



BSI Standards Publication

AEROSPACE SERIES

**Specification for nickel-
chromium-cobalt-titanium-
aluminium heat-resisting alloy
seamless tubes (Nickel base,
Cr 19.5, Co 18.0, Ti 2.5, Al 1.5)**

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 4, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 January 2011. It was prepared by Panel ACE/61/-/48, *Heat resisting alloys for aerospace purposes*, under the authority of Technical Committee ACE/61, *Metallic materials for aerospace purposes*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This standard supersedes BS HR 402:1973, which is withdrawn.

Information about this document

This is a full revision of BS HR 402 and introduces the following principal changes.

- a) Change in title.
- b) Requirements are stated in tabular format in accordance with EN 4500-1 and EN 4500-3.

Hazard warnings

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It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its methods are expressed either as a set of instructions or in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for nickel-chromium-cobalt-titanium-aluminium heat-resisting alloy seamless tubes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS HR 100, *Procedure for inspection, testing and acceptance of wrought heat resisting alloys*

3 Technical requirements

Material to this standard shall conform to Table 1.

NOTE The format and symbols used in Table 1 are derived from EN 4500-1 and EN 4500-3.

Table 1 Technical requirements for nickel-chromium-cobalt-titanium-aluminium heat-resisting alloy seamless tubes

1	Material designation	BS HR 402								
2	Chemical composition %	Element	C	Si	Mn	S	Ag	Al	B	Bi
		Min.	—	—	—	—	—	1.0	—	—
		Max.	0.13	1.0	1.0	0.015	5 ppm	2.0	0.020	1 ppm
		Element	Co	Cr	Cu	Fe	Pb	Ti	Zr	Ni
		Min.	15.0	18.0	—	—	—	2.0	—	Base
Max.	21.0	21.0	0.2	1.5	20 ppm	3.0	0.15			
3	Method of melting	Induction melted and cast in air; induction melted, vacuum refined and cast in air; consumable electrode remelted.								
4.1	Form	Seamless tube								
4.2	Method of production	—								
4.3	Limit dimension(s)	mm	—							
5	Technical specification	Sections 1 and 6 of BS HR 100								

6.1	Delivery condition	Cold worked + softened								
	Heat treatment	1 100°C ≤ θ ≤ 1 150 °C / 1 min ≤ t ≤ 10 min / AC or OQ or WQ								
6.2	Delivery condition code	A								
7	Use condition	Cold worked + softened + precipitation treated								
	Heat treatment	Delivery condition + θ = (750 ± 10) °C / t = 4 h / AC								

Characteristics

8.1	Test sample(s)	See Section 6 of BS HR 100								
8.2	Test piece(s)	See Section 6 of BS HR 100								
8.3	Heat treatment	Delivery condition	Use condition						Reference ¹⁾ (see line 29)	
9	Dimensions concerned	mm	—	a < 0.5	0.5 ≤ a ≤ 1.0	a > 1.0	—			
10	Thickness of cladding on each face	%	—							
11	Direction of test piece	—		L				L		
12	Temperature	θ	°C	Ambient			—			
13	T	Proof stress	R _{p0.2}	MPa	—	≥ 690	≥ 690	—		
14		Strength	R _m	MPa	—	≥ 1 080	≥ 1 080	≥ 1 080	—	
15		Elongation	A	%	—	—	≥ 15	≥ 20	—	
16		Reduction of area	Z	%	—					
17	Hardness	HV ≤ 250		HV ≥ 280				—		
18	Shear strength	R _c	MPa	—						
19	Bending	κ	—	—						
20	Impact strength	—								
21	C	Temperature	θ	°C	—			870		
22		Time	h		—			t _R ≥ 30		
23	C	Stress	σ _a	MPa	—					
24		Elongation	a	%	—					
25		Rupture stress	σ _R	MPa	—			140		
26		Elongation at rupture	A	%	—					
27	Notes (see line 98)	¹⁾								

Table 1 Technical requirements for nickel-chromium-cobalt-titanium-aluminium heat-resisting alloy seamless tubes (continued)

29	Reference heat treatment	—	Solution treated + precipitation treated $\theta = (1080 \pm 10)^\circ\text{C} / t = 8 \text{ h} / \text{AC} + \theta = (700 \pm 10)^\circ\text{C} / t = 16 \text{ h} / \text{AC}$
33	Flattening test	—	See Section 6 of BS HR 100
		4	$a \geq 1 \text{ mm}$
		5	Delivery condition
		6	Flattened to a distance of not more than four times the wall thickness
		7	The samples shall be free from cracks.
44	External defects	—	See Section 6 of BS HR 100
95	Marking	—	See Section 6 of BS HR 100
96	Dimensional inspection	—	See Section 6 of BS HR 100
98	Notes	—	¹⁾ Tested at a convenient stage prior to manufacture of the tube.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 4500-1, *Metallic materials – Rules for the drafting and presentation of material standards – Part 1: General rules*¹⁾

EN 4500-3, *Metallic materials – Rules for the drafting and presentation of material standards – Part 3: Specific rules for heat resisting alloys*¹⁾

¹⁾ Published as ASD-STAN Prestandard at the date of publication of this standard.

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