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BSI Standards Publication

AEROSPACE SERIES

Specification for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy billets, bars and forgings (Cobalt base, Cr 20, W 15, Ni 10, Mn 1.5)

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 January 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This standard supersedes BS HR 40:1972, which is withdrawn.

Information about this document

This is a full revision of BS HR 40. The principal change from the previous edition is that the requirements are stated in tabular format in accordance with 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 requirements are expressed 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 cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy supplied in the following forms.

a) Bars and extruded sections for machining: annealed, designation HR 40A.

b) Billets and bars for forging: hot or cold worked and subsequently machined or ground, designation HR 40B.

c) Forgings: annealed, designation HR 40C.

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, Table 2 and Table 3.

NOTE The format and symbols used in Table 1, Table 2 and Table 3 are derived from EN 4500-1 and EN 4500-3.

Table 1 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy bars and extruded sections for machining**

1	**Material designation**			**BS HR 40**								
2	**Chemical composition %**	Element		C	Si	Mn	P	S	Cr	Fe	Ni	W	Co
		Min.		0.05	—	1.0	—	—	19.0	—	9.0	14.0	Base
		Max.		0.15	0.4	2.0	0.040	0.030	21.0	3.0	11.0	16.0	
3	**Method of melting**			Air melted; vacuum melted; air melted and vacuum refined; consumable electrode remelted									
4.1	**Form**			Bars and extruded sections for machining (HR 40A)									
4.2	**Method of production**			Extruded									
4.3	**Limit dimension(s)**		mm	—									
5	**Technical specification**			Sections 1 and 2 of BS HR 100									

6.1	**Delivery condition**		Annealed
	Heat treatment		1 200 °C $\leqslant \theta \leqslant$ 1 230 °C / rapid cool
6.2	**Delivery condition code**		U
7	**Use condition**		Delivery condition
	Heat treatment		—

Characteristics

8.1	**Test sample(s)**				See Section 2 of BS HR 100
8.2	**Test piece(s)**				See Section 2 of BS HR 100
8.3	**Heat treatment**				Use condition
9	**Dimensions concerned**			mm	—
10	**Thickness of cladding on each face**			%	—
11	**Direction of test piece**				L
12	T	**Temperature**	θ	°C	Ambient
13	T	**Proof stress**	$R_{p0.2}$	MPa	$\geqslant$ 340
14	T	**Strength**	R_m	MPa	$\geqslant$ 860
15	T	**Elongation**	A	%	$\geqslant$ 35
16	T	**Reduction of area**	Z	%	—
17	**Hardness**				HBW $\leqslant$ 282 or HV $\leqslant$ 290
18	**Shear strength**		R_c	MPa	—
19	**Bending**		κ	—	—
20	**Impact strength**				—
21	C	**Temperature**	θ	°C	815
22	C	**Time**		h	t_R = 23
23	C	**Stress**	σ_a	MPa	—
24	C	**Elongation**	a	%	—
25	C	**Rupture stress**	σ_R	MPa	165
26	C	**Elongation at rupture**	A	%	$\geqslant$ 10
27	**Notes** (see line 98)				—

Table 1 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy bars and extruded sections for machining** *(continued)*

34	**Grain size**	—	See Section 1 of BS HR 100	
		2	a or D < 20 mm: 5% of batch	a or D ⩾ 20 mm: 10% of batch
		3	Transverse sample	
		5	Use condition	
		7	Maximum average transverse grain size diameter ⩽ 0.180 mm. Occasional grains of up to 0.360 mm are permitted.	
44	**External defects**	—	See Section 2 of BS HR 100	
51	**Macrostructure**	—	See Section 2 of BS HR 100	
61	**Internal defects**	—	See Section 2 of BS HR 100	
95	**Marking**	—	See Section 2 of BS HR 100	
96	**Dimensional inspection**	—	See Section 2 of BS HR 100	
98	**Notes**	—	—	

Table 2 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy billets and bars for forging**

1	**Material designation**			**BS HR 40**									
2	**Chemical composition %**	Element		C	Si	Mn	P	S	Cr	Fe	Ni	W	Co
		Min.		0.05	—	1.0	—	—	19.0	—	9.0	14.0	Base
		Max.		0.15	0.4	2.0	0.040	0.030	21.0	3.0	11.0	16.0	
3	**Method of melting**			Air melted; vacuum melted; air melted and vacuum refined; consumable electrode remelted									
4.1	**Form**			Billets and bars for forging (HR 40B)									
4.2	**Method of production**			—									
4.3	**Limit dimension(s)**		mm	—									
5	**Technical specification**			Sections 1 and 3 of BS HR 100									

6.1	**Delivery condition**		Hot or cold worked and subsequently machined or ground [1)]	
	Heat treatment		—	
6.2	**Delivery condition code**		F	
7	**Use condition**		Delivery condition	
	Heat treatment		—	

Characteristics

8.1	**Test sample(s)**			See Section 3 of BS HR 100		
8.2	**Test piece(s)**			See Section 3 of BS HR 100		
8.3	**Heat treatment**			Delivery condition	Reference (see line 29)	
9	**Dimensions concerned**		mm	—		
10	**Thickness of cladding on each face**		%	—		
11	**Direction of test piece**			—	L	
12	T	**Temperature**	θ °C	—	Ambient	
13	T	**Proof stress**	$R_{p0.2}$ MPa	—	$\geqslant$ 340	
14	T	**Strength**	R_m MPa	—	$\geqslant$ 860	
15	T	**Elongation**	A %	—	$\geqslant$ 35	
16	T	**Reduction of area**	Z %	—		
17	**Hardness**			—	HBW $\leqslant$ 282 or HV $\leqslant$ 290	
18	**Shear strength**		R_c MPa	—		
19	**Bending**		κ —	—		
20	**Impact strength**			—		
21	C	**Temperature**	θ °C	—	815	
22	C	**Time**	h	—	t_R = 23	
23	C	**Stress**	σ_a MPa	—		
24	C	**Elongation**	a %	—		
25	C	**Rupture stress**	σ_R MPa	—	165	
26	C	**Elongation at rupture**	A %	—	$\geqslant$ 10	
27	**Notes** (see line 98)			[1)]		

Table 2 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy billets and bars for forging** *(continued)*

29	**Reference heat treatment**	—	Annealed 1 200 °C $\leqslant \theta \leqslant$ 1 230 °C / rapid cool	
34	**Grain size**	—	See Section 1 of BS HR 100	
		2	a or D < 20 mm: 5% of batch	a or D $\geqslant$ 20 mm: 10% of batch
		3	Transverse sample	
		5	See line 29	
		7	Maximum average transverse grain size diameter $\leqslant$ 0.180 mm. Occasional grains of up to 0.360 mm are permitted.	
44	**External defects**	—	See Section 3 of BS HR 100	
51	**Macrostructure**	—	See Section 3 of BS HR 100	
61	**Internal defects**	—	See Section 3 of BS HR 100	
95	**Marking**	—	See Section 3 of BS HR 100	
96	**Dimensional inspection**	—	See Section 3 of BS HR 100	
98	**Notes**	—	[1)] Material of other than round section may be supplied in the descaled condition.	

Table 3 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy forgings**

1	**Material designation**			**BS HR 40**								
2	**Chemical composition %**	Element		C	Si	Mn	P	S	Cr	Fe	Ni	W	Co
		Min.		0.05	—	1.0	—	—	19.0	—	9.0	14.0	Base
		Max.		0.15	0.4	2.0	0.040	0.030	21.0	3.0	11.0	16.0	
3	**Method of melting**			Air melted; vacuum melted; air melted and vacuum refined; consumable electrode remelted									
4.1	**Form**			Forgings (HR 40C)									
4.2	**Method of production**			Forged from HR 40B stock									
4.3	**Limit dimension(s)**		mm	—									
5	**Technical specification**			Sections 1 and 4 of BS HR 100									

6.1	**Delivery condition**			Annealed
	Heat treatment			1 200 °C $\leqslant \theta \leqslant$ 1 230 °C / rapid cool
6.2	**Delivery condition code**			U
7	**Use condition**			Delivery condition
	Heat treatment			—

Characteristics

8.1	**Test sample(s)**				See Section 4 of BS HR 100
8.2	**Test piece(s)**				See Section 4 of BS HR 100
8.3	**Heat treatment**				Delivery condition
9	**Dimensions concerned**			mm	—
10	**Thickness of cladding on each face**			%	—
11	**Direction of test piece**				L
12	**T**	**Temperature**	θ	°C	Ambient
13		**Proof stress**	$R_{p0.2}$	MPa	$\geqslant$ 340
14		**Strength**	R_m	MPa	$\geqslant$ 860
15		**Elongation**	A	%	$\geqslant$ 35
16		**Reduction of area**	Z	%	—
17	**Hardness**				HBW $\leqslant$ 282 or HV $\leqslant$ 290
18	**Shear strength**		R_c	MPa	—
19	**Bending**		κ	—	—
20	**Impact strength**				—
21	**C**	**Temperature**	θ	°C	815
22		**Time**		h	t_R = 23
23		**Stress**	σ_a	MPa	—
24		**Elongation**	a	%	—
25		**Rupture stress**	σ_R	MPa	165
26		**Elongation at rupture**	A	%	$\geqslant$ 10
27	**Notes** (see line 98)				—

Table 3 **Technical requirements for cobalt-chromium-tungsten-nickel-manganese heat-resisting alloy forgings** *(continued)*

34	**Grain size**	—	See Section 1 of BS HR 100
		2	As required by the drawing or inspection schedule
		3	Transverse sample
		5	Use condition
		7	Maximum average transverse grain size diameter ⩽ 0.180 mm. Occasional grains of up to 0.360 mm are permitted.
44	**External defects**	—	See Section 4 of BS HR 100
51	**Macrostructure (grain flow)**	—	See Section 4 of BS HR 100
61	**Internal defects**	—	See Section 4 of BS HR 100
95	**Marking**	—	See Section 4 of BS HR 100
96	**Dimensional inspection**	—	See Section 4 of BS HR 100
98	**Notes**	—	—

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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