



## CORPORATE PURCHASING SPECIFICATION

AA 195 11

Rev. No. 09

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**CARBON STEEL CASTINGS-FUSION WELDING QUALITY****1.0 GENERAL**

This specification governs the quality requirements of Carbon Steel Castings-Fusion Welding Quality.

**2.0 APPLICATION**

For pressure containing parts for high temperature service and of quality suitable for assembly with other castings or wrought steel parts by fusion welding.

**3.0 CONDITION OF DELIVERY**

Normalised / Normalised & tempered

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

Castings shall not be painted

**4.0 COMPLIANCE WITH NATIONAL STANDARDS**

There is no Indian standard covering this material. However, assistance has been derived from ASTM A 216-1993, Gr: WCC, in preparing this specification.

**5.0 DIMENSIONS AND TOLERANCES**

The castings shall be true to the pattern/drawing.

Holes for machining up to and including 50 mm in diameter are to be cast solid, unless otherwise stated in BHEL order/drawing.

Unless otherwise specified in BHEL order/drawing, untoleranced dimensions for the castings shall be as per tolerance class 4 of BHEL standard AA 023 04 02.

**Revisions :**

36<sup>th</sup> MOM of MRC-FCF+HTM

**APPROVED :**

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE-MRC (FCF+HTM)

Rev. No. 09

Amd.No.

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Prepared  
HYDERABAD


Issued  
Corp. R&D

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Dt :

Year:04-11-2011

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**6.0 MANUFACTURE**

The steel for the castings shall be made by basic electric furnace process or such other process as may be agreed to between BHEL and the manufacturer.

The steel shall be fully killed.

**7.0 HEAT TREATMENT**

Heat treatment shall be carried out at suitable temperatures to give the properties specified.

Any flame or arc cutting which may have to be done, shall be carried out before heat treatment.

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

**8.0 FINISH**

All castings shall be properly fettled and dressed and all surfaces shall be thoroughly cleaned.

Machined surfaces shall have the surface finish as indicated in the drawing

**9.0 FREEDOM FROM DEFECTS**

Castings shall be free from defects such as porosity , blow holes, sand inclusion, shrinkage, cavities, hard spots, cold shuts, cracks, etc., which may adversely affect machining and utility of castings.

When it is necessary to remove risers by flame cutting, care shall be taken to make the cut at a sufficient distance from the body of the casting so as to prevent any defect being introduced into the casting due to local heating.

**10.0 CHEMICAL COMPOSITION**

The melt analysis of steel and the permissible variation in the composition of the castings from the melt analysis shall be as specified below:

Element	Melt analysis, Percent, max	Permissible Variation, percent
*Carbon	0.25	0.02
Silicon	0.60	0.05
*Manganese	1.20	0.06
Sulphur	0.045	0.008
Phosphorus	0.040	0.008

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**Note:** 1. In the interest of uniform welding, the concentration of the unspecified alloying elements shall not exceed the limits specified below. Whenever specified in the enquiry/order, the test results of these elements shall also be included in the test certificate. However, the manufacture shall ensure that these elements are within the limits specified.

Element	Percent, Max.
Copper	0.30
Nickel	0.50
Chromium	0.50
Molybdenum	0.20
Vanadium	0.03

1. Total content of these unspecified elements 1.00

2. For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% Mn above the maximum specified will be permitted up to a maximum of 1.40%.

**11.0 TEST SAMPLES**


Manufacturers shall carryout mechanical testing as per following sampling plan.

**11.1** Unless otherwise specified for castings weighting up to 500 kg. piece weight one keel block, separately cast per melt per heat treatment batch shall be supplied according to the sketch given below:

**11.2** Unless otherwise specified castings weighing more than 500 kg shall be provided with integrally cast keel block.

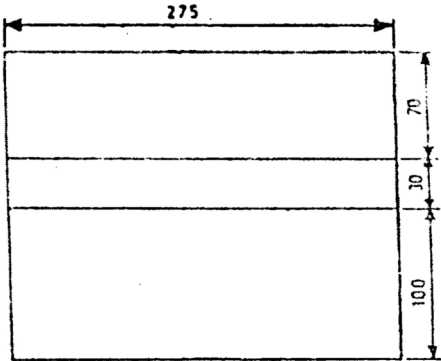
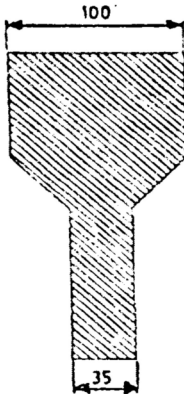
**11.3** Retests shall be carried out as per IS : 8800

**11.4** Keel blocks with proper identification and representative of the castings shall be supplied along with the consignment for testing at BHEL works.

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**DETAIL OF KEEL BLOCK**

**ALL DIMENSIONS IN mm**

**12.0 MECHANICAL PROPERTIES:**

The test pieces, after being heat treated as per clause CI.7.0 above, shall show the following properties:

**12.1 Tensile**

The test pieces shall show the following properties when tested in accordance with ASTM A 370

Tensile strength	:	485 - 655 N/mm <sup>2</sup>
Yield strength	:	275 N/mm <sup>2</sup> , min.
Elongation on 50mm gauge length	:	22 percent, min.
Reduction in area	:	35 percent, min.

**12.2 Hardness (Brinell): for information only:**

150 - 205 HB.


**13.0 NON-DESTRUCTIVE TESTS:**

The following tests shall be conducted:

- 1) Ultrasonic examination to BHEL standard AA 085 01 04 / AA 085 01 05
- 2) Liquid penetrate examination to BHEL standard AA 085 0131.
- 3) Magnetic particle examination to BHEL standard AA 085 01 33 and norms of acceptance as per BHEL standard AA 085 01 34.

Norms of acceptance shall be as specified in BHEL order/drawing



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**14.0 REPAIR OF CASTINGS**

The manufacturer without the prior permission of BHEL shall not carry out repair of castings.

**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 CERTIFICATES**

Three copies of test certificates shall be supplied unless otherwise stated in BHEL 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 test certificate shall bear the following information:

- i) Dimensional inspection.
- ii) Detail of heat treatment
- iii) Chemical composition & unspecified alloying elements whenever called for
- iv) Results of mechanical tests
- v) Results of NDT tests.

**17.0 PACKING AND MARKING**

Castings shall be suitably packed to prevent corrosion and damage during transit. Machined surfaces shall be properly protected with anticorrosive compounds. Each package or casting (when supplied separately) shall be legibly marked with the following information.

AA 195 11: C.S. Castings - F.W. Quality  
 BHEL Order No.  
 Consignment/Identification No.  
 Melt No.  
 Weight  
 Supplier's Name

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

1. AA 023 04 02	2. AA 085 01 04	3. AA 085 01 05	4. AA 085 01 31
5. AA 085 01 34	6. ASTM A 216	7. ASTM A 370	8. IS : 8800

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### ANNEXURE 1 - RECOMMENDED TEST CERTIFICATE FORMAT FOR CASTINGS

SUPPLIERS'S NAME AND ADDRESS														
1. Customer :							6. Cast No. & Date :							
2. TC No. & Date :							7. Batch No. :							
3. PO No. :							8. Heat Code :							
4. Process of Melting :							9. Spec.. No. :							
5. Deoxidisation Process							10. Test Bar Size							
II. CASTING COVERED BY T.C.														
St. No.	Drawing No. & Item No.					Description				Quantity & Weight				
12. CHEMICAL COMPOSITION (PERCENT)														
Element	C	SI	Mn	S	P									
As per Min.														
Spec. Max..														
Actual Values.														
13. HEAT TREATMENT (To be accompanied by Recorder Chart, wherever called for)														
Condition	Temp. °C				Soaking Time. Hrs..				Cooling Medium					
14. MECHANICAL PROPERTIES														
	T.S. N/mm2	Y.S. 0.5/0.2% Proof N/mm2	% E on GL 5.65 SO	% R.A. Min	Hardness BHN Min. 3 Values	Impact Value, Joules	Bend							
As per Min.														
Spec. Max.														
Actual Values.														
15. Surface Finish (When called for in the order/drg)														
16. DIMENSIONAL INSPECTION														
17. NON-DESTRUCTIVE TESTS														
Nature of Test	Acceptance Level	Instrument used	Range	Results	Any other details									
Ultrasonic														
Radiographic														
Dye Penetrant/ Magnetic Particle														
18. OTHER TESTS, IF ANY (MICRO- Scopic, Hydraulic, Etc.)														
19. IDENTIFICATION ON CASTING AS PER CPS.														
<p style="text-align: center; font-size: small;">We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with the drawings, specifications and purchase order.</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p style="font-size: x-small;">Signature &amp; Seal of the Inspecting Officer (Purchase Representative)</p> <p style="font-size: x-small;">Date :</p> </div> <div style="width: 45%;"> <p style="font-size: x-small;">Signature and Seal of the Chief of Quality Control Chief Metallurgist of the Supplier.</p> <p style="font-size: x-small;">Date :</p> </div> </div> <p style="font-size: x-small; margin-top: 5px;"><b>INSTRUCTION:</b></p> <p style="font-size: x-small;">a) If steel is produced by LD or Oxygen process, Nitrogen content should be furnished and shall not exceed 0.009%</p> <p style="font-size: x-small;">b) Test Certificates are to be furnished as per Purchase Order and Specifications, in A4 Size transparent paper.</p> <p style="font-size: x-small;">c) All the entries including signature should be in black ink.</p> <p style="font-size: x-small;">d) If testing is done by outside agencies, the original TCs shall be furnished.</p> <p style="font-size: x-small;">e) The actual Test Certificate may run into more than one A4 size paper, if needed, to facilitate filling up of details.</p>														



# CORPORATE PURCHASING SPECIFICATION

AA19731

Rev No. 04

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## MALLEABLE IRON CASTINGS - BLACKHEART

### 1.0 GENERAL:

This specification governs the quality requirements of Blackheart Malleable Iron Castings, having a tensile strength of 350 N/mm<sup>2</sup>, minimum.

### 2.0 APPLICATION:

Suitable for general engineering purposes.

### 3.0 CONDITION OF DELIVERY:

Heat treated (malleableized).

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

Castings shall not be painted.

### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Castings shall comply with the requirement of the following national standard and also meet the requirements of this specification.

IS: 14329 – 1995 : Malleable Iron Castings.

Gr.:BM 350

### 5.0 DIMENSION AND TOLERANCES:

Castings shall be true to the pattern / drawing.

Holes for machining up to including 60mm in diameter are to be cast solid, unless otherwise stated in BHEL order / drawing.

Untoleranced dimensions, weights, etc., for the casings shall be as per BHEL standard AA0230402.

### 6.0 MANUFACTURE:

The method of manufacture, its chemical composition and heat treatment is left to the discretion of the manufacturer.

Revisions:

Cl 30.8.34 of MOM of MRC-(FC&amp;F+HTM)

APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(FCF+HTM)

Rev No.04

Amd No.

Reaffirmed

Prepared

Issued

Dt. of 1<sup>st</sup> Issue

Dt:01-10-2005

Dt:

Year:2014

HEP, Bhopal

Corp.R&amp;D

April, 1978

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## 7.0 HEAT TREATMENT:

All castings along with the samples shall undergo malleableizing heat treatment in order to achieve the mechanical properties specified.

## 8.0 FINISH:

All castings shall be properly fettled and dressed and all surfaces shall be thoroughly cleaned. The machined surfaces shall have the surface finish as indicated in the drawing.

## 9.0 FREEDOM FROM DEFECTS:

Castings shall be free from defects such as porosity, blow holes, sand inclusions, shrinkage, cavities, hard spots, cold shuts, cracks, etc., which may adversely affect machining and utility of castings.

## 10.0 CHEMICAL COMPOSITION:

The phosphorus or iron content shall not be more than 0.12, percent.

## 11.0 TEST SAMPLES:

Selection and heat treatment of test samples shall be in accordance with IS:14329

## 12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties:

### 12.1 Tensile:

When tested in accordance with IS:1608, the test pieces shall show then following properties:

Tensile strength : 350 N/mm<sup>2</sup>, min.

0.2% Proof stress : 200 N/mm<sup>2</sup>, min.


Elongation Lo=3D : 10 percent, min.

### 12.2 Hardness (Brinell): IS:1500

150 HB, maximum.

## 13.0 MICROSTRUCTURE:

The material shall be free from primary graphite and shall not contain free cementite or pearlite in a form or amount detrimental to the physical properties or machinability of the castings.

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<p><b>14.0 NON-DESTRUCTIVE TEST:</b></p> <p>Magnetic particle inspection:</p> <p>As per BHEL standard AA0850133 and norms of acceptance as per BHEL standard AA0850134 at level 2</p> <p><b>15.0 ADDITIONAL TESTS:</b></p> <p>If specified in the drawing/order, castings shall be subjected to following tests:</p> <p><b>15.1 Hydraulic Test:</b></p> <p>Norms of acceptance shall be as specified in BHEL order/drawing.</p> <p><b>15.2 Any other Tests:</b></p> <p>Norms of acceptance shall be as per mutual agreement between BHEL and the manufacturer.</p> <p><b>16.0 REPAIR OF CASTINGS:</b></p> <p>Repair of castings shall not be carried out by the manufacturer without the prior permission of BHEL.</p> <p><b>17.0 TEST CERTIFICATES:</b></p> <p>Three copies of test certificates shall be supplied unless otherwise stated in BHEL order, preferably in the test certificate format annexed to this specification (Annexure -1).</p> <p>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.</p> <p>The test certificate shall bear the following information:</p> <ul style="list-style-type: none"><li>Dimensional inspection.</li><li>Details of heat treatment.</li><li>Reduction ratio</li><li>Chemical composition.</li><li>Microstructure</li><li>Results of mechanical and NDT tests</li></ul> <p>Results of additional tests called for in the order / drawing.</p>		

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**CORPORATE PURCHASING  
SPECIFICATION****18.0 PACKING AND MARKING:**

Castings shall be suitably packed to prevent corrosion and damage during transit. Machined surfaces shall be properly protected with anticorrosive compounds.

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

AA19731: MALLEABLE IRON CASTINGS - BLACKHEART

BHEL Order No.:

Consignment/Identification No.;

Melt No.

Weight

Supplier's Name

**19.0 REFERRED STANDARDS (Latest publications including amendments):**

1. AA0230402

2. AA0850133

3. AA0850134

4. IS:1500

5. IS:1608

6. IS:14329



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## ANNEXURE – 1

## RECOMMENDED TEST CERTIFICATE FORMAT FOR CASTINGS

SUPPLIERS'S NAME AND ADDRESS														
1. Customer :						6. Cast No. & Date :								
2. TC No. & Date :						7. Batch No. :								
3. PO No. :						8. Heat Code :								
4. Process of Melting :						9. Spec.. No. :								
5. Deoxidisation Process						10. Test Bar Size								
II. CASTING COVERED BY T.C.														
Sl. No.	Drawing No. & Item No.					Description				Quantity & Weight				
12. CHEMICAL COMPOSITION (PERCENT)														
Element	C	SI	Mn	S	P									
As per Min.														
Spec. Max..														
Actual Values.														
13. HEAT TREATMENT (To be accompanied by Recorder Chart, wherever called for)														
Condition		Temp. °C			Soaking Time. Hrs..				Cooling Medium					
14. MECHANICAL PROPERTIES														
	T.S. N/mm2	Y.S. 0.5/0.2% Proof N/mm2	% E on GL 5.65 SO	% R.A. Mn	Hardness BHN Mn. 3 Values	Impact Value, Joules	Bend							
As per Min.														
Spec. Max.														
Actual Values.														
15. Surface Finish (When called for in the order/drg)														
16. DIMENSIONAL INSPECTION														
17. NON-DESTRUCTIVE TESTS														
Nature of Test	Acceptance Level	Instrument used		Range		Results		Any other details						
Ultrasonic														
Radiographic														
Dye Penetrant/ Magnetic Particle														
18. OTHER TESTS, IF ANY (MICRO- Scope, Hydraulic, Etc.)														
19. IDENTIFICATION ON CASTING AS PER CPS.														
<p>We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with the drawings, specifications and purchase order.</p> <p>Signature &amp; Seal of the Inspecting Officer (Purchase Representative)</p> <p>Date :</p> <p>INSTRUCTION:</p> <p>a) If steel is produced by LD or Oxygen process, Nitrogen content should be furnished and shall not exceed 0.009%  b) Test Certificates are to be furnished as per Purchase Order and Specifications, in A4 Size transparent paper.  c) All the entries including signature should be in black ink.  d) If testing is done by outside agencies, the original TCs shall be furnished.  e) The actual Test Certificate may run into more than one A4 size paper, if needed, to facilitate filling up of details.</p>														
<p>Signature and Seal of the Chief of Quality Control Chief Metallurgist of the Supplier.</p> <p>Date :</p>														

414851/2024/HEP-TXM20500



REAFFIRMATION - NOTIFICATION

AA 085 01 31 Rev.No.02

AA 085 01 31: PROCEDURE FOR LIQUID PENETRANT EXAMINATION

This standard is "Reaffirmed 1998." ✓

Please see instructions on the reverse

Ref:	Approved	Issued	Date	Cum.Sl.No.
Cl: 13.6.20 OF MOM OF WG-NDT	WG-NDT	CORP.R&D	15.12.98	R 2440



414851/2024/HEP-TXM20500



## AMENDMENT -- NOTIFICATION

AA 085 01 31 REV.02

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AA 085 01 31: PROCEDURE FOR LIQUID PENETRANT EXAMINATIONCl.1.3: This clause should be modified as below:

"This standard confirms substantially with ASTM E165 and ASME code Section V, Article 6."

✓

REF:  
Cl.8.12 of MOM OF WG(NDT)

AMD. NO.  
01

APPROVED  
WG(NDT)

ISSUED  
Corp.R&D

DATE  
June '93

CUM.SR.NO.  
A 1279

PROCEDURE FOR LIQUID PENETRANT EXAMINATION1.0 SCOPE:

1.1 This standard details the procedure for liquid penetrant examination of non-porous ferrous and non-ferrous and non-metallic materials such as ceramics, plastics, glass, etc.

1.2 Typical surface discontinuities detectable by this method are cracks, seams, laps, cold shots, porosity, laminations, etc.

1.3 This standard conforms substantially with ASTM E 165 - 1980 (Reapproved 1983) and ASME code section V, Article 6.

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 DESCRIPTION:

In principle a liquid penetrant is applied to the surface to be examined and allowed to enter discontinuities, excess penetrant removed, the part dried and a developer applied. The developer functions both as a blotter to absorb penetrant that has been trapped in discontinuities and as a contrasting back ground to enhance the visibility of penetrant indications.

4.0 APPROVED METHODS & MATERIALS:

4.1 Either a colour contrast or fluorescent penetrant method may be used. Any one of the following penetrants shall be used:

- (a) Solvent Removable
- (b) Post Emulsifying
- (c) Water Washable

4.2 For nickel base alloys and/or for stainless steel materials used in nuclear components the penetrant materials, cleaner, penetrant developer, etc., used shall not contain sulphur or halogen above 1% by weight.

4.3 Selection of liquid penetrant material shall be from the same family (brand). Inter-mixing of family of liquid penetrant materials is not allowed.

5.0 PROCEDURE:5.1 Surface Preparation:

## Revisions:

Cl.7.10 of MOM of WG(NDT)

INTERPLANT  
STANDARDIZATION COMMITTEE - WG  
(NDT)

## Rev. No.

02

## Rev. Date

NOV. '92

## Revised:

CORP. R&amp;D

## Prepared

CORP. R&amp;D

## Issued

CORP. R&amp;D

## Date

Issue:  
SEP. '79



- 5.1.1 Surface preparation by grinding or machining or other method may be employed where surface irregularities may mask indications of unacceptable discontinuities.
- 5.1.2 The surface to be examined and all adjacent areas within at least 25 mm shall be dry and free from any dirt, lint, scale, rust, welding flux, weld spatter, grease, oil or other extraneous matter that could obscure surface openings or otherwise interfere with examination.
- 5.1.3 The surface to be examined shall be cleaned with detergents, organic solvents, descaling solutions or paint removers. Degreasing and ultrasonic cleaning may be employed to increase cleaning efficiency. Cleaning method employed is an important part of the examination procedure. Cleaning solvents shall meet the requirements of Cl.4.2.

**Caution:** Blasting with shot or dull sand, rotofinishing, buffing, wire brushing the soft material or machining with dull tools shall not be used as they maypeen the discontinuities at the surface.

## 5.2 Drying:

Drying, after cleaning the surface to be examined, shall be accomplished by normal evaporation or with forced hot air, as appropriate. A minimum period of time shall be established to ensure that the cleaning solution has evaporated prior to application of the penetrant.

## 5.3 Application Of Penetrants:

- 5.3.1 The penetrant shall be applied by dipping, brushing or spraying. If the penetrant is applied by spraying using compressed air type apparatus, filters shall be placed at the air inlet to preclude contamination of penetrant by oil, water or dirt sediment that may have collected in the lines. Spraying should only be performed in a booth equipped with exhaust system.
- 5.3.2 The length of penetration time is critical and depends upon the material being inspected, the process through which it has passed and the type of discontinuities expected. The recommended penetration time is given in Table 1.
- 5.3.3 The temperature of the penetrant and the surface of the part to be examined shall not be below 10°C(50°F) nor above 50°C(125°F) throughout the examination period. Local heating or cooling is permitted provided the temperatures remain in the range of 10 to 50°C during the examination. Where it is not practical to comply with these temperature limitations, other temperatures and times shall be used provided the procedures are qualified as described in Annexure-I.

## 5.4 Removal Of Excess Penetrant:

After the penetration time specified in the procedure has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimise removal of penetrant from discontinuities.





# CORPORATE STANDARD

AA 085 01 31

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## 5.4.1 Postemulsifying Penetrants:

The emulsifier shall be applied by spraying or dipping. The emulsifying time shall not exceed 5 minutes. After emulsification, the mixture shall be removed by water spray.

## 5.4.2 Solvent Removable Penetrants:

Excess penetrant shall be removed by wiping with a cloth or absorbent paper repeating the operation until most traces of penetrants have been removed. The remaining traces shall be removed by wiping the surface lightly with cloth or absorbent paper moistened with solvent.

**Caution:** Care shall be taken to avoid excess solvent as this may remove penetrants from discontinuities. Flushing the surface with solvent following the application of the penetrant and prior to developing is prohibited.

## 5.4.3 Water Washable Penetrants:

Excess water washable penetrant shall be removed with a water spray. The water pressure shall not exceed 0.35 N/mm<sup>2</sup> (50 Psi) and the water temperature shall not exceed 43.3°C (110°F).

## 5.5 Drying:

Surface shall be dried before the application of developer.

- 5.5.1 a) If postemulsifying or water washable method is used, the surface shall be dried by blotting with clean materials or by using circulating warm air, provided the temperature of the surface is not raised above 50°C (125°F).
- b) For solvent removable method, the surface may be dried by normal evaporation, blotting, wiping or forced air.

## 5.6 Application Of Developer:

The developer shall be applied as soon as possible after the removal of the excess penetrant. Two types of developer, dry or wet, shall be used with fluorescent penetrant. With colour contrast penetrants, only wet developer shall be used.

### 5.6.1 Application Of Dry Developer:

Dry developer shall be applied by a soft brush, a hand operated powder bulb or a powder gun or other means provided the powder is dusted evenly over the entire surface being examined.

### 5.6.2 Application Of Wet Developer

Prior to applying suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

## CORPORATE STANDARD



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(a) Aqueous Developer Application:

Aqueous developer may be applied to either a wet or dry surface. It shall be applied by dipping, spraying or other means provided a thin coating is obtained over the entire surface being examined. Drying time may be decreased by using warm air, provided the surface temperature of the part is not raised above 50°C.

(b) Non-aqueous Developer Application:

Non-aqueous developer shall be applied only on a dry surface. It shall be applied by spraying, except where safety or restricted access preclude it. Under such conditions developer may be applied by brushing. Drying shall be by normal evaporation.

6.0 EXAMINATION:

Observe the surface during the application of the developer to detect nature of any indications which tend to bleed out profusely. Final examination shall be done between 7 minutes at the earliest and 30 minutes at the latest after application of the developer. The nature of discontinuities corresponding to the indications shall be defined depending upon the method of setting, appearance, direction, shape and dimensions of the same. If the bleed out does not alter the examination results, longer periods are permitted. If the surface to be examined is large enough to preclude complete examination within the prescribed time the surface shall be examined in increments.

6.1 Colour Contrast Penetrants (Visible Dye Penetrants):

6.1.1 With colour contrast penetrants the developer forms a reasonably uniform coating. Surface discontinuities are indicated by bleeding out of the penetrant which is normally of a deep red colour. Indication with a light pink colour may indicate excessive cleaning. Inadequate cleaning may leave an excessive background making interpretation difficult.

6.1.2 Adequate illumination is required to ensure no loss of the sensitivity in the examination. Examination shall be done under natural or suitable light (illumination level shall be in the order of 500 LUX).

6.2 Fluorescent Penetrants:

Examination of the surface shall be carried out with a high intensity black light in a darkened area or booth. Black light shall have a wave length of 3650 Å°. The bulbs shall be allowed to warm up for not less than 5 minutes prior to use in the examination. The black light intensity shall be at least of 800 µW/cm<sup>2</sup> on the surface of the part being examined and the light source being kept at a distance of at least 375 mm from the surface being examined. The operator should allow his eyes to become accustomed to the darkness of the inspection booth for at least 5 minutes before inspecting the parts. He should avoid looking directly into the black light and also avoid going from the darkness to



# CORPORATE STANDARD

AA 085 01 31

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the light and back again without allowing sufficient time for his eyes to adjust to the darkness. The intensity shall be measured at least once every 8 hours and whenever the work station is changed.

## 7.0 EVALUATION OF INDICATIONS & INTERPRETATION:

- 7.1 As the developer dries to a smooth, even white coating, indications will appear at the locations of discontinuities. Depth of surface discontinuities may be correlated with the richness of colour and speed of bleeding out. However, localised surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are non-relevant.
- 7.2 Usually, a crack or similar opening will show a line and light cracks or partially welded lap will show a broken line. Gross porosity may produce large indications covering an entire area. Very fine porosity is indicated by random dots.
- 7.3 Any non-relevant indication shall be regarded as a defect until the indication is either eliminated by surface conditioning or it is Proved non-relevant by other NDT methods.
- 7.4 Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications which are circular or elliptical with the length less than three times the width.
- 7.5 All indications shall be evaluated in terms of the acceptance standards of the referencing documents.

## 8.0 ACCEPTANCE STANDARDS:

- 8.1 For castings - Refer Corporate Standard AA 085 01 32.
- 8.2 For Austenitic Forgings - Refer Corporate Standard AA 085 01 30.
- 8.3 For Welds - Refer Corporate Standard AA 085 01 29.

## 9.0 POST EXAMINATION CLEANING:

Surfaces examined shall be cleaned after evaluation of the test with dry cotton rag with or without water rinse.

**TABLE - 1 (Clause 5.3.2)**

### Suggested Penetration Time For Post-emulsified And Solvent Removable Penetrants

Material	Form	Type of discontinuity	*Penetration time (min.)
Aluminium	Castings	Porosity	5
		Cold shut	5
	Extrusions & Forgings	Laps	10
		Lack of fusion	5
		Porosity	5
		Cracks	10
	All forms		

**CORPORATE STANDARD****TABLE - 1 (Clause 5.3.2) Contd.**

Material	Form	Type of discontinuity	*Penetration time (min.)
Magnesium	Castings	Porosity	5
		Cold shut	5
	Extrusions &	Laps	10
	Forgings	Lack of fusion	10
	Welds	Porosity	10
	All forms	Cracks	10
Steel	Castings	Porosity	10
		Cold shut	10
	Extrusions &	Laps	10
	Forgings	Lack of fusion	20
	Welds	Porosity	20
	All forms	Cracks	20
Brass & Bronze	Castings	Porosity	5
		Cold shut	5
	Extrusions &	Laps	10
	Forgings	Lack of fusion	10
	Brazed parts	Porosity	10
	All forms	Cracks	10
Plastics	All forms	Cracks	5
Glass	All forms	Cracks	5
Carbide tipped tools	All forms	Lack of fusion	5
		Porosity	5
		Crack	20
Titanium & high temperature alloys	All forms		20 to 30
Ceramic	All forms	Cracks	5
		Porosity	5

\* For lower temperatures, penetration time should be increased.

**ANNEXURE - 1 (Clause 5.3.3)****PROCEDURE FOR NON-STANDARD TEMPERATURES****A.1 General:**

When it is not practical to conduct a liquid penetrant examination within the temperature range of 15.6 to 51.6°C (60 to 125°F), the examination procedure at the proposed lower or higher temperature range requires qualification. This shall require the use of a quench cracked aluminium block, which is designated as 'Liquid Penetrant Comparator Block'.



The liquid penetrant comparator block shall be made of aluminum, ASTM B209, Type 2024 or SB-211. Type 2024, 10 mm (3/8 in.) thick, and shall have approximate face dimensions of 50 mm x 75 mm (2 in. x 3 in.). At the centre of each face, an area approximately 25 mm in diameter shall be marked with a 510°C (950°F) temperature indicating crayon or paint. The marked area shall be heated with a blow torch, a Bunsen burner or similar device to a temperature between 510°C (950°F) and 524°C (975°F). The specimen shall then be immediately quenched in cold water which produces a network of the fine cracks on each face. The block shall then be dried by heating to approximately 149°C (300°F). After cooling, the block shall be cut into two halves. One half of the specimen shall be designated block 'A' and the other block 'B' for identification in subsequent processing. Figure 1 illustrates the comparator blocks "A" and "B". As an alternate to cutting the block in half to make blocks "A" and "B", separate blocks 50 mm x 75 mm (2 in. x 3 in.) can be made using the heating and quenching technique as described above. Two comparator blocks with closely matched crack patterns may be used. The blocks shall be marked "A" and "B".

### A.3 Comparator Application:

- (a) If it is desired to qualify a liquid penetrant examination procedure at a temperature of less than 15.6°C (60°F) the proposed procedure shall be applied to block "B" after the block and all materials have been cooled and held at the proposed examination temperature until the comparison is completed. A standard procedure which has previously been demonstrated as suitable for use shall be applied to block "A" in the 15.6 to 51.6°C (60 to 125°F) temperature range. The indications of cracks shall be compared between blocks "A" and "B". If the indications obtained under the proposed condition on block "B" are essentially the same as obtained on block "A" during examination at 15.6 to 51.6°C (60 to 125°F), the proposed procedure shall be considered qualified for use.
- (b) If the proposed temperature for the examination is above 51.6°C (125°F), block "B" shall be held at this temperature throughout the examination. The indication of cracks shall be compared as described in T-647.3(a) while block "B" is at the proposed temperature and block "A" is at the 15.6 to 51.6°C (60 to 125°F) temperature range.
- (c) A procedure qualified at a temperature lower than 15.6°C (60°F) shall be qualified from that temperature to 15.6°C (60°F).
- (d) To qualify a Procedure for temperatures above 51.6°C (125°F), the upper and lower temperature limits shall be established and the procedure qualified at these temperatures.
- (e) As an alternate to the requirements of (a) and (b) when using color contrast penetrants, it is permissible to use a single comparator block for the standard and non-standard temperatures and to make the comparison by photography.



## CORPORATE STANDARD



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- (f) When the single comparator block and photographic technique is used, the processing details (as applicable) described in (a) and (b) above shall apply. The block shall be thoroughly cleaned between the two processing steps. Photographs shall be taken after processing at the nonstandard temperature and then after processing at the standard temperature. The indication of cracks shall be compared between the two photographs. The same criteria for qualification as (a) above shall apply.
- (g) Identical photographic techniques shall be used to make the comparison photographs.

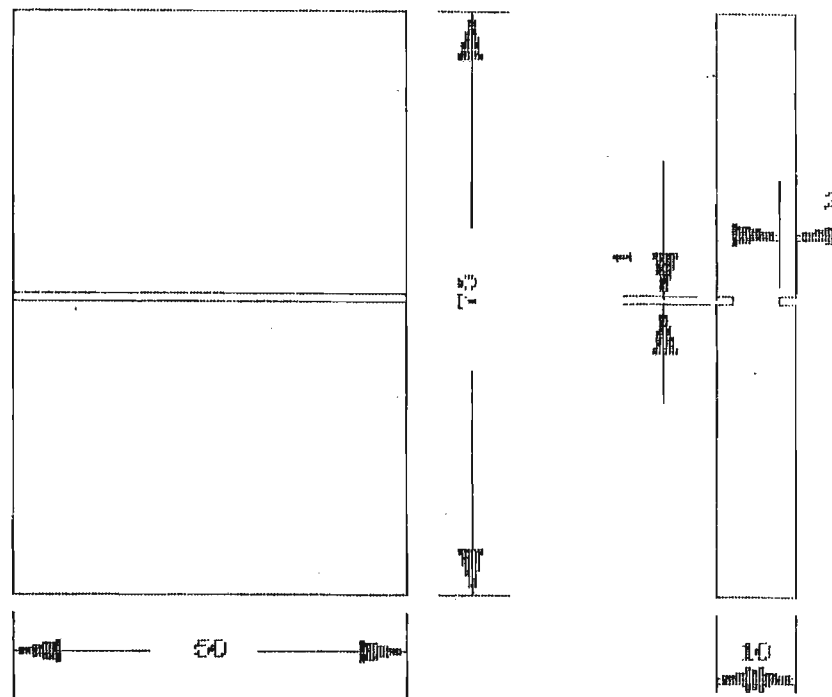



FIGURE: 1-LIQUID PENETRANT COMPARATOR BLOCK

414851/2024/HEP-TXM20500

	AMENDMENT -NOTIFCATION		AA 085 01 32	Rev.N0.00	
			PAGE 1 OF 1		
<p>AA 085 01 32: <u>EVALUATION AND ACCEPTANCE STANDARD FOR LIQUID PENETRANT EXAMINATION OF CASTINGS</u></p> <p><b>PAGE 2 OF 2: CI 4.0 ACCEPTANCE STANDARDS:</b></p> <p>In the table, title of the column 3 (Unacceptable defects) is modified as "<u>Linear defects</u>"</p>					
Please see Instructions on the reverse.					
Ref:	Amd No	Approved	Issued	Date	Cum.Sr.No
CI. 12.8.7 OF MOM OFWG(NDT)	01	WG-NDT	CORP. R&D	01.03.99	A 2516



EVALUATION AND ACCEPTANCE STANDARD FOR  
LIQUID PENETRANT EXAMINATION OF CASTINGS

1.0 SCOPE:

1.1 This standard is applicable for Liquid Penetrant examination of castings.

1.2 The procedure adopted for this examination is as per Corporate Standard AA 085 01 31

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 the 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 Defects which occur as mechanical discontinuities at the surface will be indicated by the bleeding out of the penetrant, however, localised surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are not relevant to the detection of defects.

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

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

3.4 Indications measuring less than 1.5mm across shall not be taken into consideration unless they are clustered in group of more than 4 Nos. with intervening gap of less than the largest dimensions of adjacent flaws. Such clusters shall be evaluated as single defect.

Revision

Approved :

INTERPLANT NON-  
DESTRUCTIVE TESTING COMMITTEE

Prepared

Issued

Date

Date

Corp. R&amp;D

CORP : R &amp; D

10 SEPT 79



## 4.0 ACCEPTANCE STANDARDS:

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

Level	No. of acceptable indications per 100 sq. cm. surface area of length not exceeding 25cm.	Unacceptable defects.
I	2 Nos. of 3mm circular indication.	Crack and hot tears.
II	3 Nos. of 3mm circular indication. One 5mm circular or linear indication.	-do-
III	3 Nos. of 3mm circular indication. 2 Nos. of 4mm circular indication. One 6mm circular or linear indication. One in-line indication of 10mm maximum length.	-do-
IV	4 Nos. of 3mm circular indication. 3 Nos. of 4mm circular indication. 2 Nos. of 8mm circular or linear indication.  One in-line indication of 15mm maximum length.	-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.



# CORPORATE STANDARD

AA 085 01 33

Rev. No. 02

PAGE 1 OF 7

## 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)		
Rev. No. 02	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
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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**CORPORATE STANDARD**

AA 085 01 33

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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.

## CORPORATE STANDARD



## 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:

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





## CORPORATE STANDARD

AA 085 01 33

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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  

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

NIlf = Value Calculated for low fill factor coils using  

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

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.

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

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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## CORPORATE STANDARD



## 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 grater 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.



# CORPORATE STANDARD

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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

414851/2024/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.



## CORPORATE PURCHASING SPECIFICATION

AA56105

Rev No. 07

PAGE 1 of 5

## CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT

## 1 GENERAL

This specification deals with the quality requirements of two pack Chemical resistant Epoxy Based Priming Paint pigmented with Red Oxide Zinc Phosphate.

## 2 APPLICATION

The paint shall be used as a primer in the painting system for protection of steel work, both under marine and inland outdoor conditions.

## 3 COMPLIANCE WITH NATIONAL STANDARDS

The material shall comply, in general, with the following national standards and also meet the requirements of this specification

IS 14506 : 1998 : Epoxy red oxide zinc phosphate weldable primer, two component

## 4 COMPOSITION

The paint consists of two components i.e. base and accelerator. The base contains epoxy binder suitably pigmented with red oxide and zinc phosphate and extenders. The accelerator is polyamide and solvent to cure the base of the paint system.

## 5 MIXING RATIO

The components of paint are to be mixed as recommended in the product data sheet supplied by the manufacturer of the paint. The type and content of the binding material as determined by infrared spectroscopy or thin layer chromatography shall be strictly adhered to the "Type approved sample".

## 6 COLOUR

Red oxide.

## 7 FINISH

Smooth and matt.

## 8 FREEDOM FROM DEFECTS

The base of the paint system shall remain free from defects like hard setting of pigments, skinning and livering when kept in closed container till its shelf life.

## 9 SAMPLING

As per IS 101.

## Revisions:

As per clause 44.5 a) of MOM of MRC-CPO+NM

## APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(CPO+NM)

Rev No.07

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Prepared  
HPBP, Trichy

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Dt:

Year:2021

AA56105	<b>CORPORATE PURCHASING SPECIFICATION</b>	
Rev No. 07		
PAGE 2 of 5		

**10 TECHNICAL REQUIREMENTS**

Unless otherwise specified, the sample (mixed paint) shall be tested in accordance with IS 101.

**10.1 Mass per 10 litres**

12 kg, minimum

**10.2 Consistency**

Paint shall be mixed so that it produces a smooth and uniform paint suitable for application.

40 - 60 secs by FC No.4 at  $27 \pm 2^\circ\text{C}$ .

**10.3 Drying time**

a) Soft dry : 4 hours, maximum

b) Hard dry : 16 hours, maximum

**10.4 Volatile matter, percent by mass**

30, maximum

**10.5 Pigment content, percent by mass**

40, minimum.

**10.6 Volume solids, percent**

35, minimum.

**10.7 Dry film thickness per coat**

25 microns, minimum.

**10.8 Flash point**

$20^\circ\text{C}$ , minimum.

**10.9 Pot life at ambient temperature (Annexure-A)**

4 hours, minimum.

**10.10 Zinc phosphate, percent by mass on pigment (Annexure-B)**

16 percent by mass, minimum.

**10.11 Scratch Hardness (IS 101 : Part 5 : Sec 1)**

After the film is cured for 7 days and tested under of 2000gm, no such scratch as to show the bare metal shall be produced.

**10.12 Flexibility and Adhesion (IS 101 : Part 5 : Sec 2)**

The film shall not show sign of damage detachment or cracking when tested after 4 days of curing.

**10.13 Type Test**

Salt spray test for 300 hours (IS 101 : Part 6 : Sec 1):

The test panel prepared from this material shall show no signs of corrosion after continuous exposure for 300 hours in salt spray cabinet.



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## 11 TYPE APPROVAL

### Samples

Samples for type approval testing shall be accepted only from those manufacturers whose manufacturing and testing facilities are considered satisfactory to ensure continuous supply of good product.

## 12 TEST CERTIFICATES

Unless otherwise stated, three copies of test certificates shall be supplied along with each consignment giving following information:

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

AA56105, Rev.07: CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT

BHEL Order No.

Manufacture's/Supplier's Name and Trade mark, if any.

Batch/Lot No.

Quantity supplied

Date of manufacture and Expiry

Test results of clause 10

Mixing Ration

## 13 KEEPING PROPERTY

When stored in covered dry place in the original sealed containers under normal temperature conditions, the material shall retain the properties prescribed in this specification for a period of 12 months after the date of manufacture, which shall be subsequent to the date of placement of BHEL order.

## 14 PACKING AND MARKING

Unless otherwise stated, base and hardener shall be packed separately in steel containers of approximate capacities. Each container shall bear the following information:

AA56105: CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT

BHEL Order No.

Batch / Lot No.

Supplier's/ Manufacturer's Name and Trade mark, if any

Name of components

Mixing ration

Date of manufacture and expiry

Quantity supplied

## 15 REFERRED STANDARDS (Latest Publications Including Amendments)

- 1) IS 101 : Part 5 : Sec 1
- 2) IS 101 : Part 5 : Sec 2
- 3) IS 101 : Part 6 : Sec 1
- 4) IS 101

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Annex A (CI 10.9)

PROCEDURE FOR TESTING OF POT LIFE

If the mixed paint, as recommended by the supplier, could be still thinned, the end of the working life (pot life) has not been reached. The end of the working life is reached when the test material (paint) gels, becomes stringy or cannot be thinned for application. The time interval between the mixing time and time of gelling shall be reported as pot life of the mixed paint.

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### ANNEXURE - B (CI 10.10)

#### PROCEDURE FOR TESTING OF ZINC PHOSPHATE CONTENT

##### A.1 General

The pigment is extracted from the paint and pigment is taken for the determination of Zinc phosphate content.

##### A.2 Reagents required

###### A.2.1 Quinoline solution

50ml of quinoline is dissolved in 60ml of hydrochloric acid and 30ml of water with constant stirring. The solution is cooled and filtered. This is diluted to 1000ml and stored in a polythene bottle.

###### A.2.2 Citric molybdic acid reagent

54gm of pure molybdic acid and 12gm of sodium hydroxide are dissolved in 400ml of hot water. 60gm of citric acid and 140ml of hydrochloric acid are added to 200ml of water. Now molybdic acid solution is added with citric acid solution and is made upto 1000ml. (The solution may be green or blue colour on its exposure to light). If necessary 0.5 percent potassium bromate solution is added until the green colour becomes pale. This solution is kept in a polyethylene bottle and stored in a dark place.

##### A.3 Procedure

1 gm of the sample is weighed into a 250ml beaker and 30ml of 1:1 nitric acid and 5ml of 1:1 hydrochloric acid is added. The content is boiled well and filtered and made up to 200ml. 50ml of aliquot is pipetted out into a 500ml conical flask and this is diluted to 100ml. 30ml of citric molybdic acid solution is added and boiled gently. 10ml of quinoline solution is added from burette with continuous swirling. (Add 3 to 4 ml drop wise and balance in steady stream).

The precipitate is filtered into a weighed Gooch crucible provided with glass fibre or filter paper previously dried at 250°C. The precipitate is washed with water and dried at 250°C. The dried precipitate (quinoline phosphomolybdate) is weighed and calculated for its weight by difference.

A blank determination is carried out in the same way as the determination but omitting the test solution.


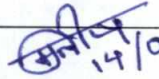


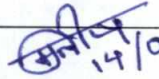


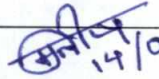


Calculation

$$\% \text{ Zinc phosphate, by mass} = \frac{(M1 - M0) \times 0.3816}{1 \text{ Mass of sample in gm.}} \times 100$$

Where


M1 = mass of precipitate in gm obtained in sample

M0 = mass of precipitate in gm obtained in blank

		 <p style="text-align: center;"><b>PRODUCT STANDARD</b> <b>TME DIVISION, BHOPAL</b></p>	<p style="text-align: center;"><b>TM 94217</b> <b>REV.06</b></p> <p style="text-align: center;"><b>PAGE 01 OF 09</b></p>													
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<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LTD.</b> It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<b><u>SPECIFICATION FOR AIR DRYING PAINT FINISH FOR TRACTION MACHINES</u></b> <b>(THIS SPEC. SUPERSEEDS SPEC. NO. BP0674184)</b>															
	<p><b>1. <u>GENERAL:</u></b></p> <p>This standard details the process to be followed to provide the standard paint finish for traction motors, traction generators/alternators, motor generators, motor alternators &amp; ECC, Auxiliary machines, oil rig motors &amp; alternators for application in Indian Railways/Oil Rigs. This standard also covers the painting requirements of traction machines/oil rig machines for coastal areas/export. The finishing of the outer surfaces of the field coils and armature, including commutators and creepage surfaces, is covered by the appropriate Insulation Process Specifications where a special finish is required, it will be called for on the appropriate drawings and specification sheets.</p> <p><b>2. <u>COMPLIANCE WITH STANDARDS:</u></b></p> <p>This standard to be used along with corporate standard AA0674123.</p> <p><b>3. <u>MATERIALS:</u></b></p> <p><b>3.1 <u>Materials Required:</u></b></p> <p>The finish painting of different traction machines/oil rig machines shall be as per table-4 of the specification unless otherwise mentioned in the drawing/work order/MID.</p> <p><b>Note:</b> The materials shall be used after ensuring that material TC's is as per the requirement of paint specification &amp; expiry date of paint is not crossed.</p> <p><b>3.1.1 Primer Paint:</b></p> <p>i) Anti Corrosive priming paint to AA56101 (Red). ii) Inorganic ethyl zinc silicate primer to AA56113.</p> <p><b>3.1.2 Intermediate Paint:</b></p> <p>i) High build intermediate epoxy paint to AA56112.</p> <p><b>3.1.3 Finish Paints:</b></p> <p>i) <b>Polyurethane finishing paint to AA56142:</b> For requirements of Industrial, Oil rigs &amp; Traction machines including for coastal areas &amp; export. ii) <b>Paint to AA56128 (Aluminum):</b> For blower motors.</p>															
	<table border="1"> <tr> <td data-bbox="268 1720 625 1802"> Revision : 06 Date: 14.05.2021 </td> <td data-bbox="625 1720 821 1802"> Distribution </td> <td data-bbox="821 1720 986 1802"> Qty. </td> <td colspan="3" data-bbox="986 1720 1497 1802"> Approved :  (M. Verma) </td> </tr> <tr> <td data-bbox="268 1802 625 1933"></td> <td data-bbox="625 1802 821 1933"> TXM TAM TGM/TNX QTM TME </td> <td data-bbox="821 1802 986 1933"> 1 1 1 1 2 </td> <td data-bbox="986 1802 1173 1933"> Prepared:  (J. Kumar) </td> <td data-bbox="1173 1802 1359 1933"> Checked:  (R. Chaudhry) </td> <td data-bbox="1359 1802 1497 1933"> Date:  14.05.21 </td> </tr> </table>					Revision : 06 Date: 14.05.2021	Distribution	Qty.	Approved :  (M. Verma)				TXM TAM TGM/TNX QTM TME	1 1 1 1 2	Prepared:  (J. Kumar)	Checked:  (R. Chaudhry)
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	<table border="1"> <thead> <tr> <th>Primer Paint</th> <th>Intermediate Paint</th> <th>Finish Paint</th> </tr> </thead> <tbody> <tr> <td>AA56113</td> <td>AA56112</td> <td>AA56142</td> </tr> <tr> <td>AA56101</td> <td>-</td> <td>AA56128</td> </tr> </tbody> </table>		Primer Paint	Intermediate Paint	Finish Paint	AA56113	AA56112	AA56142	AA56101	-	AA56128
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AA56113	AA56112	AA56142									
AA56101	-	AA56128									
<p>For achieving better quality of painting, the combinations of primer paint, intermediate paint &amp; finish paint as mentioned in above table shall be used.</p>											
	<p><b>3.4 MIXING OF PAINTS:</b></p>										
	<p><b>3.4.1</b> Before application, any skin formed on the paint in the tin shall be carefully removed, any settled pigment broken up and loosened, and the paint shall be thoroughly stirred to ensure complete and uniform mixing of the constituents. Care shall be taken to avoid air entry into the paint whilst stirring.</p>										
	<p><b>3.4.2 AA56113 PRIMER:</b></p> <p>AA56113 primer as supplied consists of two separate ingredients viz primer base and accelerator. Shortly before use mix together primer base and accelerator in the proportion 1:1 by volume or as recommended by supplier, care being taken not to entrain air while mixing. It is important that only small quantity of primer which can be consumed within 4 hours can be mixed. Further thinning of the paint prepared as above is not required for application by spraying.</p>										
	<p><b>3.4.3 EPOXY RED GEL COAT (BP27476):</b></p> <p>This consist of 3 parts viz Epoxy red gel coat, Hardner EH411 and Diluent C. These to be mixed in the ratio 100:40:10 by weight. Should the consistency of the paint require adjustment the same to be done by using special Thinner/MEK.</p>										
	<p><b>4. APPLICATION :</b></p> <p>A complete paint (as per Table 1, 2, 3 &amp; 4) should be applied so that the equipment has a well finished appearance &amp; adequate protection against corrosion. It is important that each coat of paint is completely dry before the next is applied. <b>The paint shall be applied by spraying/air less spraying only.</b></p>										
	<p><b>5. PROCESS FOR PAINTING OF TRACTION/OIL RIG/INDUSTRIAL MACHINE COMPONENTS:</b></p> <p>For the painting of Traction/Oil rig/Industrial machines components, the process mentioned in painting scheme no. 8 of annexure-II(a) of corporate standard AA0674123 shall be followed.</p>										





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**TABLE NO. 1**

**FINISHING PAINT FOR NON-ROTATING PARTS OF TRACTION MACHINES**

Part	Traction Motors		Other Machines	
	Paint	Coats	Paint	Coats
Exterior surfaces of machines including gearcase	AA56142 (Black)	2	AA56142 (Traffic Green)	2
	AA56142 (Traffic Green)	2	AA56142 (Light Grey)	2
	AA56142 (Light Grey)	2		2
Interior Surface of machines	CIT-033 (See note-2)	2	CIT-033 (See note-2)	2
Surface in contact with Lubricant	AA56132 (Jasmine Yellow)	2	AA56132 (Jasmine Yellow)	2
		2		2
Terminal Box Interiors	BP27476/ BP27599 Bectol Red.	2	BP 27595	2
Field coils & pole assy. and Connections	CIT-064	2	CIT-064	2
Brush gear and brush gear Insulators	Plant Standard BP0674183 to be followed			

**NOTES:**

1. Light alloy & glass fibre cover and other readily detachable parts in the traction machines shall not be painted.
2. Interior surface of frames & pole pads to be painted with CIT-033 for adjacent coils, cable etc.
3. Epoxy bonded components must not be painted prior to bonding.
4. The paint/colour of finish painting in different traction machines/oil rig machines is mentioned in table-4 of this specification.



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**TABLE-2**  
**FINISHING PAINT FOR ROTATING PART OF TRACTION MACHINES**

Part	Paint	Coats	Remarks
<b>Steel Fans:</b>			
1) TM4601, TM4603	AA56142 (Traffic Green)	2	-
2) AG3101, AG2702, TA10102	AA56142 (Light Grey)	2	

**TABLE-3**  
**FINISHING PAINT FOR MISCELLANEOUS EQUIPMENT**

Equipment	Part	Paint	Coats
Eddy Current Clutch and gear boxes surface	Steel surfaces	AA56142 (Traffic Green)	2
	Coil	See Insulation Spec.	-
	Interior of gear box	AA56132	2

**TABLE-4**  
**PAINT/COLOUR FOR FINISH PAINTING OF DIFFERENT TRACTION/OIL RIG MACHINES**

**Note:** The finish painting of different traction machines/oil rig machines shall be as per table-4 of the specification unless otherwise mentioned in the drawing/work order/MID.


Type of machine	Paint/Colour*
<b>A) Traction Motors:</b>	
TM4906AZ	AA56142(Black)
TM4907BZ	
TM4603AZ	
HS15250A	
TM3701AZ	
TM4605AZ	
TM5002AZ	AA56142 (Light grey) (631 export) & Black for WDP2
TM4303CZ/BY & TM4303DY	AA56142 Traffic Green for CZ/BY (EMU & MEMU application) & Black for DY (DEMU application)

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	<b>3) Measurement of Primer &amp; Intermediate Paint Thickness (As per AA0674105):</b>																				
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i.	Test is carried out by the application of a cross-cut test in accordance with BHEL Standard AA0674105.	Detachment of small flakes of the coating at the intersections of the cuts. A cross cut area not significantly greater than 5% is affected.																			
	<b>Note:</b> The sample size for quality checking of painting of traction machines should be as per IS: 2500 Part-2, Level 4 and AQL 1% as mentioned below:-																				
	<table><tr><th>Lot size</th><th>Sample size</th></tr><tr><td>2 to 8</td><td>3</td></tr><tr><td>9 to 15</td><td>3</td></tr><tr><td>16 to 25</td><td>4</td></tr><tr><td>26 to 50</td><td>5</td></tr><tr><td>51 to 100</td><td>7</td></tr><tr><td>101 to 150</td><td>10</td></tr><tr><td>151 to 300</td><td>15</td></tr><tr><td>301 to 500</td><td>20</td></tr></table>	Lot size	Sample size	2 to 8	3	9 to 15	3	16 to 25	4	26 to 50	5	51 to 100	7	101 to 150	10	151 to 300	15	301 to 500	20		
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	<b>Imp.:</b> When sample size equals or exceeds lot size, every item in the lot shall be inspected.																				

		 <b>PRODUCT STANDARD</b> <b>TME DIVISION, BHOPAL</b>  TME/2021	<b>TM 94217</b> <b>REV.06</b>	
			<b>PAGE 09 OF 09</b>	
<b>COPYRIGHT AND CONFIDENTIAL</b> The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LIMITED</b> It must not be used directly or indirectly in any way detrimental to the interest of the company		<p style="text-align: right;"><u><b>Annexure-II</b></u></p> <p style="text-align: center;"><u><b>Checklist for Painting of Traction Machines</b></u></p>		
		<b>Machine type:</b>	<b>Machine/Component no.:</b>	
		<b>Date of Painting:</b>		
		<table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Check points as per the requirement of annexure-I</th> <th>Checking Remark (100%TP &amp; 20%QC)</th> </tr> </thead> </table>	Sl. No.	Check points as per the requirement of annexure-I
Sl. No.	Check points as per the requirement of annexure-I	Checking Remark (100%TP & 20%QC)		
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<table border="1"> <tbody> <tr> <td>4.</td> <td> <b>Inspection for Process Control (After Finish Painting):</b>  i. Visual inspection of finished component for absence of paint film defects  ii. Total thickness of paint </td> <td>   (ok/not ok)  .....microns (ok/not ok) </td> </tr> </tbody> </table>	4.	<b>Inspection for Process Control (After Finish Painting):</b> i. Visual inspection of finished component for absence of paint film defects ii. Total thickness of paint	 (ok/not ok) .....microns (ok/not ok)	
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5.	<b>Adhesion by Tape Test (As per AA0674105):</b> i. Adhesion by tape test	 (ok/not ok)		
		<p><b>Abbreviations:-</b>  TP – Task Performer, QC – QTM/BHEL Authorized Quality Inspection Agency</p> <p><b>Note:</b> 1) For the components supplied by the supplier in finish painted condition, the supplier to furnish dully filled checklist for each component along with consignment.  2) The acceptance criteria shall be as per annexure-I.</p> <p style="text-align: center;"> <span style="margin-right: 200px;">(Task performer's signature)</span> <span>(QC's signature)</span> </p>		