BS 4HR 601:2010

BSI Standards Publication

AEROSPACE SERIES

Specification for nickel-chromium-titanium-aluminium heat-resisting alloy bar and wire (maximum diameter or minor sectional dimension of 30 mm) for the manufacture of fasteners (nickel base, Cr 19.5, Ti 2.2, Al 1.4)

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Publishing and copyright information

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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 30 November 2010. It was prepared by Panel ACE/61/-/48, *Heat resisting alloys*, 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This standard supersedes BS 3HR 601:1989, which is withdrawn.

Information about this document

This standard is a full revision of BS HR 601. The principal change from the previous edition is that the requirements are stated in tabular format in accordance with the EN 4500-1 and EN 4500-3.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

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-titanium-aluminium heat-resisting alloy in the following forms, for the manufacture of fasteners.

a) Bar and wire for machining: cold worked and solution treated, designation HR 601A.

b) Bar and wire for continuous cold forging or cold extrusion: cold worked and softened, designation HR 601B.

c) Bar and wire for hot upset forging: cold worked, designation HR 601C.

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*

ASTM E 112, *Standard methods for determining average grain size* [1)]

3 Technical requirements

Material to this standard shall conform to the technical requirements specified in Table 1.

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

NOTE 2 Final heat treatment should be as specified in the fastener product specification.

1) Available for download from www.astm.org.

Table 1 **Technical requirements for nickel-chromium-titanium-aluminium heat-resisting alloy bar and wire for the manufacture of fasteners**

1	**Material designation**		**BS HR 601**							
2	**Chemical composition %**	**Element**	C	Si	Mn	S	Ag	Al	B	Bi
		Min.	0.040	—	—	—	—	1.0	—	—
		Max.	0.10	1.0	1.0	0.015	5 ppm	1.8	0.008	1 ppm
		Element	Co	Cr	Cu	Fe	Pb	Ti	Ni	
		Min.	—	18.0	—	—	—	1.8	Base	
		Max.	2.0	21.0	0.2	1.5	20 ppm	2.7		

3	**Method of melting**		Air melted; air melted and vacuum refined; vacuum melted; consumable electrode remelted		
4.1	**Form**		Bar and wire for machining (HR 601A)	Bar and wire for continuous cold forging or cold extrusion (HR 601B)	Bar and wire for hot upset forging (HR 601C)
4.2	**Method of production**		—		
4.3	**Limit dimension(s)**	mm	a or D ≤ 30		
5	**Technical specification**		Sections 1 and 9 of BS HR 100		

6.1	**Delivery condition**	8% ≤ cold worked ≤ 12% + straightened + solution heat treated + ground or descaled	8% ≤ cold worked ≤ 12% + softened	8% ≤ cold worked ≤ 12% + straightened + ground
	Heat treatment	θ = (1 080 ±10) °C/ AC or faster [1)]	1 080 °C ≤ θ ≤ 1 120 °C/ WC	—
6.2	**Delivery condition code**	W	A	F
7	**Use condition**	Delivery condition		
	Heat treatment	—		

Characteristics

8.1	**Test sample(s)**			See Section 9 of BS HR 100			
8.2	**Test piece(s)**			See Section 9 of BS HR 100			
8.3	**Heat treatment**			Delivery condition			Reference (see line 29)
9	**Dimensions concerned**		mm	a or D ≤ 30 Bar and wire for machining	a or D ≤ 30 Bar and wire for continuous cold forging or cold extrusion	a or D ≤ 30 Bar and wire for hot upset forging	a or D ≤ 30
10	**Thickness of cladding on each face**		%	—			
11	**Direction of test piece**			—	L	—	L
12	T	**Temperature**	θ °C	Ambient	Ambient	Ambient	Ambient
13	T	**Proof stress**	$R_{p0.2}$ MPa	—	—	—	≥620
14	T	**Strength**	R_m MPa	—	≤900	—	≥1 000
15	T	**Elongation**	A %	—	—	—	≥20
16	T	**Reduction of area**	Z %	—			
17	**Hardness**			HV ≤ 330	—	HV ≤ 370	—
18	**Shear strength**		R_c MPa	—			
19	**Bending**		κ —	—			
20	**Impact strength**			—			
21	C	**Temperature**	θ °C	—			750
22	C	**Time**	h	—			$t_R \geq 30$
23	C	**Stress**	σ_a MPa	—			
24	C	**Elongation**	a %	—			
25	C	**Rupture stress**	σ_R MPa	—			340
26	C	**Elongation at rupture**	A %	—			
27	**Notes (see line 98)**			[1)]			

Table 1 **Technical requirements for nickel-chromium- titanium-aluminium heat-resisting alloy bar and wire for the manufacture of fasteners** *(continued)*

29	**Reference heat treatment**	—	Solution treated + precipitation treated θ = (1 080 °C ±10) °C/AC or faster [1)] + θ = (750 ±10) °C/ t = 4 h/AC
34	**Grain size**	—	See Section 9 of BS HR 100
		5	Bar and wire for machining, continuous cold forging or cold extrusion: delivery condition Bar and wire for hot upset forging: reference (see line 29)
		7	ASTM E 112, uniform 4 or finer, no duplex grain
44	**External defects**	—	See Section 9 of BS HR 100
51	**Macrostructure**	—	See Section 9 of BS HR 100
95	**Marking**	—	See Section 9 of BS HR 100
96	**Dimensional inspection**	—	See Section 9 of BS HR 100
98	**Notes**	—	[1)] D ≤ 15 mm: 15 min ≤ t ≤ 30 min; 15 mm ≤ D ≤ 30 mm: 30 min ≤ t ≤ 60 min

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* [2)]

EN 4500-3, *Metallic materials – Rules for the drafting and presentation of material standards – Part 3: Specific rules for heat resisting alloys* [2)]

[2)] Published as ASD-STAN Prestandard at the date of publication of this standard.

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