



TME 2019

# PRODUCT STANDARD

## TME DIVISION, BHOPAL

TM 12548

Rev. No. 01

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### Specification for Identification Marking of Traction Machines Components

**1.0 Scope:** This specification governs the requirements for identification marking of all components of traction machines (except electrical items, hardwares & bearings) either manufactured in-house or outsourced in raw material, semi-finished or fully finished condition.

**2.0 Identification marking of components:** The component manufacturer shall provide the identification marking depending upon the type of component (raw material/semi-finished castings, raw material/semi-finished forgings & fabricated components, fully finished components or sheet metal components) manufactured by it as per guidelines given below:-


#### A) CASTED COMPONENTS:

| Sl. No. | Condition of supply              | Identification marking requirement  |
|---------|----------------------------------|---|
| 1.      | Castings/ semi-finished castings | <p><b>a) Method of marking in castings:</b> Each casting shall be <b>embossed &amp; punched</b> on un-machined surface/ <b>etched</b> on machined surface legibly and indelibly with following details:-</p> <p>i) <b>Supplier's name initial , Heat no.</b> ← To be embossed.<br/>(Example: SAIL/341)</p> <p>ii) <b>xxxxx , MM-YY</b> ← To be embossed/punched on cast surface or etched on machined surface.</p> <p style="margin-left: 40px;">└── 4 digits of date of manufacturing in MM-YY format</p> <p style="margin-left: 40px;">└── Manufacturer's unique job serial no.</p> <p>(Example: 00345/0319)</p> <p><b>b) Method of marking in semi-finished castings:</b> Each casting shall be <b>embossed &amp; punched</b> on un-machined surface/ <b>etched</b> on machined surface legibly and indelibly with following details:-</p> <p>i) <b>Supplier's name initial , Heat no.</b> ← To be embossed.<br/>(Example: SAIL/341)</p> <p>ii) <b>xxxxx , MM-YY</b> ← To be embossed/punched on cast surface or etched on machined surface.</p> <p style="margin-left: 40px;">└── 4 digits of date of manufacturing in MM-YY format</p> <p style="margin-left: 40px;">└── Manufacturer's unique job serial no.</p> <p>(Example: 00345/0319)</p> <p><b>c) Size &amp; location:</b> For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.</p> |

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| Rev. No. 01      | Distribution                                  | Prepared       | Checked           | Approved       |
|------------------|---|----------------|-------------------|----------------|
| Date: 16/03/2019 | TME - 2 MNX - 1<br>TXM - 1 TAM - 1<br>QTM - 1 | <br>(J. Kumar) | <br>(R. Chaudhry) | <br>(M. Verma) |



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|           |                                   |  |
|-----------|-----------------------------------|--|
| <b>2.</b> | Machined castings on labour basis | <p><b>a) Method of marking after finish machining:</b></p> <p><b>i) When embossed marking is not removed:</b> In case the embossed marking is not removed during finish machining of the component, the component shall be punched with following details below the already existing embossed marking:-</p> <div style="margin-left: 20px;"> <p><b>Supplier's name intial , xxxxx , MM-YY</b></p> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="margin-left: 150px; font-size: 0.8em;"> <p>4 digits of date of manufacturing in MM-YY format</p> <p>Manufacturer's unique job serial no.</p> </div> </div> <div style="margin-left: 20px; margin-top: 10px;"> <p><b>(Example: SAIL/341)</b> ← Already embossed.</p> <p><b>ABCD/00345/0319</b> ← To be punched.</p> </div>  |
|           |                                   | <p><b>ii) When embossed marking is removed:</b> In case the component is machined all over &amp; the embossed marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format &amp; manufacturer's details shall be punched below the above punched marking as per details given below:-</p> <div style="margin-left: 20px;"> <p><b>Supplier's name intial , xxxxx , MM-YY</b></p> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="margin-left: 150px; font-size: 0.8em;"> <p>4 digits of date of manufacturing in MM-YY format</p> <p>Manufacturer's unique job serial no.</p> </div> </div> <div style="margin-left: 20px; margin-top: 10px;"> <p><b>(Example: SAIL/341)</b> ← To be punched.</p> <p><b>ABCD/00345/0319</b> ← To be punched.</p> </div> <p><b>b) Size &amp; location:</b> For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.</p> |
| <b>3.</b> | Fully finished casted components  | <p><b>a) Method of marking in finished components:</b></p> <p><b>i) When embossed marking is not removed during machining:</b> Each component shall be <b>embossed &amp; punched</b> on un-machined surface/ <b>etched</b> on machined surface legibly and indelibly with following details:-</p> <div style="margin-left: 20px;"> <p><b>Supplier's name initial , Heat no.</b> ← To be embossed/already embossed.</p> <p><b>(Example: SAIL/341)</b></p> <p><b>xxxxxx , MM-YY</b> ← To be embossed/punched.</p> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="display: flex; align-items: center; margin-left: 100px;"> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-right: 5px;"></div> </div> <div style="margin-left: 150px; font-size: 0.8em;"> <p>4 digits of date of manufacturing in MM-YY format</p> <p>Manufacturer's unique job serial no.</p> </div> </div> <div style="margin-left: 20px; margin-top: 10px;"> <p><b>(Example: 00345/0319)</b></p> </div>   |



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ii) **When embossed marking is removed during machining:** In case the component is machined all over & the embossed marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format & manufacturer's details shall be punched below the above punched marking as per details given below:-

Supplier's name initial , xxxxx , MM-YY

4 digits of date of manufacturing in MM-YY format

Manufacturer's unique job serial no.

(Example: SAIL/341)

← To be punched.

ABCD/00345/0319

← To be punched.

b) **Size & location:** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.

**B) FORGING / FABRICATED COMPONENTS:**

1. Raw material/ semi-finished forgings and fabricated components

a) **Method of marking in forgings & fabrications:** Each component shall be punched legibly and indelibly with following details:-

Supplier's name initial , xxxxx , MM-YY , xxx

Heat no.

4 digits of date of manufacturing (forging/fabrication) in MM-YY format

Manufacturer's unique job serial no.

(Example: SAIL/00345/0319/341)

b) **Size & location:** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.

2. Machined forgings/ fabrications on labour basis

a) **Method of marking after finish machining:**

i) **When punched marking is not removed:** In case the punched marking is not removed during finish machining of the component, the component shall be punched with following details below the already existing punched marking:-

Supplier's name initial , xxxxx , MM-YY

4 digits of date of manufacturing in MM-YY format

Manufacturer's unique job serial no.

(Example: SAIL/00345/0319/341)

← Already punched.

ABCD/00345/0319

← To be punched.



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|                                   |   |  |
|-----------------------------------|---|--|
|                                   |   | <p><b>ii) When punched marking is removed:</b> In case the component is machined all over &amp; the punched marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format &amp; manufacturer's details shall be punched below the above punched marking as per details given below:-</p> <p><b>Supplier's name initial , xxxxx , MM-YY</b></p> <div style="margin-left: 150px;"> <div style="margin-left: 100px;">4 digits of date of manufacturing in MM-YY format</div> <div style="margin-left: 100px;">Manufacturer's unique job serial no.</div> </div> <p><b>(Example: SAIL/00345/0319/341)</b> ← To be punched.</p> <p><b>ABCD/00345/0319</b> ← To be punched.</p> <p><b>b) Size &amp; location:</b> For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.</p> |
| 3.                                | Fully finished forged/fabricated components | <p><b>a) Method of marking in finished components:</b> Each component shall be <b>punched</b> on un-machined surface/ <b>etched</b> on machined surface legibly and indelibly with following details:-</p> <p><b>Supplier's name initial / xxxxx / MM-YY / xxx</b></p> <div style="margin-left: 150px;"> <div style="margin-left: 100px;">Heat no.</div> <div style="margin-left: 100px;">4 digits of date of manufacturing in MM-YY format</div> <div style="margin-left: 100px;">Manufacturer's unique job serial no.</div> </div> <p><b>(Example: SAIL/00345/0319/341)</b></p> <p><b>b) Size &amp; location:</b> For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.</p>  |
| <b>C) SHEET METAL COMPONENTS:</b> |   |  |
| 1.                                | Sheet metal components                      | <p><b>a) Method of marking:</b> Each component shall be <b>etched</b> or <b>punched</b> as the case may be legibly with following details:-</p> <p><b>Supplier's name initial , xxxxx , MM-YY</b></p> <div style="margin-left: 150px;"> <div style="margin-left: 100px;">4 digits of date of manufacturing in MM-YY format</div> <div style="margin-left: 100px;">Manufacturer's unique job serial no.</div> </div> <p><b>(Example: SAIL/00345/0319)</b></p> <p><b>b) Size &amp; location:</b> For etching/painting and size &amp; location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.</p>  |

|  |   |  |  |  |  |   |   |                                |
|--|---|--|--|--|--|---|---|--------------------------------|
|  |   |  <p style="text-align: center;"><b>PRODUCT STANDARD</b><br/><b>TME DIVISION, BHOPAL</b></p> | <p style="text-align: center;"><b>TM 94217</b><br/><b>REV.05</b></p>     |  |  |   |   |                                |
| TME/2013   |   | <p style="text-align: center;"><b>PAGE 01 OF 09</b></p>  |  |  |  |   |   |                                |
| <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> | <p><b><u>SPECIFICATION FOR AIR DRYING PAINT FINISH FOR TRACTION MACHINES</u></b><br/><b>(THIS SPEC. SUPERSEEDS SPEC. NO. BP0674184)</b></p>   |  |  |  |  |   |   |                                |
|  | <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).<br/>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) Polyurethane finishing paint to <b>AA56142</b>: For requirements of Industrial, Oil rigs &amp; Traction machines including for coastal areas &amp; export.<br/>ii) Paint to <b>AA56128 (Aluminum)</b>: For blower motors.</p> |  |  |  |  |   |   |                                |
| <p>Revision : 05</p> <p>Date: 14.07.18</p>   |   | <p style="text-align: center;">Distribution</p> <p>TXM<br/>TAM<br/>TGM/TNX<br/>QTM<br/>TME</p>   | <p style="text-align: center;">Qty.</p> <p>1<br/>1<br/>1<br/>1<br/>2</p> | <p>Approved : <br/>(M. Verma)</p> <table border="1" style="width: 100%;"> <tr> <td data-bbox="1015 1854 1197 1995"> <p>Prepared: <br/>(J. Kumar)</p> </td> <td data-bbox="1197 1854 1385 1995"> <p>Checked: <br/>(R. Chaudhry)</p> </td> <td data-bbox="1385 1854 1528 1995"> <p>Date:<br/><br/>14.07.18</p> </td> </tr> </table> |  | <p>Prepared: <br/>(J. Kumar)</p> | <p>Checked: <br/>(R. Chaudhry)</p> | <p>Date:<br/><br/>14.07.18</p> |
| <p>Prepared: <br/>(J. Kumar)</p>  | <p>Checked: <br/>(R. Chaudhry)</p>   | <p>Date:<br/><br/>14.07.18</p>   |  |  |  |   |   |                                |

|   |                            |  <p><b>PRODUCT STANDARD</b><br/><b>TME DIVISION, BHOPAL</b></p>   | <p><b>TM 94217</b><br/><b>REV.05</b></p> <p><b>PAGE 02 OF 09</b></p> |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
|---|----------------------------|--|--|-------|---------|-----------|---------------------------------|---------------|--------------|-------|----------------------|--------------------|--------------|-------|----------------------|---------|----------------------------|-------|----------------------|-------------------------|--------------|-------|----------------------|---------|--------|-------|----------------------|---------------------------------------|-------------------------|-------|-------------|
| <p style="writing-mode: vertical-rl; transform: rotate(180deg);"> <b>COPYRIGHT AND CONFIDENTIAL</b><br/>           The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LIMITED</b><br/>           It must not be used directly or indirectly in any way detrimental to the interest of the company         </p> |                            | <p>TME/2013</p> <p>iii) Oil Resistant Air Drying Synthetic Enamel to AA56132 (Jasmine Yellow shade):<br/>For surfaces in contact with lubricant.</p> <p>iv) Epoxy Red Gel Coat (Base, Hardner &amp; Diluent ) to BP27476 or Anti Tracking Red Insulating Varnish to BP 27599 or Becktol Red- Prop of M/s Dr Beck &amp; Co.Pune: For coils &amp; insulation.</p> <p>v) Anti Tracking Epoxy based finishing paint to CIT-033: For interior surfaces of frame &amp; pole pads.</p> <p>vi) Silicone based finishing paint to CIT-064: For field coils &amp; pole assy. and connections.</p> <p>vii) Grey Insulating Enamel to BP 27595: For terminal box interiors.</p> <p><b>3.1.4 Thinners:</b></p> <p>The application of thinners for different primer/finish paints are as given in clause 3.2.</p> <p>i) White Spirit Gr. 145/205 to AA56701.</p> <p>ii) Xylole-Industrial Solvent Grade to AA56703.</p> <p>iii) Special Thinner for Epoxy Red Gel Coat/MEK.</p> <p>iv) Derusting Solution (hydrochloric acid/sulphuric acid) to BP0690086.</p> <p><b>3.2 Consistency of Materials at normal shop temperature in cup No.4 of IS:3944:</b></p> <table border="1" data-bbox="312 1193 1477 1812"> <thead> <tr> <th>Paint</th><th>Thinner</th><th>Applicant</th><th>Consistency in Seconds to 27° C</th></tr> </thead> <tbody> <tr> <td>AA56101 (Red)</td><td>White spirit</td><td>Spray</td><td>30<sub>+2</sub> sec</td></tr> <tr> <td>AA56128 (Aluminum)</td><td>White spirit</td><td>Spray</td><td>30<sub>+2</sub> sec</td></tr> <tr> <td>AA56142</td><td>As recommended by supplier</td><td>Spray</td><td>30<sub>+2</sub> sec</td></tr> <tr> <td>AA56132(Jasmine Yellow)</td><td>White Spirit</td><td>Spray</td><td>30<sub>+2</sub> sec</td></tr> <tr> <td>BP25795</td><td>Xylole</td><td>Spray</td><td>30<sub>+2</sub> sec</td></tr> <tr> <td>BP27476/<br/>BP2799<br/>Becktol<br/>Red.</td><td>Special Thinner/<br/>MEK</td><td>Spray</td><td>30 – 40 sec</td></tr> </tbody> </table> <p>For application by spray, the paints shall be obtained ready for use or thinned down to the flow time shown on the chart when measured at the shop temperature. The consistency of the paint require adjustment, the appropriate thinner given in the above chart shall be used.</p> |  | Paint | Thinner | Applicant | Consistency in Seconds to 27° C | AA56101 (Red) | White spirit | Spray | 30 <sub>+2</sub> sec | AA56128 (Aluminum) | White spirit | Spray | 30 <sub>+2</sub> sec | AA56142 | As recommended by supplier | Spray | 30 <sub>+2</sub> sec | AA56132(Jasmine Yellow) | White Spirit | Spray | 30 <sub>+2</sub> sec | BP25795 | Xylole | Spray | 30 <sub>+2</sub> sec | BP27476/<br>BP2799<br>Becktol<br>Red. | Special Thinner/<br>MEK | Spray | 30 – 40 sec |
| Paint   | Thinner                    | Applicant  | Consistency in Seconds to 27° C                                      |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| AA56101 (Red)   | White spirit               | Spray  | 30 <sub>+2</sub> sec   |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| AA56128 (Aluminum)  | White spirit               | Spray  | 30 <sub>+2</sub> sec   |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| AA56142   | As recommended by supplier | Spray  | 30 <sub>+2</sub> sec   |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| AA56132(Jasmine Yellow)   | White Spirit               | Spray  | 30 <sub>+2</sub> sec   |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| BP25795   | Xylole                     | Spray  | 30 <sub>+2</sub> sec   |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |
| BP27476/<br>BP2799<br>Becktol<br>Red.   | Special Thinner/<br>MEK    | Spray  | 30 – 40 sec  |       |         |           |                                 |               |              |       |                      |                    |              |       |                      |         |                            |       |                      |                         |              |       |                      |         |        |       |                      |                                       |                         |       |             |

|  |                    |  <p style="text-align: center;"><b>PRODUCT STANDARD</b><br/><b>TME DIVISION, BHOPAL</b></p> <p>TME/2013</p>   | <p style="text-align: center;"><b>TM 94217</b><br/><b>REV.05</b></p> <p style="text-align: center;"><b>PAGE 03 OF 09</b></p> |                    |              |         |         |         |         |   |         |
|--|--------------------|--|--|--------------------|--------------|---------|---------|---------|---------|---|---------|
| <p style="writing-mode: vertical-rl; transform: rotate(180deg);">COPYRIGHT AND CONFIDENTIAL</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> |                    | <p><b>3.3 <u>Compatibility chart for Primer Paint, Intermediate Paint &amp; Finish Paint:</u></b></p> <table border="1" data-bbox="389 533 1347 674"> <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> <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 <u>MIXING OF PAINTS:</u></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 <u>AA56113 PRIMER:</u></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 <u>EPOXY RED GEL COAT (BP27476):</u></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. <u>APPLICATION :</u></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. <u>PROCESS FOR PAINTING OF TRACTION/OIL RIG/INDUSTRIAL MACHINE COMPONENTS:</u></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> | Primer Paint   | Intermediate Paint | Finish Paint | AA56113 | AA56112 | AA56142 | AA56101 | - | AA56128 |
| Primer Paint   | Intermediate Paint | Finish Paint   |  |                    |              |         |         |         |         |   |         |
| AA56113  | AA56112            | AA56142  |  |                    |              |         |         |         |         |   |         |
| AA56101  | -                  | AA56128  |  |                    |              |         |         |         |         |   |         |



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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/<br>BP27599<br>Becktol 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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|--|--|--|----------------------------------|-----------------|--------------|--|----------------|-------------------------|----------------|-------------------|----------------------------|----------|----------------------|----------------------------|-------------------------|--|------------------------|---|--|
|  | TME/2013   |  | PAGE 05 OF 09                    |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <b>TABLE-2</b><br><b>FINISHING PAINT FOR ROTATING PART OF TRACTION MACHINES</b>  |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <table border="1"> <thead> <tr> <th>Part</th> <th>Paint</th> <th>Coats</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td><b>Steel Fans:</b></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1) TM4601, TM4603</td> <td>AA56142<br/>(Traffic Green)</td> <td>2</td> <td>-</td> </tr> <tr> <td>2) AG3101, AG2702, TA10102</td> <td>AA56142<br/>(Light Grey)</td> <td>2</td> <td></td> </tr> </tbody> </table>  | Part   | Paint                            | Coats           | Remarks      | <b>Steel Fans:</b>                         |                |                         |                | 1) TM4601, TM4603 | AA56142<br>(Traffic Green) | 2        | -                    | 2) AG3101, AG2702, TA10102 | AA56142<br>(Light Grey) | 2  |                        |   |  |
| Part   | Paint  | Coats  | Remarks                          |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
| <b>Steel Fans:</b>   |  |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
| 1) TM4601, TM4603  | AA56142<br>(Traffic Green)   | 2  | -                                |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
| 2) AG3101, AG2702, TA10102   | AA56142<br>(Light Grey)  | 2  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <b>TABLE-3</b><br><b>FINISHING PAINT FOR MISCELLANEOUS EQUIPMENT</b>   |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <table border="1"> <thead> <tr> <th>Equipment</th> <th>Part</th> <th>Paint</th> <th>Coats</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Eddy Current Clutch and gear boxes surface</td> <td>Steel surfaces</td> <td>AA56142 (Traffic Green)</td> <td>2</td> </tr> <tr> <td>Coil</td> <td>See Insulation Spec.</td> <td>-</td> </tr> <tr> <td>Interior of gear box</td> <td>AA56132</td> <td>2</td> </tr> </tbody> </table>  | 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                       |  |                        |   |  |
| 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                                |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <b>TABLE-4</b><br><b>PAINT/COLOUR FOR FINISH PAINTING OF DIFFERENT TRACTION/OIL RIG MACHINES</b>   |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <b>Note:</b> 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.  |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |
|  | <table border="1"> <thead> <tr> <th>Type of machine</th> <th>Paint/Colour</th> </tr> </thead> <tbody> <tr> <td colspan="2"><b>A) Traction Motors:</b></td> </tr> <tr> <td>TM4906AZ</td> <td rowspan="6">AA56142(Black)</td> </tr> <tr> <td>TM4907BZ</td> </tr> <tr> <td>TM4603AZ</td> </tr> <tr> <td>HS15250A</td> </tr> <tr> <td>TM3701AZ</td> </tr> <tr> <td>TM4605AZ</td> </tr> <tr> <td>TM5002AZ</td> <td>AA56142 (Light grey) (631 export) &amp; Black for WDP2</td> </tr> <tr> <td>TM4303CZ/BY &amp; TM4303DY</td> <td>AA56142<br/>Traffic Green for CZ/BY (EMU &amp; MEMU application) &amp; Black for DY (DEMU application)</td> </tr> </tbody> </table> |  |                                  | 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<br>Traffic Green for CZ/BY (EMU & MEMU application) & Black for DY (DEMU application) |  |
| 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<br>Traffic Green for CZ/BY (EMU & MEMU application) & Black for DY (DEMU application)  |  |                                  |                 |              |  |                |                         |                |                   |                            |          |                      |                            |                         |  |                        |   |  |

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| Type of Machine  | Paint/Colour           |
|--|------------------------|
| IM3601AZ   | AA56142(Light Grey)    |
| IM3301AZ/IM3302AZ  |                        |
| 6FRA6068   |                        |
| 6FXA7059   |                        |
| TAO-659  |                        |
| OIM5101AZ  |                        |
| OM4903BX/CX  | AA56142(Traffic Green) |
| TM4601BY/BX  |                        |
| IM4507AZ/BZ  | AA56142(Black)         |
| <b>B) Traction Alternators &amp; Generators:</b>           |                        |
| All traction alternators, Generators,<br>AG's & Gear boxes | AA56142(Light Grey)    |
| ECC9005/2/M  | AA56142(Traffic Green) |
| BM2101AZ   | AA56128 (Aluminium)    |
| DY3423/M   |                        |
| MG51BX/CW  | AA56142(Black)         |
| AG903CW  |                        |
| AG1404AZ   |                        |

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|--|--|---|---------|---------------|---------------------|----|---|--|-----|------------------------------|------------------------------------|------|---|--|---------|-----------|---------------------|----|--|--------------------------------|-----|--|-----------------------------|------|--|---|-----|---|---|----|---|-------------------------------------|-----|---|
|  | TME/2013   | <b>PAGE 07 OF 09</b>  |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| <b>COPYRIGHT AND CONFIDENTIAL</b><br>The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LIMITED</b><br>It must not be used directly or indirectly in any way detrimental to the interest of the company | <u><b>Annexure-I</b></u>   |   |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
|  | <p style="text-align: center;"><b><u>Acceptance criteria for Painting of Traction Machines</u></b></p> <p>The acceptance criteria for the check points, which are to be ensured during painting of Traction Machines as per the requirements of specification TM94217, are as given below. The supplier to furnish below mentioned check points for each component in the format as per annexure-II along with consignment.</p> <p><b>1) <u>Checking of Painting Material:</u></b></p> <table border="1" data-bbox="359 772 1508 1019"> <thead> <tr> <th>Sl. no.</th> <th>To be checked</th> <th>Acceptance criteria</th> </tr> </thead> <tbody> <tr> <td>i.</td> <td>Expiry date of primer &amp; intermediate paint.</td> <td>Primer &amp; intermediate paint shall be within expiry date.</td> </tr> <tr> <td>ii.</td> <td>Expiry date of finish paint.</td> <td>Paint shall be within expiry date.</td> </tr> <tr> <td>iii.</td> <td>Verification of supplier's TC as per paint specification.</td> <td>Painting material shall be used only after verification of TC.</td> </tr> </tbody> </table> <p><b>2) <u>Surface Preparation (Before Primer Painting):</u></b></p> <table border="1" data-bbox="359 1131 1508 1937"> <thead> <tr> <th>Sl. no.</th> <th>Operation</th> <th>Acceptance criteria</th> </tr> </thead> <tbody> <tr> <td>i.</td> <td>Dressing &amp; grinding of all flame-cut edges, welds &amp; any major imperfections.</td> <td>No sharp edges or protrusions.</td> </tr> <tr> <td>ii.</td> <td>Degreasing by using white sprite to AA56701 &amp; removal of varnish in wet condition.</td> <td>Free from grease &amp; varnish.</td> </tr> <tr> <td>iii.</td> <td>Removal of light rust by hydrochloric acid/sulphuric acid to BP0690086 and removal of heavier localized rust by using emery cloth, steel scratch brush or portable power tool with abrasive tool &amp; then applying hydrochloric acid/sulphuric acid.</td> <td>Surface should exhibits grey colour in place of red rust.</td> </tr> <tr> <td>iv.</td> <td>In case surface is widely rusted to such an extent that pitting with hard rust flakes is exhibited, the surface shall be sand/shot blasted.</td> <td>Surface should exhibits clean &amp; grey colour in place of red rust.</td> </tr> <tr> <td>v.</td> <td>Visual inspection of condition of surface of components before application of primer paint.</td> <td>As per the requirement of clause 5.</td> </tr> <tr> <td>vi.</td> <td>Checking of surface finish of the components.</td> <td>Surface finish shall be as per IS:3073.</td> </tr> </tbody> </table> |   | Sl. no. | To be checked | Acceptance criteria | i. | Expiry date of primer & intermediate paint. | Primer & intermediate paint shall be within expiry date. | ii. | Expiry date of finish paint. | Paint shall be within expiry date. | iii. | Verification of supplier's TC as per paint specification. | Painting material shall be used only after verification of TC. | Sl. no. | Operation | Acceptance criteria | i. | Dressing & grinding of all flame-cut edges, welds & any major imperfections. | No sharp edges or protrusions. | ii. | Degreasing by using white sprite to AA56701 & removal of varnish in wet condition. | Free from grease & varnish. | iii. | Removal of light rust by hydrochloric acid/sulphuric acid to BP0690086 and removal of heavier localized rust by using emery cloth, steel scratch brush or portable power tool with abrasive tool & then applying hydrochloric acid/sulphuric acid. | Surface should exhibits grey colour in place of red rust. | iv. | In case surface is widely rusted to such an extent that pitting with hard rust flakes is exhibited, the surface shall be sand/shot blasted. | Surface should exhibits clean & grey colour in place of red rust. | v. | Visual inspection of condition of surface of components before application of primer paint. | As per the requirement of clause 5. | vi. | Checking of surface finish of the components. |
| Sl. no.  | To be checked  | Acceptance criteria   |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| i.   | Expiry date of primer & intermediate paint.  | Primer & intermediate paint shall be within expiry date.          |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| ii.  | Expiry date of finish paint.   | Paint shall be within expiry date.                                |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| iii.   | Verification of supplier's TC as per paint specification.  | Painting material shall be used only after verification of TC.    |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| Sl. no.  | Operation  | Acceptance criteria   |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| i.   | Dressing & grinding of all flame-cut edges, welds & any major imperfections.   | No sharp edges or protrusions.                                    |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| ii.  | Degreasing by using white sprite to AA56701 & removal of varnish in wet condition.   | Free from grease & varnish.                                       |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| iii.   | Removal of light rust by hydrochloric acid/sulphuric acid to BP0690086 and removal of heavier localized rust by using emery cloth, steel scratch brush or portable power tool with abrasive tool & then applying hydrochloric acid/sulphuric acid.   | Surface should exhibits grey colour in place of red rust.         |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| iv.  | In case surface is widely rusted to such an extent that pitting with hard rust flakes is exhibited, the surface shall be sand/shot blasted.  | Surface should exhibits clean & grey colour in place of red rust. |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| v.   | Visual inspection of condition of surface of components before application of primer paint.  | As per the requirement of clause 5.                               |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |
| vi.  | Checking of surface finish of the components.  | Surface finish shall be as per IS:3073.                           |         |               |                     |    |   |  |     |                              |                                    |      |   |  |         |           |                     |    |  |                                |     |  |                             |      |  |   |     |   |   |    |   |                                     |     |   |

|   |  <p style="text-align: center;"><b>PRODUCT STANDARD</b><br/><b>TME DIVISION, BHOPAL</b></p>  | <p style="text-align: center;"><b>TM 94217</b><br/><b>REV.05</b></p> <p style="text-align: center;">PAGE 08 OF 09</p>                       |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
|---|---|---|----------------------|---------------------|--|---|---------------|--|--|-----------------|----------|---|-----------|---|------------|----|------------|----|------------|----|
|   | TME/2013  |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
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|   | <table border="1"> <thead> <tr> <th>Sl. no.</th><th>Description of Paint</th><th>Acceptance criteria</th></tr> </thead> <tbody> <tr> <td>i.</td><td>Measurement of primer paint thickness after one coat of primer paint as per clause 2.1.1, 2.1.2 &amp; 2.1.3 of AA0674105.</td><td>60-90 microns</td></tr> <tr> <td>ii.</td><td>Measurement of total paint thickness (primer + intermediate) after one coat of intermediate paint as per clause 2.1.1, 2.1.2 &amp; 2.1.3 of AA0674105.</td><td>120-180 microns</td></tr> </tbody> </table> | Sl. no.   | Description of Paint | Acceptance criteria | i.   | Measurement of primer paint thickness after one coat of primer paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.                       | 60-90 microns | ii.  | Measurement of total paint thickness (primer + intermediate) after one coat of intermediate paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105. | 120-180 microns |          |   |           |   |            |    |            |    |            |    |
| Sl. no.   | Description of Paint  | Acceptance criteria   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| i.  | Measurement of primer paint thickness after one coat of primer paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.   | 60-90 microns   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| ii.   | Measurement of total paint thickness (primer + intermediate) after one coat of intermediate paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.  | 120-180 microns   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <b>4) Inspection for Process Control (After Finish Painting):</b>   |   |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <table border="1"> <thead> <tr> <th>Sl. no.</th><th>Type of inspection</th><th>Acceptance criteria</th></tr> </thead> <tbody> <tr> <td>i.</td><td>Visual inspection of finished components for various paint film defects such as gloss, uniformity of shade, wrinkle, orange peel effect, blistering etc.</td><td>Free from paint film defects.</td></tr> <tr> <td>ii.</td><td>Measurement of total thickness of paint as per clause 2.1.1, 2.1.2 &amp; 2.1.3 of AA0674105.</td><td>160-220 microns with high spots of 250 microns</td></tr> </tbody> </table> | Sl. no.   | Type of inspection  | Acceptance criteria  | i.                  | Visual inspection of finished components for various paint film defects such as gloss, uniformity of shade, wrinkle, orange peel effect, blistering etc. | Free from paint film defects.   | ii.           | Measurement of total thickness of paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105. | 160-220 microns with high spots of 250 microns   |                 |          |   |           |   |            |    |            |    |            |    |
| Sl. no.   | Type of inspection  | Acceptance criteria   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| i.  | Visual inspection of finished components for various paint film defects such as gloss, uniformity of shade, wrinkle, orange peel effect, blistering etc.  | Free from paint film defects.   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| ii.   | Measurement of total thickness of paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.  | 160-220 microns with high spots of 250 microns  |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <b>5) Adhesion by Tape Test (As per AA0674105):</b>   |   |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <table border="1"> <thead> <tr> <th>Sl. no.</th><th>Description of Test</th><th>Acceptance criteria</th></tr> </thead> <tbody> <tr> <td>i.</td><td>Test is carried out by the application of a cross-cut test in accordance with BHEL Standard AA0674105.</td><td>Detachment of small flakes of the coating at the intersections of the cuts. A cross cut area not significantly greater than 5% is affected.</td></tr> </tbody> </table>   | Sl. no.   | Description of Test   | Acceptance criteria  | 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. |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| Sl. no.   | Description of Test   | Acceptance criteria   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| 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. |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <p><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:-</p>   |   |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><u>Lot size</u></th><th><u>Sample size</u></th></tr> </thead> <tbody> <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> </tbody> </table>  |   |   | <u>Lot size</u>      | <u>Sample size</u>  | 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 |
| <u>Lot size</u>   | <u>Sample size</u>  |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| 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  |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |
| <p><b>Imp.:</b> When sample size equals or exceeds lot size, every item in the lot shall be inspected.</p>  |   |   |                      |                     |  |   |               |  |  |                 |          |   |           |   |            |    |            |    |            |    |

|  |   |   |   |
|--|---|---|---|
| COPYRIGHT AND CONFIDENTIAL<br>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED<br>It must not be used directly or indirectly in any way detrimental to the interest of the company   |  | <b>PRODUCT STANDARD</b><br><b>TME DIVISION, BHOPAL</b>  | <b>TM 94217</b><br><b>REV.05</b>  |
|  | TME/2013  |   | PAGE 09 OF 09   |
|  | <b>Annexure-II</b><br><b>Checklist for Painting of Traction Machines</b>          |   |   |
| Machine type:  |   | Machine/Component no.:  |   |
| Date of Painting:  |   |   |   |
|  | Sl. No.   | Check points as per the requirement of annexure-I   | Checking Remark<br>(100%TP & 20%QC)   |
|  | 1.  | <b>Checking of Painting Material:</b><br>i. Expiry date of primer & intermediate paint<br>ii. Expiry date of finish paint<br>iii. Verification of supplier's TC as per paint specification  | (ok/not ok)<br>(ok/not ok)<br>(ok/not ok)   |
|  | 2.  | <b>Surface Preparation (Before Primer Painting):</b><br>i. Visual inspection for absence of sharp edges or protrusions<br>ii. Visual inspection for absence of grease & varnish<br>iii. Visual inspection for absence of light rust<br>iv. Visual inspection for absence of widely spread rust<br>v. Visual inspection for condition of surface as per the requirement of clause 5<br>vi. Surface finish of the component | (ok/not ok)<br>(ok/not ok)<br>(ok/not ok)<br>(ok/not ok)<br>(ok/not ok)<br>.....microns (ok/not ok) |
|  | 3.  | <b>Measurement of Primer &amp; Intermediate Paint Thickness:</b><br>i. Paint thickness after one coat of primer paint<br>ii. Total paint thickness (primer + intermediate ) after one coat of intermediate paint  | .....microns (ok/not ok)<br>.....microns (ok/not ok)  |
|  | 4.  | <b>Inspection for Process Control (After Finish Painting):</b><br>i. Visual inspection of finished component for absence of paint film defects<br>ii. Total thickness of paint  | (ok/not ok)<br>.....microns (ok/not ok)   |
|  | 5.  | <b>Adhesion by Tape Test (As per AA0674105):</b><br>i. Adhesion by tape test  | (ok/not ok)   |
| <b>Abbreviations:-</b><br>TP – Task Performer, QC – QTM/BHEL Authorized Quality Inspection Agency<br><b>Note: 1)</b> For the components supplied by the supplier in finish painted condition, the supplier to furnish dully filled checklist for each component along with consignment.<br><b>2)</b> The acceptance criteria shall be as per annexure-I. |   |   |   |
| (Task performer's signature)   |   | (QC's signature)  |   |



# CORPORATE PURCHASING SPECIFICATION

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&amp;GPS

**APPROVED:**INTERPLANT MATERIAL RATIONALISATION  
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HPEP, Hyderabad

Corp.R&amp;D

July, 1976

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# CORPORATE PURCHASING SPECIFICATION

AA10108

Rev No. 11

PAGE 1 of 2

## 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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|               |         |            |                 |          |                              |
|---------------|---------|------------|-----------------|----------|------------------------------|
| Rev No.11     | Amd No. | Reaffirmed | Prepared        | Issued   | Dt. of 1 <sup>st</sup> Issue |
| Dt:22-02-2014 | Dt:     | Year:      | HPEP, Hyderabad | Corp.R&D | July, 1976                   |

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Rev No. 11

PAGE 2 of 2

# 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 PURCHASING SPECIFICATION

AA10301

Rev No.05

PREFACE SHEET

## COLD DRAWN SPRING STEEL WIRE - ZINC COATED

FOR INTERNAL USE ONLY

REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

### Comparable Standards:

- 1) INDIAN : IS : 4454, Part 1 – 2001, Gr: SM  
Finish: Zinc Coated

### Suggested/Probable Suppliers and Grades:

Refer plant vendors list.

### User Plants References:

- 1) HEP, BHOPAL : PS10 01.  
2) HEEP, HARDWAR : 0550.000

Revisions:  
Cl. 26.6.22 of MOM of MRC-S&GPS

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|               |         |            |             |          |                              |
|---------------|---------|------------|-------------|----------|------------------------------|
| Rev No.05     | Amd No. | Reaffirmed | Prepared    | Issued   | Dt. of 1 <sup>st</sup> Issue |
| Dt:15-01-2004 | Dt:     | Year:2020  | HEP, Bhopal | Corp.R&D | August, 1976                 |

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# CORPORATE PURCHASING SPECIFICATION

AA10301

Rev No.05

PAGE 1 of 4

## COLD DRAWN SPRING STEEL WIRE - ZINC COATED

### 1.0 GENERAL:

This specification governs the quality of requirements of Zinc coated cold drawn carbon steel wire.

### 2.0 APPLICATION:

Suitable for the manufacture of cold formed helical springs, spring-rings and wire forms subjected to moderate load cycles-statically stressed.

### 3.0 CONDITION OF DELEVERY;

Wire shall be supplied in the form of coils in Zinc Coated, Cold drawn condition.

### 4.0 Compliance with National Standards:

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

IS: 4454, Part 1- 2001, Gr.: SM : Steel wires for mechanical springs.

### 5.0 DIMENSIONS AND TOLERANCES:

#### 5.1 Sizes:

The material shall be supplied to the dimensions specified on BHEL order.

Wires above 0.30 mm and upto and including 20.0 mm in diameter only shall be ordered to this specification

#### 5.2 Tolerances:

5.2.1 The tolerances of the wire shall comply with Table-4 of IS: 4454, Part-1.

5.2.2 The cross-section of the round wire shall be circular to within half the tolerance of the permitted diameter tolerance, specified above.

Revisions:  
Cl. 26.6.22 of MOM of MRC-S&GPS

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|               |         |            |             |          |                              |
|---------------|---------|------------|-------------|----------|------------------------------|
| Rev No.05     | Amd No. | Reaffirmed | Prepared    | Issued   | Dt. of 1 <sup>st</sup> Issue |
| Dt:15-01-2004 | Dt:     | Year:2020  | HEP, Bhopal | Corp.R&D | August, 1976                 |

AA10301

Rev No. 05

PAGE 2 of 4

# CORPORATE PURCHASING SPECIFICATION



## 6.0 MANUFACTURE:

Steel for springs shall be manufactured by the open heath, electric, basic oxygen or a combination of these processes. If any other process is employed, prior approval of BHEL shall be obtained.

Material shall be manufactured form killed steel.

The wire shall be drawn in the galvanised condition.

## 7.0 FREEDOM FROM DEFECTS:

The surface of the wire shall be smooth and free from defects such as grooves, seams, pits, die marks, tears, rust, scale, scratches and any harmful defects which may have a noticeable adverse effect on application of the wire.

## 8.0 SAMPLING:

Unless otherwise agreed to method of drawing representative sample of material and criteria for conformity shall be as per Annex. C of IS: 4454, Part 1.

## 9.0 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the finished product form the melt analysis shall be as follows:

| Element    | Melt analysis |        | Permissible variation,<br>percent, in product analysis |
|------------|---------------|--------|--|
|            | % Min.        | % Max. |  |
| Carbon     | 0.35          | 1.0    | ± 0.02   |
| Silicon    | 0.10          | 0.30   | ± 0.03   |
| Manganese  | 0.30          | 1.20   | + 0.05   |
| Sulphur    | ---           | 0.03   | + 0.005  |
| Phosphorus | ---           | 0.03   | + 0.005  |
| Copper     | ---           | 0.20   | --   |

### NOTE:

- i) P + S = 0.055%, max.
- ii) Cu + Ni + Cr = 0.35%, max

## 10.0 ZINC COATING:

Zinc Coating Process (Hot dip galvanising) shall be as per IS: 2629

The final weight of zinc coating shall not be less than 60 gm/m<sup>2</sup> on any size of wire when tested as per IS: 6745



# CORPORATE PURCHASING SPECIFICATION

AA10301

Rev No.05

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## 11.0 WRAPPING TEST:

The wire shall be bent or wrapped round a mandrel of appropriate diameter given below without cracking of the base wire, or cracking or flaking of the coating to such an extent that any zinc can be removed by rubbing with bare fingers.

| Diameter of wire, mm         | Minimum complete turns of wrap | Mandrel diameter |
|------------------------------|--------------------------------|------------------|
| 3.80 and under               | 6                              | 4 D*             |
| Over 3.80 up to and incl.7.5 | 6                              | 5 D              |
| Over 7.5                     | $\frac{1}{4}$ (one 90° bend )  | 5 D              |

\* Diameter of wire = D

## 12.0 MECHANICAL PROPERTIES:

### 12.1 Tensile:

The tensile test shall be carried out in accordance with IS: 1608.

The tensile strength and percentage reduction of area obtained from the test pieces shall comply with those given in Table 5 of IS: 4454, Part 1.

### 12.2 Wrapping:

The wrapping test shall be applicable to wires with nominal diameter less than 3mm. Wrapping test when carried out in accordance with IS:1755 shall not show on visual examination any sign of fracture upon closely coiled for at least four turn around a mandrel of diameter equal to diameter of wire.

### 12.3 Torsion:

For wires of diameter 0.5 mm and up to and including 10.0 mm.

The sample piece of length equal to 100 times the wire diameter, but not exceeding 500mm shall be twisted in accordance with IS: 1717. The test piece shall withstand, without failure, the minimum number of turns given in Table 6 of IS: 4454, Part I. The fracture shall be perpendicular to the wire axis and surface shall not split. Any secondary helical fracture shall be ignored.

### 12.4 Cast of Wire:

As per IS: 4454

AA10301

Rev No. 05

PAGE 4 of 4

# CORPORATE PURCHASING SPECIFICATION



## 13.0 INSPECTION AT SUPPLIER'S WORKS:

Whenever specified tests and inspection are to be conducted in the presence of BHEL's representative.

The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification

The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his works, the supplier shall make necessary arrangements for carrying out the prescribed test elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL's works and the final acceptance of the material shall be based on these test results.

## 14.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

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

The test certificate shall bear the following information:

AA10301: Rev. No. 05: COLD DRAWN SPRING STEEL WIRE - ZINC COATED

BHEL order No:

Supplier's Reference:

Name:

Identification No:

Cast No./Lot No:

Results of Tests:

Results of chemical mechanical and Zinc coating tests.

## 15.0 PACKING AND MARKING:

The wires shall be supplied in coils having a maximum weight of 50kg. The wires shall be coiled in such a way that the coils remain flat when the ties are cut. The coils shall be suitably packed to prevent corrosion and damage during transit.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10301: COLD DRAWN SPRING STEEL WIRE - ZINC COATED

BHEL Order No:

Consignment/Identification No:

Size and Weight:

Supplier's Name:

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

1) IS: 1608

2) IS: 1717

3) IS: 1755

4) IS: 2629

5) IS: 4454, Part1

6) IS: 6745



## CORPORATE PURCHASING SPECIFICATION

AA 121 14

Rev. No. 03

PREFACE SHEET

## FREE CUTTING BRASS BARS, RODS, WIRES AND SECTIONS (HALF HARD)

FOR INTERNAL USE ONLY  
REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

Comparable Standards:

- |           |  |
|-----------|--|
| 1. INDIAN | : IS : 319 - 89 (Reaffirmed 1996)<br>Gr: 1 (HB) - Half hard bars 6mm and above.<br>IS: 8364-1989 (Reaffirmed 1996)<br>Gr: 1 (HB) - Half hard wires upto 6mm. |
| 2. GERMAN | : DIN 17660-1983<br>DIN 17672-1983 Gr: CuZn40Pb3 (F44)   |

Suggested/Probable Suppliers and Grades:

Refer plant vendors list.

User Plant References:

- |                  |  |
|------------------|--|
| 1. BHOPAL        | : PS 12018   |
| 2. HEEP, HARDWAR | : 0502.208   |
| 3. HYDERABAD     | : IS:319 Type-1 (1/2 H), CSN 423223.0, ASEA 21570.00 |

Revisions :

Cl: 17.11.25 of MOM of MRC-NFCW+HE

APPROVED :

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## CORPORATE PURCHASING SPECIFICATION

AA 121 14

Rev. No. 03

PAGE 1 OF 4

## FREE CUTTING BRASS BARS, RODS, WIRES AND SECTIONS (HALF HARD)

### 1.0 GENERAL:

This specification governs the quality requirements of Free cutting Brass Bars, Rods, Wires and Sections.

### 2.0 APPLICATION:

For screws and bushes.

### 3.0 CONDITION OF DELIVERY:

"Half Hard" wires upto 6mm diameter may be supplied in coils.

### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following national standard and also meet the requirements of this specification.

IS : 319 - 89 (Reaffirmed 1996) : Free cutting Brass Bars, Rods and Sections  
Gr: 1 (HB) - Half hard

IS: 8364-1989 (Reaffirmed 1996) : Free cutting Rods and Sections  
Gr: 1 (HB) - Half hard

### 5.0 DIMENSIONS AND TOLERANCES:

#### 5.1 Sizes:

The material shall be supplied to the dimensions specified in BHEL order:

#### 5.2 Tolerances:

##### 5.2.1 Wires:

Tolerances shall be as per Table-1 of IS:9861.

##### 5.2.2 Bars/Rods and Sections:

Tolerances for round, square, rectangular and hexagonal rods shall be as given in Table-1, 2, 3 and 4 respectively of IS:2826.

#### Revisions :

Cl: 17.11.25 of MOM of MRC-NFCW+HE

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AA 121 14

Rev. No. 03

PAGE 2 OF 4

## CORPORATE PURCHASING SPECIFICATION

**6.0 MANUFACTURE:**

By rolling / extrusion / drawing.

**7.0 FREEDOM FROM DEFECTS:**

The material shall be clean, smooth free from surface defects, reasonably straight and free from twists.

**8.0 CHEMICAL COMPOSITION:**

The analysis of copper when analysed in accordance with IS:3685 (Method for chemical analysis of brasses) or any other conventional/Instrumental methods shall be as follows:

| Element                               | Percent   |      |
|---------------------------------------|-----------|------|
|                                       | Min.      | Max  |
| Copper plus incidental nickel         | 56        | 59.0 |
| Lead                                  | 2.0       | 3.5  |
| *Iron                                 | ----      | 0.35 |
| *Total Impurities<br>(excluding Iron) | ----      | 0.7  |
| Zinc                                  | Remainder |      |

**Note:** These elements need not be determined, when the materials supplied conform with mechanical properties specified.


**9.0 TEST SAMPLES:**

**9.1** One sample per heat shall be taken for chemical analysis.

**9.2** One sample per heat per size shall be taken for other tests.

**10.0 MECHANICAL PROPERTIES:**

When tested in accordance with IS 1608, (Mechanical testing of metals-Tensile testing), the material shall show the following properties. The fractured test piece shall be free from pipes and such other defects.

|   |  |                                    |  |             |
|---|--|------------------------------------|--|-------------|
|  |  | CORPORATE PURCHASING SPECIFICATION |  | AA 121 14   |
|   |  |                                    |  | Rev. No. 03 |
|   |  |                                    |  | PAGE 3 OF 4 |

| Cross sectional dimension, mm |              | Ultimate tensile strength, in N/mm <sup>2</sup> | Percent, elongation |
|-------------------------------|--------------|---|---------------------|
| Over                          | upto & incld | min.  | min.                |
| -                             | 10           | 410   | 4.0                 |
| 10                            | 12           | 405   | 4.0                 |
| 12                            | 25           | 395   | 6.0                 |
| 25                            | 50           | 355   | 12.0                |
| 50                            | ---          | 325   | 17.0                |

- Upto 10 mm size, guage length shall be 100 mm. Above 10mm size gauge length shall be  $5.65\sqrt{So}$  .

**11.0 MERCUROUS NITRATE TEST:**

The mercurous nitrate test shall be carried out on a piece cut from each bar/rod selected for testing. When tested in accordance with IS: 2305, the test piece shall not show any sign of cracking. Should any specimen fail under mercurous nitrate test, all bars/rods submitted for inspection at the same time shall be withdrawn but may be resubmitted for inspection after stress relieving treatment.

**12.0 OPTIONAL TEST:**

If specified in the order/drawing, the material shall be tested for its electrical conductivity. The electrical conductivity shall be as per mutual agreement within BHEL and manufacturer. Refer ASTM B 193 , clause 6 for temperature correction factor.

**13.0 RETEST:**

Should any of the test pieces first selected, fail to pass the prescribed tests mentioned under various clauses in this specification, two further samples from the same batch shall be selected for testing one of which shall be from the same component from which the original test sample was taken, unless that component has been withdrawn by the supplier.

Should the test pieces form both these additional samples pass, the batch represented by the test sample shall be accepted. Should the test pieces from either of these additional samples fail, the batch represented by the test samples shall be rejected.

**14.0 INSPECTION AT SUPPLIER ' WORKS:**

When ever specified, tests and inspection are to be conducted in the presence of BHEL's representative..

|             |                                    |   |
|-------------|------------------------------------|---|
| AA 121 14   | CORPORATE PURCHASING SPECIFICATION |  |
| Rev. No. 03 |                                    |   |
| PAGE 4 OF 4 |                                    |   |

The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his works, the supplier shall make necessary arrangements for carrying out the prescribed test elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL's works and the final acceptance of the material shall be based on these test results.

#### 15.0 TEST CERTIFICATES:

Unless other wise stated, three copies of certificates shall be supplied along with each consignment.

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

The test certificate shall bear the following information:

AA 12114 (Rev.03) Free cutting brass bars, rods, wires and sections (Half hard)  
 BHEL Order No.  
 Manufacturer 's/Supplier's Name:  
 Lot/Identification/Batch/Melt No.  
 Sizes and Quantity Supplied  
 Results of dimensional inspection, chemical analysis, mechanical and all other tests as called for.


#### 16.0 PACKING AND MARKING:

The material shall be suitably packed in crates to prevent corrosion and damage during transit. Each package or crate shall be legibly marked with the following information:

AA 12114 :  
 BHEL Order No.  
 Identification No:  
 Size  
 Weight  
 Supplier's Reference and Name

#### 17.0 REFERRED STANDARDS : (Latest Publications Including Amendments):

- |             |               |             |
|-------------|---------------|-------------|
| 1. IS:319   | 2. IS: 1608   | 3. IS: 3205 |
| 4. IS: 2826 | 5. IS: 3685   | 6. IS: 8364 |
| 7. IS: 9861 | 8. ASTM B 193 |             |

|  |   |                 |  |           |                  |
|--|---|-----------------|--|-----------|------------------|
|   | <b>CORPORATE PURCHASE SPECIFICATION</b> |                 | AA 193 33  |           |                  |
|  |   |                 | Rev. No. 09  |           |                  |
|  |   |                 | PREFACE SHEET  |           |                  |
| <h2 style="margin: 0;">CARBON STEEL FORGINGS, CLASS 4</h2> <p style="margin: 10px 0 0 0;">FOR INTERNAL USE ONLY<br/>REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS</p> <p style="margin: 20px 0 0 0;"><b>Comparable Standards:</b></p> <div style="display: flex; justify-content: space-between; align-items: flex-start; margin: 10px 0;"> <div>1. INDIAN</div> <div style="text-align: right;">: IS: 2004 - 1991<br/>Gr: Class 4 (45 C8)</div> </div> <p style="margin: 20px 0 0 0;"><b>Suggested/Probable Suppliers and Grades:</b><br/>Refer plant vendors list.</p> <p style="margin: 20px 0 0 0;"><b>User Plant References:</b></p> <div style="display: flex; justify-content: space-between; margin: 10px 0;"> <div>1. BHOPAL</div> <div style="text-align: right;">: PS10211</div> </div> <div style="display: flex; justify-content: space-between; margin: 5px 0;"> <div>2. HEEP, HARDWAR</div> <div style="text-align: right;">: GOST 1050, Gr:45</div> </div> <div style="display: flex; justify-content: space-between; margin: 5px 0;"> <div>3. HYDERABAD</div> <div style="text-align: right;">: IS 2004, CI 4 &amp; CSN 411600.0</div> </div> <div style="display: flex; justify-content: space-between; margin: 5px 0;"> <div>4. TIRUCHY</div> <div style="text-align: right;">: IS:2004, CLASS 4</div> </div> |   |                 |  |           |                  |
| Revisions : 36 <sup>th</sup> MOM OF MRC+HTM  |   |                 | <b>APPROVED :</b><br>INTERPLANT MATERIAL RATIONALISATION<br>COMMITTEE-MRC (FC&F+HTM) |           |                  |
| Rev. No. 09  | Amd.No.                                 | Reaffirmed      | Prepared   | Issued    | Dt. of 1st Issue |
| Dt.:23.01.2007   | Dt :                                    | Year:04-11-2011 | HARDWAR  | Corp. R&D | JANUARY.1978     |



## CORPORATE PURCHASE SPECIFICATION

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**CARBON STEEL FORGINGS, CLASS 4**

↑

**1.0 GENERAL:**

This specification governs the quality requirements of Carbon Steel Forgings, class 4.

↑

**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 2001) (RA-2006) } Carbon Steel Forgings For General Engineering

Gr: Class 4 (45C8), } 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+HTM

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Dt :

Year:04-11-2011

HARDWAR

Corp. R&amp;D

JANUARY 1978

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**6.0 MANUFACTURE:**

Forgings shall be manufactured from steel produced by the open hearth, electric or such other 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 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,<br>percent |       | Permissible<br>variation,<br>percent |
|------------|---------------------------|-------|--------------------------------------|
|            | Min.                      | Max.  |                                      |
| Carbon     | 0.40                      | 0.50  | ± 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                              |



## CORPORATE PURCHASE SPECIFICATION

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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 | 0.05          |
| 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<br>(See Cl.11.3)                            | Limiting ruling section, mm |                      |                      |                      |
|--|--|-----------------------------|----------------------|----------------------|----------------------|
|  |  | Upto &<br>incl 100          | >100 &<br>upto 300   | > 300 &<br>upto 500  | >500 &<br>upto 800   |
| Tensile strength<br>N/mm <sup>2</sup>                              | Longitudinal/<br>Transverse/<br>Radial/Tangential  | 620                         | 620                  | 530                  | 530                  |
| Yield strength<br>min, N/mm <sup>2</sup>                           | Longitudinal/<br>Transverse/<br>Radial/Tangential  | 320                         | 320                  | 275                  | 275                  |
| Elongation<br>on 5.65 $\sqrt{S_0}$<br>gauge length<br>percent, min | Longitudinal<br>Transverse<br>Radial<br>Tangential | 15<br>8<br>10<br>11         | 14<br>7<br>9<br>10   | 15<br>8<br>10<br>10  | 13<br>6<br>8<br>9    |
| Reduction in<br>area, percent<br>min.                              | Longitudinal<br>Transverse<br>Radial<br>Tangential | 38<br>23<br>25<br>30        | 35<br>21<br>24<br>28 | 32<br>19<br>21<br>24 | 30<br>18<br>19<br>23 |
| *Hardness,<br>Brinell, HB  | —  | 175-207                     | 175-207              | 149-197              | 149-197              |
| Charpy<br>Impact Value<br>(2mm, U-Notch)<br>min., Joules           | Longitudinal<br>Transverse<br>Radial<br>Tangential | 31<br>16<br>19<br>24        | 27<br>14<br>16<br>21 | 23<br>12<br>14<br>16 | 23<br>12<br>14<br>16 |

**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 33 : Carbon Steel Forgings, Class 4 ↑

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) IS: 2004 |            |            |



## CORPORATE PURCHASE SPECIFICATION

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

| SUPPLIER'S NAME AND ADDRESS<br>TEST CERTIFICATE FOR FORGINGS  |                  |                        |                        |                    |   |  |         |                   |        |
|---|------------------|------------------------|------------------------|--------------------|---|--|---------|-------------------|--------|
| 1. Customer:  |                  |                        |                        |                    | 9. Reorder:   |  |         |                   |        |
| 2. TC No. & Date:   |                  |                        |                        |                    | 10. Bulk:   | <input type="checkbox"/> Ingot to 300mm<br><input type="checkbox"/> 115mm to 180mm |         |                   |        |
| 3. PO No.:  |                  |                        |                        |                    | 11. Forging No.:  |  |         |                   |        |
| 4. Process of Forging:  |                  |                        |                        |                    | 12. Heat/Melt No.:  |  |         |                   |        |
| 5. Direction of Forging:  |                  |                        |                        |                    | 13. Spec No.:   |  |         |                   |        |
| 6. Forging Method:  |                  |                        |                        |                    | 14. Test Direction & Axis:  |  |         |                   |        |
| 7. Heat Treatment Approval of Steam:  |                  |                        |                        |                    | 15. Supplier of the Ingot/Ingot:  |  |         |                   |        |
| 8. Disposal To:   |                  |                        |                        |                    | 16. Bloom and 17. Ingot:  |  |         |                   |        |
| 15. FORGING SPECIFICATION (TO BE FILL IN THE GRID)  |                  |                        |                        |                    |   |  |         |                   |        |
| Serial  |                  | Drawing No. & Revision |                        |                    | Description   |  |         | Quantity & Weight |        |
|   |                  |                        |                        |                    |   |  |         |                   |        |
| 16. CHEMICAL COMPOSITION (PERCENT)  |                  |                        |                        |                    |   |  |         |                   |        |
| Element   |                  | C                      | Si                     | Mn                 | S   | P  |         |                   |        |
| As Per Spec   | Min              |                        |                        |                    |   |  |         |                   |        |
|   | Max              |                        |                        |                    |   |  |         |                   |        |
| Actual Value  |                  |                        |                        |                    |   |  |         |                   |        |
| 17. HEAT TREATMENT<br>(To be accompanied by Heat-treatment Chart, whenever called for)  |                  |                        |                        |                    |   |  |         |                   |        |
| Duration  | Heating Rate     | Temp °C                |                        | Soaking Time       | Min   | Cooling Rate   | °C/hr   | Cooling Medium    |        |
|   |                  |                        |                        |                    |   |  |         |                   |        |
| 18. MECHANICAL PROPERTIES   |                  |                        |                        |                    |   |  |         |                   |        |
|   |                  | TS                     | YS                     | % Elongation       | % Reduction of Area   | Hardness   | Impact  | Bend Test         |        |
|   |                  | N/mm <sup>2</sup>      | 0.5/0.2% Proof Min/Max | 5.8% Elongation    | WR4, Min  | BHN/Min. 3   | V-notch | Angle of bend     | Charpy |
| As Per Spec   | Min              |                        |                        |                    |   |  |         |                   |        |
|   | Max              |                        |                        |                    |   |  |         |                   |        |
| Actual Value  |                  |                        |                        |                    |   |  |         |                   |        |
| 19. SURFACE INSPECTION<br>(To be called for in the order)   |                  |                        |                        |                    |   |  |         |                   |        |
| 20. DIMENSIONAL INSPECTION  |                  |                        |                        |                    |   |  |         |                   |        |
| 21. NON DESTRUCTIVE TESTS   |                  |                        |                        |                    |   |  |         |                   |        |
| Nature of Test  | Acceptance level | Instrument used        |                        | Range              | Results   | Any other data   |         |                   |        |
| Ultrasonic  |                  |                        |                        |                    |   |  |         |                   |        |
| Fluorescent   |                  |                        |                        |                    |   |  |         |                   |        |
| Dye penetrant   |                  |                        |                        |                    |   |  |         |                   |        |
| Magnetic Particle   |                  |                        |                        |                    |   |  |         |                   |        |
| 22. METALLOGRAPHIC EXAMINATION<br>(To be conducted if called for and photomicrographs to be attached along with a report)   |                  |                        |                        |                    |   |  |         |                   |        |
| Location of Sample  | Etchant used     | Magnification          |                        | Condition observed | Relative %  |  |         |                   |        |
|   |                  |                        |                        |                    |   |  |         |                   |        |
| Microstructure  | Microetch        | Inclusion Rating       |                        |                    |   |  |         |                   |        |
|   |                  |                        |                        |                    |   |  |         |                   |        |
| 23. OTHER TESTS (IF ANY MICROSCOPIC, SURFACE TENSILE, ETC)  |                  |                        |                        |                    |   |  |         |                   |        |
| 24. IDENTIFICATION OF FORGING AS PER PURCHASE SPEC.   |                  |                        |                        |                    |   |  |         |                   |        |
| We hereby certify that the items mentioned above have been tested and inspected in pursuance and a label to be in accordance with drawings specifications and purchase order. |                  |                        |                        |                    |   |  |         |                   |        |
| SIGNATURE, NAME & SEAL OF THE<br>AUTHORISED SIGNATORY   |                  |                        |                        |                    | SIGNATURE, NAME & SEAL OF THE<br>CHIEF OF QUALITY CONTROL<br>OR HEAD METALLURGIST OF THE SUPPLIER |  |         |                   |        |
| DATE:   |                  |                        |                        |                    | DATE:   |  |         |                   |        |
| INSTRUCTIONS  |                  |                        |                        |                    |   |  |         |                   |        |
| a) Details of all heat treatment processes carried out should be furnished separately 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 blue colour ink.  |                  |                        |                        |                    |   |  |         |                   |        |
| d) 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, or by large filing up of details.   |                  |                        |                        |                    |   |  |         |                   |        |



## CORPORATE PURCHASE SPECIFICATION

AA 195 11

Rev. No. 09

PREFACE SHEET

## CARBON STEEL CASTINGS - FUSION WELDING QUALITY

FOR INTERNAL USE ONLY  
REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

**Comparable Standards:**

1. AMERICAN : ASTM A 216 - 1993  
Gr: WCC

**Suggested/Probable Suppliers and Grades:**

Use plant's vendor list.

**User Plant References:**

1. BHOPAL : PS 10 202  
2. HEER, HARDWAR : 0550.41, GR: 15Ω; 20Ω; 25Ω & 30Ω  
CSW - C 20 \$ CSW - C 25.  
3. HYDERABAD : ASTM A 216, Gr: WCA  
: CSN 422641.1  
: CSN 422643.1  
: CSN 422650.2  
: IS : 2986  
: γ 87 - 30, Type L  
4. TRICHY : ASTM A 216, Gr: WCB  
: ASTM A 216, Gr: WCC

**Revisions :**

36<sup>th</sup> MOM of MRC – FCF+HTM

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Year:04-11-2011

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Corp. R&amp;D

MARCH, 1978



## CORPORATE PURCHASING SPECIFICATION

AA 195 11

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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

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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,<br>Percent, max | Permissible<br>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                             |
| -----      |                                |                                   |



## CORPORATE PURCHASING SPECIFICATION

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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%.

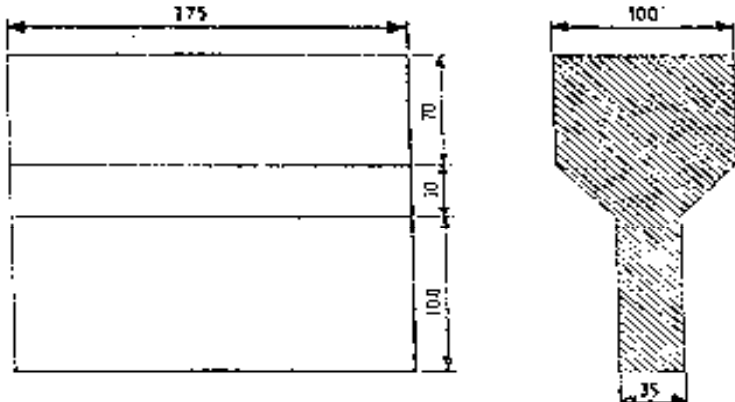
**11.0 TEST SAMPLES**

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.

|             |                                    |   |
|-------------|------------------------------------|---|
| AA 195 11   | CORPORATE PURCHASING SPECIFICATION |  |
| Rev. No. 09 |                                    |   |
| PAGE 4 OF 6 |                                    |   |

DETAIL OF KEEL BLOCK



ALL DIMENSIONS IN mm

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause Cl.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



## CORPORATE PURCHASING SPECIFICATION

AA 195 11

Rev. No. 09

PAGE 5 OF 6

**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    |

|             |   |   |
|-------------|---|---|
| AA 195 11   | <b>CORPORATE PURCHASING SPECIFICATION</b> |  |
| Rev. No. 09 |   |   |
| PAGE 6 OF 6 |   |   |

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

| SUPPLIER'S NAME AND ADDRESS  |                           |  |                    |             |                               |                         |                |                   |  |
|--|---------------------------|--|--------------------|-------------|-------------------------------|-------------------------|----------------|-------------------|--|
| 1. Customer :  |                           |  |                    |             | 8. Cast No. & Date :          |                         |                |                   |  |
| 2. TC No. & Date :   |                           |  |                    |             | 7. Batch No. :                |                         |                |                   |  |
| 3. PO No. :  |                           |  |                    |             | 6. Matl. Code :               |                         |                |                   |  |
| 4. Process of Molding :  |                           |  |                    |             | 9. Spec. No. :                |                         |                |                   |  |
| 5. Deposition 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.<br>N/mm <sup>2</sup> | Y.S.<br>0.50.2% Proof<br>N/mm <sup>2</sup> | % El on<br>5.65 SO | % R.A.<br>% | Hardness BHN<br>Min. & Values | Impact<br>Value, Joules | Bend           |                   |  |
| As per Min.  |                           |  |                    |             |                               |                         |                |                   |  |
| Spec. Max.   |                           |  |                    |             |                               |                         |                |                   |  |
| Actual Values  |                           |  |                    |             |                               |                         |                |                   |  |
| 15. Surface Finish<br>(When called for in the order/dwg)   |                           |  |                    |             |                               |                         |                |                   |  |
| 16. DIMENSIONAL INSPECTION   |                           |  |                    |             |                               |                         |                |                   |  |
| 17. NON-DESTRUCTIVE TESTS  |                           |  |                    |             |                               |                         |                |                   |  |
| Nature of Test   | Acceptance Level          | Instrument used                            | Range              | Results     | Any other details             |                         |                |                   |  |
| Ultrasonic   |                           |  |                    |             |                               |                         |                |                   |  |
| Radiographic   |                           |  |                    |             |                               |                         |                |                   |  |
| Dye Penetrant/<br>Magnetic Particle  |                           |  |                    |             |                               |                         |                |                   |  |
| 18. OTHER TESTS, IF ANY (MICRO-<br>Scopio, Hydraulic, Etc.)  |                           |  |                    |             |                               |                         |                |                   |  |
| 19. IDENTIFICATION ON<br>CASTING AS PER GPS.   |                           |  |                    |             |                               |                         |                |                   |  |
| <p>We hereby certify that the items mentioned above have been tested and inspected in our premises 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>Signature &amp; Seal of the Inspecting Officer<br/>(Purchase Representative)</p> <p>Date :</p> </div> <div style="width: 45%;"> <p>Signature and Seal of the Chief of Quality Control<br/>Chief Metallurgist of the Supplier.</p> <p>Date :</p> </div> </div> <p><b>INSTRUCTION:</b></p> <p>a) If steel is produced by LD or Oxygen process, Nitrogen content should be furnished and shall not exceed 0.006%.</p> <p>b) Test Certificates are to be furnished as per Purchase Order and Specifications, in A4 Size transparent paper.</p> <p>c) All the entries including signature should be in black ink.</p> <p>d) If testing is done by outside agencies, the original TCs shall be furnished.</p> <p>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

AA55152

Rev No.03

PREFACE SHEET

## RUST PREVENTIVE SOLUTION, CLEAR (TRP)

FOR INTERNAL USE ONLY  
REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

## Equivalent/Comparable Standards

INDIAN

: IS: 1154-2000

## User Plants and Replaced Plant Specifications/References

- |                    |          |
|--------------------|----------|
| 1) BHOPAL          | : HE1609 |
| 2) HEEP, HARIDWAR  | : HE1709 |
| 3) HPEP, HYDERABAD | : HE1709 |

## Revisions:

## APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(CPO+NM)

|               |         |            |             |          |                              |
|---------------|---------|------------|-------------|----------|------------------------------|
| Rev No.03     | Amd No. | Reaffirmed | Prepared    | Issued   | Dt. of 1 <sup>st</sup> Issue |
| Dt:26-05-2012 | Dt:     | Year:2019  | HEP, Bhopal | Corp.R&D | 01-11-1982                   |

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|---|---|-------------|
|  | <b>CORPORATE PURCHASING SPECIFICATION</b> | AA55152     |
|   |   | Rev No. 03  |
|   |   | PAGE 1 of 2 |

## RUST PREVENTIVE SOLUTION, CLEAR (TRP)

### 1 GENERAL

This specification governs the quality requirements of temporary rust preventive solution, clear (TRP) used for the protection of various ferrous components. Normally this material provides protection upto six months and thereafter requires reapplication, if necessary.

### 2 APPLICATION

Depending upon components and their sizes, the rust preventive can be applied by brush, dip or spray. A liberal coat is desirable for adequate protection. The surface to be coated with anti rust solution should be absolutely clean and free from rust.

### 3 REMOVAL

This TRP can be removed by cotton cloth soaked in white spirit to BHEL specification AA 56701.

### 4 COLOUR

Brown

### 5 COMPLIANCE WITH NATIONAL STANDARDS

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

IS: 1154 - 2000: Temporary Corrosion Preventive, Fluid, Soft Film, Solvent deposited, Water displacing

### 6 COMPOSITION

The composition shall be based on wool fat and other corrosion inhibitors.

### 7 TEST SAMPLES

Half a litre of sample shall be taken for testing and approval.

### 8 PROPERTIES

When tested in accordance with the relevant clauses of BHEL standard AA0850001, the test sample shall show the following properties:

#### 8.1 Consistency

65 ± 10 seconds in Ford Cup No.4 at 27± 0.5°C

#### 8.2 Drying Time

Tack free in 16 hours, shall remain soft to facilitate removal when not required.

#### 8.3 Flash Point

32°C, min. (Absolute temp)

#### 8.4 Weight

9.1 ± 0.2 kg per 10 litres

|                   |         |            |  |                    |  |
|-------------------|---------|------------|--|--------------------|--|
| <b>Revisions:</b> |         |            | <b>APPROVED:</b><br>INTERPLANT MATERIAL RATIONALISATION<br>COMMITTEE – MRC(CPO+NM) |                    |  |
| Rev No.03         | Amd No. | Reaffirmed | Prepared<br>HEP, Bhopal  | Issued<br>Corp.R&D | Dt. of 1 <sup>st</sup> Issue<br>01-11-1982 |
| Dt:26-05-2012     | Dt:     | Year:2019  |  |                    |  |

AA55152

Rev No. 03

PAGE 2 of 2

**CORPORATE PURCHASING SPECIFICATION****8.5 Protection against corrosion at high temperature and humidity**

To pass the test.

**8.6 Salt spray corrosion test**

100 hours

**9 TEST CERTIFICATES**

Three copies of test certificates shall be supplied along with each consignment, giving the following information:

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

- AA55152, Rev. 03: RUST PREVENTIVE SOLUTION, CLEAR (TRP)
- BHEL Order No.
- Batch / Lot No.
- Supplier's/ Manufacturer's Name and Trade mark, if any
- Date of manufacture and expiry
- Test results of clause 8.

**10 KEEPING PROPERTY**

When stored in a 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 not less than 12 months after the date of manufacture which shall be subsequent to the date of placing the order.

**11 PACKING & MARKING**

Unless otherwise specified, the material shall be supplied in 4 kg steel containers, which shall be leak free, dry and clean.

Each container shall marked with the following information:

- AA55152: RUST PREVENTIVE SOLUTION, CLEAR (TRP)
- BHEL Order No.
- Supplier's / Manufacturer's Name and Trade mark, if any
- Batch No. /Lot No.
- Date of manufacture and expiry
- Quantity supplied

**12 ENVIRONMENTAL REQUIREMENTS**

The supplier shall furnish Material Safety Data Sheet (MSDS) covering all information relating to human safety and environmental impacts of the hazardous materials particularly during their transportation, storage, handling and disposal along with each supply.

Each container shall be marked with corresponding symbol and minimum worded cautionary notice for flammable / corrosive / toxic / harmful / irritant and oxidizing etc. as applicable.

**13 REFERRED STANDARDS (Latest Publications Including Amendments)**

- 1) AA0850001
- 2) AA56701



## CORPORATE PURCHASING SPECIFICATION

AA56113

Rev No.02

PREFACE SHEET

## INORGANIC ETHYL ZINC SILICATE PRIMER

FOR INTERNAL USE ONLY  
REMOVE THIS PREFACE BEFORE ISSUE TO SUPPLIERS

## Equivalent/Comparable Standards

INDIAN

: IS: 14946-2001, Main coat

## User Plants and Replaced Plant Specifications/References

- |                    |           |
|--------------------|-----------|
| 1) HEP, BHOPAL     | : ---     |
| 2) HEEP, HARIDWAR  | : HW56175 |
| 3) HPEP, HYDERABAD | : ---     |
| 4) HPBP, Trichy    | : ---     |

## Revisions:

## APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(CPO+NM)

|               |         |            |                 |          |                              |
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## CORPORATE PURCHASING SPECIFICATION

AA56113

Rev No. 02

PAGE 1 of 4

## INORGANIC ETHYL ZINC SILICATE PRIMER

## 1 GENERAL

This specification prescribes the quality requirements and application procedure for two components, air-drying, Inorganic Zinc Ethyl Silicate priming paint. This priming paint when applied on steel structures provides excellent resistance to temperature, soil chemicals, salts, water, and chemical resistance under marine conditions and outside weather ability.

## 2 APPLICATION

The material shall be intended for use as a primer coat in the painting system on new steel structures internally and externally. Normally, for best performance, the surface to be coated shall be ensured free from oil, loose rust/dust etc., followed by blast cleaning to Sa 2 ½ min. with a surface profile of 35 to 50 microns. This shall be followed by application of single coat of the priming paint by spray method so as to achieve dry film thickness t of 65-75 microns. The surface profile after blasting shall be 20-35 microns.

## 3 COMPLIANCE WITH NATIONAL STANDARDS

The material shall comply with the requirements of following Indian standard and also, meet other requirements of this specification:

IS: 14946-2001, Main coat: Zinc Ethyl Silicate Primer, Two Components

## 4 COLOUR

The colour of the material shall be Grey.

## 5 FINISH

Smooth and Matt.

## 6 COMPOSITION

The material shall be two components moisture and self-cured Inorganic Ethyl Silicate Binder pigmented with zinc metal powder conforming to IS: 14355 and having a purity of 99% and particle size of 4-5 microns, in the recommended proportion. The coating of this material attains water resistance within 30 minutes of application and remains unaffected by rains, condensation or dew etc. The manufacturer shall specify the principal type of binder used.

The supplier of the material shall declare that components of paint supplied shall meet the legislative requirements ISO 14001.

## 7 MIXING RATIO

The components of paints are to be mixed in the proportion as recommended by supplier of the material.

## 8 TEST METHODS

Unless specified otherwise, tests shall be conducted as prescribed in relevant parts and section of Indian standard IS: 101 and IS: 14946. The test panels shall preferably be prepared on blast cleaned surface.

## Revisions:

## APPROVED:

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01-06-2001

Dt:26-05-2012

Dt:

Year:2019

AA56113

Rev No. 02

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**CORPORATE PURCHASING SPECIFICATION****9 PROPERTIES**

The material shall meet the following technical requirements:

**9.1 DRYING TIME**

- Surface dry : 15 minutes, max.
- Hard dry : 2 hrs. min.
- Time to topcoat : 24 hrs. min.

**9.2 CONSISTENCY**

The liquid component mixed with powder shall be suitable for application by spray as such or when thinned in the proportions at specified by the manufacturer.

**9.3 FLASH POINT**

Not below 15°C

**9.4 MASS PER TEN LITRES**

20 kgs., min.

**9.5 VOLUME SOLIDS**

60% , min.

**9.6 POT LIFE OF MIX (ANNEXURE D OF IS: 14946)**

4 hrs. min. at 30°C

**9.7 DRY FILM THICKNESS**

65-75 microns per coat when measured after 72 hrs. of curing.

**9.8 RESISTANCE TO SALT SPRAY TEST (TYPE TEST)**

The material shall pass resistance to salt spray test, when test panels cured for 72 hrs. are subjected to continuous exposure for 2000 hrs.

**9.9 PROTECTION AGAINST CORROSION UNDER CONDITIONS OF CONDENSATION (TYPE TEST)**

The material shall pass the test, when test panels cured for 72 hrs. are subjected to exposure at specified conditions for 2000 hrs.

**9.10 HEAT RESISTANCE TEST**

The film shall not show signs of cracking, blistering or flaking when coated test panels air-dried for 48 hrs., are kept at 400±10°C for 6 hrs followed by plunging in cold water-three cycles, min.

**9.11 COMPOSITION****9.11.1 SOLID CONTENT**

68%, min. by weight of mixed paint.

**9.11.2 TOTAL METALLIC ZINC CONTENT (ANNEXURE B OF IS: 14946)**

75%, min. by weight in non-volatile portion of the paint.

**9.12 MUD-CRACKING TEST**

The coating applied to dry film thickness of 120 microns minimum, shall not show any mud cracking when viewed under 10 X magnification.

**9.13 SEDIMENTATION TEST**

There shall not be any segregation of zinc powder from the base material within 2 hrs in the

|   |   |             |
|---|---|-------------|
|  | <b>CORPORATE PURCHASING SPECIFICATION</b> | AA56113     |
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mixed paint.

#### 9.14 CURE TEST

The coated test panels air dried for 48 hrs shall pass the cure test when tested according to test procedure given in ASTM D 4752.

#### 10 KEEPING PROPERTY

When stored in covered dry place in the original sealed containers under normal ambient conditions, the liquid portion shall not show thickening, curdling, gelling or hard caking and also retain the properties of mixed paint prescribed in this specification for a period of six months from date of delivery.

#### 11 TEST CERTIFICATES

Unless otherwise stated, three copies of test certificates and product data sheet 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.

- AA56113, Rev. 02: INORGANIC ETHYL ZINC SILICATE PRIMER
- BHEL Order No. & Date
- Batch / Lot No.
- Supplier's/ Manufacturer's Name and Trade mark, if any
- Quality supplied
- Date of manufacture and expiry
- Test values as per clause 9
- Mixing ratio
- Technical information, if any:

#### 12 PACKING AND MARKING

Unless otherwise stated, the components of paint shall be supplied separately in moisture and leak proof containers in packing size as specified in the BHEL order.

Each container of the consignment shall bear the following information printed or pasted at suitable place so as to protect it from damage during transportation and handling:

- AA56113: INORGANIC ETHYL ZINC SILICATE PRIMER
- BHEL Order No. & Date
- Batch / Lot No.
- Supplier's/ Manufacturer's Name and Trade mark, if any
- Name of contents:
- Mixing ratio:
- Quantity in container
- Date of manufacture and expiry
- Technical information, If any:

#### 13 ENVIRONMENTAL REQUIREMENTS

The supplier shall furnish Material Safety Data Sheet (MSDS) covering all information relating to human safety and environmental impacts of the hazardous materials particularly during their transportation, storage, handling and disposal along with each supply.

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Rev No. 02

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**CORPORATE PURCHASING SPECIFICATION**

Each container shall be marked with corresponding symbol and minimum worded cautionary notice for flammable / corrosive / toxic / harmful / irritant and oxidizing etc. as applicable.

**14 PRECAUTIONS**

- a) Use off the mixed paints within stipulated pot life i.e., 4 hrs after mixing and should be continuously agitated during application.
- b) Inorganic Zinc silicate primer should not be applied at relative humidity below 50% and the surface should remain free from condensation at the time of application.
- c) After completion of the work, the application equipment must be cleaned thoroughly immediately with thinner and kept safely for next use.
- d) The surface to be painted must be blast cleaned to Sa 2 ½, min. and the painting shall be done by spray method uniformly. However, brush may be used for touch up of local areas only.

**15 REFERRED STANDARDS (Latest Publications Including Amendments)**

- 1) IS: 101
- 2) IS: 14355
- 3) AA0674101
- 4) ASTM D4752



# CORPORATE PURCHASING SPECIFICATIONS

AA56142

Rev. No.06

PREFACE SHEET

## FULL GLOSS POLYURETHANE FINISHING PAINT

FOR INTERNAL USE ONLY

REMOVE THIS PREFACE SHEET BEFORE ISSUE TO SUPPLIERS

### Equivalent / Comparable Standards:

1. INDIAN

IS:13213 – 1991 (RA-2007)

### Suggested/ Probable Suppliers and Grades:

1. Berger paints : Bergerthane Enamel
2. Asian paints : Apcothane CF 674
3. J&N paints : J&N 992
4. Refer plant vendor's list

### User plants & Replaced Plant Specifications / References:

1. TIRUCHY
2. HEEP, Haridwar
3. Bhopal

Revisions:  
As per 40<sup>th</sup> MOM of MRC-CPO

**APPROVED:**  
INTER PLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(CPO)

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# CORPORATE PURCHASING SPECIFICATIONS

AA56142

Rev. No.06

PAGE 1 of 8

## FULL GLOSS POLYURETHANE FINISHING PAINT

### 1.0 SCOPE:

This specification governs the quality requirements of Polyurethane Finishing Paint (Two pack system). This is recommended for exterior applications where it is desirable for gloss retention for long periods, chemical and corrosion resistance. This paint is suitable for both brush and spray application.

The paint shall be compatible on surface primed with epoxy priming as per AA56109 and intermediate paint as per AA56112.

### 2.0 APPLICATION:

Suitable for use in as those exterior surfaces where it is designed to retain colour and gloss for long period in addition to provide excellent chemical and corrosion resistance.

### 3.0 COLOUR

As specified in BHEL order.

### 4.0 COMPLIANCE WITH NATIONAL STANDARD:

The material shall comply with the requirements of the following national standard and also shall meet the requirements of this specification.

IS: 13213 - 1991(RA-2007): "POLYURETHANE FULL GLOSS ENAMEL (TWO PACK)"

### 5.0 FINISH: Smooth and full glossy

### 6.0 FREEDOM FROM DEFECTS:

The components of the paint shall remain free from defects like hard settling of pigments, skinning, livering (excessive viscosity build up) when kept in closed container till its shelf life.

The dried paint film shall be free from defects like bittyness, floating of pigments, surface haze, orange peeling, colour fading, wrinkles etc.

The paint shall conform to the requirements of ISO 14001 and shall be free from lead/ lead components.

### 7.0 CHEMICAL COMPOSITION:

The paint consists of two components enamel and a hardener solution to be mixed by volume. The mixing ratio of base and hardener shall be as per supplier's recommendation. Enamel shall consist of an appropriate polyol, pigments, solvents and additives. The hardener solution shall consist of an aliphatic polyisocyanate, solvents, and additives.

Revisions:  
As per 40<sup>th</sup> MOM of MRC-CPO

**APPROVED:**  
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Issued  
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Dt. of 1<sup>st</sup> Issue  
Jan 1991

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Rev. No.06

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# CORPORATE PURCHASING SPECIFICATIONS



Note:

- 1) The base contains acrylic resin and acid /alkalic / light fast pigments.
- 2) The mixed paint shall be stirred well for 20 minutes to mature and must be consumed within 4.0 hours after mixing.
- 3) The content and nature of the components shall be strictly same as type approved sample. This shall be confirmed by IR spectrography / thin layer chromatography which should be provided by supplier.

## 8.0 TEST SAMPLES:

Tender samples will not be required when once the type approval is given and the supplier concerned declares that the material for which the tender is given of the same quality as the type approved sample.

Sampling of paint shall be done as per IS: 101.

- 8.1. To draw a representative sample, the contents of the container selected for sampling shall be mixed as thoroughly as possible by shaking or stirring or both or by rolling, so as to bring all portions into uniform distribution.
- 8.2. The samples shall be taken in a suitable, clean, dry air-tight glass bottle of one litre capacity. It should be almost but not completely filled by the sample.
- 8.3. In case of failure of first sample, two samples shall be drawn from other two drums of the same consignment at random and failure of the second sample in complying with the specification will lead to the rejection of the whole consignment.

## 9.0 TEST METHODS

Unless otherwise specified, the samples shall be tested in accordance with relevant part and section of IS 101

### 9.1. PROPERTIES:

#### 9.1.1. Drying Time (at ambient temperature)

- a) Surface dry : 3.0 hours, maximum
- b) Hard dry : 8.0 hours, maximum
- c) Full cure : 7days, maximum
- d) Hard dry at 70°C : 30 minutes, maximum with 15 minutes flash off time.

#### 9.1.2. Consistency

Suitable for brushing and spraying. 40 - 60 secs by F.C No.4 at  $27 \pm 20^\circ \text{C}$ .

#### 9.1.3. Fineness of grind

10 microns, minimum

#### 9.1.4. Gloss at 60°

85, minimum.

#### 9.1.5. Scratch Hardness after full cure for 7 days under load of 1000 gms, min.



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No such scratch as to show the bare metal

## 9.1.6. Flexibility and adhesion test

No visible damage or detachment of paint film when tested by Erichsen cupping test up to 8mm.

## 9.1.7. Weight

9.0 kg, minimum per 10 litres of mixed paint. However it shall be within  $\pm 3.0\%$  of type approved sample.

## 9.1.8. Dry film thickness per coat of application

25 - 30 microns

## 9.1.9. Volume solids

40.0%, minimum

## 9.1.10. Flash Point

20°C, minimum of each component

## 9.1.11. Pot life at 27 $\pm$ 2°C

4.0 hours, minimum

## 10.0 TYPE APPROVAL

### 10.1. Samples

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

### 10.2. Type Test

#### 10.2.1. Accelerated Tests (IS:13213):

Tests shall be conducted as per procedure given in below for chemical resistance to Sulphuric acid, Caustic potash, Oil & Solvents and the result shall not show any signs of blistering, wrinkling and lifting. Difference in gloss and colour between immersed and un-immersed area of paint film shall be minimum.

#### PROCEDURE:

Preparation of painted panels generally as per IS: 101.

Apply one coat of epoxy zinc phosphate primer (two pack) at minimum 35microns dry film thickness by spraying and allow to dry for at least 6 hours and not more than 24 hours. Dry rub with emery paper No.400 and wipe clean with a dry soft cloth.

Apply one coat of epoxy surfacer (two pack) at minimum 35 microns dry film thickness by spraying and allow to dry for at least 6 hours and not more than 24hours. Wet rub with water proof emery paper No.400 and allow to dry.

Apply one coat of full gloss polyurethane enamel (two pack) at minimum 35microns dry film thickness by spraying and allow to air dry for 7 days.

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Note: For immersion tests prepare and paint both sides of the panels and protect the edges of the panels by sealing with a chlorinated rubber paint.

## Resistance to Sulphuric acid:

Immerse 3/4<sup>th</sup> of the panel in 30% sulphuric acid for 24 hours. Remove the panel, wash in running fresh water and allow it to dry for an hour.

## Resistance to Caustic potash:

Immerse 3/4<sup>th</sup> of the panel in 20% solution of potassium hydroxide for 24 hours. Remove the panel, wash in running fresh water and allow it to dry for an hour.

## Resistance to Oil:

Immerse 3/4<sup>th</sup> of the panel in a mineral lubricating oil for 24 hours. Remove the panel and wipe the excess oil with cotton, wash it with mineral turpentine and allow to dry for 30 minutes.

## Resistance to Solvents:

Test one panel for resistance to xylene, ethanol and acetone respectively. Take a clean white sterilized cotton and soak it in the solvent and place it on the painted panel without squeezing the cotton. Immediately cover the soaked cotton with a suitable watch glass and leave it for 6 hours. Remove the watch glass and the soaked cotton, wipe the area with a clean dry cotton.

## 10.2.2. Durability Test ( IS:8662)

### 10.2.2.1. Normal Outdoor Exposure Test:

Preparation of panels for the test and tests shall be as per procedure given in Annexure. Test panels shall be exposed at an angle of 45° facing south. The test shall satisfy the requirements laid down for at least 12 months after painting.

### 10.2.2.2. Accelerated Weathering Test ( IS:8662)

The test shall satisfy the requirement laid down, after 1000 hrs. test in Xenon Arc Type Weatherometer ( with rotating day / night device ) with a cycle of 3 minutes rainfall and 17 minutes dry period.

### PROCEDURE:

Preparation of panels for the test shall be as per the procedure given in the Annexure. Samples of panels shall be tested in duplicate in a accelerated weathering apparatus and samples drawn from the exposed films shall be evaluated for gloss and various film properties.

The requirement of the test shall be taken to have been satisfied if the performance in respect of the film characteristics is within the limits specified below:



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|    |  |  |
|----|--|--|
| a) | Gloss  | The film shall have a minimum gloss retention of 50% of the original value |
| b) | Colour   | The film shall have a minimum rating of 8                                  |
| c) | Freedom from Checking, Cracking, Flaking, Chalking, Spotting, Blistering and corrosion | -do-   |

## NOTE:

- Test certificate of Cl.10.2.1 & 10.2.2 shall be forwarded by the supplier in line with IS: 13213 and IS: 8662 at the time of type approval. While supplying the material supplier shall furnish these test certificates after every two years.
- Supplier should submit the results of Cl.10.0 at the time of type approval and once in a year there after.

## 11.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied giving the following information.

In addition, the supplier shall ensure to send one copy of test certificates along with the despatch documents to facilitate quick clearance of the material.

AA56142 (Rev.No.06) – FULL GLOSS POLYURETHANE FINISHING PAINT

BHEL Order No.

Supplier's Name& Trade Mark, if any.

Batch No.

Date of Manufacture

Test Results of clause 7.0:

## 12.0 KEEPING PROPERTIES

When stored under cover in a dry place in the original sealed container under normal temperature conditions, the base and accelerator shall retain the properties of the mixed paint prescribed in this specification for period of not less than 12 months after the date of manufacture which shall not be earlier than one month of the scheduled delivery date mentioned in BHEL order.

## 13.0 PACKING AND MARKING:

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

AA56142: FULL GLOSS POLYURETHANE FINISHING PAINT

BHEL Order No.

Manufacturer's / supplier's name.

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# CORPORATE PURCHASING SPECIFICATIONS



Trade mark, if any.

Batch/lot no.

Date of manufacture and expiry.

Quantity supplied.

Mixing ratio.

## 14.0 ENVIRONMENTAL REQUIREMENTS:

The supplier shall furnish Material Safety Data Sheet (MSDS) covering all information relating to human safety and environmental impacts of the hazardous materials particularly during their transportation, storage, handling and disposal along with each supply. Each container shall be marked with corresponding symbol and minimum worded cautionary notice for flammable / corrosive / toxic / harmful / irritant and oxidizing etc. as applicable.

## 15.0 REFERRED STANDARDS (Latest Publications Including Amendments):

- 1) IS:101
- 2) IS:8662
- 3) IS:335
- 4) IS:13213
- 5) AA56109
- 6) AA56112



# CORPORATE PURCHASING SPECIFICATIONS

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## ANNEXURE (Cl: 10.2.2.1)

### PROCEDURE OF DURABILITY TEST:

#### PREPARATION OF TEST PANELS:

The panel shall be mild steel plate of 1.25mm thick and free from surface defects. Size of the panel for outdoor exposure test shall be 300mm x 300mm and for the Accelerated weathering test 150mm x 150mm. Panels shall be cleaned and the back and edges of the panels shall be protected with two coats of a suitable paint.

The surface of the test panels to be exposed shall be prepared as follows, taking care that total dry film thickness of the complete system shall be between 75 and 100 microns. Air drying of films shall be done at temperature  $27 \pm 2^\circ \text{C}$  and at a relative humidity of  $65 \pm 5$  percent.

- Apply one coat of ready mixed paint red oxide zinc chrome primer by brushing and allow to air dry for 24 hours.
- Rub down lightly with waterproof emery paper No.280/330, wipe off the surface with a clean and dry soft cloth and then apply by brushing one coat of the under coating enamel and allow it to dry for 24 hours.
- Rub down, wet, with water proof emery paper No.280/320 wipe off the surface with a clean and dry soft cloth and then apply by brushing one coat of the finishing enamel and allow it to dry for 24 hours.
- Rub down, wet, with water proof emery paper No.220, wash and wipe off water, and when the surface is dry, apply by brushing a second coat of the finishing enamel and allow it to dry for 7 days before subjecting to exposure test.

#### OUT DOOR EXPOSURE TEST:

Expose in open the test panels prepared as above in duplicate at an angle of  $45^\circ$  facing south. Examine the condition of the exposed films at monthly intervals for the first quarter and thereafter quarterly for the rest of the period for the properties gloss, colour, checking, cracking, flaking, chalking and spotting.

For the above examinations, wash the right hand half of the surface of the two test panels by pouring water and then wiping with a soft cloth or chamois leather. Examine the same half of the test panel at each examination. At the end of the stipulated period for durability test examine the two halves of the test panels. The sample shall be considered satisfactory if the material surface underneath as well as condition of the film in both the halves, the one washed periodically as well as the one washed only for the final examination is satisfactory by the method of evaluation given below. Stray film failure due to extraneous causes other than climatic shall be ignored.

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## ANNEXURE - CONTINUED

### Evaluation and Rating of Film Characteristics:

- a) Gloss: Specular 45° and 60° head glossometer reading.
- b) Colour: The initial rating for a good colour match shall be 10. The colour Retention on exposure shall be expressed and recorded as the abbreviation of the type of colour change followed by numerical rating as follows:

| <u>RATING</u>                | <u>TYPE OF COLOUR CHANGE</u> |
|------------------------------|------------------------------|
| 10 - Good match              | D - Darkening                |
| 9 - Satisfactory             | F - Fading                   |
| 8-7 - Slight colour change   | B - Blueing                  |
| 6-5 - Definite colour change | R - Reddening                |
| 4-3 - Bad Colour change      | Y - Yellowing                |
| 2-1 - Very bad colour change | L - Loss of colour           |
| 0 - Complete colour change   |                              |

- c) Checking: Freedom for checking shall be rated as 10 for no checking and 0 for most severe and complete checking.
- d) Cracking: Freedom for cracking shall be rated as 10 for no cracking and 0 for most severe and complete cracking.
- e) Flaking: Freedom for flaking shall be rated as 10 for no flaking and 0 for most severe and complete flaking.
- f) Chalking: Freedom for chalking shall be rated as 10 for no chalking and 0 for most severe and complete chalking.
- g) Spotting: Freedom from spotting shall be rated as follows:

| Numerical value | Rating            |
|-----------------|-------------------|
| 10              | No spotting       |
| 9               | Satisfactory      |
| 8-7             | Slight spotting   |
| 6-5             | Definite spotting |
| 4-3             | Bad spotting      |
| 2-1             | Very bad spotting |
| 0               | Complete spotting |

- h) Blistering and Corrosion: The film shall remain generally free from blisters and the metal underneath shall show no signs of corrosion on exposure for 12 months. A few isolated blisters without any signs of corrosion underneath as well as one or two localized corrosion and/or rust spots shall not constitute a cause of failure.

|   |                             |             |
|---|-----------------------------|-------------|
|  | <h1>CORPORATE STANDARD</h1> | AA0230208   |
|   |                             | Rev. No. 01 |
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## GENERAL TOLERANCES – TOLERANCES FOR LINEAR AND ANGULAR DIMENSIONS WITHOUT INDIVIDUAL TOLERANCE INDICATIONS

### 0.0 GENERAL

When selecting the tolerance class, the respective customary workshop accuracy has to be taken into consideration. If smaller tolerances are required or larger tolerances are permissible and more economical for any individual feature, such tolerances should be indicated to the relevant nominal dimension(s).

General tolerance for linear and angular dimensions apply when drawings or associated specifications refer to this standard in accordance with clauses 3 and 4. If there are general tolerances for other International standards, reference shall be made to them on the drawings or associated specifications. For a dimension between an unfinished and a finished surface, e.g. of cast or forged parts, for which no individual tolerance is directly indicated, the larger of the two general tolerances in question applies, e.g. for castings, see ISO 8062, Castings - system of Dimensional Tolerances.

### 1.0 SCOPE

The standard is intended to simplify drawing indications and it specifies general tolerances for linear and angular dimensions without individual tolerance indications in four tolerance classes.

It applies to the dimensions of parts that are produced by metal removal or parts that are formed from sheet metal.

#### NOTE:

- 1) The concepts behind the general tolerancing of linear and angular dimensions are described in Annex-A.
- 2) These tolerances may be suitable for use with materials other than metals.

This standard only applies for the following dimensions which do not have an individual tolerance indication:

- a) Linear dimensions (e.g. external sizes, internal sizes, step sizes, diameters, radii, distances, external radii and chamfer heights for broken edges).
- b) Angular dimensions, including angular dimensions usually not indicated, e.g. right angles (90°), unless reference to IS: 2102 (Part 2) is made, or angles of uniform polygons.
- c) Linear and angular dimensions produced by machining assembled parts.

It does not apply for the following dimensions:

- a) Linear and angular dimensions which are covered by reference to other standards on general tolerances.
- b) Auxiliary dimensions indicated in brackets.
- c) Theoretically exact dimensions indicated in rectangular frames.

### 2.0 COMPLIANCE WITH STANDARDS

This standard is based on IS: 2102 (Part 1)-1993 (ISO 2768-1).

### 3.0 GENERAL TOLERANCES

**3.1** Linear dimensions are given in Table 1 and 2.

**3.2** Angular dimensions: General tolerance specified in angular units control only the general orientation of lines or line elements of surfaces, but not their form deviations.

The general orientation of the line derived from the actual surface is the orientation of the contracting line of ideal geometrical form. The maximum distance between the contacting line and the actual line shall be the least possible value (see IS: 12160).

The permissible deviations of angular dimensions are given in Table 3.

|   |          |            |  |                     |  |
|---|----------|------------|--|---------------------|--|
| Revisions: As per clause 17.7 of MOM of PGC-DOP+BES |          |            | <b>APPROVED:</b><br>PROCEDURAL GUIDELINES COMMITTEE –<br>PGC (DOP+BES) |                     |  |
| Rev. No. 01   | Amd. No. | Reaffirmed | Prepared<br>HEP, Bhopal  | Issued<br>Corp. R&D | Dt. of 1 <sup>st</sup> Issue<br>22-06-1978 |
| Dt: 01-12-1995                                      | Dt:      | Year: 2013 |  |                     |  |

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**CORPORATE STANDARD****4.0 INDICATIONS ON DRAWINGS:**

If general tolerances in accordance with this standard shall apply, the following information shall be indicated.

Example: AA0230208 m

**5.0 REJECTION**

Unless otherwise stated, work pieces exceeding the general tolerance shall not lead to automatic rejection provided that the ability of the work piece to function is not impaired (see clause A4).

**6.0 NOTE:**

**6.1** For “permissible deviations for Un-toleranced dimensions of castings” refer AA0230402.

**6.2** For “Tolerances and machining allowances for flame cutting” refer AA0621101.

**6.3** For “General tolerances for welding construction for length and angles” refer AA0621104.

**6.4** For “General tolerances for welded structures form and position” refer AA0621105.

**Table 1 – Permissible deviations for linear dimensions except for broken edges**  
(external radii and chamfer heights, see table 2)

Values in millimetres

| Tolerance class |             | Permissible deviations for basic size range |                   |                    |                      |                       |                        |                         |                         |
|-----------------|-------------|---|-------------------|--------------------|----------------------|-----------------------|------------------------|-------------------------|-------------------------|
|                 |             | 0.5 <sup>1)</sup><br>Up to 3                | Over 3<br>Up to 6 | Over 6<br>Up to 30 | Over 30<br>Up to 120 | Over 120<br>Up to 400 | Over 400<br>Up to 1000 | Over 1000<br>Up to 2000 | Over 2000<br>Up to 4000 |
| Designation     | Description |   |                   |                    |                      |                       |                        |                         |                         |
| f               | Fine        | ±0.05                                       | ±0.05             | ±0.1               | ±0.15                | ±0.2                  | ±0.3                   | ±0.5                    | -                       |
| m               | Medium      | ±0.1  | ±0.1              | ±0.2               | ±0.3                 | ±0.5                  | ±0.8                   | ±1.2                    | ±2                      |
| c               | Coarse      | ±0.2  | ±0.3              | ±0.5               | ±0.8                 | ±1.2                  | ±2                     | ±3                      | ±4                      |
| v               | Very coarse | -   | ±0.5              | ±1                 | ±1.5                 | ±2.5                  | ±4                     | ±6                      | ±8                      |

1) For nominal sizes below 0.5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s).

**Table 2 – Permissible deviations for broken edges** (external radii and chamfer heights)


Values in millimetres

| Tolerance class |             | Permissible deviations for basic size range |                |        |
|-----------------|-------------|---|----------------|--------|
|                 |             | 0.5 <sup>1)</sup> up to 3                   | Over 3 up to 6 | Over 6 |
| Designation     | Description |   |                |        |
| f               | fine        | ±0.2  | ±0.5           | ±1     |
| m               | medium      |   |                |        |
| c               | coarse      | ±0.4  | ±1             | ±2     |
| v               | very coarse |   |                |        |

1) For nominal sizes below 0.5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s)

**Table 3 – Permissible deviations of angular dimensions**

| Tolerance class |             | Permissible deviations for ranges of lengths, in millimetres, of the shorter side of the angle concerned |                     |                      |                       |          |
|-----------------|-------------|--|---------------------|----------------------|-----------------------|----------|
|                 |             | Up to 10   | Over 10<br>Up to 50 | Over 50<br>Up to 120 | Over 120<br>Up to 400 | Over 400 |
| Designation     | Description |  |                     |                      |                       |          |
| f               | fine        | ±1°  | ±0°30'              | ±0°20'               | ±0°10'                | ±0.5'    |
| m               | medium      |  |                     |                      |                       |          |
| c               | coarse      | ±1°30'   | ±1°                 | ±0°30'               | ±0°15'                | ±0°10'   |
| v               | very coarse | ±3°  | ±2°                 | ±1°                  | ±0°30'                | ±0°20'   |

|   |                               |  |
|---|-------------------------------|--|
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|---|-------------------------------|--|

Annex A

(informative)

Concepts behind general tolerancing of linear and angular dimensions

A.1 General tolerances should be indicated on the drawing by reference to this standard in accordance with clause 4.

The values of general tolerances correspond to tolerance classes of customary workshop accuracy, the appropriate tolerance class being selected and indicated on the drawing according to the requirement of the components.

A.2 Above certain tolerance values, there is usually no gain in manufacturing economy by enlarging the tolerance. For example, a feature having a 35 mm diameter could be manufactured to a high level of conformance in a workshop with “customary medium accuracy”. Specifying a tolerance of ± 1 mm would be of not benefit in this particular workshop, as the general tolerance values of ± 0.3 mm would be quite adequate.

However, if, for functional reasons, a feature requires a smaller tolerance value than the general tolerance values, these should not be indicated adjacent to the dimension but should be stated on the drawing as described in clause 4. This type of tolerance allows full use of the concept of general tolerancing.

There will be “exceptions to the rule” where the function of the feature allows a larger tolerance than the general tolerances, and the larger tolerance will provide manufacturing economy. In these special cases, the larger tolerance should be indicated individually adjacent to the dimension for the particular feature, e.g. the depth of blind holes drilled at assembly.

A.3 Using general tolerances leads to the following advantages:

a) drawings are easier to read and thus communication is made more effective to the user of the drawing;

b) The design draughtsman saves time by avoiding detailed tolerance calculations as it is sufficient to know that the function allows a tolerance greater than or equal to the general tolerance;

c) The drawing readily indicates which feature can be produced by normal process

capability, which also assists quality engineering by reducing inspection levels;

d) Those dimensions remaining, which have individually indicated tolerances, will, for the most part, be those controlling features for which the function requires relatively small tolerances and which therefore may require special effort in the production – this will be helpful for production planning and will assist quality control services in their analysis of inspection requirements;

e) Purchase and sub-contract supply engineers can negotiate orders more readily since the “customary workshop accuracy” is known before the contract is placed; this also avoids arguments on delivery between the buyer and supplier, since in this respect the drawing is complete.

These advantages are fully obtained only when there is sufficient reliability that the general tolerances will not be exceeded, i.e. when the customary workshop accuracy of the particular workshop is equal to or fine than the general tolerances indicated in the drawing.

The workshop should therefore

- Find out by measurements what is customary workshop accuracy is;

- Accept only those drawings having general tolerances equal to or greater than its customary workshop accuracy;

- Check by sampling that its customary workshop accuracy does not deteriorate.

Relying on underlined “good workmanship” with all its uncertainties and misunderstandings is no longer necessary with the concept of general geometrical tolerances. The general geometrical tolerances defines the required accuracy of “good workmanship”.

A.4 The tolerance the function allows is often greater than the general tolerances. The function of the part is, therefore, not always impaired when the general tolerance is (occasionally) exceeded at any feature of the work piece. Exceeding the general tolerance should lead to a rejection of the work piece only if the function is impaired.

|   |                           |             |
|---|---------------------------|-------------|
|  | <b>CORPORATE STANDARD</b> | AA0674107   |
|   |                           | Rev. No. 04 |
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## PROCESS FOR ELECTROPLATING OF ZINC ON STEEL SURFACES FROM CYANIDE BATH

### 1 GENERAL

This standard details the process for high-speed bright zinc plating on steel surfaces from cyanide zinc solution bath by tank or barrel to provide protection against corrosion and to give a bright attractive finish to the surface.

### 2 APPLICATION

Used for components like fasteners, nuts, bolts, electronic panels etc. This process is not suitable for plating on cast iron surfaces.

### 3 COMPLIANCE WITH NATIONAL STANDARDS

This Standard has reference to the following Indian Standards regarding surface condition and quality of deposit.

IS 1340 : 1977 : Code of Practice for chromate conversion coating on Zinc and Cadmium coated articles and zinc base alloys.

IS 1573 : 1986 : Electroplated coatings of Zinc on Iron and Steel.

IS 3203 : 1982: Methods of Testing Local Thickness of Electroplated Coatings.

IS 9844 : 1981: Method of testing of corrosion resistance of Electroplated and Anodized Aluminium coatings by neutral salt spray test.

### 4 MATERIALS

| Material                                    | CPS No./IS No./Available from                      |
|---|--|
| Sodium cyanide for electroplating           | AA55610  |
| Caustic Soda (Tech.)                        | AA54201  |
| Nitric Acid (Tech.)                         | AA54102  |
| Zinc Anodes (99.98% Purity, Min.) (Grade 1) | IS 2605  |
| Bright Zinc Salts                           | M/s. Ronuk Industries Ltd. Mumbai                  |
| Zinc Brightener Zn-21                       |  |
| Zinc Brightener Zn-22                       |  |
| Zinc Purifier                               |  |
| Zinc Brite 16 Salt                          |  |
| Zinc Brite 20 Brightener                    | M/s. Grauer & Weil (I) Ltd., Mumbai                |
| Monicol Purifier                            |  |
| Zinek Salt - 501                            |  |
| Super Zinc Brightener – 505                 | M/s. Platewel Processes & Chemicals Ltd., Vadodara |
| Supra Zinc Brightener 555                   |  |
| Zincad Purifier - 503                       |  |
| Teknobrite CZ 920 Salt                      | M/s. Artek Surfin Chemicals (P) Ltd., Mumbai       |

Revisions: As per clause 28.16.6 of MOM of 28<sup>th</sup> MRC (CPO)

**APPROVED:**  
INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC (CPO&NM)

|                |                |            |                         |                     |  |
|----------------|----------------|------------|-------------------------|---------------------|--|
| Rev. No. 04    | Amd. No. 02    | Reaffirmed | Prepared<br>HEP, Bhopal | Issued<br>Corp. R&D | Dt. of 1 <sup>st</sup> Issue<br>01-01-1985 |
| Dt: 15-10-2000 | Dt: 15-10-2002 | Year: 2021 |                         |                     |  |

AA0673603

Rev. No. 04

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**CORPORATE STANDARD**

Teknobrite CZ 920 Brightener

Purisol

M/s. Artek Surfin Chemicals (P) Ltd., Mumbai

**5 EQUIPMENT****5.1 Plating Tank / Vat**

The Tank/vat shall be made of plain welded steel sheets with rubber lining. The vat shall be provided with an insulated frame on top fitted with insulators for holding the anode and cathode rods. The tank shall also be provided with exhaust system.

**5.2 Barrel**

The plating barrel shall be constructed out of polypropylene perspex and shall be so driven as to rotate at 5 to 12 rpm.

**5.3 Rinsing Tanks**

Mild steel tank lined with rubber / FRP / PVC.

**5.4 Hot Water Rinsing Tank (Optional)**

Mild steel tank with rubber / FRP lining and heating arrangements.

**6 COMPOSITION OF ELECTROLYTE AND OPERATING INSTRUCTIONS****6.1 Composition of Electrolyte (Bath Solution) and Operating Conditions**

The electrolyte shall be prepared according to any one of the following compositions and operated at the conditions specified below:

|         | Parameter                          | Composition |              |                 |                    |
|---------|------------------------------------|-------------|--------------|-----------------|--------------------|
|         |                                    | I<br>RONUK  | II<br>G&W    | III<br>PLATEWEL | IV<br>ARTEK SURFIN |
| Sl. No. | Name of salt                       | Bright Zinc | Zinek. Brite | Zinek 501       | Tekno Brite CZ 920 |
|         | Salt Content                       |             |              |                 |                    |
|         | For vat                            | 180-200     | 200          | 200             | 200                |
|         | For barrel                         | 200-220     | 200          | 200             | 200                |
| 1       | Zinc Brightener Zn-21, ml/l        | 1.5         | ---          | ---             | ---                |
| 2       | Zinc Brightener Zn-22, ml/l        | 2.5         | ---          | ---             | ---                |
| 3       | Super zinc                         | ---         | ---          | 6-8             | ---                |
|         | Brightner-505, ml/l                | ---         | ---          | 3-5             | ---                |
| 4       | Supra Zinc                         |             |              |                 |                    |
|         | Brightener 555, ml/l               | ---         | 3-5          | ---             | ---                |
| 5       | Zinc Brite 20                      |             |              |                 |                    |
|         | Brightener, ml/l                   | ---         | 3-5          | ---             | ---                |
| 6       | Tekno Brite CZ 920 Brightener      | ---         | ---          | ---             | 2-4                |
| 7       | Monicol Purifier, ml/l             | ---         | 5            | ---             | ---                |
| 8       | Zincad Purifier-503, ml/l          | ---         | ---          | 5               | ---                |
| 9       | Purisol, ml/l                      | ---         | ---          | ---             | 4                  |
| 10      | Temperature                        | Room-55     | 20-45        | 25-55           | 20-45              |
| 11      | Anode to Cathode Ratio             | 1:1         | 1:1          | 1:1             | 1:1                |
| 12      | Current density, A/dm <sup>2</sup> |             |              |                 |                    |
|         | a) For vat                         | 1.5-4.5     | 2-5          | 2-5             | 2-5                |
|         | b) For barrel                      | 1.5-4.5     | 0.5-2        | 0.5-2           | 0.5-2              |

|  |                           |             |
|--|---------------------------|-------------|
|  | <b>CORPORATE STANDARD</b> | AA0673603   |
|  |                           | Rev. No. 04 |
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|    |                  |       |       |       |       |
|----|------------------|-------|-------|-------|-------|
| 13 | Voltage, (Volts) |       |       |       |       |
|    | a) For vat       | 6-8   | 2-6   | 3-6   | 2-5   |
|    | b) For barrel    | 12-15 | 10-15 | 12-16 | 10-15 |

## 6.2 Preparation of Electrolyte

**6.2.1** The vat/barrel shall be filled with water, preferably with demineralised water, to about two-thirds of its capacity.

**6.2.2** The required amount of salt shall be added to the bath in small quantities with stirring.

**6.2.3** The temperature of the solution should not raise beyond 70°C.

**6.2.4** Stirring shall be continued until all the salts get dissolved.

**6.2.5** The solution shall then be brought upto the working level by adding cold demineralised water. At this stage the temperature of the bath shall be at the working range.

**6.2.6** The requisite amount of purifier shall now be added to the solution and stirred thoroughly. If necessary, filtration at this stage shall be carried out. Then requisite amount of brightener shall be added.

## 6.3 Analysis of the Electrolyte

The solution shall be analysed initially after make up and subsequently at suitable intervals.

## 6.4 Maintenance of the Electrolyte

**6.4.1** The concentration of the electrolyte shall be maintained as below:

| Parameter                    | Composition |           |           |           |
|------------------------------|-------------|-----------|-----------|-----------|
|                              | I           | II        | III       | IV        |
|                              | RONUK       | G&W       | Platewel  | ARTEK     |
| Zinc as metal, g/l           | 33-40       | 30-40     | 30-34     | 30-40     |
| Total Sodium Cyanide, g/l    | 90-105      | 75-140    | 80-90     | 75-140    |
| Total Sodium Hydroxide, g/l  | 75-93       | 65-85     | 70-80     | 65-85     |
| Sodium Cyanide to Zinc ratio | 2.5-3:1     | 2.5-3.5:1 | 2.7-3.2:1 | 2.5-3.5:1 |

## 6.4.2 Addition of Brighteners

Brightness of the deposit shall be maintained by adding brighteners for every 1000 ampere-hours as shown below:

| Brightener                   | Composition |         |          |         |
|------------------------------|-------------|---------|----------|---------|
|                              | I           | II      | III      | IV      |
|                              | RONUK       | G&W     | PLATEWEL | ARTEK   |
| Brightener Zn-21, ml         | 60          | ---     | ---      | ---     |
| Brightener Zn-22, ml         | 100         | ---     | ---      | ---     |
| Zinc Brite 20 Brightener:    |             |         |          |         |
| i) For vat, ml               | ---         | 100-150 | ---      | ---     |
| ii) For barrel, ml           | ---         | 150-200 | ---      | ---     |
| Super Zinc Brightner-505:    |             |         |          |         |
| i) For vat, ml               | ---         | ---     | 150      | ---     |
| ii) For barrel, ml           | ---         | ---     | 200      | ---     |
| Supra Zinc Brightener – 555  | ---         | ---     | 100      | ---     |
| Teknobrite CZ 920 Brightener | ---         | ---     | ---      | 100-250 |

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Brighteners may be added directly into the bath and stirred well. Excess of brightner must be avoided.

**6.4.3** Bath shall be analyzed periodically and if the values do not lie in the limits as given in 6.3.1, required chemicals shall be added to the bath to bring the composition to the required level.

**6.4.4 Purification of Electrolyte:**

The electrolyte shall be filtered at least once in a week or as required addition of 0.25 ml of zinc purifier per litre of solution for Composition-I, 0.1 to 0.2 ml of Monicol per litre for Composition-II and 0.1 to 0.2 ml of Zincad-503 purifier for Composition-III shall be made daily and stirred well to eliminate impurities in the solution and also to settle before resuming the work.

**7 PROCESS:****7.1 Cleaning**

All articles shall be properly cleaned as described in BHEL Standard AA0673601: Process for cleaning and preparation of metal surfaces prior to electroplating or BP0673693: Electroplating of zinc on steel surface from Acid bath.

**7.2 Rinsing**

All articles shall be rinsed thoroughly after cleaning to avoid contamination of the plating solution.

**7.3 Plating**

It shall be ensured that the current is on before the articles are put into barrel or tank.

All articles shall be plated at the specified current density for a duration, which will depend on the thickness of the deposit required.

**7.4 Cold Rinsing**

After removal from the plating bath, all articles shall be rinsed thoroughly in cold running water till all the traces of solution are removed.

**7.5 Drying**

The rinsed articles shall be dried using a centrifugal drier or hot air blower /hot air oven.

**8 HEAT TREATMENT: (Whenever required)**

Note : Steels of tensile strength of 100 kgf/mm<sup>2</sup> or corresponding hardness should be heat treated.

**8.1 Stress Relieving Before Plating: (IS 1573)**

In accordance with IS 1573.

**8.2 Stress Relieving after Plating: (IS 1573)**

In accordance with IS 1573.

**9 PASSIVATION**

Electroplated heat treated articles shall be passivated as per AA0673604 : Process for Passivation of Zinc And Cadmium Plated Articles.


**10 CARE OF ANODES**

Anodes shall be removed from the bath when the bath is idle.

Ensure that the anodes are bright in luster while plating is on.

**11 PRECAUTIONS**

**11.1** While preparing the solution the operator shall use rubber hand gloves, apron and respirator mask to avoid irritation of skin and suffocation due to fumes. The safety precautions for electroplating shop and handling of chemicals given in AA0462801 shall be followed.

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**11.2** Solution shall be kept covered when not in use.

**11.3** Any chemical that may be necessary to be added shall be dissolved in a part of the original solution (except brighteners) before adding it to the vat/barrel. It shall be poured through a filter or perforated bucket.

**11.4** Any metal that may be deposited on any part of the vat/barrel shall be removed immediately.

**11.5** Any article that becomes lodged in any part of the vat / barrel shall be removed immediately.

**11.6** Remove Zinc Anode at the end of shift so as to avoid dissolution of zinc metal during idle period.

**12 INSPECTION AND QUALITY OF DEPOSIT**

When tested in accordance with the test methods shown against each, the deposit shall conform to the norms specified below:

**12.1 SAMPLING**

Minimum of 1% of each batch of tank/barrel load of part there of shall be taken at random for testing with a minimum of 5 samples. When plated components are big and cannot be subjected to any of the specified test, a test panel of suitable size of the same basis metal shall be plated along with component under identical conditions for the purpose of testing. For corrosion resistance tests, test piece of minimum 150 mm. length, and 100 mm width and approximately 1 mm thick shall be used.

**12.2 Condition of Surface**

The plated surface shall appear as a smooth and continuous film over the basis metal and shall be free from defects such as pits, stains, cracks, blisters, nodules, pinholes, un-plated areas and other superficial blemishes visible to the unaided eye. The plated surface shall be bright with required passivation.

**12.3 Thickness of Deposit (IS 3203)**

The minimum thickness shall be as specified on relevant drawing on BHEL order.

**12.4 Adhesion (IS 1573)**

Flaking and blistering of the coating is not acceptable and the coating shall continue to adhere to the base metal after this test.

**12.5 Humidity test (IS 1573)**

Breakdown of the film or appearance of white corrosion products after two cycles of the test shall be taken as failure.

**13 ADDITIONAL TESTS**

Whenever required, the following test shall be conducted as per the test methods shown against each and the norms of acceptance shall be as specified below:

**13.1 SALT SPRAY TEST (IS 9844)**

When tested in accordance with IS 9844 white corrosion products shall not be visible within 96 hours on plated and passivated components.

**14 REJECTION**

If the samples taken do not comply with clauses 12.2 to 12.5 and 13, a further quantity not less than twice the number originally taken, shall be subjected to these tests. If any one of these samples also fails, the whole batch shall be rejected.

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**CORPORATE STANDARD****15 REFERRED STANDARDS (Latest Publications Including Amendments)**

- 1) IS 1573
- 2) IS 2605
- 3) IS 9844
- 4) AA54102
- 5) AA54201
- 6) AA55610
- 7) AA0673601
- 8) AA0673604

|   |                           |             |
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## PROCESS FOR PASSIVATION OF ZINC AND CADMIUM PLATED ARTICLES

### 1 GENERAL

This standard details the compositions of the passivation solution and the procedure for passivation of zinc and cadmium electroplated articles.

### 2 APPLICATION

To increase resistance to corrosion and finger marking.

### 3 COMPLIANCE WITH NATIONAL STANDARDS

This standard has reference to the following Indian standards regarding the quality of the passivated film:

IS 1340 : 1977: Code of practice for chromate conversion coating on zinc and cadmium coated articles and zinc base alloys

IS 1573 : 1986: Electroplated coating of zinc on iron and steel.

### 4 MATERIAL

| Material                          | CPS No. / IS No. /Available From            |
|-----------------------------------|---|
| Sulphuric Acid (Technical)        | AA54101                                     |
| Nitric Acid (Technical)           | AA54102                                     |
| Chromic Acid-Electroplating Grade | AA54104                                     |
| Sodium Bichromate (Technical)     | AA55612                                     |
| Ginthox - Q.982 (L)               | M/s Grauer & Weil (I) Ltd., Mumbai.         |
| Ginthos – 995                     |   |
| Kempas – 755                      | M/s Artek surfen Chemicals (P) Ltd., Mumbai |
| Zinc chrome 62L                   | M/S Platewel & process chemicals, Vadodara  |

### 5 EQUIPEMENT

#### 5.1 Passivating Rinsing Tank

FRP/PVC lined mild steel tank preferable with heating arrangements.

#### 5.2 Cascade Rinsing Tank

FRP/PVC lined mild steel tank with suitable partitions and provided with running water facilities, water cascading from one partition to the other

#### 5.3 Acid Treatment Tank (Optional)

FRP/PVC lined mild steel tank

#### 5.4 Rinsing Tank - After Acid Treatment - (optional)

FRP/PVC lined mild steel tank

Revisions: As per 40<sup>th</sup> MOM of MRC-CPO

**APPROVED:**  
INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC (CPO&NM)

|                |          |            |                            |                     |  |
|----------------|----------|------------|----------------------------|---------------------|--|
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**CORPORATE STANDARD****5.5 Hot Air Oven**

Hot air oven suitable for heating 50-70°C

**5.6 Centrifugal Drier**

A standard centrifugal drier suitable for drying barrel components

**6 COMPOSITION/PREPARATION OF SOLUTIONS & OPERATING INSTRUCTIONS****6.1 Passivating Solution****6.1.1 Composition and Operating Conditions**

The passivating solution shall be made of any one of the following compositions and operating conditions

**6.2 Preparation of solution**

**6.2.1** The tank shall be filled with water preferably demineralised water to about two-thirds of its capacity.

**6.2.2** The required amount of salt/chemical shall be added to the bath in small quantities with stirring.

**6.2.3** After complete dissolution, the required quantity of recommended acid shall be poured to the solution with stirring.

**6.2.4** Finally, the solution shall be brought to the operating level by adding water.

**6.3 Maintenance of the solution**

Any deficiency of the acid from the above composition shall be corrected by cautious addition of concentrated acid.

After the solution has been working from some time/and or any deficiency in the solution, if observed, then the passivating chemicals shall be added to keep the solution upto the working strength, or if required a fresh solution shall be prepared. While making the addition the salt shall be dissolved in the separate acid resisting container with the required quantity and then added to the tank.

**7 PROCESS****7.1 Acid Treatment**

**7.1.1** Zinc/cadmium plated, heat treated articles after proper rinsing, shall be dipped in 0.4 to 0.5% nitric acid solution for 5-10 seconds.

**7.1.2** After acid treatment, the articles shall be rinsed in clean cold running water.

**7.2 Passivation**

**7.2.1** The articles shall then be immersed in the passivating solution as specified in clause 6.1.1 for 10 to 30 seconds.

**7.2.2** The articles shall be drained for about 30 seconds after passivation.

**7.2.3** The passivated articles shall be double rinsed in cold water for a period sufficient to ensure that water draining from the articles contains no trace of yellow colouration. The total rinsing time shall not be longer than 5 minutes.

**7.2.4** After rinsing, the articles shall be dried off using air oven/compressed air. In case of barrel plating, the articles shall be dried by means of centrifugal drier.

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### 7.3 Age Hardening

No article shall be used in assemblies within 24 hours of age hardening after passivation.

Note:

After passivation, no heat treatment of the plated articles shall be done.

## 8 INSPECTION

### 8.1 Visual

All the jobs shall be tested visually the passivated film shall have a greenish iridescent or greenish yellow iridescent appearance, free from areas of unconverted zinc or cadmium plating.

### 8.2 Adhesion (IS 8602)

Adherence may be determined after age hardening by rubbing the surface with white paper. The paper must not show more than a slight trace of stain and the treated surface shall not show signs of having been rubbed through.

### 8.3 Chromate Film Test (IS 1573)

The chromate film shall be free from bare (unconverted zinc) patches and shall be adherent.

## 9 REFERRED STANDARDS (Latest Publications Including Amendments)

- 1) IS 1340
- 2) IS 1573
- 3) IS 8602
- 4) AA54101
- 5) AA54102
- 6) AA54104
- 7) AA55612



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### PROCESS FOR PAINTING OF METAL COMPONENTS AND STEEL SURFACES

#### 1.0 GENERAL:

This standard details the process to be followed to provide a coating on metal components and technical information regarding generic of paint medium and application related information. The paint shall be applied by spray/brush/airless spray and dried by stoving/air drying. The painted surface shall be protecting the components in their environment of exposure. This specification supersedes other AA 0674111 and 0674122.

#### SPECIFIC DEFINITIONS:

**DFT** : Dry Film Thickness; the thickness of the dried or cured paint coating film.

**Operating Temp.** : Temperature at which painting is to be performed.

**TDFT** : Total Dry Film Thickness, the thickness of the total number of coatings specified after curing.

**VS%** : Volume Solids Percent

#### 1.1 METHODS OF PAINT APPLICATION

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mixing ratio, the maturation time, the method of application, the use of thinners and coating intervals. The dry film thickness of individual coatings shall be as specified. Areas with inadequate coating thickness shall be thoroughly cleaned, if necessary, abraded and additional compatible coats shall be applied until they meet the required film thickness.

Painting shall not be performed when the temperature is less than 3°C above the dew point of the surrounding air or when the relative humidity of the air is greater than 85% unless local conditions dictate otherwise and the Principal is in agreement. Guidance on the estimation of the probability of condensation can be found from the Table referred in Annexure-I.

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In addition, paints shall not be applied under the following conditions:

- when the surface temperature is greater than 40°C (unless a higher temperature is recommended by the paint manufacturer).
- when the air temperature is less than 10°C (depending on local conditions).
- when there is the likelihood of an unfavorable change in the weather conditions within two hours after painting.
- when there is deposition of moisture in the form of rain, condensation, frost etc. on the surface.
- when the available light, ventilation is not adequate for painting.

If condensation, rain, dust or other foreign materials contaminate the surface of a paint coating which is not dry to the touch, the paint shall be removed, the surface re-cleaned and fresh paint is applied in accordance with this specification.

Paints shall not be applied within 50mm of edges which will later have to be welded. Such weld areas should be taped for a distance of 50mm on either side of the weld line.

Extra coats of paint shall be applied on the areas where the shape and/or plane of application result in thinly applied coatings etc., at edges, welds, corners etc. To compensate for these effects, stripes coats of paints shall be applied (normally applied first so that they will be covered by the full coat).

When zinc rich primers are used, care shall be taken to avoid any possibility of over spraying onto duplex or austenitic stainless steels, nickel alloys or 9% nickel steel components.

**Note :** Zinc rich primers shall not be applied on equipment made from the above mentioned materials unless such equipment is located in a shielded position which will minimise the risk of molten zinc falling onto the equipment in the event of a fire.

Proper application of protective coatings is an important criterion in giving the paint system its required life. To achieve good finish out of paint systems recommended paint putty mastic compound may be used after primer / under coat compatible with system and recommended by manufacturer.

Given below are the four main application procedures along with the advantages and disadvantages of each.

#### 1.1.1 Brush application :

Used frequently for decorative paints, in protective coatings this is in vogue in painting complex areas where the use of spray methods would increase the loss factor. However, a word of caution about brush application, it is difficult to achieve higher thickness with a high build coating by brush application in one coat. The process is relatively slow and may result in a poor finish for thixotropic or high viscosity top coats.



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### 1.1.2 Conventional spray:

A widely accepted method of paint application where liquid paint is atomised by an air stream. A correct combination of air pressure, air volume and fluid flow has to be selected to achieve full atomisation and a paint film free of defect. One may also face problems like sagging, pin holing and poor paint flow if the control parameters are not monitored properly.

The major disadvantage of conventional spray is that high build coatings cannot be applied by this method, as most paints have to be thinned to a suitable viscosity for satisfactory atomisation.

### 1.1.4 Airless spray

This is by far the fastest and most versatile method because it enables application at variable thicknesses. The equipment utilises an electric or air driven motor and a high pressure fluid pump to compress the coating to extreme pressures. The paint is then made to pass through a special tip which atomises it, and thus controls the application properties.

The main advantages of this method are :

- High build coatings can be applied without thinning.
- Fast rate of application achievable.
- Reduce pollution and environmental friendly.
- Reduced wastage of material.
- Less air consumption and saving of power.

As already indicated, the special tips used in the spray gun and the pressure control enables one to monitor application of very low to very high viscosity products. Similarly, different slot angles produce spray fans of different widths. The selection of a particular fan width is dependent on the shape and size of the structure to be painted. The choice of fan width is also related to orifice size. For the same orifice size the paint applied per unit area will be less, wider the spray fan. The general indication of orifice sizes is given below to help in choosing the proper orifice size for a paint.

#### Wet film thickness

Upto 50 microns  
100-200 microns  
>200 microns  
Mastics

#### Orifice size(mm)

0.02 – 0.03  
0.03 – 0.04  
0.04 – 0.07  
0.10 – 0.15

There are several designs of tips available, the choice of which depends upon the finish required, the ease of application and ease of cleaning blockages from tips.

Table-1.

| Mode of Application | FORD CUP: 4<br>Viscosity in<br>secs. |
|---------------------|--------------------------------------|
| Brushing            | 40-60                                |
| Spraying            | 30±2                                 |

**Note:** Viscosity measurement of high build epoxy paint may be done by viscometer.



Above table gives general guideline about consistency to be maintained for brush/spray/airless spray painting unless otherwise specified by paint manufacturer.

## 1.2 PREPARATION OF PAINT :

All industrial paints generally consist of a binder medium, pigment, thinner and accelerator. The composition of constituents varies based on performance requirements.

The primer which form first coat on a surface has higher concentration of pigments and extenders than the finish paint which has higher concentration of medium. The concentration and type of accelerator depends on drying cycle requirements. Air drying paints are generally single pack systems except aluminum paints, epoxy, polyurethane etc. Some of the stoving compositions are also available in single pack. The binder mediums generally used in paints are oil based Alkyd phenolics, epoxy, silicone, vinyl ester and urethane resins. Generic information is provided in Cl.3 of this specification. All the paint manufacturers mostly provide processing conditions to be followed before application. However, a few are given below :

- (a) When the containers of air drying paints are opened, the material is observed for skin formation. The skin formed should be carefully removed and settled pigment has to be broken up and loosened by vigorous stirring preferably mechanically to ensure homogenous dispersion. Care should be taken to avoid air entrapment while stirring. The paint, if required may be strained through muslin cloth or 60mesh sieve.

### (b) Maturation process :

Maturation is an important criterion for two pack products where curing takes place through chemical reaction when the components are mixed before application. The mixed paint is normally matured for about 30 minutes to initiate the reaction process which ensures thickness build up and proper drying of the paint film unless otherwise specified.

Maturation time is, however, to be adjusted depending on pot life and ambient temperature. Products having a short pot life should be allowed less maturation time as recommended by supplier to provide the adequate effect during film formation.

## 1.3 APPLICATION LOSSES AND SPREADING RATE ESTIMATION

It is extremely complicated to estimate accurately the quantity of paint required for a particular job since the theoretical spreading rate does not take into account the various "losses" involved during application.

In the following paragraphs general guidelines are described taking into account major areas of losses and to arrive at appropriate requirement. Usually two types of losses are considered : "**Apparent Losses**" where the paint-though on the surface-does not contribute to the required thickness, and "**Actual Losses**" where the paint is wasted.



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### Apparent Losses

Effect of blast profile: On a blasted surface the film thickness over the peaks is less than the thickness over the troughs. However, it is the thickness over the peaks which is most important in relation to performance of the paint coating and hence it can be considered that the paint which does not contribute to this thickness is "lost in the steel profile". The extent of paint "loss" is proportional to the surface roughness produced by blasting or in other words, the dimension and type of abrasive used.

Typical "losses" in dry paint film thickness for given blast profiles are given below:

| <u>Surface</u>               | <u>Blast profile</u>         | <u>DFT loss</u>       |
|------------------------------|------------------------------|-----------------------|
| - Steel blasted using round  | 0-50 microns                 | 10 microns            |
| - Shot And shop primed       |                              |                       |
| - Fine open blasting         | 50-100 microns               | 35 microns            |
| - Coarse open blasting       | 100-150 microns              | 60 microns            |
| - Old pitted steel-reblasted | 150-300 microns<br>(or more) | 125 microns (or more) |

**Paint distribution loss :** This is loss of paint resulting from over-application when an attempt is made to achieve the minimum specified paint thickness with reasonable certainty.

The extra paint consumed over and above that calculated from the theoretical spreading rate is dependent on the method of application as well as on the type of structure being painted. A simple structure with a high proportion of flat surfaces should not incur heavy losses, but for complex structure losses will be high. Typical details given below:

| <u>Application</u>    | <u>Type of structures</u> | <u>Loss(%)</u>  |
|-----------------------|---------------------------|---|
| Brush + Roller        | Simple structures         | 5%  |
| -do-                  | Complex structures        | 10-15%  |
| Spray } Air / Airless | Simple structures         | 20%   |
| Spray }               | Complex structures        | 60% for single coat<br>40% for two coats<br>30% for three coats |

When an open complex structure is sprayed, no realistic estimate can be made of paint distribution loss. In case the specification calls for a minimum thickness at all measured points, the distribution losses would be higher than those indicated above.

**Actual losses:** These include the paint loss during application and wastage

**Application Loss:** The paint which drips from a brush or roller during transfer from the container to the surface being painted can be termed as application loss. With care, this can be discounted as a significant contribution to overall "loss".



When application is done by spraying, losses are inevitable and their extent is dependent largely on the shape of the structure being painted together with atmospheric conditions.

The following spray losses are common:

|                                    |   |
|------------------------------------|---|
| Well ventilated but confined space | 5%  |
| Outdoors in almost static air      | 5 – 10%   |
| Outdoors in windy conditions       | Over 20% (This figure can be abnormally high if painting is done in unsuitable windy conditions). |

**Paint wastage:** Some wastage is inevitable like paint spill, certain amount remaining in discarded containers and in case of two pack materials mixed paint left beyond its pot life.

The following losses are common:

|                       |                  |
|-----------------------|------------------|
| Single pack materials | Not more than 5% |
| Two pack materials    | 5-10%            |

#### Spreading rate estimation:

Having given by the paint supplier the theoretical spreading rate and with the preceding loss factors, it is possible to calculate the practical spreading rate, as is illustrated by the following example for guidance.

#### Example :

Two coats of two pack paint are to be applied by spray in a confined space to a blasted surface of complete structure to yield a DFT of 100 microns per coat. The theoretical spreading rate is 6.0 sq. mtr/ltr. What is the practical spreading rate?

#### First coat

|  |   |
|--|---|
| Required DFT                                       | 100 microns                               |
| Loss due to surface roughness                      | 10 microns                                |
| Loss due to distribution 40% i.e. $100 \times 0.4$ | 40 microns                                |
|  | -----                                     |
|  | 150.0 microns                             |
| Loss due to application 5% i.e. $150 \times 0.05$  | 7.5 microns                               |
|  | -----                                     |
|  | 157.5 microns                             |
| Loss due to wastage 10% ie. $157.5 \times 0.1$     | 15.75 microns                             |
|  | -----                                     |
|  | 173.25 microns                            |
| Extra paint used $(173.25 - 100)$                  | $= \frac{73.25 \times 100}{100} = 73.3\%$ |



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## Second coat

|  |               |
|--|---------------|
| Required DFT                                       | 100 microns   |
| Loss due to surface roughness                      | Nil           |
| Loss due to distribution 40% i.e. $100 \times 0.4$ | 40 microns    |
|  | -----         |
|  | 140 microns   |
| Loss due to application 5% i.e. $140 \times 0.05$  | 7 microns     |
|  | -----         |
|  | 147 microns   |
| Loss due to wastage 10% i.e. $147 \times 0.1$      | 14.7 microns  |
|  | -----         |
|  | 161.7 microns |

$$\text{Extra paint used } (161.7 - 100) = \frac{61.7 \times 100}{100} = 61.7\%$$

$$\text{Total loss for two coats} = \frac{73.3 + 61.7}{2} = 67.5\%$$

In other words, for the two coat of two pack system, 67.5% more paint is required than would be calculated from the theoretical spreading rate.

**Loss factors :** In the above example the theoretical spreading rate is 6 sq.mtr/ltr. In practice 1.68 ltr. Of paint can be expected to cover 6 sq.mtr.

Therefore, the practical spreading rate is  $\frac{6}{1.68} = 3.6$  sq.mtr. /ltr.

The loss factor is usually expressed as the difference between the theoretical and practical spreading rates expressed as a percentage of the theoretical spreading rate. In the above example the loss factor is:

$$\frac{6 - 3.6}{6} = 40\%$$

## Calculation of Volume Solids :

The volume solid of a paint can be calculated as follows :

$$\% \text{ volume solid} = \frac{\text{DFT(microns)} \times \text{Theoretical coverage(sq.mtr./ltr)}}{10}$$

The volume solids of a paint is an indicator of the mileage it will give at a specified thickness. A service life data published on life of paint with various polymeric medium in different environments is given in Table-II.

## 1.4 THINNER CONSUMPTION:

This is another important parameter and has to be closely monitored to obtain the desired performance from the paint film. In each Data Sheet a special section is devoted to thinner consumption which should be strictly adhered to. However, it should be noted that the mentioned quantity is only for adding to the paint. The consumption for an optimum environment depends on prevailing temperature, application methods, nature of surface, weather conditions and may require adjustment in thinner volume. The thinner used should be compatible with the paint and corresponds to the same batch of paint.

|                |                           |   |
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Adding a small percentage of extra thinner does not necessarily impair the film properties, but excess thinning increases the quantity of liquid paint without contributing to the solid content. The volume solid, after thinning, should be calculated and the resultant coverage worked out to achieve the recommended film thickness.

$$\text{Volume solid percentage after thinning} = \frac{\% \text{ Volume solid} \times 100}{\% \text{ thinner added} + 100}$$

## 2.0 SURFACE PREPARATION :

Surface preparation may be carried out as per BHEL STANDARD AA 0674101. However following instructions in general should be adhered to unless otherwise agreed upon

- ◆ Surfaces not to be painted shall be properly masked.
- ◆ Surfaces shall be cleaned by solvent cleaning method to remove oil, grease, dirt, cutting fluids and other contaminants.
- ◆ Surfaces to be coated shall be blast cleaned with suitable abrasive to the required surface finish for operating temperatures above 120° C and a minimum of a commercial blast cleaning for operating temperatures below 120° C.
- ◆ The average maximum blast profile shall be between 3.5 to 6.0 mils. For sand castings, average maximum surface profiles after blasting to be specified.
- ◆ All traces of abrasive and other debris shall be removed by brushing, sweeping, blowing with clean compressed air, and vacuuming before the application of any coating.

## 3.0 GENERIC PAINT CHARACTERISTICS:

Paint have polymeric resins as binder mediums. These mediums are selected depending on the environment in which it has to operate.

For ease of reference, a generic description of the paint mediums are indicated below together with a specific characterisation of some of their properties.

- ◆ High solids, amine-cured epoxies:  
Polyamine-cured epoxies generally have a good resistance to chemicals and solvents.
- ◆ High build, polyamide-cured epoxies :  
Polyamide-cured epoxies exhibit a longer pot life, superior flexibility and durability compared with amine-cured epoxies. They possess adequate chemical resistance.
- ◆ High build, aliphatic polyurethanes :  
Two component isocyanate-free urethanes produce extremely hard, resistant and durable coatings. Aliphatic urethanes are preferred over aromatic urethanes because of their excellent durability and gloss retention.



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- ◆ Phenolic epoxies :  
Two component, high build, amine-cured phenolic epoxy coatings have excellent resistance to a wide range of solvents and (organic) acids.
- ◆ (Alkyl) zinc silicate :  
Two component, moisture curing, zinc (alkyl) silicate coating, containing a minimum of 75% metallic zinc, is a hard, abrasion resistant coating that can withstand temperatures up to 400°C.
- ◆ Aluminium pigmented silicate :  
One component, (alkyl) silicate, zinc-free coating is suitable for temperatures up to 600°C.
- ◆ Aluminium silicones :  
Aluminium pigmented, silicone resin-based paint. Heat resistant up to 600°C. A minimum temperature of 200°C is required for 2 hours to obtain a sufficient cure.
- ◆ Silicone acrylics :  
One component, aluminium (or colour) pigmented acrylic-modified silicone resin. Heat resistant up to 350°C. Full cure can be achieved at ambient temperature.
- ◆ Zinc-rich epoxy primer :  
Two component, epoxy based primer. Developed to provide sacrificial protection to steel surfaces.
- ◆ Solvent free epoxies :  
Two component, amine cured, modified epoxies without solvent. They can be applied as a heavy duty coating up to 28 mil thick.
- ◆ Polysiloxane :  
Two component, inorganic polysiloxane. Used for heat resistance (continuous and cyclic) up to 1110°C Current experience with this coating is good but still very limited.
- ◆ Thermally sprayed metal coatings :  
Thermally sprayed metal coatings may be used in applications where organic coatings are ineffective or cause product contamination.
- ◆ Black coal tar epoxy :  
Generally, Thixotropic amine cured two pack system. Conventional epoxy blended with high purity coal tar to impart flexibility, is mostly recommended for inner sides of water tanks.

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**The estimated life of the resin systems for various environments is given in Table-2.**

Lead containing paints, should not be used because of the associated health and environmental restrictions that apply unless otherwise insisted upon.

Paints specifically intended for use on austenitic stainless steels or high nickel-chromium alloys shall not contain free chlorides or other halides after curing, although trace amounts in the raw materials is accepted. Chlorides or other halides tied up within the cured resin's chemical molecule are acceptable, unless they are subject to release through ageing within the temperature range specified. Such paint formulations shall also not contain metallic zinc, because of the possibility of inducing liquid metal embrittlement.

**Note:** It has been shown that zinc oxide or zinc phosphate, which are the more recent non-lead, non-chromate, corrosion inhibitive pigment developments, do not cause embrittlement even at 850°C.

### **3.1.0 PREPARATION OF THE PAINT AIR DRYING ENAMEL:**

#### **3.1.1 Removal of skin from the paint:**

Before application, any skin formed on the paint in the container shall be carefully removed, any settled pigment broken up and loosened and the paint thoroughly stirred to ensure complete and uniform mixing of the constituents. Care shall be taken to avoid entering air into the paint while stirring. The paint shall be strained through a muslin cloth or 60 mesh sieve.

#### **3.1.2 Consistency of the paint:**

The paint shall be used at an appropriate consistency depending on the mode of application. Table 1 provides the general guidance.

The above consistency shall be adjusted using white spirit or recommended thinner to AA 56701 depending on mode of application.

### **3.2.0 PREPARATION OF THE PAINT (ETCH PRIMER AND EPOXIDE PAINTS):**

#### **3.2.1 Etch primer:**

Etch primer, as supplied, consists of two separate ingredients viz., primer base and accelerator. Shortly before use, mix together the primer base and accelerator in the proportions as per the recommendation of the supplier. The paint prepared as above does not require any thinning.

#### ***IMPORTANT NOTE:***

After mixing, the paint shall be allowed to mature for 30 minutes unless otherwise specified. The mixed paint shall be used within 8 hours.



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### 3.2.2 COMPOSITION:

The paint shall consist of a two pack system viz., base and accelerator, as per AA 56103.

Generally the base, shall consist of zinc tetroxy chromate pigment dispersed in Polyvinyl butyl resin solution while accelerator shall consists of orthophosphoric acid in suitable solutions like butanol, industrial methylated spirit, etc.

The base shall be in such a condition that uniform and smooth dispersion material is obtained by stirring. There shall not be any tendency for viscosity build up, gelling and pigment settlement throughout the shelf life of the paint.

Etch primer may be applied prior to epoxy paint wherever recommended.

### 3.2.3 Mixing of the constituents of epoxide paints:

- a) These paints, as supplied, consist of two separate ingredients, namely base and accelerator. Shortly before mixing and use, these shall be thoroughly stirred. The base and the accelerator shall be accurately mixed together in the proportions as per the recommendations of the supplier.

Accelerator should be added to the base but not the base to the accelerator. The paints shall be mixed with continuous stirring until a uniform consistency is obtained.

- b) Consistencies of the paints :  
The paints mixed shall be used at an appropriate consistency depending on mode of application. Table 1 provides general guidance.

#### **Important Note:**

After mixing, the paint shall be allowed to mature for 30 minutes and the mixed paint shall be used within 8 hours, unless otherwise specified in, by the paint supplier. All other properties should be as per individual specification.

### 3.2.4 Safety precautions:

Etch primer and epoxy paints are liable to cause irritation to the skin. This may transpire into inflammation, swelling, rash or pustules on the hands, arms and occasionally on the whole body.

Following precautions should be observed while handling these materials:

- i) Work place and storage rooms shall be adequately ventilated.
- ii) Before starting the work, hands should be washed with soap and water and good barrier cream applied.
- iii) Maximum care should be taken to avoid splashes on the skin
- iv) Splashing on the skin should be immediately washed with soap and water.
- v) After the work, hands, arms and face should be washed with soap and water followed by thorough drying with a clean towel.



### 3.3.0 PREPARATION OF THE PAINTS (ALUMINUM SILICON):

3.3.1 Mixing of paint material shall be in strict accordance with manufacturer's instructions

3.3.2 Thinning shall only be done if necessary for the workability of the paint and in accordance with manufacturer's instructions. Petroleum or mineral spirits shall be used for thinning and shall not exceed 5% by volume.

#### 3.3.3 Application over ethyl silicate zinc-rich primer:

- (a) Underlying inorganic zinc primer shall be completely cured before application of aluminum silicone topcoat.
- (b) Apply one coat of aluminum silicone paint to achieve a dry film thickness of 15 - 30  $\mu\text{m}$ . A thin mist coat may be necessary before full coat application to avoid top coat bubbling.

Allow to air dry for 16 hours before direct exposure to operating conditions of the heat or before curing.

All other properties should be as per relevant corporate supplier's standard.

### 3.4.0 PAINT APPLICATION :

3.4.1 Paint application shall comply with the requirements of individual specification and with the paint manufacturer's printed instruction.

3.4.2 Paint shall be applied at ambient temperatures preferably not below 10° C.

3.4.3 Conventional air spray or airless spray application is acceptable. Brush application is also acceptable for surfaces inaccessible to spray and for touch up coats.

3.4.4 After thorough mixing of the product of two component systems, the maturation time as indicated in the manufacturer's product data sheet is to be allowed before applying the paint.

3.4.5 Short shelf life / two component paint mixture thickens as the time progresses and at the end of the pot life period, the mixture becomes highly viscous and unusable. It is best to consume mixed paint at least one hour before the end of the pot life.

3.4.6 Avoid using excess solvent than the recommended volumes since this leads to reduced dry film thickness, sagging and longer curing time.

3.4.7 Apply Epoxy Primer paint to achieve a dry film thickness of 35-50 microns and a coat of etch primer wherever recommended.

3.4.8 Allow the painted substrate to dry for 16 hrs before direct exposure to outside weather conditions or heat. In case of stoving paints, it is to be stoved at temperature and time specified in a suitable oven.

3.4.9 Apply a coat of finish paint after ensuring removal of dust, dirt and other contaminants from the primed surface. Intermediate coats of paints may be applied wherever recommended.



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**3.4.10** All measurements and instrument calibration shall be in accordance with the specification AA 067 41 05 and the data to be recorded in accordance with AA 067 41 06 for each job.

### 3.5.0 QUALITY CHECKS & INSPECTION:

**3.5.1** Following points shall be ensured to achieve overall quality of the job:

- (a) Compressed air used for spray application shall be free from oil, moisture and other contaminants.
- (b) Steel surfaces to be painted shall be free from burrs, sharp edges, lamination, surface imperfections and any other contamination detrimental to paint adhesion finish or appearance.
- (c) All surfaces to be coated have been cleaned in accordance with the requirements of BHEL STANDARD AA 067 4101.
- (d) All surfaces to be coated shall be completely dry before paint application.
- (e) Paint components shall be mixed as prescribed / recommended and mixed paint shall be consumed within specified pot life.
- (f) Drying / curing requirements shall be fully satisfied.
- (g) Damaged paint coating shall be properly touched up before another coating application.
- (h) All paint coating measurements like thickness gloss, finishing and adhesion shall be usable as per AA 067 41 05.

### 3.5.2 INSPECTION:

#### a) VISUAL:

The painted surfaces shall be free from spacks of iron, salt or dust. It shall be smooth and uniform and there will be no visible porosity, pot holes, or any other paint coating defects. If runs and sags dry spray and over spray are present these defects shall not be more than 5% in any given area (sq. feet) and cumulatively not more than 2% of total surface area unless otherwise specified.

- b) Dry film thickness DFT:** Dry film thickness should be measured with an appropriate measurement gauge calibrated as per AA 067 41 05. Unless otherwise specified.

#### c) ADHESION:

The adhesion of the primer to the steel substrate and the intercoat adhesion of the subsequent coat(s) after curing shall be determined by the application of a cross-cut test in accordance with BHEL Standard AA 067 41 05.



- d) Gloss level: As per AA 067 41 05.
- e) Finish: as per AA 067 41 05.
- f) Shade: As per IS : 5 unless otherwise specified.
- g) Coated surfaces are smooth and uniform in coverage.
- h) There is no visible porosity or pot holes.
- i) Unacceptable defects such as peeling, blistering cracking and damage caused by external sources are clearly marked with a mark-free chalk and with in the specification requirements.
- j) Runs and sags, dry spray and over spray are not present in excess of 5% in any given square foot and cumulatively not in excess of 2% of any surface. Unless otherwise specified
- k) Drying time/curing time requirements have been satisfied.
- l) Holiday / pinhole detection shall be conducted on all conventional thin film thickness, having total DFT 0.5mm or less, by low voltage wet sponge method as per ASTM D5162. This is carried out after top coat applied & fully cured / dried. For tank & vessel internals 100% of the surface shall be tested. Special attention shall be paid to welds, edges & irregular surfaces for holiday / pinhole testing. For external surfaces, random inspection, which shall be representation of entire surface shall be tested. No pinhole is acceptable.

### 3.6.0 PAINTING SCHEMES:

Selection of painting scheme has to be made on specific operational and environmental requirements. Similarly, selection of colours have to be made suitably unless both are specified by the customer. – BHEL painting scheme for various power equipment and related components is given in annexure - II. However, any deviation from number of coats and thickness specified by customer shall be followed.

Typical painting schedules for various industrial components and painting systems are also given in Annexure III and IV respectively. For general reference.

The list of BHEL Corporate Standards on Paints is enclosed in Annexure-V.



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## ANNEXURE-I.

RELATIONSHIP BETWEEN 'DEW POINT', AIR TEMPERATURE AND RELATIVE HUMIDITY.

| Air Temp.<br>°C | 'Dew Point' in °C at Relative Humidity of |     |     |     |     |     |     |     |     |
|-----------------|---|-----|-----|-----|-----|-----|-----|-----|-----|
|                 | 50%                                       | 55% | 60% | 65% | 70% | 75% | 80% | 85% | 90% |
| 5               | -5  | -3  | -2  | -1  | 0   | 1   | 2   | 3   | 4   |
| 6               | -3  | -3  | -1  | 0   | 1   | 2   | 3   | 4   | 4   |
| 7               | -3  | -1  | 0   | 1   | 2   | 3   | 4   | 5   | 5   |
| 8               | -2  | -1  | 1   | 2   | 3   | 4   | 5   | 6   | 6   |
| 9               | -1  | 0   | 1   | 3   | 4   | 5   | 6   | 7   | 7   |
| 10              | 0   | 1   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
| 11              | 1   | 2   | 4   | 5   | 6   | 7   | 8   | 9   | 9   |
| 12              | 2   | 3   | 5   | 5   | 7   | 8   | 9   | 9   | 10  |
| 13              | 3   | 4   | 5   | 6   | 8   | 9   | 10  | 10  | 11  |
| 14              | 4   | 5   | 6   | 7   | 8   | 10  | 11  | 12  | 12  |
| 15              | 5   | 6   | 7   | 8   | 9   | 11  | 12  | 12  | 13  |
| 16              | 5   | 7   | 8   | 9   | 10  | 12  | 12  | 13  | 14  |
| 17              | 7   | 8   | 9   | 10  | 12  | 12  | 14  | 14  | 15  |
| 18              | 7   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  |
| 19              | 8   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  |
| 20              | 9   | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  |
| 21              | 10  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  |
| 22              | 11  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| 23              | 12  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  |
| 24              | 13  | 14  | 16  | 17  | 18  | 19  | 20  | 21  | 22  |
| 25              | 14  | 15  | 17  | 18  | 19  | 20  | 21  | 22  | 23  |
| 26              | 15  | 16  | 18  | 19  | 20  | 21  | 22  | 23  | 24  |
| 27              | 16  | 17  | 18  | 20  | 21  | 22  | 23  | 24  | 25  |
| 28              | 17  | 18  | 19  | 21  | 22  | 23  | 24  | 25  | 26  |
| 29              | 18  | 19  | 20  | 22  | 23  | 24  | 25  | 26  | 27  |
| 30              | 18  | 20  | 21  | 23  | 24  | 25  | 26  | 27  | 28  |

## BHEL PAINTING SCHEME FOR PRODUCT Annexure II

| Sl. No. | System                                  | Environment<br>(See note 1) | General description  | **<br>Painting<br>Scheme<br>reference | Total Dry<br>film<br>Thickness,<br>In $\mu\text{m}$<br>TDFT | Remarks |
|---------|---|-----------------------------|--|---------------------------------------|---|---------|
| 1       | Power Boiler                            | Rural                       | Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.                                      | 1                                     | 80  |         |
|         |   | Industrial                  | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.        | 2                                     | 180   |         |
|         |   | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 3                                     | 180   |         |
|         |   | Industrial and coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 8                                     | 180   |         |
| 2       | HRSG /Industrial Boilers                | Rural                       | Chlorinated Rubber Based, chemical resistant   | 4                                     | 120   |         |
|         |   | Industrial                  | Epoxy Two pack (Organic) Zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane | 5                                     | 155   |         |
|         |   | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 3                                     | 180   |         |
|         |   | Industrial and Coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 8                                     | 180   |         |
| 3       | Column, Pressure Vessel, Heat Exchanger | Rural                       | Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane                                       | 1                                     | 80  |         |
|         |   | Industrial                  | Epoxy Two pack (organic) Zinc rich, Epoxy Two pack chemical resistant and Two pack Polyurethane    | 5                                     | 155   |         |

\*\* Refer Annexure - II (a)

Note -1 : The painting scheme specified provides life to first maintenance of 5 years, under specified environment.

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## II Continued..

| Sl. No. | System                                 | Environment<br>(See note 1) | General description  | **<br>Painting<br>Scheme<br>reference | Total<br>Dry film<br>Thickness,<br>in $\mu\text{m}$<br>TDFT | Remarks |
|---------|--|-----------------------------|--|---------------------------------------|---|---------|
| 4       | Tankage                                | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 3                                     | 180   |         |
|         |  | Industrial and Coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.        | 8                                     | 180   |         |
|         |  | Rural                       | Chlorinated Rubber Based, chemical resistant   | 4                                     | 120   |         |
|         |  | Industrial                  | Epoxy Two pack chemical resistant and Two pack Polyurethane  | 7                                     | 175   |         |
|         |  | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 3                                     | 180   |         |
|         |  | Industrial and coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 8                                     | 180   |         |
|         |  | Rural                       | Epoxy Two pack (organic) zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane | 5                                     | 155   |         |
|         |  | Industrial                  | Epoxy Two pack chemical resistant and Two pack Polyurethane  | 7                                     | 175   |         |
| 5       | Rotating Equipment, Pumps, Compressors | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 3                                     | 180   |         |
|         |  | Industrial and coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane         | 8                                     | 180   |         |

\*\* Refer Annexure - II (a)



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## II Continued..

| Sl. No. | System  | Environment<br>(See note 1) | General description  | **<br>Painting<br>Scheme<br>reference | Total<br>Dry film<br>Thickness,<br>in $\mu\text{m}$<br>TDFT | Remarks              |
|---------|---|-----------------------------|--|---------------------------------------|---|----------------------|
| 6       | Piping Valve Fittings   | Rural                       | Chlorinated Rubber based, chemical resistant   | 4                                     | 120   |                      |
|         |   | Industrial                  | Epoxy Two pack chemical resistant and Two pack Polyurethane.                               | 7                                     | 175   |                      |
|         |   | Coastal                     | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane | 3                                     | 180   |                      |
|         |   | Industrial and coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane | 8                                     | 180   |                      |
| 7       | Transformers Tank conservation Bushing Turact Header, Piping work support structure | Rural                       | Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.                              | 1                                     | 80  |                      |
|         |   | Industrial                  | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane | 2                                     | 180   |                      |
|         |   | Coastal                     | Epoxy Two pack chemical resistant and Two pack Polyurethane                                | 7                                     | 175   |                      |
|         |   | Industrial and Coastal      | Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane | 8                                     | 180   |                      |
| 8       | Control Cubicles  | For indoor installation     | Epoxy Two pack chemical resistant and Two pack Polyurethane                                | 10                                    | 170   | appln. Only by spray |

**\*\* Refer Annexure -II (a)**

**Note 1:** Rural = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90° C  
Industrial = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90° C  
Coastal = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90° C  
Industrial & Coastal = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90° C

**Note 2:** For operating temperature 91 - 400 ° C and 401 to 600 ° C, the painting scheme reference no: 6 and no: 9 respectively shall be followed

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## BHEL Painting Schemes Details

## ANNEXURE - II (a)

| Paint reference Scheme | Surface Prepn. Grade/ Surface profile            | Primer Coat                                       |              |                      | Intermediate coat                                |              |                      | Finish coat  |              |                      | Total DFT, in $\mu\text{m}$ |
|------------------------|--|---|--------------|----------------------|--|--------------|----------------------|--|--------------|----------------------|-----------------------------|
|                        |  | Primer paint                                      | No. of coats | DFT in $\mu\text{m}$ | Intermediate paint                               | No. of coats | DFT in $\mu\text{m}$ | Finish paint (See note)                              | No. of coats | DFT in $\mu\text{m}$ |                             |
| 1                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Epoxy zinc rich primer (Two pack)<br>AA 561 14    | 1            | 50                   | - -  | --           | --                   | Full gloss polyurethane finishing paint<br>AA 561 42 | 1            | 30                   | 80                          |
| 2                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Inorganic Ethyl zinc silicate primer<br>AA 561 13 | 1            | 75                   | High build intermediate Epoxy paint<br>AA 561 12 | 1            | 75                   | Full gloss Polyurethane finishing paint<br>AA 561 42 | 1            | 30                   | 180                         |



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## II (a) Continued....

Note: The shade of finish paint shall be decided based on the option of concerned unit / customer's requirement.

| Paint reference Scheme | Surface Prepn. Grade/ Surface profile            | Primer Coat   |              |                      | Intermediate coat                                |              |                      | Finish coat  |              |                      | Total DFT, in $\mu\text{m}$ |
|------------------------|--|---|--------------|----------------------|--|--------------|----------------------|--|--------------|----------------------|-----------------------------|
|                        |  | Primer paint  | No. of coats | DFT in $\mu\text{m}$ | Intermediate paint                               | No. of coats | DFT in $\mu\text{m}$ | Finish paint (See note)  | No. of coats | DFT in $\mu\text{m}$ |                             |
| 3                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Inorganic Ethyl zinc silicate primer<br>AA 561 13                     | 1            | 75                   | High build intermediate epoxy paint<br>AA 561 12 | 1            | 75                   | Full gloss Polyurethane finishing paint<br>AA 561 42                     | 1            | 30                   | 180                         |
| 4                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Chemical resistant Chlorinated Rubber base priming paint<br>AA 561 07 | 2            | 70                   |  |              |                      | Chemical resistant chlorinated rubber based finishing paint<br>AA 561 36 | 2            | 50                   | 120                         |

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| Paint reference Scheme | Surface Prepn. Grade/ Surface profile            | Primer Coat   |              |                      | Intermediate coat                                |              |                      | Finish coat  |              |                      | Total DFT, in $\mu\text{m}$ |
|------------------------|--|---|--------------|----------------------|--|--------------|----------------------|--|--------------|----------------------|-----------------------------|
|                        |  | Primer paint  | No. of coats | DFT in $\mu\text{m}$ | Intermediate paint                               | No. of coats | DFT in $\mu\text{m}$ | Finish paint (See note)                                    | No. of coats | DFT in $\mu\text{m}$ |                             |
| 5                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Epoxy based zinc rich primer (Two pack)<br>AA 561 14                          | 1            | 50                   | High build intermediate Epoxy paint<br>AA 561 12 | 1            | 75                   | Full gloss Polyurethane finishing paint<br>AA 561 42       | 1            | 30                   | 155                         |
| 6                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Inorganic Ethyl zinc silicate primer<br>AA 561 13                             | 1            | 75                   |  |              |                      | Heat resistant air dry Aluminium paint Gr - I<br>AA 561 49 | 2            | 40                   | 115                         |
| 7                      | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ | Chemical resistant epoxide redoxide zinc phosphate priming paint<br>AA 561 05 | 2            | 70                   | High build intermediate epoxy paint<br>AA 561 12 | 1            | 75                   | Full gloss Polyurethane finishing paint<br>AA 561 42       | 1            | 30                   | 175                         |



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| Paint<br>referenc<br>e<br>Scheme | Surface<br>Prepn.<br>Grade/<br>Surface<br>profile    | Primer Coat   |                 |              | Intermediate coat  |                 |              | Finish coat  |                 |              | Total<br>DFT,<br>in µm |
|----------------------------------|--|---|-----------------|--------------|--|-----------------|--------------|--|-----------------|--------------|------------------------|
|                                  |  | Primer paint  | No. of<br>coats | DFT<br>in µm | Intermediate<br>paint                                      | No. of<br>coats | DFT<br>in µm | Finish paint<br>(note See)                                     | No. of<br>coats | DFT<br>in µm |                        |
| 8                                | Shot<br>Blasting<br>to<br>Sa 2 1/2<br>35 to 50<br>µm | Inorganic Ethyl zinc<br>silicate primer<br>t<br>AA 561 13                     | 1               | 75           | High build<br>intermediate<br>epoxy paint<br><br>AA 561 12 | 1               | 75           | Full gloss<br>Polyurethane<br>finishing paint<br><br>AA 561 42 | 1               | 30           | 180                    |
| 9                                | Shot<br>Blasting<br>to<br>Sa 2 1/2<br>35 to 50<br>µm | Two pack, air drying<br>heat resistant<br>Polysilaxone paint<br><br>AA 561 43 | 1               | 100          | --   | --              | --           | --   | --              | --           | 100                    |

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## II (a) Continued....



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| Paint reference Scheme | Surface Prepn. Grade/ Surface profile  | Primer Coat   |              |                      | Intermediate coat                                |              |                      | Finish coat  |              |                      | Total DFT, in $\mu\text{m}$ |
|------------------------|--|---|--------------|----------------------|--|--------------|----------------------|--|--------------|----------------------|-----------------------------|
|                        |  | Primer paint  | No. of coats | DFT in $\mu\text{m}$ | Intermediate paint                               | No. of coats | DFT in $\mu\text{m}$ | Finish paint (See note)                              | No. of coats | DFT in $\mu\text{m}$ |                             |
| 10                     | Shot Blasting to Sa 2 1/2 35 to 50 $\mu\text{m}$ or Phosphating to coating weight of 16.15 gm per sq.m | Chemical resistant epoxide redoxide zinc phosphate priming paint<br>AA 561 05 | 1            | 35                   | High build intermediate epoxy paint<br>AA 561 12 | 1            | 75                   | Full gloss Polyurethane finishing paint<br>AA 561 42 | 2            | 60                   | 170                         |

## CORPORATE STANDARD



## ANNEXURE-III

## TYPICAL PAINTING SCHEDULE

PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS, STRUCTURAL STEEL AND FIRE-FIGHTING SYSTEMS.

| ITEM  | OPERATING TEMPERATURE (°C) | SUBSTRATE                       | PAINT SYSTEM No.(Annexure-V) |
|---|----------------------------|---------------------------------|------------------------------|
| PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS etc. | <120                       | Carbon steel, low alloy steel   | 1                            |
|   | <120                       | 9% Ni steel                     | 2                            |
|   | 120-200                    | Carbon steel, low alloy steel   | 3                            |
|   | 200-450                    | Carbon steel low alloy steel    | 4                            |
|   | Ambient – 200              | Stainless steel                 | 5                            |
|   | 200-450                    | Stainless steel                 | 6                            |
|   | Ambient – 1100             | Carbon steel, stainless steel   | 7*                           |
| STRUCTURAL STEEL, LADDERS, GRATINGS etc.            | -                          | Carbon steel, low alloy steel   | 1                            |
|   | -                          | Hot dip galvanized carbon steel | 8**                          |
| FIRE FIGHTING SYSTEMS(above ground)                 | <120                       | Carbon steel                    | 9                            |

\* Current experience with this polysiloxane coating is good but still very limited.

\*\* This duplex system shall only be applied to hot dip galvanized steel in cases where access for future maintenance is difficult.



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## ANNEXURE-III (continued..)

| ITEM  |                                    | OPERAT-ING<br>TEMPERA-<br>TURE<br>(°C) | SUBSTRATE                        | PAINT SYSTEM<br>NUMBER<br>(Annexure-V) |
|---|------------------------------------|--|----------------------------------|--|
| CRUDE OIL<br>TANKS BOTTOM<br>and LOWEST<br>SHELL COURSE | INTERNAL<br>Non-corrosive          | <80                                    | Carbon steel,<br>low alloy steel | 10*                                    |
|   | INTERNAL<br>Corrosive              | <80                                    | Carbon steel,<br>low alloy steel | 11                                     |
| CRUDE OIL<br>TANKS<br>ROOF and SHELL                    | INTERNAL                           | <80                                    | Carbon steel,<br>low alloy steel | 10*                                    |
|   | EXTERNAL                           | <80                                    | Carbon steel,<br>low alloy steel | 1                                      |
| STORAGE TANKS   | INTERNAL                           | <120                                   | Carbon steel,<br>low alloy steel | 10*                                    |
|   | EXTERNAL                           | <120                                   | Carbon steel<br>Low alloy steel  | 1                                      |
|   |                                    | 50-200                                 | Stainless steel                  | 5                                      |
|   | INTERNAL,<br>Chemical<br>Resistant | <60                                    | Carbon steel,<br>Low alloy steel | 12                                     |
|   | INTERNAL<br>Industrial water<br>** | <80                                    | Carbon steel,<br>low alloy steel | 11                                     |
| LPG SPHERES<br>and BULLETS                              | INTERNAL                           | <120                                   | Carbon steel,<br>low alloy steel | 10                                     |
|   | EXTERNAL                           | <120                                   | Carbon steel,<br>low alloy steel | 1                                      |
| MOUNDED LPG<br>STORAGE ***                              | EXTERNAL                           | Ambient                                | Carbon steel                     | 13                                     |

\* This treatment is a shop-applied temporary protection only. No further painting is required after construction.

\*\* Primer is optional for use in industrial water tanks

\*\*\* For full details about this system, manufacturer's instructions may be followed.

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## Annexure-III (Continued...)

| ITEM  | OPERATING TEMPERATURE (° C) | SUBSTRATE                         | PAINT SYSTEM NUMBER (Annexure-V) |
|---|-----------------------------|-----------------------------------|----------------------------------|
| FURNACES, STACKS, FLARE STACKS And FLUE DUCTS | <120                        | Carbon steel, low alloy steel     | 1                                |
|   | 120-200                     | Carbon steel, Low alloy steel     | 3                                |
|   | 200-550                     | Carbon steel, Low alloy steel     | 14                               |
|   | <400                        | Carbon steel, hot-dip galvanised* | 15                               |
|   | <200                        | Stainless                         | 5                                |
|   | 200-450                     | Stainless                         | 6                                |
|   | Ambient-1100                | Carbon steel, stainless steel     | 7**                              |
| OFF SHORE STRUCTURES, TIDAL ZONES             | <120                        | Carbon steel, Low alloy steel     | 11                               |
| TOP SIDE FACILITIES, EQUIPMENT and PIPING     | <120                        | Carbon steel, Low alloy steel     | 9                                |
|   | 120-200                     | Carbon steel, Low alloy steel     | 3                                |

\* For long life time service (>20 years) a hot dip galvanised duplex system is preferred.

\*\* Current experience with this polysiloxane coating is good but still very limited.



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## ANNEXURE-IV

### TYPICAL PAINT SYSTEMS.

| SYS. No. | SURFACE PREPARATION  | PAINT SYSTEM  |   |  |
|----------|--|---|---|--|
|          |  | Primer  | Inter-coat  | Top-coat   |
| 1        | Sa 2 ½   | Alkyl zinc silicate<br>DFT 75 microns                                   | High build,<br>epoxy sealer<br>DFT 75 microns                             | High build, aliphatic<br>polyurethane<br>DFT 75 microns                  |
| 2        | Sa 2 ½   | High build,<br>polyamide cured,<br>(zinc free) epoxy<br>DFT 100 microns | -   | High build, high<br>solids, polyamide-<br>cured epoxy<br>DFT 100 microns |
| 3        | Sa 2 ½   | Alkyl zinc silicate<br>DFT 75 microns                                   | -   | 2 coats<br>silicone acrylic<br>TDFT 60 microns                           |
| 4        | Sa 2 ½   | Alkyl zinc silicate   | -   | 2coats<br>heat resistant,<br>aluminium silicone<br>TDFT 50 microns       |
| 5        | Light sweep blast<br>(steam clean if not<br>possible)  | Silicone<br>Acrylic<br>DFT 25 mic.                                      | -   | Silicone acrylic<br>DFT 25 microns                                       |
| 6        | Light sweep blast<br>(steam clean if not<br>possible)  | Heat-resistant,<br>Aluminium silicone<br>DFT 25 microns                 | -   | Heat resistant,<br>aluminium silicone<br>DFT 25 microns                  |
| 7        | Carbon steel<br>SA 2 ½<br>Stainless steel-<br>sweep blast to<br>surface profile of<br>40 microns |   | Polysiloxane<br>DFT 125<br>microns  | Polysiloxane<br>DFT 125 microns  |
| 8.       | Hot dip galvanized<br>after light sweep<br>blast   | Zinc-rich epoxy<br>primer<br>DFT 40 mic.                                | -   | High build, aliphatic<br>polyurethane<br>DFT 100 microns                 |
| 9        | Sa 2 ½   | Alkyl zinc silicate<br>DFT 75 microns                                   | Polyamide<br>cured,<br>MIO<br>pigmented,<br>Epoxy tie coat<br>DFT 40 mic. | 2coats high solids<br>Aluminium-pigmented<br>epoxy<br>TDFT 200 microns   |

## CORPORATE STANDARD



## Annexure-IV (Continued...)

| SYS. No. | SURFACE PREPARATION                               | PAINT SYSTEM  |   |  |
|----------|---|---|---|--|
|          |   | Primer  | Inter-coat  | Top-coat   |
| 10       | Sa 2 ½  | Zinc-rich epoxy<br>DFT 25 microns                     | -   | -  |
| 11       | Sa 2 ½  | Polyamide-cured epoxy primer<br>DFT 75 microns        | -   | Solvent-free high solids, amine-cured epoxy<br>DFT 500 microns   |
| 12       | Sa 2 ½  | Amine cured, phenolic epoxy primer<br>DFT 100 microns | Amine adduct-cured, Phenolic epoxy<br>DFT 100 microns         | High build, amine adduct-cured epoxy<br>DFT 100 microns          |
| 13       | Sa 2 ½  | -   | -   | Solvent-free, high solids epoxy (hot applied)<br>DFT 800 microns |
| 14       | SA 2 ½  | Zinc silicate<br>DFT 75 microns                       | -   | Alkyl silicate<br>Aluminium-pigmented<br>DFT 40 microns          |
| 15       | Hot dip galvanized (slightly sweep blast if aged) | Zinc-rich epoxy primer<br>DFT 75 microns              | Polyamide-cured, MIO pigmented, Epoxy tie coat<br>DFT 40 mic. | High solids, Aluminum-pigmented epoxy<br>DFT 100 microns         |



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## ANNEXURE-V.

### LIST OF CORPORATE PAINT SPECIFICATION.

|           |   |
|-----------|---|
| AA 561 01 | ANTI-CORROSIVE PRIMING PAINT  |
| AA 561 03 | ETCH PRIMER   |
| AA 561 05 | CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT                       |
| AA 561 07 | CHEMICAL RESISTANT CHLORINATED RUBBER BASED PRIMING PAINT.                              |
| AA 561 11 | ALKYD BASE RED OXIDE ZINC PHOSPHATE ANTI CORROSIVE PRIMING PAINT                        |
| AA 561 12 | HIGH BUILD INTRMEDIATE EPOXY PAINT  |
| AA 561 13 | INORGANIC ETHYL ZINC SILICATE PRIMER  |
| AA 561 14 | EPOXY BASED ZINC RICH PRIMER -TWO PACK  |
| AA 561 26 | HIGH QUALITY FULL GLOSSY OUTDOOR FINISHING PAINT  |
| AA 561 27 | NON-YELLOWING FULL GLOSSY WHITE PAINT   |
| AA 561 28 | ALUMINIUM PAINT FOR GENERAL PURPOSES  |
| AA 561 31 | CHEMICAL RESISTANT EPOXIDE FINISHING PAINT  |
| AA 561 32 | OIL RESISTANT, AIR DRYING, SYNTHETIC ENAMEL   |
| AA 561 34 | HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr. 2<br>(TEMPERATURE UPTO 400 <sup>0</sup> C) |
| AA 561 35 | HIGH BUILD BLACK COAL TAR EPOXIDE PAINT   |
| AA 561 36 | CHEMICAL RESISTANT CHLORINATED RUBBER BASED FINISHING PAINT .                           |
| AA 561 40 | EXTRA HIGH BUILD BLACK COAL TAR EPOXIDE PAINT   |
| AA 561 42 | POLY URETHANE FINISHING PAINT   |
| AA 561 43 | TWO PACK, AIR DRYING, HEAT RESISTANT POLYSILOXANE PAINT.                                |
| AA 561 49 | HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr.1<br>(TEMPERATURE UPTO 600 <sup>0</sup> C)  |
| AA 561 59 | EPOXY POLYESTER POWDER COATING MATERIAL   |
| AA 561 60 | EPOXY POWDER COATING MATERIAL   |

**TABLE - II**  
**Estimated Service Life Years, Before First Maintenance Painting)**  
**of Paint Protective Coating, Galvanizing and Zinc-Rich Systems.**

| Sl. No. | Number of coats | Coating system   | Surf. Prep SSPC * | Minimum DFT mill or microns. | Maint.sched | Sea coast Maint. | Sea coast Heavy Industrial | Caustic  | Acid      | Fresh water Immersion | Salt water / Brine immersion | Ammonia  | Chlorine  | Solvents / Gasoline | Mild       | Moderate | severe    | Dry heat resistance °C |
|---------|-----------------|--|-------------------|------------------------------|-------------|------------------|----------------------------|----------|-----------|-----------------------|------------------------------|----------|-----------|---------------------|------------|----------|-----------|------------------------|
| 1       | 2               | Alkyd primer/top                                       | 2/3               | 4.0<br>100                   | I           | 1                | 1                          | 0.5      | 0.5       | N                     | N                            | 0.5      | 0.5       | 0.5                 | 3          | 2        | 1         | 66-94                  |
| 2       | 3               | Alkyd primer/top                                       | 2/3               | 6.0<br>150                   | I           | 2                | 2                          | 1        | 1         | N                     | N                            | 1        | 1         | 1                   | 6          | 4        | 2         | 66-94                  |
| 3       | 2               | Alkyd primer/<br>silicone alkyd                        | 6                 | 4.0<br>100                   | I           | 2.5              | 2.5                        | 1        | 1         | N                     | N                            | 1        | 1         | 1                   | 7          | 5        | 2.5       | 149-177                |
| 4       | 2               | Universal primer<br>/HB epoxy                          | 2/3               | 6.0<br>150                   | I           | 4                | 3                          | 3        | 2         | N                     | N                            | 3        | 2         | 3                   | 7          | 5        | 3         | 121-149                |
| 5       | 3               | Universal primer/<br>HB epoxy/ Acrylic<br>polyurethane | 2/3               | 7.5<br>180                   | I           | 5                | 3                          | 3        | 3         | N                     | N                            | 3        | 3         | 3                   | 9          | 6        | 4         | 149                    |
| 6       | 2               | Epoxy primer /<br>HB epoxy                             | 2.3               | 6.0<br>150                   | I           | 4                | 3                          | 3        | 2         | N                     | N                            | 3        | 2         | 3                   | 7          | 5        | 3         | 121-149                |
| 7       | 2               | Epoxy zinc/ HB<br>epoxy/ Acrylic<br>polyurethane       | 6                 | 7.0<br>175                   | I<br>P      | 6<br>9           | 3<br>4.5                   | 3<br>4.5 | 4<br>6    | N<br>N                | N<br>N                       | 3<br>4.5 | 4<br>6    | 5<br>7.5            | 11<br>16.5 | 8<br>12  | 5<br>7.5  | 149                    |
| 8       | 3               | Epoxy zinc/HB<br>Epoxy / Acr. Ure                      | 10                | 9.0<br>225                   | I<br>P      | 8<br>12          | 6<br>9                     | 6<br>9   | 7<br>10.5 | N<br>N                | N<br>N                       | 6<br>9   | 7<br>10.5 | 6<br>9              | 15<br>19.5 | 10<br>15 | 7<br>10.5 | 149                    |

\* Rust grades as per SSPC Vis-2 or SSPC D- 610:

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**CORPORATE STANDARD**



1194847/2022/HEP-TAM21300



REAFFIRMATION - NOTIFICATION

AA 085 01 04 Rev.No.01

AA 085 01 04: ULTRASONIC EXAMINATION, ACCEPTANCE STANDARDS AND  
CLASSIFICATION OF CARBON, LOW ALLOY AND MARTENSITIC STEEL CASTINGS

This standard is "Reaffirmed 1998."

Please see instructions on the reverse

|  |                    |                    |                   |                      |
|--|--------------------|--------------------|-------------------|----------------------|
| Ref:<br>Cl: 13.6.5 OF MOM OF<br>WG-NDT | Approved<br>WG-NDT | Issued<br>CORP.R&D | Date<br>15.12.98, | Cum.Sl.No.<br>R 2436 |
|--|--------------------|--------------------|-------------------|----------------------|

1194847/2022/HEP-TAM21300



## AMENDMENT -- NOTIFICATION

AA 085 01 04 REV.01

PAGE 1 OF 1

1.0 TITLE: Title of the standard is changed as below:

"ULTRASONIC EXAMINATION, ACCEPTANCE STANDARDS AND CLASSIFICATION OF CARBON, LOW ALLOY AND MARTENSITIC STEEL CASTINGS"

(Change is underlined)

2.0 Cl.1:SCOPE: Scope of the standard is modified as below:

"This standard details the ultrasonic testing procedure, acceptance standards and classification of carbon, low alloy and martensitic steel castings."

3.0 Cl.4: This clause is modified as below:

### PERSONNEL REQUIREMENT:

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

REF:

Cl.8.7 of MOM of WG(NDT)

AMD. NO.

01

APPROVED

WG(NDT)

ISSUED

Corp.R&amp;D

DATE

June '93

CUM.SR.NO.

A 1274



# CORPORATE STANDARD

AA 085 01 04

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## ULTRASONIC EXAMINATION, ACCEPTANCE STANDARD AND CLASSIFICATION OF STEEL CASTINGS

### 1. SCOPE:

This standard details the ultrasonic testing procedure, acceptance standard and classification of steel castings.

### 2. STAGE OF EXAMINATION:

Ultrasonic examination shall be generally carried out after heat treatment of the casting and rough machining, if called for in the order. Ultrasonic examination shall be repeated after weld rectification, if any.

### 3. SURFACE PREPARATION:

Smooth "as cast" surface, free from adhered or fused sand and irregularities is adequate for ultrasonic examination. Loose scales and excessive surface irregularities such as that caused by removal of runner and riser shall be ground off. While grinding care shall be taken to avoid surface undulations which would interfere with probe contact. To improve coupling efficiency of as cast surfaces or to remove rust or paint, shot-blasting or sand-blasting may be carried out. Rough machined surfaces should have a minimum surface finish of 6.2 microns.

### 4. OPERATING PERSONNEL:

The operator performing the ultrasonic test shall be conversant with the ultrasonic techniques and the equipment.

### 5. EQUIPMENT CHARACTERISTICS:

#### 5.1 Frequency Range:

The equipment shall be capable of operating over a frequency range of at least 0.5 to 12 MHz.

#### 5.2 CRT Screen Presentation:

"A" scope presentation shall be used. The trace shall be well defined, easy to read and associated with permanent graticule scale marking for both range and amplitude.

#### 5.3 Linearity Of Amplification:

The amplifier shall be linear within  $\pm 2$ dB upto at least 1/2 full screen height and any deviation above this should be known to the operator. Supression affects linearity and the effect of suppression over full range should be recorded.

Revisions: Cl. 3.14 of the minutes of meeting of WG(NDT)

Approved: **INTERPLANT  
STANDARDIZATION COMMITTEE -WG(NDT)**

| Rev. No. | Rev. Date | Revised:   | Prepared   | Issued    | Date      |
|----------|-----------|------------|------------|-----------|-----------|
| 01       | June '88  | Corp (R&D) | Corp (R&D) | CORP. R&D | Sept, '79 |

**5.4 Linearity Of Time Base:**

The time base shall be linear as far as possible and non-linearity should not exceed 1% of the full scale graticule reading.

**5.5 Resolution:**

The resolution of probe and flaw detection apparatus shall be such as to show separately the indications from two or more nearby reflecting surfaces separated by twice the wave length.

**5.6 Sensitivity Of The Equipment:**

The sensitivity of the equipment shall be checked with the longitudinal wave probes used, by placing the probe on the metallised surface of the plastic insert of IS:4904/IW test block. The minimum number of multiple echoes from the plastic insert at full gain setting shall be as given below:

| <u>Frequency range, MHz</u> | <u>Number of multiple echoes</u> |
|-----------------------------|----------------------------------|
| 1                           | 3                                |
| 2                           | 4                                |
| 4 to 6                      | 2                                |

**6. COUPLANT:**

To ensure adequate transmission of ultrasonic energy between probe and casting, a suitable couplant having good wetting characteristic shall be used. Oil, glycerine or Polycell paste may be used. For better adaption of cast surfaces, a thin protective plastic cover over the longitudinal probe is recommended.

**7. TESTABILITY OF CASTINGS:**

The testability of a casting is expressed as the minimum equivalent flaw size discernible with sufficient accuracy. The echo height of largest allowable equivalent flaw at the back wall distance shall be at least 8 dB above grass level. The testability can be determined on a parallel wall area of the casting using either a BSS diagram or a test block containing the appropriate flat bottomed hole. The surface quality of the test block should correspond to that of the casting. Sufficient testability is proved when the following condition is fulfilled.

| <u>Type of probe</u>                                | <u>Discernible defect size 8dB above noise level, mm</u> |
|---|--|
| -----   | -----  |
| 2-4 MHz Normal beam probe<br>(Tested from one side) | 3 or (Largest size allowable)                            |



## 8. TESTING PROCEDURE:

### 8.1 Selection Of Probes:

For all ultrasonic examinations, the highest frequency compatible with the size, metallurgical condition and thickness of the casting shall be used.

### 8.2 Testing Technique:

While selecting testing technique the following factors must be taken into account.

- (i) Type, orientation, position and incidence of defects likely to be encountered in the casting under consideration.
- (ii) Thickness and profile of the section.
- (iii) Structural condition.

All parts of the casting surface where a contact probe can be used, shall be tested by overlapping scans (20 - 25 mm) with normal beam probes, irrespective of casting geometry and availability of reference back echo. Normal beam probe of minimum 2 MHz frequency shall be used but shall be augmented by a thorough shear wave examination of location where the manufacturing method of the casting gives rise to features which may cause internal planer defects due to risers, chills, fillets, brackets, bosses and changes in section thickness. When examining areas of the casting which are to be further machined, a double crystal probe shall be used to reveal defects very near to the surface. This type of probes may also be used for the examination of thin sections and weld repaired areas, to determine depth of flaws, etc. Smaller diameter probes may be used for more critical examination of suspected areas. Testing shall be carried out from both sides of the wall wherever possible to assess the loss in wall thickness.

## 9. EQUIPMENT CALIBRATION:

### 9.1 Depth Range:

The depth range of the equipment shall be adjusted for normal and shear wave probes using known thickness of the casting or standard calibration block. When latter is used, velocity difference, if any, should be taken into account.

### 9.2 Sensitivity:

The scanning sensitivity of the apparatus shall be adjusted using either DGS diagram or standard test block with flat bottomed hole so that maximum acceptable equivalent defect will give an indication height of 75% screen height +8 dB. When test block is used for sensitivity calibration, distance amplitude curve shall be plotted on CRT screen to facilitate



correct defect size assessment. While estimating the size of defect, compensation shall also be made for difference in surface condition and attenuation in the test block and casting.

#### 10. SIGNIFICANT ULTRASONIC INDICATIONS:

The following ultrasonic indications are significant and must be considered during testing of castings:

- (a) All defect echoes beyond the acceptance level.
- (b) All echo indications which suggest crack like planer defects perpendicular to/approximately perpendicular to the test surface.
- (c) Loss of back echoes occuring not due to the casting geometry. (If loss of back echo cannot be attributed to the presence of a defect inspite of examining with different transducers, then such loss shall not exceed 75% ).

#### 11. ACCEPTANCE STANDARD:

The casting wall is divided into four zones as shown below:

- Zone 1: Middle 1/3 wall thickness
- Zone 2: Outer 1/3 wall thickness but not less than 16mm
- Zone 3: Inner 1/3 wall thickness but not less than 16mm
- Zone 4: 16 mm from surface of zone 2 if machined and 16 mm from surface of zone 3 whether machined or unmachined.
- Zone 5: Fabrication weld zone. Volume of casting representing weld preparation length plus further 25 mm length of casting.

The castings are categorised into three levels according to the size distribution and number of defects permissible.

Ultrasonic indications exceeding those shown in the table below as well as cracks, hot tears and cold shuts are unacceptable.

1194847/2022/HEP-TAM21300

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| DEFECT PARAMETER              | CLASSIFICATION<br>LEVEL | ZONE 1      |      | ZONE 2 & 3  |      | ZONE 4      |      |
|-------------------------------|-------------------------|-------------|------|-------------|------|-------------|------|
| -----                         |                         |             |      |             |      |             |      |
| A. Equivalent flaw dia.       | W*                      | 3           |      | 3           |      | 3           |      |
| As fraction of                | I                       | 1/5 WT**    | 10   | 1/8 WT      | 6    | 1/16 WT     | 3    |
| wall thickness in mm          | II                      | 1/5 WT      | 10   | 1/8 WT      | 6    | 1/16 WT     | 3    |
|                               | III                     | 1/4 WT      | 12   | 1/6 WT      | 8    | 1/12 WT     | 4    |
| -----                         |                         |             |      |             |      |             |      |
| B. Decrease of back-echo in   | W*                      | Not allowed |      | Not allowed |      | Not allowed |      |
| percentage associated         | I                       | 90          |      | 75          |      | "           |      |
| with the defect               | II                      | 90          |      | 75          |      | "           |      |
|                               | III                     | 95          |      | 85          |      | "           |      |
| -----                         |                         |             |      |             |      |             |      |
| C. Thickness of defect as     | W*                      | 5           | 3 mm | 5           | 3 mm | 5           | 3 mm |
| percentage of                 | I                       | 15          |      | 10          |      | 5           |      |
| wall thickness                | II                      | 15          |      | 10          |      | 5           |      |
|                               | III                     | 20          |      | 15          |      | 10          |      |
| -----                         |                         |             |      |             |      |             |      |
| D. Length of defect in mm     | W*                      | 3           |      | 3           |      | 3           |      |
| (See Note below)              | I                       | 100         |      | 75          |      | 12          |      |
|                               | II                      | 120         |      | 100         |      | 50          |      |
|                               | III                     | 150         |      | 120         |      | 75          |      |
| -----                         |                         |             |      |             |      |             |      |
| E. Area of individual defect  | W*                      |             |      |             |      |             |      |
| in cm                         | I                       | 120         |      | 10          |      | 0.25        |      |
|                               | II                      | 150         |      | 20          |      | 0.50        |      |
|                               | III                     | 200         |      | 30          |      | 10          |      |
| -----                         |                         |             |      |             |      |             |      |
| F. Accumulated area of defect | W*                      |             |      |             |      |             |      |
| in 1000 cm area               | I                       | 200 cm      |      | 10 cm       |      | 2.5 cm      |      |
|                               | II                      | 300 cm      |      | 40 cm       |      | 5 cm        |      |
|                               | III                     | 400 cm      |      | 60 cm       |      | 10 cm       |      |
| -----                         |                         |             |      |             |      |             |      |
| G. Minimum distance between   | W*                      | 6L+         |      | 6L+         |      | 6L+         |      |
| defects 'X' (See Fig. 1)      | I                       | 4L          |      | 4L          |      | 6L          |      |
|                               | II                      | 4L          |      | 4L          |      | 6L          |      |
|                               | III                     | 4L          |      | 4L          |      | 6L          |      |



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\* W = Fabrication Weld Zone : 75 mm length from the edges shall constitute the fabrication weld zone which excludes the excess machining allowance. In the case of unacceptable defects beyond 30 mm from the edge, they may be referred to BHEL for further evaluation with respect to actual weld preparation.

\*\* WT = Wall thickness

L+ = Length of defects

Note (For item D):

Close by defects will be treated as a single defect if the distance between the extremities of the adjacent defects is less than the length of the longest defect. The total length of the defect shall be considered as the length of the flaws plus the distance in between.

Minimum Distance Between Defects 'X' (For item G)

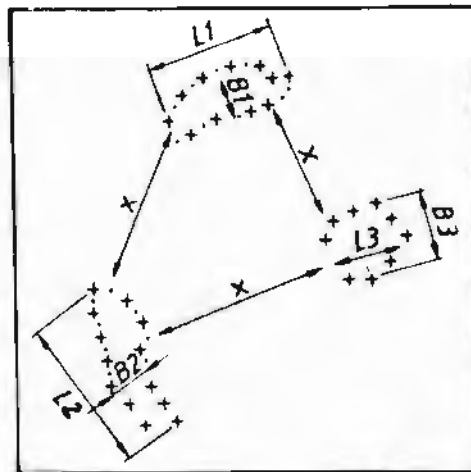


Fig - 1

L = Length of defect  
B = Breadth of defect  
X = Minimum distance between defects



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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:<br>Cl 12.8.8 of MOM of WG-NDT |         |            | Approved:<br>INTERPLANT STANDARDIZATION<br>COMMITTEE - (WG-NDT) |           |                  |
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## 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:

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 sensitivity. 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

$$NI_{hf} = \text{Value calculated for high fill factor coils using} \\ \frac{35000}{(L/D) + 2} \quad (10\%)$$

$$NI_{lf} = \text{Value Calculated for low fill factor coils using} \\ \frac{40,000 \times R}{(L/D) - 5} \quad (10\%)$$

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.

$$Y = \frac{\pi(12)^2}{\pi(24)^2} = \frac{1}{4}$$

## 6.2.2.1.3 High Fill Factor Coils:

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

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

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

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

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

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

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

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 70

2. BHEL CS AA 085 01 59

1194847/2022/HEP-TAM21300

|  |                              |                     |                  |                        |
|--|------------------------------|---------------------|------------------|------------------------|
|    | REAFFIRMATION - NOTIFICATION | AA 0850134          | REV. _           |                        |
| <p style="text-align: center;"><u>AA 0850134: EVALUATION AND ACCEPTANCE</u><br/><u>STANDARD FOR MAGNETIC PARTICLE</u><br/><u>EXAMINATION OF CASTINGS</u></p> <p style="text-align: center;">This Standard is <u>"Reaffirmed 1992"</u>.</p> |                              |                     |                  |                        |
| REF:<br>Cl. 7.13 of MOM of WG(NDT)   | APPROVED<br>WG(NDT)          | ISSUED<br>Corp. R&D | DATE<br>Dec. '92 | CUM. SR. NO.<br>R 0882 |



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AA 085 01 34

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# 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.

Revisions

Approved :

INTERPLANT NON-  
DESTRUCTIVE TESTING COMMITTEE

Prepared

Issued

Date

Date

Corp. R&amp;D

CORP : R &amp; D

10 SEPT 7

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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 & not tears.       |
| 2     | 3 Nos. of 3mm long indication.<br>One of 5mm long indication.   | -do-                      |
| 3     | 3 Nos. of 3mm long indication.<br>2 Nos. of 4mm long indication.<br>One of 6mm long indication.<br>One in line indication of - (10mm Max. lgth.)    | -do-                      |
| 4     | 4 Nos. of 3mm long indication.<br>3 Nos. of 4mm long indication.<br>2 Nos. of 6mm long indication.<br>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.



## PLANT STANDARD BHOPAL

BP 085 01 78

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### MAGNETIC PARTICLE INSPECTION AND ACCEPTANCE STANDARD FOR CRITICAL FASTENERS

**SUPERSEDES**  
**BP 085 01 78 REV.01**

#### 1. SCOPE :

This standard covers the visual and magnetic particle testing procedure and acceptance standards for fasteners used for critical applications e.g. Commutator Bolts, Main Pole Bolts, Axle Cap Bolts of Traction Machines etc., to detect surface defects.

Testing shall be carried out on Fasteners in the fully fabricated & heat-treated condition, if any.

#### 2. TESTING PROCEDURE :

##### 2.1 Surface Finish

Fasteners shall be free from dust, grease, oil etc.

##### 2.2 Operating Personnel

The operator performing the testing shall be fully conversant with magnetic particle testing technique and the acceptance standards laid down.

##### 2.3 Visual Examination

Fasteners shall be visually examined after cleaning its surface and any defects observed shall be recorded.

##### 2.4 Magnetic Particle Inspection

2.4.1 Fasteners shall be magnetic particle tested to ASTM-E-709 (BHEL Corporate Standard AA 085 01 33 in general .

2.4.2 When alternating current is used for circular magnetization, using direct contact method, the following current range shall be used.

For Fasteners upto 125 mm diameter

140 – 180 Ampere per centimeter of the diameter.

For Fasteners above 125 mm diameter and upto 375 mm diameter

100 – 140 Ampere per centimeter of the diameter.

Revision : Reviewed & Brought upto date

Issued by :

**STANDARDS AND MATERIALS GROUP**  
**TECHNICAL SERVICES DEPARTMENT**

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### 3. NON – DEESTRUCTIVE TESTING :

#### At Supplier's Works

100 Visual and magnetic particle testing as per clause 2 (above) shall be carried out at the Supplier's works and necessary test certificates shall be supplied, to BHEL.

Only fasteners which meet the Acceptance standards laid down in clause 4 (below) shall be dispatched to BHEL, Bhopal.

### 4. ACCEPTANCE STANDARDS :

Fasteners on testing, shall comply with the following requirements :

Any defect not specifically covered by this acceptance standard shall be referred to Technical Services Department, BHEL, Bhopal , for its approval.

#### 4.1 Linear Indications

Any Linear Indication, transverse to the longitudinal axis of the fasteners is not acceptable.

#### 4.2 Cracks

Cracks of any type, in any location irrespective of the dimension, is not acceptable,

#### 4.3 Seams

4.3.1 Seams found in the threaded portion of the fastener is not acceptable irrespective of the dimensions.

4.3.2 Seams found on the shank portion shall not have a depth more than  $0.03 \times d$ , where 'd' is the nominal diameter of the fasteners.

#### 4.4 Laps and Folds

Laps and folds of any depth or length are not acceptable, at the root of the threads.

If found, other than at the root of the threads, BHEL, Bhopal should be consulted, before dispatch of the material.

### 5. DEMAGNETISATION :

After the magnetic particle testing is over , demagnetization shall be carried out by using a suitable method.

### 6. PROTECTIVE COATING :

All fasteners after testing and demagnetization, shall be suitably protected by coat of rust preventive.



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### ANNEXURE - I

#### CHECK TEST AT BHEL WORKS

#### 1) SAMPLING :

Random samples shall be taken, as detailed below, from each size and from each lot of fasteners, which have been supplied & certified as per clause 1 to 6 of this standard (Refer Page 1 & 2)

#### TABLE - A

For Established suppliers ('A' Class Suppliers)

Methods for sampling of fasteners, shall be following :

| Sampling Plan Lot size<br>Nos. | Sample Size<br>Nos. | Acceptance<br>No. |
|--------------------------------|---------------------|-------------------|
| Upto 1000                      | 5                   | 0                 |
| Above 1000 upto 3000           | 8                   | 0                 |
| Above 3000 upto 10,000         | 13                  | 0                 |
| Above 10,000 upto 35,000       | 20                  | 0                 |
| Above 35,000                   | 32                  | 1                 |

#### TABLE - B

For other than Established suppliers / New Suppliers

The sampling size shall be double that of Table 'A' keeping the Acceptance Number same, as detailed below :

| Sampling Plan Lot size<br>Nos. | Sample Size<br>Nos. | Acceptance<br>No. |
|--------------------------------|---------------------|-------------------|
| Upto 1000                      | 10                  | 0                 |
| Above 1000 upto 3000           | 16                  | 0                 |
| Above 3000 upto 10,000         | 26                  | 0                 |
| Above 10,000 upto 35,000       | 40                  | 0                 |
| Above 35,000                   | 64                  | 1                 |

#### 2) NON - DESTRUCTIVE TESTING :

These samples shall be subjected to visual and magnetic particle examination as detailed in clause 2 (refer page 1)

#### 3) EVALUATION :

The whole lot shall be accepted if the samples as mentioned in the above plans, (A and B) meet the acceptance standard mentioned in clause 4 (refer page - 2).