



## CORPORATE PURCHASE SPECIFICATION

AA 193 32

Rev. No. 10

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**CARBON STEEL FORGINGS, CLASS-3**

↑

**1.0 GENERAL:**

This specification governs the quality requirements of Carbon Steel Forgings, class 3.

↑

**2.0 APPLICATION:**

Suitable for general engineering purposes.

**3.0 CONDITION OF DELIVERY:**

Normalised/Normalised and tempered.

Rough machining of the forgings shall be carried out, unless otherwise specified in the BHEL order/drawing.

**4.0 COMPLIANCE WITH NATIONAL STANDARDS:**

The forgings shall comply, in general with the requirement of the following National standards and also meet the requirements of this specification.

IS::2004: 1991 (RA-2006) } Carbon Steel Forgings For General Engineering

Gr: 3 (30C8), } Purposes.

↑

**5.0 DIMENSIONS AND TOLERANCES:**

The dimensions and tolerances shall be as specified in the order/ drawing. Wherever these are not specified, specified, the machining allowances and tolerances shall be as specified below:

For finish machined drawings :  $3 \pm 1$  mm

For rough machined drawings :  $\pm 1$  mm

Revisions : 36<sup>th</sup> MOM OF MRC FCF+HTM

**APPROVED :**  
INTERPLANT MATERIAL RATIONALISATION  
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**6.0 MANUFACTURE:**

Forgings shall be manufactured from steel produced by the open hearth, electric or such other <sup>↑</sup> process as may be agreed to between BHEL and the manufacturer.

Steel shall be fully killed.

Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1.

For sizes above 250 mm ruling section, the minimum reduction ratio shall be 3.5:1

**Note:** Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate."

**7.0 HEAT TREATMENT:**

Forgings shall be normalised / normalised and tempered at suitable temperature to achieve <sup>↑</sup> the mechanical properties specified.

Test pieces shall also be heat treated along with the forgings they represent.

**8.0 FINISH:**

As mentioned in the drawing.

**9.0 FREEDOM FROM DEFECTS:**

The forging shall be free from defects, such as cracks, fold, flakes, seams, segregation, nonmetallic inclusions and other defects which may affect the utility of the forging.

**10.0 CHEMICAL COMPOSITION:**

The melt analysis of steel and permissible variation in the composition of the forgings from the melt analysis shall be as follows:

Element	Melt analysis, percent		Permissible variation, percent
	Min.	Max.	
Carbon	0.25	0.35	± 0.03
Silicon	0.15	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.040	+ 0.005
Phosphorus	---	0.040	+ 0.005



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**Notes:**

1. Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, max.
Nickel	0.30
Chromium	0.30
Copper	0.25
Molybdenum	0.15
Vanadium	0.05
Tin	0.05
Boron	0.0003

2. When steel is aluminium killed or killed with both aluminium and silicon, the requirements of minimum silicon content shall not apply. For aluminium killed steel the total aluminium content shall be within 0.02 to 0.05 percent.
3.  $Mo \leq 0.15\%$ , limiting to meeting conditions of  $Cr + Mo + Ni = 0.5\%$ .

**11.0 TEST SAMPLES:**

- 11.1 Unless otherwise specified in the order/drawing, test samples shall be taken from each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall not have further heat treatment.

Test samples shall be taken from locations indicated on the drawing, leaving enough material, if required for testing at BHEL's end, integral with forgings.

The samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5mm below the heat treated surface.

- 11.2 When integral test pieces are not called for, a test sample, having similar reduction ratio and heat treatment, as the forgings it represents, shall be provided per heat, per heat treatment batch, for check testing at BHEL, along with the forgings. The samples shall be properly identified and correlated with the Heat/Heat treatment Batch No./ Test Certificate No. Test samples shall be taken, at a distance of 12.5mm below the heat-treated surface.
- 11.3 Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/ configuration does not permit the same, test samples may be taken in the transverse or radial direction.

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## 12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting ruling section of 800 mm. Properties for thicker sections shall be subject to agreement between BHEL and the manufacturer. Test methods are specified below:


- 12.1 Tensile test : IS:1608
- 12.2 Hardness test (Brinell) : IS:1500
- 12.3 Charpy Impact Value (2mm U-Notch) : IS:1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl.11.3)	Limiting ruling section, mm			
		Upto & incl 100	>100 & upto 300	> 300 & upto 500	>500 & upto 800
Tensile strength N/mm <sup>2</sup>	Longitudinal/	490	470	450	450
	Transverse/ Radial/Tangential	490	470	450	450
Yield strength min, N/mm <sup>2</sup>	Longitudinal/	270	245	230	220
	Transverse/ Radial/Tangential	270	245	230	220
Elongation on 5.65 $\sqrt{S_0}$ gauge length percent, min	Longitudinal	21	19	18	17
	Transverse	10	9	8	7
	Radial	14	12	11	10
	Tangential	16	14	13	12
Reduction in area, percent min.	Longitudinal	42	40	35	32
	Transverse	25	24	22	20
	Radial	27	26	24	22
	Tangential	34	32	32	30
*Hardness, Brinell, HB	—	140-192	140-192	135-190	135-190
Charpy Impact Value (2mm, U-Notch) min., Joules	Longitudinal	35	31	27	23
	Transverse	18	16	14	12
	Radial	21	19	17	15
	Tangential	26	23	20	17

**Note:** 1. Unless otherwise stated on the order/drawing, small forgings of non-critical nature weighing less than 300kg shall be accepted on the basis of chemical composition and hardness.

\* 2. Hardness test can be conducted only, when tensile test can not be performed.

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13.0

ULTRASONIC TESTS:

13.1

For forgings ordered by BHEL, Hyderabad: Unless other wise specified on the drawing, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2.

3.13.2

For forgings ordered by other units: If specified on the drawing/order, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2, unless otherwise specified.

14.0

ADDITIONAL TESTS:

If specified in the drawing/order, the following tests shall be conducted:

14.1

Bend Test (Longitudinal):

The test pieces (230mm long and 32 mm square with edges rounded off, where the dimensions permit) shall be capable of being bent cold by direct pressure without fracture, until the sides are parallel, round a mandrel having a diameter of 44 mm when tested as per IS:1599.

14.2

Magnetic particle test.

14.3

Any other tests: Norms of acceptance shall be as specified in the drawing/order.

15.0

SCOPE OF THIRD PARTY INSPECTION:

Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:

1.

Review of supplier's declared chemical composition.

2.

Selection of test samples for mechanical tests and witness of mechanical tests.

3.

Witness of Non-destructive tests as applicable.

4.

Review of HT charts.

5.

Dimensional inspection.

16.0

TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure 1).

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The following details shall be furnished in the test certificate:

i)

Reduction ratio

ii)

Dimensional Inspection.

iii)

Chemical composition including trace elements.

iv)

Results of mechanical tests.

v)


Results of Ultrasonic test

vi)

Details of heat treatment

vii)

Results of additional tests called for in the drawing/order.

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**17.0 PACKING & MARKING:**

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

Machined surfaces shall be properly protected with anticorrosive compounds.

Each package or forging (when supplied separately) shall be legibly marked with the following information:

AA 193 32 : Carbon Steel Forgings, Class 3 ↑

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

**18.0 REFERRED STANDARDS (Latest publications Including Amendments):**

1) AA 085 01 18	2) IS:1499	3) IS:1500	4) IS:1599
5) IS: 1608	6) 2004		



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**ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS**

SUPPLIER'S NAME AND ADDRESS TEST CERTIFICATE FOR FORGINGS														
1. Customer:					9. Reduction Ratio } Ingot to Bloom Bloom to Blank									
2. TC No. & Date:					10. Batch No.:									
3. PO No.:					11. Heat/Melt No.									
4. Process of Melting Ingot:					12. Spec. No.									
5. Deoxidisation Process:					13. Test Bar Size & Nos.									
6. Forging Method:					14. Supplier of the ingot/billet/ Bloom and TC reference.									
7. BHEL's Reference for Approval of Bloom														
8. Discard: Top % Bottom %														
15. FORGINGS COVERED BY TEST CERTIFICATE														
S.No.		Drawing No. & Item No.			Description					Quantity & Weight				
16. CHEMICAL COMPOSITION (PERCENT)														
Element		C	Si	Mn	S	P								
As Per Specn.		Min.												
		Max.												
Actual Values														
17. HEAT TREATMENT (To be accompanied by Recorder Chart, Whenever called for)														
Condition		Heating Rate, °C/hr.		Temp. °C		Soaking Time, Hrs.		Cooling Rate, °C/hr		Cooling Medium				
18. MECHANICAL PROPERTIES														
		T.S. N/mm <sup>2</sup>	Y.S. 0.5/0.2% Proof N/mm <sup>2</sup>	% Elongation 5.65√So GL	% R.A. Min.	Hardness BHN (Min. 3 values)	Impact Value Joules	Bend Test						
								Angle of bend	Dia of mandrel	Result				
As Per Specn.		Min.												
		Max.												
Actual Values														
19. SURFACE FINISH (When called for in the order/drg.)														
20. DIMENSIONAL INSPECTION														
21. NON-DESTRUCTIVE TESTS														
Nature of Test		Acceptance level		Instrument used		Range		Results		Any other detail				
Ultrasonic														
Radiographic														
Dye penetrant/ Magnetic Particle														
22. METALLOGRAPHIC EXAMINATION (To be conducted if called for and photo micrographs to be attached along with a report)														
Location of Sample		Etchant used		Magnification		Constituent observed		Relative %						
Microstructure		Macroetch		Inclusion Rating										
23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)														
24. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC.														
We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.														
SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER DATE:										SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER DATE:				
INSTRUCTIONS														
a) Details of all heat treatment processes carried out should be furnished sequentially in 17.														
b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.														
c) All the entries including signature should be in block colour ink.														
d) If testing is done by outside agencies, the original TCs shall be furnished.														
e) The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.														



# CORPORATE PURCHASING SPECIFICATION

AA10119

Rev No.15

PREFACE SHEET

## STRUCTURAL STEEL - WELDABLE QUALITY (PLATES, SECTIONS, STRIPS, FLATS AND BARS)

FOR INTERNAL USE ONLY

REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

### Equivalent/Comparable Standards:

- 1) IS: 2062 – 2011 : Grade: E250- BR (With impact test)
- 2) DIN EN 10025-2:2005 : Grade: S275JR

### Suggested/Probable Suppliers and Grades:

Refer Plant Vendors List

### User Plants and Replaced Plant Specifications/References:

- 1) HEP, BHOPAL :
- 2) HEEP, HARDWAR :
- 3) HPEP, HYDERABAD :

#### Revisions:

Clause No. 1, 3, 5 & 8 revised (as per MOM of 38th MRC meeting), Clause 10 added

#### APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(S&GPS)

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# CORPORATE PURCHASING SPECIFICATION

AA10119

Rev No. 15

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## STRUCTURAL STEEL - WELDABLE QUALITY (PLATES, SECTIONS, STRIPS, FLATS AND BARS)

### ORDERING DESCRIPTION

#### 1.0 GENERAL:

The material shall conform to IS 2062 – 2011, E250-Gr.BR (with mandatory Impact Test) or DIN EN 10025-2:2005, Gr. S275JR and comply with following additional requirements.

#### 2.0 APPLICATION:

For general engineering purposes, suitable for welding.

#### 3.0 CONDITION OF DELIVERY:

3.1 Bars & Sections shall be supplied in Hot rolled in straight lengths without twists and bends.

3.2 The material shall be supplied as per IS: 2062 – 2011, E250 Gr.BR (with mandatory Impact Test) or as per DIN EN 10025-2:2005 Gr. 275JR.

3.3 Any other additional requirement as per BHEL Purchase order.

#### 4.0 DIMENSIONS AND TOLERANCES:

##### 4.1 Sizes:

Material shall be supplied to the dimensions specified in BHEL Order.

##### 4.2 Tolerances:

The tolerances on hot rolled material shall comply with IS: 1852 or any other equivalent national standard.

##### 4.3 Straightness for hot rolled bars:

Unless otherwise specified, the permissible deviation in straightness shall not exceed 5 mm in any 1000 mm length.

#### 5.0 TEST SAMPLES:

The selection of test pieces for all tests like Chemical, Mechanical etc. shall be as per IS: 2062, E250-Gr.BR or DIN EN 10025-2, Gr. S275JR.

#### Revisions:

Clause No. 1, 3, 5 & 8 revised (as per MOM of 38th MRC meeting), Clause 10 added

#### APPROVED:

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June, 1976

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## 6.0 ULTRASONIC EXAMINATION:

Plates shall be ultrasonically examined in accordance with BHEL standard AA0850120 (or ASTM-A435) as detailed below and shall comply with the acceptance standards specified therein.

### 6.1 For plates above 40 mm thick:

Shall be ultrasonically examined unless when otherwise specified in order.

## 7.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA10119 - Rev.No.15/ IS: 2062-Gr: BR (with mandatory Impact test) or DIN EN 10025-2, Gr. S275JR,

BHEL order No.

Melt No, Size & Quantity, Batch No with heat treatment details, Results of Chemical analysis,

Mechanical tests & NDT, Supplier's name, Identification No, TC No, Signature of Competent Authority, etc.

## 8.0 PACKING AND MARKING:

Plates shall be transported suitably to avoid damage during transit.

Each plate shall be marked with Melt No. Material grade and specification, BHEL Order No, Supplier's Name Identification No, Size & weight, on any one corner and encircled with paint preferably of white colour.

## 9.0 REJECTION AND REPLACEMENT

If the material does not comply with the requirements of this specification during receipt inspection at BHEL or if any defect is found during further processing of material, BHEL reserves the right to reject the whole consignment and the supplier shall replace the material free of cost. The rejected material shall be taken back by the supplier after fulfilling the commercial terms and conditions.

## 10.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1852

2) ASTM - A435

3) AA0850120

	<h1 style="text-align: center;">CORPORATE PURCHASING SPECIFICATION</h1>	AA10108
		Rev No.11
		PREFACE SHEET

## STRUCTURAL STEEL-STANDARD QUALITY (PLATES, SECTIONS, STRIPS, FLATS & BARS)

FOR INTERNAL USE ONLY

REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

### Equivalent/Comparable Standards:

- |             |   |                                       |
|-------------|---|---------------------------------------|
| 1. INDIAN   | : | IS : 2062 – 2011, Gr: E250, Quality A |
| 2. AMERICAN | : | ASTM A131M – 2013                     |
| 3. JAPANESE | : | JIS G3106 – 2008                      |
| 4. EUROPEAN | : | EN 10025 – 2:2004 Gr. S275JR          |

### Suggested/Probable Suppliers and Grades:

- |              |   |                        |
|--------------|---|------------------------|
| 1. M/S TISCO | : | TISTEN 42              |
| 2. M/S SAIL  | : | i) MA 300 HY           |
|              |   | ii) Lloyds, Gr :A      |
|              |   | iii) IS : 2062, Gr : A |

### User Plants and Replaced Plant Specifications/References:

- |                    |   |           |
|--------------------|---|-----------|
| 1. HEP, BHOPAL     | : | PS 10108  |
| 2. TP, JHANSI      | : | PS 10108  |
| 3. HEEP, HARDWAR   | : | 0500.001  |
| 4. HPEP, HYDERABAD | : | HY0210299 |
| 5. HPBP, TIRUCHY   | : |           |

Revisions: As per Cl. No. 38.1 of MOM of MRC-S&GPS			<b>APPROVED:</b> INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(S&GPS)		
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# CORPORATE PURCHASING SPECIFICATION

AA10108

Rev No. 11

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## STRUCTURAL STEEL-STANDARD QUALITY (PLATES, SECTIONS, STRIPS, FLATS & BARS)

### (ORDERING DESCRIPTION)

#### 1.0 GENERAL:

This specification governs the quality requirements of structural steel plates, strips, flats, bars and sections such as angles, beams, channels and tees etc. of IS: 2062 – 2011, Gr: E250, Quality A

#### 2.0 APPLICATION:

For general engineering purpose.

#### 3.0 CONDITION OF DELIVERY:

Plates, Bars & Sections: Hot rolled in straight lengths without twists & Bends

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Material shall comply with the requirements of IS: 2062 – 2011, Gr: E250, Quality A

Material offered to EN 10025-2:2004 Gr. S275JR is also acceptable. The tolerance on dimensions for plates shall comply with EN 10029.

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 DIMENSIONS:

##### 5.1.1 Sizes

Material shall be supplied to the dimensions specified on BHEL Order.

##### 5.1.2 Length

Unless otherwise specified, hot rolled bars and sections shall be supplied in 3 to 6 metres length.

##### 5.2 Tolerances:

5.2.1 The tolerances on hot rolled material shall comply with IS: 1852. However, no plate shall be under the specified thickness at any point.

Revisions:  
As per Cl. No. 38.1 of MOM of MRC-S&GPS

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AA10108

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# CORPORATE PURCHASING SPECIFICATION



## 5.2.2 Straight for hot rolled bars:

Unless otherwise specified, the permissible deviation in straightness shall not exceed 5 mm in any 1000 mm length.

## 6.0 HARDNESS (BRINELL):

When tested in accordance with IS: 1500, the material shall show a brinell hardness in the range of 120-156 HB.

Note: Hardness test shall be conducted only when tensile test cannot be performed.

## 7.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information.

AA10108 Rev.11 / IS:2062 Grade: E250 Quality A / EN 10025-2 Gr. S275JR,

BHEL order no., Melt no. Size, Results of chemical analysis and Mechanical tests, Supplier's name, Identification no. TC no., Signature of competent authority etc.

## 8.0 PACKING AND MARKING:

Plates shall be transported suitably to avoid damage during transit.

For plates below 10 mm thick, each pile (preferably of 16 plates) and each plate 10 mm thick & over shall be marked with melt no. AA10108, BHEL order no., Supplier's name, Identification no., Size & weight on any one corner and encircled with paint preferably of white colour.

## 9.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1500

2) IS: 1852

3) EN 10029



# CORPORATE STANDARD

AA 085 01 33

Rev. No. 02

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## PROCEDURE FOR MAGNETIC PARTICLE EXAMINATION

### 1.0 SCOPE:

- 1.1 This standard outlines the procedure for magnetic particle examination of ferro-magnetic materials.
- 1.2 Typical surface and subsurface discontinuities detectable by this method are cracks, seams, laps, cold shut, inclusions, etc.
- 1.3 This shall be applied to all forms of ferromagnetic material as formed and semifinished as well as, finished state, such as welds, forgings, castings, etc.
- 1.4 This standard is generally based on ASTM E 709.

### 2.0 PERSONNEL REQUIREMENT:

Personnel performing non-destructive examination and evaluation shall be qualified to the recommended practice SNT-TC-1A or any other recognised practice.

### 3.0 TEST METHOD:

Finely divided magnetic particles are applied to the surface of a part which has been suitably magnetised. The particles are attracted to regions of magnetic non-uniformity associated with defects and discontinuities, thus producing indications which are observed visually. The magnetic particle is applied either as dry powder or in a wet suspension in a liquid medium.

### 4.0 SURFACE CONDITION/PREPARATION:

The surface being inspected shall be clean and dry. It shall be free from dirt, oil, grease, sand, rust or loose scale. As cast or as welded surfaces are generally satisfactory if clean. A pressure blast is useful for this purpose. Thin paint does not interfere with the formation of indications but must be removed at points where electrical contact is to be made. If the surface is unusually rough, such as with burned in sand or very rough weld bead, interpretation may be difficult because the particle is being trapped mechanically. In case of doubt, light grinding may be necessary to determine if actual indications are present.

Revision: C1 12.8.8 of MOM of WG-NDT			Approved: INTERPLANT STANDARDIZATION COMMITTEE - (WG-NDT)		
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Dt. 15-12-97	Dt.	Year:	HYDERABAD	CORP. R&D	Sept. '79



AA 085 01 33

Rev. No. 02

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## CORPORATE STANDARD

**5.0 SEQUENCE OF OPERATION:****5.1 Method Of Examination:**

Examination shall be generally carried out by the continuous method, i.e., the magnetising current remains on, while the examination medium is being applied and excess being removed.

**5.2 Magnetisation:**

Any suitable and appropriate means for establishing the necessary magnetic flux may be employed, such as passing current through the material (e.g. 'Prod' method) using magnetic yoke, or wrapping the part with a coil through which a magnetising current is passed.

**5.3 Examination Medium:**

**5.3.1** The finely divided ferromagnetic particles used for detection of discontinuities shall be of fine grain and the same shall be of high permeability and low retentivity. It shall be of dry powders (Fluorescent and nonfluorescent) ready for use, as supplied or powder concentrates (Fluorescent and non-fluorescent) for dispersion in water or suspending light petroleum distillates.

**5.3.2 Dry Particles:**

When dry particles are used, they shall be sprayed either by a low pressure pneumatic instrument or hand operated bulb blower. Colour of the powder shall be such as to provide adequate visual contrast with the back ground of the surface being examined. The temperature of the surface of the part under examination shall not exceed 315°C (600°F). Adequate lighting should be provided for easy observation of the indication. Some coloured organic coatings applied to dry particles to improve contrast lose their colour at higher temperatures. Fluorescent dry particles shall not be used at this high temperature. Manufacturer's recommendations for temperature limitation shall be followed.

**5.3.3 Wet Particles:**

When wet particles are used, the solid magnetic particles shall be suspended in a suitable liquid medium. The concentration of the particles in the liquid medium shall be 0.2 to 0.4 ml in a 100ml sample for fluorescent particles and from 1.2 to 2.4 ml in a 100 ml for non-fluorescent particles unless otherwise specified by the particle manufacturer.

**5.3.4 Fluorescent Particles:**

IT/

**5.3.4.1** The fluorescent particle examination shall be performed using a black light in a darkened area.

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5.3.4.2 The black light used for fluorescent particle testing shall be capable of developing the wave length of 365nm., in any case the wave length should be in the range of 330 to 390nm. with an intensity of not less than 1000 uw/cm<sup>2</sup> on the surface of the part.

5.3.4.3 The black light shall be allowed to warm up for a minimum of 5 min. prior to its use or measurement of the intensity of the ultraviolet light emission.

5.3.4.4 The examiner shall be in the darkened area for atleast 5 min. prior to examining the parts using black light so that his eyes will adopt to dark viewing. Photochromic or permanently tinted lenses shall not be worn during examination.

5.3.4.5 The black light intensity shall be measured with a black light meter at least once every 8 hours and whenever the work station is changed.

5.4 Orientation of Discontinuities And Examination Coverage:

Examination shall be conducted with sufficient overlap to ensure cent percent coverage at established test sensivity. To ensure most effective detection of discontinuities each area shall be examined at least twice with the lines of flux approximately perpendicular to each other.

5.5 Demagnetisation:

Demagnetisation following examination shall be carried out where residual magnetism can interfere with subsequent process or usage. Demagnetisation is not normally required on the type of parts where the dry powder Prod magnetisation is used.

6.0 METHODS OF MAGNETISATION:

6.1 Prod Method:

6.1.1 Magnetising Technique:

6.1.1.1 Magnetisation shall be accomplished by portable Prod type electrical contacts pressed against the surface in the area to be examined. To avoid arcing, a remote control switch may be provided to permit the current to be turned on after the prods have been properly positioned and turned off before they are removed.

6.1.2 Prod Spacing:

Prod Spacing shall be maximum of 200 mm. Shorter spacing may be used to meet the limitation of geometry or dimensions of the area being examined, or to increase the sensitivity, but prod spacing less than 75 mm usually is not recommended owing to banding of the particles around the prods.

**6.1.3 Magnetising Current:**

Alternating, direct or rectified magnetising current shall be used. The current shall be 90 to 110 A per 25mm. of prod spacing for sections less than 19mm. thick and 110 to 125 A per 25mm. prod spacing for sections 19mm. and greater.

6.1.4 Prod shall be kept free of iron pick up by frequent filing. Local areas of metal being tested which have been subjected to arcing shall be ground to clean metal wherever necessary.

**6.2 Coil Method:****6.2.1 Magnetising Technique:**

Magnetisation shall be accomplished by pressing current through a multiturn coil looped around the part or section of the part to be examined to produce a magnetic field parallel to the axis of the coil.

**6.2.2 Magnetising Current:****6.2.2.1 Encircling Coils:**

There are four empirical longitudinal magnetization formulas for using encircling coils, the formula to be used depending on the fill factor.

**6.2.2.1.1 Low Fill Factor Coils:**

In this case, the cross sectional area of the fixed encircling coil greatly exceed the cross sectional area of the part (Less than 10% coil inside diameter). The part shall be placed well within the coils and close to the inside wall of the coil. For parts with length over diameter ratio (L/D) between 3 and 15 is calculated from the following equations.

- (1) Parts with low fill factor positioned closed to the inside wall of the coil:

$$= \frac{45,000}{L/D} \text{ Ampere Turns } (\pm 10\%)$$

- (2) Parts with a low fill factor positioned in the center of the coil:

$$= \frac{43,000 \times R}{(6 L/D) - 5} \text{ Ampere Turns } (\pm 10\%)$$



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## 6.2.2.1.2 Intermediate Fill Factor Coils:

When the cross section of the coil is greater than twice and less than ten times the cross section of part being examined.  

$$= (NI) hf (10-4) + (NI) lf (4-2)/8$$

Where

NIhf = Value calculated for high fill factor coils using  

$$\frac{35000}{(L/D) + 2} (10\%)$$

NIlf = Value Calculated for low fill factor coils using  

$$\frac{43,000 \times R}{(L/D) - 5} (10\%)$$

Where R = Coil Radius

Y = Ratio of the cross sectional area of the coil to the cross section of the part.

For example if the coil has an inside diameter of 24 cm. and part ( a bar) has outside diameter of 12 cm.

$$Y = \frac{n(12)^2}{n(6)^2} = 4$$

## 6.2.2.1.3 High Fill Factor Coils:

In this case, when fixed coils or cable wraps used and the corss sectional area of the coil is less than twice the corss sectional area (Including hollow portions) of the part, the coil has a high fill factor.

For prats with in a high fill factor positional coil and for parts with L/D ratio equal or greater than 3.

$$= \frac{35,000}{(L/D)+2} \text{ Ampere turns } (\pm 10\%)$$

L/D ratio for a hallow piece: When calculating L/D ratio for a hollow piece, D shall be replaced with an effective diameter Deff. Calculated using.

$$Deff. = [(At - Ah)/n]^{\frac{1}{2}}$$

Where

At = Total cross section area of part

Ah = Cross sectional area of hollow portion(s) of the part.

For a cylindrical piece this is equivalent to

$$Deff. = [(OD)^2 - (ID)^2]^{\frac{1}{2}}$$

Where

OD = Outside diameter of cylinder

ID = Inside diameter of cylinder.

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## 6.2.2.2 Through Coils:

For through coils the current specified in para 6.3.2 divided by number of turns shall be used.

## 6.3 Direct Contact Method:

## 6.3.1 Magnetising Technique:

Magnetising shall be accomplished by passing current end to end through the part to be tested to produce a circular magnetic field perpendicular to the current flow through the part.

## 6.3.2 Magnetising Current:

Direct or rectified current shall be used at 280 to 360 amperes per centimeter of part for diameter upto 125 mm; 200 to 280 amperes per centimeter of part for diameter greater than 250mm.

(Note: A different means of magnetising shall be used for the second examination to fulfil the requirements specified in Cl.5.4).

## 6.4 Yoke Method:

## 6.4.1 Application:

This method shall be used only to detect surface discontinuities which actually come to the surface.

## 6.4.2 Magnetising Technique:

6.4.2.1 Alternating current electromagnetic yoke shall be used to magnetise, provided the yoke has a lifting power of at least 4.5 Kg and a pole spacing of 75 to 150 mm.

6.4.2.2 Alternatively direct current electromagnetic or permanent magnetic yoke shall be used to magnetise, provided the yoke has a lifting power of at least 18 kg and a pole spacing of 75 to 150 mm.

## 6.5 Threading Bar and Coil Technique:

6.5.1 If the part is hollow, flaws in a longitudinal direction may be detected by passing the magnetising current through a bar or cable held within the bore of the part. Alternatively a threading coil may be used.

6.5.2 The current strength shall be equivalent to not less than 10500 ampere turns (a.c; r.m.s value) or 15000 ampere turns (d.c.) per metre of the maximum distance of the bar cable from the surface of the bore of the part.



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6.5.3 Because of limitations of the equipment, it may be necessary to magnetise the part at several positions within the bore, with the bar or cable lying on the bore surface, in which case the distance between spacing of the conductor or coil for successive checks shall not be greater than 100 mm.

**Note:** Magnetising particle field indicator shall be used to establish adequacy of the magnetic field.

## 7.0 CALIBRATION:

Calibration of the ammeter shall be done as per BHEL Standard AA 085 01 59.

## 8.0 EVALUATION OF INDICATIONS & INTERPRETATION:

8.1 If the indication is caused by the surface discontinuity the particles are usually tightly held to the surface by a relatively strong magnetic leakage field. The line of particles will be sharp and well defined.

8.2 If the indication is caused by surface discontinuity, the particles are held in a broad fuzzy accumulation rather than being sharp and well-defined.

8.3 Non-relevant indications are caused by distortion of magnetic field resulting from magnetic writing, cold working, hard and soft spots, boundaries of heat affected zone, abrupt change of section, etc. Care shall be taken to identify and eliminate them as they may mask the actual defect.

8.4 Relevant indications are those which result from mechanical discontinuities. Linear indications are those in which the length is more than three times the width. Rounded indications are indications in which are circular or elliptical with the length less than three times the width.

## 9.0 REFERRED STANDARDS (Latest Publication Including Amendments):

1. ASTM E 709

2. BHEL CS AA 085 01 59



267714/2024/HEP-TXM20500



## REAFFIRMATION - NOTIFICATION

AA 0850134

REV. \_

AA 0850134: EVALUATION AND ACCEPTANCE  
STANDARD FOR MAGNETIC PARTICLE  
EXAMINATION OF CASTINGS

This Standard is "Reaffirmed 1992".

REF:

Cl. 7.13 of MOM of WG(NDT)

APPROVED

WG(NDT)

ISSUED

Corp. R&amp;D

DATE

Dec. '92

CUM. SR. NO.

R 0882



# EVALUATION AND ACCEPTANCE STANDARD FOR MAGNETIC PARTICLE EXAMINATION OF CASTINGS

## 1.0 SCOPE:

1.1 This standard is applicable for Magnetic Particle Examination of Castings.

1.2 The procedure adopted for this examination is as per Corporate Standard AA 085 01 33

## 2.0 DEFINITION OF INDICATIONS:

2.1 Circular indications are those more or less elliptical with major axis not more than three times the minor axis.

2.2 Linear indications are those having length in excess of three times average width.

2.3 In-line indications are those in group of three or more indications aligned side by side in line with intervening gaps of less than 2mm measured edge to edge.

## 3.0 EVALUATION OF INDICATIONS:

3.1 Discontinuities and defects will be indicated by the retention of magnetic particles. All such indications are not necessarily defects, since exclusive surface roughness, magnetic permeability variations and machining marks may also produce similar indications.

3.2 Any indication suspected to be non-relevant is to be considered relevant till it is proved otherwise.

3.3 Broad areas of particle accumulation which could mask indications or discontinuities are unacceptable and those areas shall be cleaned and re-examined.

3.4 Relevant indications are those which results from unacceptable mechanical discontinuities.

## 4.0 ACCEPTANCE STANDARD:

5.1 Castings are classified into four levels as detailed below according to the size and number of flaws permissible.

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Revision

Approved :

INTERPLANT NON-DESTRUCTIVE TESTING COMMITTEE

Prepared

Issued

Date

Date

Corp. R&D

CORP : R & D

10 SEPT 79





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Level	No. & size of acceptable indications per 100 sq. cm. area and length not exceeding 25 cm.	Unacceptable indications.
1	2 Nos. of 3mm long indication.	Cracks & hot tears.
2	3 Nos. of 3mm long indication. One of 5mm long indication.	-do-
3	3 Nos. of 3mm long indication. 2 Nos. of 4mm long indication. One of 6mm long indication. One in line indication of - (10mm Max.lgth. )	-do-
4	4 Nos. of 3mm long indication. 3 Nos. of 4mm long indication. 2 Nos. of 8mm long indication. One in line indication of - (15mm Max.lgth. )	-do-

Note: The minimum permissible distance between any two or more acceptable individual flaws shall not be less than the major dimension of the larger flaw.