



UNIT STANDARDS

E1504-98

TITLE :

FORGINGS OF BORON STEEL, GRADE-1

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DATE 1993-05-27

0. GENERAL :

This specification is a branch specification meant for Steel Forgings, whose material conforms to E1504- "Boron Steel, Grade-1".

1. SCOPE :

This specification gives the quality requirements, sampling & acceptance criteria and designation of forgings to E1504 material.

2. QUALITY REQUIREMENTS :

2.1 RAW MATERIAL TO BE USED :

2.1.1 DEOXIDATION :

The bar stock to be used shall be of fully killed steel.

2.1.2 SHAPE & SIZE :

Unless otherwise specified, the raw material to be used shall be of hot rolled category upto 140 mm diameter/RCS with a reduction ratio of 6:1 minimum and shall be of hot forged category for above 140 mm diameter/RCS with a reduction ratio of 4:1 minimum.

2.1.3 CHEMICAL COMPOSITION (WEIGHT %):

(As per Check Analysis)

ELEMENT	% WEIGHT
Carbon	0.32 to 0.37
Silicon	0.15 to 0.35
Manganese	1.20 to 1.50
Sulphur, max.	0.030
Phosphorus, max.	0.030
Chromium, max.	0.20
Nickel, max.	0.25
Molybdenum, max.	0.05
Boron, min.	0.0005
Nickel + Chromium, max	0.30

NOTE :

Elements not specified above shall not be added to this steel, except for the purpose of finishing.

PREPARED BY:

CSD

ISSUE NO:

-

REPLACEMENT FOR:

-

REF:

E1504
(SMnB435H)

APPROVED BY:

ALTERED BY:

Handwritten signature
1993/05/27

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2.1.4 HARDENABILITY :

The following Jominey End Quench Hardenability values shall be ensured (Test as per IS:3848-1981) :

<u>J₁ Distance</u> <u>in mm</u>	<u>Hardness Limits HRC</u>	
	<u>Max.</u>	<u>Min.</u>
1.5	56	51
15.0	52.5	32
25.0	36	10

2.1.5 INCLUSION RATING :

Inclusion Rating shall be 2.5 - A,B,C,D - ASTM E45 or better.

2.1.6 MATERIAL SOUNDNESS :

SURFACE :

The raw material shall be free from cracks, laps, seams and shuts.

See Clause 2.1.7 on Surface Conditioning. Defects beyond permissible levels shall be removed.

INTERNAL :

The raw material used for forgings shall be tested for internal soundness by macro-etching, as per ASTM E381. For acceptance, the material shall comply with the requirements of ASTM E381, as follows :

103 cm³ or less :

Acceptable : S-3, R-2 and C-2 (inclusive)

Over 103 cm³ :

Acceptable : S-3, R-3 and C-3 (inclusive)

2.1.7 UNACCEPTABLE :

- Raw material containing Flute-Cracks, Gassy, Butt Tears, Splash and Flakes are unacceptable in any degree, as per ASTM E381 Plate-II - Ungraded Series.
- Recovered materials (The term "Recovered Materials" means materials collected or recovered from solid waste and reprocessed to



atleast one-half the cross section of the as-cast material(See Clause 2.1.3).Flanges and other enlargements on forging need not be reduced to this ratio, but shall be reduced in ratio of not less than 1.7 to 1. Where an upsetting operation or expanding on mandrel is employed, no fixed ratio between the as-cast cross sectional area and that of the forging can be specified.In all the cases, approval of sample/product print shall be obtained before bulk production.

All material supplied shall be wrought.

2.2.4 STABILITY :

Material shall be furnished in a condition to withstand, for an indefinite time, exposure to all climatic conditions without developing any internal or external cracks that may develop before material is subjected to reheating (refer (ii) of Clause 2.2.7).

2.2.5 GRAIN SIZE :

The grain size of the forgings as supplied shall fall within the numbers 5 to 8 (inclusive) of ASTM E-112.

The grain structure shall be considered satisfactory if 70% of grains are within the specified grain size limits.

The grain size requirement is applicable to all forgings regardless of cross sectional area.

2.2.6 HEAT TREATMENT :

Heat treatment shall be as specified in the drawing.

2.2.7 FREEDOM FROM DEFECTS :

Forgings shall be free from :

- i) Sub-surface conditions, random conditions and centre segregation exceeding severity levels of S-3,R-2, and C-3 respectively (see Plate I of ASTM E 381).
- ii) Forging defects such as cracks, hot tears, and forging laps/folds-exceeding 3 mm in length.
- iii) Thermal defects such as burnt structure : excessive grain growth (coarser than grain



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become a source of raw material, as opposed to virgin raw material).

c) Used or rebuilt products

NOTE : Sufficient discard shall be made from the bar stock, to secure freedom from piping and undue segregation in the forgings.

2.1.8 SURFACE CONDITIONING :

The raw material (bar/billet/bloom) may be conditioned to remove injurious surface defects, provided the depth of conditioning does not exceed 1.6 mm for each 2 cm of dimension concerned, upto a maximum depth of 19 mm and also provided that the width of the conditioning is at least 4 times its greatest depth. The maximum depth of conditioning on two parallel sides at opposite locations shall not exceed one and half times the maximum allowed for the side. Conditioned area shall be flared to result in a uniform blending.

2.2 FORGINGS :

2.2.1 CONDITION OF SUPPLY :

2.2.1.1 The forgings shall be supplied in normalised condition to a hardness of 201 to 255 BHN and shall be blast cleaned to remove scale and rust. Surface treatment shall be as per PR1029-B - "Rust Preventive Coatings for Castings & Forgings", as applicable to the forging.

2.2.1.2 Raw forgings shall not be machined unless specified in the purchase order. They shall be finish-forged to the shape and size as specified in the forging drawing.

2.2.1.3 Forgings shall be close-trimmed to remove flashes/extra protrusions at the parting line.

2.2.2 FLOW LINE PATTERN :

The flow-line pattern shall be as indicated in the forging drawing and as agreed to on the basis of approved drawing/sample.

2.2.3 REDUCTION FROM CAST STRUCTURE :

Cast billets or ingots or concast bars shall be processed by hot working so that the cross section of the finished forgings is reduced to

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TABLE -2

SCALE OF SAMPLING & PERMISSIBLE NUMBER OF DEFECTIVES FOR
VISUAL, NDT AND DIMENSIONAL CHARACTERISTICS

No. of items in the lot	For Visual Charac- teristics		For NDT & Dimen- sional Characteristics	
	No. of items to be selected	Accep- tance no.	No. of items to be selected	Accep- tance no.
up to 15	5	0	3	0
16 to 25	8	0	5	0
26 to 50	13	1	8	0
51 to 100	20	1	13	0
101 to 150	32	2	20	1
151 to 300	50	3	32	1
301 to 500	80	5	50	2

Note : The associated AQL's (the maximum percent defective that, for the purpose of sampling of steel forgings, can be considered satisfactory as a process average) for visual characteristics and mass/dimensional characteristics are 2.5 and 1.5 respectively. These AQL values will strictly hold good only in case of large lots.

5. DESIGNATION :

Forgings are designated with a 2-digit shape/process code of 98, which follows the 5-digit material code.

Against material column of the Forging drawings, the code to be used shall be E1504-98, which indicates that it is a Forging of E1504 material.

6. RUST PREVENTION :

Refer Company Standard PR1029-B - "Rust Preventive Coatings for Castings & Forgings", for details of rust prevention.

7. PACKING AND MARKING :

Forgings shall be suitably packed to prevent corrosion and damage during transit.

Forgings shall be legibly embossed with Vendor Code, Heat Code and Material Code "B1".



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size ASTM 5), grain boundary oxide & sulphide films, graphitisation and pitted surface

iv) Dendrites extending beyond half-radius from centre

v) Flute cracks, Gassy, Butt tears, Splash, Flakes and Pattern (Ref : Plate II of ASTM E 381).

These defects shall be examined by :

a) Macro-etch of longitudinal & transverse sections as per ASTM A317.

b) Magnetic Particle Test as per IS:7743-1975 - "Recommended Practice For Magnetic Particle Testing & Inspection Of Steel Forgings".

2.2.8 REPAIR OF DEFECTS :

Repair welding is not permitted unless specifically approved by Product Engineering/ Quality Control Department of BEML or their authorised representative.

Defects may be ground or chipped out provided the defective area isaired (blended) into the surrounding area and dimensional tolerances are maintained.

3. DIMENSIONS AND TOLERANCES :

The dimensions and tolerances shall be as specified in the Forging Drawing. Wherever tolerances are not specified, they shall be as per IS:3469 - Parts I to III.

4. SAMPLING & ACCEPTANCE CRITERIA :

Sampling and acceptance shall be as per Tables 1 and 2.

TABLE - 1
SCALE OF SAMPLING FOR CHEMICAL ANALYSIS & HARDENABILITY

No. of items in a lot	No. of items to be selected
up to 50	2
51 to 150	3
151 to 500	5

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TABLE -2

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VISUAL, NDT AND DIMENSIONAL CHARACTERISTICS

No. of items in the lot	For Visual Charac- teristics		For NDT & Dimen- sional Characteristics	
	No. of items to be selected	Accep- tance no.	No. of items to be selected	Accep- tance no.
up to 15	5	0	3	0
16 to 25	8	0	5	0
26 to 50	13	1	8	0
51 to 100	20	1	13	0
101 to 150	32	2	20	1
151 to 300	50	3	32	1
301 to 500	80	5	50	2

Note : The associated AQL's (the maximum percent defective that, for the purpose of sampling of steel forgings, can be considered satisfactory as a process average) for visual characteristics and mass/dimensional characteristics are 2.5 and 1.5 respectively. These AQL values will strictly hold good only in case of large lots.

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8. TEST CERTIFICATE :

This shall be according to clause 10 of Company Standard E1504.

9. REJECTION AND REPLACEMENT :

In the event of any forging proving defective in inspection and testing on receipt at BEML, such forging shall be rejected, not withstanding any previous certification by vendor.

10. CONNECTED STANDARDS :

- a) QY1020-C - "Guidelines for Inspection of Forgings"
- b) PR1029-B - "Rust Preventive Coatings for Castings & Forgings"
- c) DS1069-E - "Identification Codes for Wrought Materials"

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