

Specification for

# Nickel and nickel alloys: seamless tube

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# Committees responsible for this British Standard

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- 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

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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 and Amendment No. 2 issued in 1987 together with further changes.

This edition of BS 3074 replaces BS 3074:1983 which is withdrawn.

It is one of a series for nickel and nickel alloys in various wrought forms intended for general engineering purposes.

Others in the series are:

BS 3071, *Specification for nickel-copper alloy castings.*

BS 3072, *Specification for nickel and nickel alloys: sheet and plate.*

BS 3073, *Specification for nickel and nickel alloys: strip.*

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 although details for the specific requirements were revised where necessary. One additional nickel chromium molybdenum niobium alloy (NA 21) was included. As previously, the same designations were used throughout the series for wrought nickel and nickel alloys.

At the same time, following agreements reached in discussions in the International Organization for Standardization, details of dimensional tolerances were revised.

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 new 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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

## Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.



## Section 1. General requirements

### 1 Scope

This British Standard specifies requirements for nickel and nickel alloy seamless tubes in the cold worked condition for outside diameters over 6 mm up to and including 115 mm and in the hot worked condition for outside diameters over 60 mm up to and including 250 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 alloy NA 18. Proof stress properties of cold worked and annealed and hot worked and annealed nickel tube at elevated temperatures are given in Appendix C and Appendix D. Appendix E 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

##### **tube**

a hollow product of round cross section having a continuous periphery

#### 2.2

##### **mean diameter**

the average of the maximum and minimum diameters as determined at any one cross section

#### 2.3

##### **mean wall thickness**

the average of the maximum and minimum wall thicknesses at any one cross section

#### 2.4

##### **cast**

the product of a furnace melt or a number of melts that are mixed prior to casting

#### 2.5

##### **batch**

tubes of the same cross section 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

#### 2.6

##### **annealing**

a heat treatment of alloys for the purpose of softening

#### 2.7

##### **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

#### 2.8

##### **precipitation treatment**

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

#### 2.9

##### **stress relief**

the heat treatment of alloys to relieve the major proportion of the internal stresses resulting from cold work

### 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 seamless tube.

### 4 Freedom from defects

Cold worked tubes shall be clean, smooth and free from harmful defects.

Hot worked tubes shall be smooth and free from harmful defects.

### 5 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 tolerances

#### 6.1 Diameter and wall thickness

**6.1.1 Cold worked tube.** For thick tube (in which the wall thickness is more than 3 % of the outside diameter) the wall thickness, outside diameter or inside diameter shall not differ at any point from that ordered by more than the appropriate tolerance given in Table 1 and Table 2.

For thin tube (in which the wall thickness is 3 % or less of the outside diameter) the wall thickness, mean outside diameter or mean inside diameter shall not differ from that ordered by more than the appropriate tolerance specified in Table 1 or Table 2 and on individual measurements, with the values increased by 0.5 % of the specified outside diameter.

Tubes required for certain applications sometimes need a unilateral tolerance on outside diameter or inside diameter, in such cases the tolerances shall be the sum of the plus and minus tolerances specified above.

**6.1.2 Hot worked tube.** For tube up to and including 125 mm outside diameter, the wall thickness, inside diameter or outside diameter shall not differ at any point from that ordered by more than the appropriate tolerance specified in Table 3 (i.e. includes ovality).

For tubes over 125 mm outside diameter, the wall thickness, mean inside diameter or mean outside diameter shall not differ from that ordered by more than the appropriate tolerance given in Table 3 (i.e. excludes ovality) and individual measurements shall not exceed twice the tolerances given in the table.

When tubes are supplied with machined outside or inside surfaces, the tolerance on the machined surface shall be  $^{+0.8}_{-0}$  mm for the outside diameter and  $^{+0}_{-1.6}$  mm for the inside diameter.

When a minimum wall thickness is ordered the thickness tolerance shall be  $^{+28.5}_{-0}$  %.

**6.2 Eccentricity.** The wall thickness at any one cross section of the tube shall not at any point differ from the mean wall thickness at that section by more than  $\pm 10$  % of that value.

**6.3 Length.** Tube ordered to a specified length shall not differ from that length by more than the appropriate tolerance given in Table 4.

**6.4 Straightness.** The straightness of both hot finished and cold finished tubes shall be 1 in 600 or better.

**Table 1 — Tolerances on diameter and wall thickness of cold worked tube for materials NA 11, NA 12, NA 13 and NA 18**

| Outside diameter |                     | Tolerances on specified outside or inside diameter |       | Tolerances on wall thickness            |                                  |       |
|------------------|---------------------|----------------------------------------------------|-------|-----------------------------------------|----------------------------------|-------|
|                  |                     |                                                    |       | Specified nominal (mean) wall thickness | Specified minimum wall thickness |       |
| Over             | Up to and including | Plus                                               | Minus | Plus and minus                          | Plus                             | Minus |
| mm               | mm                  | mm                                                 | mm    | %                                       | %                                | %     |
| 6                | 16                  | 0.15                                               | 0     | 12.5                                    | 25                               | 0     |
| 16               | 38                  | 0.15                                               | 0.15  | 10                                      | 20                               | 0     |
| 38               | 115                 | 0.25                                               | 0.25  | 10                                      | 22                               | 0     |

**Table 2 — Tolerances on diameter and wall thickness of cold worked tube for materials NA 14, NA 15, NA 15(H), NA 16, NA 17 and NA 21**

| Outside diameter |                     | Tolerances on specified outside or inside diameter | Tolerances on wall thickness            |                                  |       |
|------------------|---------------------|----------------------------------------------------|-----------------------------------------|----------------------------------|-------|
|                  |                     |                                                    | Specified nominal (mean) wall thickness | Specified minimum wall thickness |       |
| Over             | Up to and including | Plus and minus                                     | Plus and minus                          | Plus                             | Minus |
| mm               | mm                  | mm                                                 | %                                       | %                                | %     |
| 6                | 16                  | 0.15                                               | 12.5                                    | 25                               | 0     |
| 16               | 38                  | 0.20                                               | 10                                      | 20                               | 0     |
| 38               | 90                  | 0.25                                               | 10                                      | 22                               | 0     |
| 90               | 115                 | 0.40                                               | 10                                      | 22                               | 0     |

**Table 3 — Tolerances on diameter and wall thickness of hot worked tube**

| Outside diameter |                     | Tolerance on specified outside diameter or inside diameter | Tolerances on specified nominal (mean) wall thickness |
|------------------|---------------------|------------------------------------------------------------|-------------------------------------------------------|
| Over             | Up to and including | Plus and minus                                             | Plus and minus                                        |
| mm               | mm                  | mm                                                         | %                                                     |
| 60               | 140                 | 0.8                                                        | 12.5                                                  |
| 140              | 250                 | 1.2                                                        | 12.5                                                  |

**Table 4 — Tolerances on length**

| Length |                     | Tolerance |       |
|--------|---------------------|-----------|-------|
| Over   | Up to and including | Plus      | Minus |
| mm     | mm                  | mm        | mm    |
| —      | 9 000               | 4         | 0     |
| 9 000  | —                   | 7         | 0     |

## 7 Selection of samples for mechanical tests

All tubes shall be grouped into batches. One test sample shall be cut from a tube selected 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 the material as supplied and, except in certain cases for NA 18, shall be tested in that condition.

Test samples from alloy NA 18 supplied in other than the finally heat treated condition shall be either precipitation treated or solution treated and precipitation treated, as appropriate, before being submitted to the tensile test, using the conditions described by the supplier, which shall be within the ranges given in Appendix B.

When tubes are ordered to exact lengths, the test samples shall be obtained either:

- by leaving during manufacture extra material of appropriate size upon a sufficient number of tubes in a batch; or
- by taking them from the batch at random.

The purchaser shall state his requirements.

## 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.

Values of 0.2 % proof stress shall be determined.

**NOTE** The 0.2 % proof stress is determined for acceptance purposes but 1 % proof stress values are sometimes required for design purposes. Such determinations should be arranged by agreement between the supplier and the purchaser.

**8.2 Drift expanding test.** If required by the purchaser a drift test shall be made on each end of each tube from a batch of random lengths of annealed and stress relieved tubing prior to cutting to length. In the case of stress relieved tubes with annealed ends, the test shall be made either before or after annealing the ends at the option of the manufacturer.

The test shall consist of expanding a test specimen using a tapered drift having an included angle of 60° until the specified outside diameter has been increased by the amount specified for the relevant alloy in section 2. The tube shall not crack when subjected to this test.

### 8.3 Leak tightness test

**8.3.1 General.** If required by the purchaser, tubes shall be subjected to either:

- a hydraulic leak tightness test, carried out in accordance with 8.3.2; or
- an eddy current test, carried out in accordance with 8.3.3.

The choice of whether to apply test a) or test b) shall be at the option of the manufacturer, unless a specific choice is made by the purchaser.

**8.3.2 Hydraulic test.** When the hydraulic test is carried out, each tube of wall thickness 0.4 mm and over shall be tested for at least 30 s to a minimum internal hydraulic pressure of 70 bar<sup>1)</sup>, or to the internal test pressure derived from the following formula if this is less than 70 bar:

$$P = \frac{20 \times St}{D}$$

where

- $P$  is the internal hydraulic pressure (in bar);
- $t$  is the minimum wall thickness (in mm);
- $D$  is the outside diameter (in mm);
- $S$  is the fibre stress given in section 2 for each alloy (in N/mm<sup>2</sup>).

<sup>1)</sup> 1 bar = 10<sup>5</sup> N/m<sup>2</sup> = 100 kPa.