
3. Tolerances on overweight of hot rolled plate	3		
4. Tolerances on width and length of sheared, plasma torch-cut, and abrasive-cut hot rolled sheet and plate	3		
5. Tolerances on flatness of hot rolled sheet or plate	4		
6. Alloy densities for use in determining theoretical weights of plates from specified dimensions	4		

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 $+\frac{3}{0}$ 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.