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| TD-106-1<br>Rev No. 5                                                                                                                                                                                                           | Form No. | <br>HYDERABAD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>PRODUCT STANDARD</b><br><b>PUMPS</b><br><b>HYDERABAD</b>     |                              | <b>FP50710</b><br>Rev No. 00<br>Page 1 of 9 |
| <b>COPYRIGHT AND CONFIDENTIAL</b><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. |          | <p align="center"><b><u>DUPLEX STAINLESS STEEL CASTING FOR PUMP IMPELLER</u></b></p> <p><b>1.0    <u>GENERAL</u></b></p> <p>This specification governs the quality requirements of duplex stainless steel casting for impeller, impeller cone etc.</p> <p><b>2.0    <u>CONDITION OF DELIVERY</u></b></p> <p>2.1    Castings shall be supplied in rough machined condition as per the drawing dimensions.</p> <p><b>3.0    <u>REFERENCE STANDARDS</u></b></p> <p>Nearest equivalent international specification                      : ASTM A890</p> <p><b>4.0    <u>DIMENSIONS, TOLERANCES &amp; HEAT TREATMENT</u></b></p> <p>4.1    <u>Dimensions:</u><br/>The castings shall be supplied as per the dimensions indicated in drawings.</p> <p>4.2    <u>Tolerances:</u><br/>Tolerances on all machined dimensions shall be <math>\pm 0.50</math> mm unless stated otherwise. Tolerance on thickness shall + 10%</p> <p>4.3    <u>Heat treatment:</u></p> <p><u>Solution Heat treatment:</u> Heat to 1040 deg. C minimum and hold for sufficient time to heat casting uniformly to temperature, quench in water or rapid cool by any other means.</p> <p><u>Note:</u> Proper heat treatment of these alloys is usually necessary to enhance corrosion resistance and in some cases to meet mechanical properties.</p> <p>Minimum heat-treat temperatures are specified; however, it is sometimes necessary to heat-treat at higher temperatures, hold for some minimum time at temperature and then rapidly cool the castings in order to enhance the corrosion resistance and meet mechanical properties.</p> |                                                                 |                              |                                             |
|                                                                                                                                                                                                                                 |          | Ref. Doc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Revisions :</b><br><br><b>Refer to record of revisions :</b> | <b>Prepared :</b><br><br>ASK | <b>Approved :</b><br><br>MS RAM             |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
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| TD-106-1<br>Rev No.5<br>Form No.                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <br>HYDERABAD | <b>PRODUCT STANDARD</b><br><b>PUMPS</b><br><b>HYDERABAD</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      | <b>FP50710</b>                        |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      | Rev No. 00                            |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      | Page 2 of 9                           |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| <b>COPYRIGHT AND CONFIDENTIAL</b><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>5.0 MANUFACTURE:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | 5.1 The steel casting shall be made by electric furnace process with or without separate refining such as Argon Oxygen Decarburization (AOD). Any other process of steel making shall be referred to BHEL for approval.                                                                                                                                                                                                                                                                                                                   |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | 5.2 The steel castings shall be made from fully killed steel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | 5.3 The castings shall not be peened, plugged or impregnated to stop leaks etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | <b>6.0 CHEMICAL COMPOSITION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | <table border="1"> <tr> <td>Element</td> <td>C</td> <td>Si</td> <td>Mn</td> <td>Cr</td> <td>Ni</td> <td>Mo</td> <td>S</td> <td>P</td> <td>N</td> <td>Cu</td> </tr> <tr> <td rowspan="2">Ladle Analysis</td> <td>Min</td> <td>-</td> <td>-</td> <td>-</td> <td>24.00</td> <td>5.60</td> <td>2.90</td> <td>-</td> <td>-</td> <td>0.22</td> <td>3.0</td> </tr> <tr> <td>Max.</td> <td>0.03</td> <td>1.10</td> <td>1.20</td> <td>26.70</td> <td>6.70</td> <td>3.80</td> <td>0.03</td> <td>0.03</td> <td>0.33</td> <td>3.5</td> </tr> </table> |      |                                       |                                        | Element                              | C     | Si   | Mn   | Cr   | Ni   | Mo   | S   | P | N | Cu | Ladle Analysis | Min | - | - | - | 24.00 | 5.60 | 2.90 | - | - | 0.22 | 3.0 | Max. | 0.03 | 1.10 | 1.20 | 26.70 | 6.70 | 3.80 | 0.03 | 0.03 | 0.33 | 3.5 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | Element                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | C    | Si                                    | Mn                                     | Cr                                   | Ni    | Mo   | S    | P    | N    | Cu   |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | Ladle Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Min  | -                                     | -                                      | -                                    | 24.00 | 5.60 | 2.90 | -    | -    | 0.22 | 3.0 |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Max. | 0.03                                  | 1.10                                   | 1.20                                 | 26.70 | 6.70 | 3.80 | 0.03 | 0.03 | 0.33 | 3.5 |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | <b>7.0 MECHANICAL PROPERTIES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| <table border="1"> <tr> <td>Tensile strength<br/>N/mm<sup>2</sup></td> <td>Yield stress<br/>N/mm<sup>2</sup> min.</td> <td>Elongation in<br/>50 mm (A)<br/>% Min.</td> </tr> <tr> <td>690</td> <td>450</td> <td>25</td> </tr> </table>                                                                                                                                                                                                                                                 |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      | Tensile strength<br>N/mm <sup>2</sup> | Yield stress<br>N/mm <sup>2</sup> min. | Elongation in<br>50 mm (A)<br>% Min. | 690   | 450  | 25   |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| Tensile strength<br>N/mm <sup>2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Yield stress<br>N/mm <sup>2</sup> min.                                                         | Elongation in<br>50 mm (A)<br>% Min.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| 690                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 450                                                                                            | 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| (A): When ICI test bars are used for testing, the gauge length to reduced section diameter shall be 4:1                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| <b>8.0 TEST</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| 7.1 Tensile test may be conducted as per any reputed international standard, on a separately cast test specimen for each heat/melt and heat treatment batch. The size of test specimen shall be selected appropriate to the casting thickness and to carry out repeat tests if required. Heat no. /melt no. of the casting shall be stamped on the test coupons. The test specimen shall be heat treated together with the castings for all subsequent heat treatments of the casting. |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| 7.2 Re-test: In case of failure due to mechanical causes like machining etc. The supplier shall test another specimen from the same casting/lot. If the results of the mechanical tests for any heat of castings do not conform to the requirements specified in this specification, the castings may be re heat treated and tested as per manufacturer's experience and options.                                                                                                      |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| 7.3 Testing after reheat treatment shall consist of the full number of specimens taken from locations as specified in the specification / order                                                                                                                                                                                                                                                                                                                                        |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |
| Ref. Doc                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                                       |                                        |                                      |       |      |      |      |      |      |     |   |   |    |                |     |   |   |   |       |      |      |   |   |      |     |      |      |      |      |       |      |      |      |      |      |     |



| TD-106-1<br>Rev No.5<br>Form No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <br>HYDERABAD | <b>PRODUCT STANDARD</b><br><b>PUMPS</b><br><b>HYDERABAD</b> |                         | <b>FP50710</b> |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                |                                                             |                         | Page 3 of 9    |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"> <p style="writing-mode: vertical-rl; transform: rotate(180deg);"> <b>COPYRIGHT AND CONFIDENTIAL</b><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.         </p> </div> <div style="width: 85%;"> <p><b>9.0    <u>NON DESTRUCTIVE TESTS</u></b></p> <p>10.1    Liquid penetrant test shall be done on all the surfaces including the repair welding area in accordance to ASME Sec. V Article 6 &amp; 24. Acceptance criteria is as indicated in ASME Sec. VIII Div. 1 Appendix 7 including the following additional criteria: Size of indication for linear defect shall not exceed 2mm.</p> <p>10.2    Radiography test shall be done in accordance to ASME Sec. V Article 2 &amp; 22. Acceptance criteria is as indicated in ASME Sec. VIII Div. 1 Appendix 7 including the following additional criteria:<br/>The maximum acceptable severity levels for imperfections shall be as follows</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Imperfection category</th> <th colspan="3">Maximum Severity level</th> </tr> <tr> <th>Thickness &lt; 1 in.</th> <th>Thickness 1 to &lt; 2 in</th> <th>Thickness 2 to &lt; 4.5 in</th> </tr> </thead> <tbody> <tr> <td>A- Gas porosity</td> <td>1</td> <td>2</td> <td>2</td> </tr> <tr> <td>B- Sand and slag</td> <td>2</td> <td>3</td> <td>2</td> </tr> <tr> <td>C- Shrinkage (four types)</td> <td>1</td> <td>3</td> <td>-</td> </tr> <tr> <td>Type 1</td> <td>-</td> <td>-</td> <td>1</td> </tr> <tr> <td>Type 2</td> <td>-</td> <td>-</td> <td>2</td> </tr> <tr> <td>Type 3</td> <td>-</td> <td>-</td> <td>3</td> </tr> <tr> <td>D- Cracks</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>E- Hot tears</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>F- Inserts</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>G- Mottling</td> <td>0</td> <td>0</td> <td>-</td> </tr> </tbody> </table> <p>10.3    Micro structure inspection shall be carried out for Impeller castings on boss. Abnormal content shall not be observed by micro structure inspection.</p> <p>10.4    Ferrite inspection on the test piece and actual casting shall be checked with ferrite meter, and report shall be submitted.</p> <p>10.5    Corrosion resistance test shall be conducted as per method ASTM G48 Type A. These test specimen shall be prepared for each charge of foundry.</p> <p><b>10.0    <u>REPAIR WELDING:</u></b></p> <p>Major defects found during liquid penetrant test shall be repaired only after obtaining due approval of welding procedure from BHEL. Repair welding shall be done by qualified welder authorized by official organization. Necessary information of welder shall be included in the welding procedure.</p> <p>Casting in which the depth of any cavity prepared for repair welding exceeds 20% of the wall thickness or 25 mm whichever is smaller or castings in which any cavity prepared for repair welding is greater than 6500 Sq.mm shall undergo heat treatment after completion of final repairs.</p> </div> </div> |                                                                                                |                                                             |                         |                | Imperfection category | Maximum Severity level |  |  | Thickness < 1 in. | Thickness 1 to < 2 in | Thickness 2 to < 4.5 in | A- Gas porosity | 1 | 2 | 2 | B- Sand and slag | 2 | 3 | 2 | C- Shrinkage (four types) | 1 | 3 | - | Type 1 | - | - | 1 | Type 2 | - | - | 2 | Type 3 | - | - | 3 | D- Cracks | 0 | 0 | 0 | E- Hot tears | 0 | 0 | 0 | F- Inserts | 0 | 0 | 0 | G- Mottling | 0 | 0 | - |
| Imperfection category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Maximum Severity level                                                                         |                                                             |                         |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
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| A- Gas porosity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1                                                                                              | 2                                                           | 2                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| B- Sand and slag                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2                                                                                              | 3                                                           | 2                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| C- Shrinkage (four types)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1                                                                                              | 3                                                           | -                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| Type 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                                                                                              | -                                                           | 1                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| Type 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                                                                                              | -                                                           | 2                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| Type 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                                                                                              | -                                                           | 3                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| D- Cracks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0                                                                                              | 0                                                           | 0                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| E- Hot tears                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0                                                                                              | 0                                                           | 0                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| F- Inserts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0                                                                                              | 0                                                           | 0                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| G- Mottling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0                                                                                              | 0                                                           | -                       |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |
| Ref. Doc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                |                                                             |                         |                |                       |                        |  |  |                   |                       |                         |                 |   |   |   |                  |   |   |   |                           |   |   |   |        |   |   |   |        |   |   |   |        |   |   |   |           |   |   |   |              |   |   |   |            |   |   |   |             |   |   |   |



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| TD-106-1<br>Rev No.5                                                                                                                                                                                                                          |  | Form No. | <div><div>बी एच ई एल</div><div></div><div>HYDERABAD</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>PRODUCT STANDARD</b> |  | <b>FP50710</b> |
|                                                                                                                                                                                                                                               |  |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>PUMPS</b>            |  | Rev No. 00     |
|                                                                                                                                                                                                                                               |  |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>HYDERABAD</b>        |  | Page 4 of 9    |
| <div>COPYRIGHT AND CONFIDENTIAL</div> <div>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.</div> |  |          | <p>Major defect = Depth of any cavity being prepared for repair welding exceeds 20% of the wall thickness or 25mm, whichever is smaller (or) any cavity being prepared for welding is greater than 65 sq.cm.<br/>Minor defect = any defect smaller than major defect</p> <p>Following points shall be observed strictly, when weld repair is carried out.</p> <div><div>a. Defect shall be removed completely and well-grooved.</div><div>b. Groove shall be LPI tested and free of any defects.</div><div>c. Defect record shall be prepared and submitted.</div><div>d. Strain due to welding shall be avoided.</div><div>e. In case of repair welding of major defect, the base metal of the casting shall be pre-heated before welding and stress relieved after welding.</div><div>f. Flat position welding shall be carried out.</div><div>g. Welding rod used for repair welding shall be equivalent to the base metal.</div><div>h. Solution heat treatment shall once again be carried out after repair welding of major defects.</div><div>i. Liquid penetrant examination shall be carried out after repair welding.</div></div> |                         |  |                |
|                                                                                                                                                                                                                                               |  |          | <div><div>11.0</div><div><b><u>INSPECTION</u></b></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                         |  |                |
|                                                                                                                                                                                                                                               |  |          | <div><div>12.1</div><div>Supplier shall submit their manufacturing quality plan for BHEL approval.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         |  |                |
|                                                                                                                                                                                                                                               |  |          | <div><div>12.2</div><div>Castings shall be supplied with inspection and certification by BHEL or BHEL nominated Third Party Inspection Agency (TPIA).</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |  |                |
|                                                                                                                                                                                                                                               |  |          | <div><div>12.0</div><div><b><u>TEST CERTIFICATES</u></b></div></div> <p>Supplier shall furnish 2 copies of following test certificates (in English) duly certified by the inspection agency. The test certificates shall consists of the information like BHEL order No, material spec, Var.no. Supplier's name, description of item etc.</p> <div><div>a) Dimension report</div><div>b) Chemical analysis</div><div>c) Mechanical properties</div><div>d) Heat treatment charts for Hardening, tempering and stress relieving</div><div>e) LPI report.</div><div>f) 3D model of the impeller.</div><div>g) RT test record</div><div>h) Micro structure photograph</div><div>i) Ferrite inspection record</div><div>j) Corrosion resistance test record</div><div>k) Repair welding procedure and record</div><div>l) Other Inspection/test record indicated in the manufacturing drawing</div></div>                                                                                                                                                                                                                                       |                         |  |                |
| Ref. Doc                                                                                                                                                                                                                                      |  |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                         |  |                |

|                                                                                                                                                                                                                               |                                                                                                                                                                                                                                          |                                                 |                |          |                      |                 |               |   |             |             |
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| TD-106-1<br>Rev No.5<br>Form No.                                                                                                                                                                                              | <br>HYDERABAD                                                                                                                                           | <b>PRODUCT STANDARD<br/>PUMPS<br/>HYDERABAD</b> | <b>FP50710</b> |          |                      |                 |               |   |             |             |
|                                                                                                                                                                                                                               |                                                                                                                                                                                                                                          |                                                 | Rev No. 00     |          |                      |                 |               |   |             |             |
|                                                                                                                                                                                                                               |                                                                                                                                                                                                                                          |                                                 | Page 5 of 9    |          |                      |                 |               |   |             |             |
| COPYRIGHT AND CONFIDENTIAL<br><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>13.0    <u>MARKING</u></b><br><br>The following details shall be punched/etched on each casting at specified location.<br>Material code:<br>Melt No: / Heat No:<br>Name of supplier:                                                  |                                                 |                |          |                      |                 |               |   |             |             |
|                                                                                                                                                                                                                               | <b>14.0    <u>PRESERVATION &amp; PACKING</u></b><br><br>The castings shall be suitably packed and protected from damage during transit.                                                                                                  |                                                 |                |          |                      |                 |               |   |             |             |
|                                                                                                                                                                                                                               | <b>15.0    <u>VARIANT TABLE</u></b> <table><tr><td>Var. No.</td><td>Vane Profile Drawing</td><td>Casting Drawing</td><td>Material Code</td></tr><tr><td>1</td><td>01835020014</td><td>01835020015</td><td>FP9750710010</td></tr></table> |                                                 |                | Var. No. | Vane Profile Drawing | Casting Drawing | Material Code | 1 | 01835020014 | 01835020015 |
| Var. No.                                                                                                                                                                                                                      | Vane Profile Drawing                                                                                                                                                                                                                     | Casting Drawing                                 | Material Code  |          |                      |                 |               |   |             |             |
| 1                                                                                                                                                                                                                             | 01835020014                                                                                                                                                                                                                              | 01835020015                                     | FP9750710010   |          |                      |                 |               |   |             |             |
| Ref. Doc                                                                                                                                                                                                                      |                                                                                                                                                                                                                                          |                                                 |                |          |                      |                 |               |   |             |             |



## 16.0 RECORD FORMAT

### 16.1 DIAMETER, HEIGHT, VANE TIP & OUTLET WIDTH

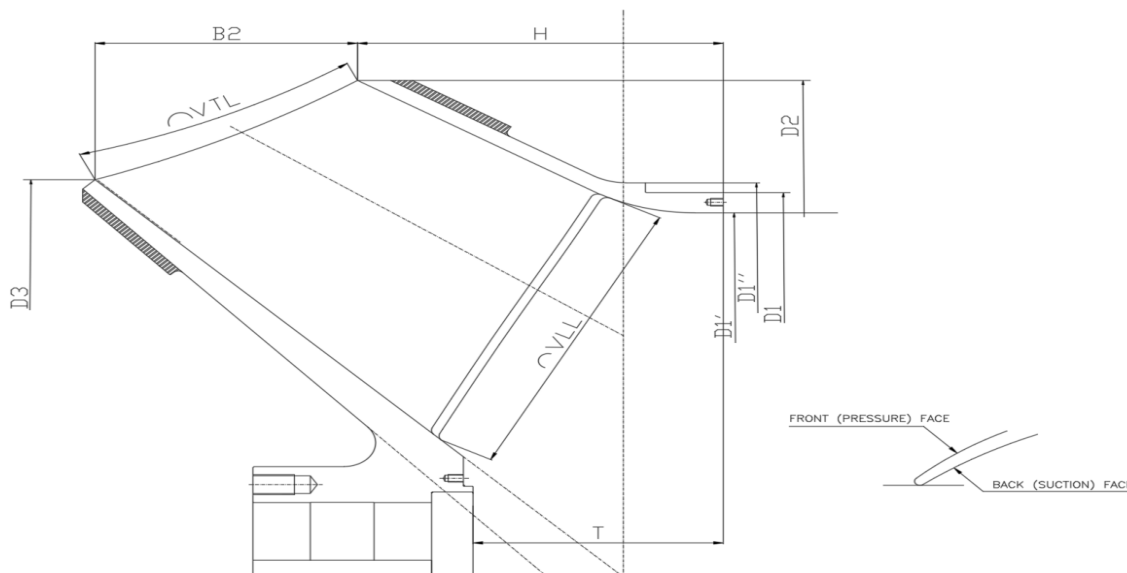
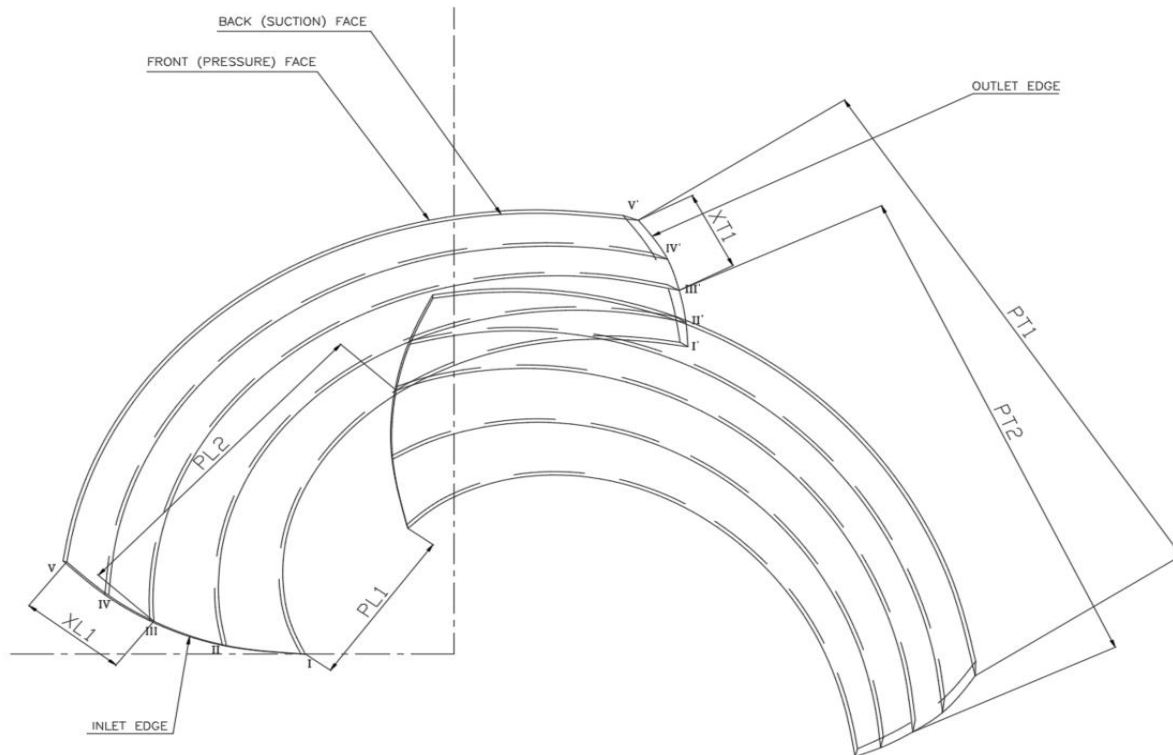


TABLE-1

| S.No | PARAMETER                            | SYMBOL | DESIGN VALUE | VANE 1 | VANE 2 | VANE 3 | VANE 4 | VANE 5 | AVERAGE | REMARKS |
|------|--------------------------------------|--------|--------------|--------|--------|--------|--------|--------|---------|---------|
| 1    | INLET OD                             | D1     |              |        |        |        |        |        |         |         |
| 2    | INLET ID                             | D1'    |              |        |        |        |        |        |         |         |
| 3    | STEP OD                              | D1''   |              |        |        |        |        |        |         |         |
| 4    | OUTLET DIAMETER                      | D2     |              |        |        |        |        |        |         |         |
| 5    | OUTLET DIAMETER AT HUB               | D3     |              |        |        |        |        |        |         |         |
| 6    | OUTLET WIDTH                         | B2     |              |        |        |        |        |        |         |         |
| 7    | VANE HEIGHT                          | H      |              |        |        |        |        |        |         |         |
| 8    | VANE TIP                             | T      |              |        |        |        |        |        |         |         |
| 9    | BACK SIDE VANE LENGTH (HUB)          | VLH    |              |        |        |        |        |        |         |         |
| 10   | FRONT SIDE VANE LENGTH (OUTER)       | VLO    |              |        |        |        |        |        |         |         |
| 11   | FRONT SIDE TRAILING EDGE VANE HEIGHT | VTL    |              |        |        |        |        |        |         |         |
| 12   | BACK SIDE LEADING EDGE VANE HEIGHT   | VLL    |              |        |        |        |        |        |         |         |

NOTE: AVERAGE RESULT SHALL BE COMPARED WITH DESIGN VALUE

### 16.2 VANE PITCH



| S.No | PARAMETER    | SYMBOL | DESIGN VALUE | VANE 1 | VANE 2 | VANE 3 | VANE 4 | VANE 5 | AVERAGE | REMARKS |
|------|--------------|--------|--------------|--------|--------|--------|--------|--------|---------|---------|
|      |              |        |              | 1 - 2  | 2 - 3  | 3 - 4  | 4 - 5  | 5 - 1  |         |         |
| 1    | INLET PITCH  | PL1    |              |        |        |        |        |        |         |         |
|      |              | PL2    |              |        |        |        |        |        |         |         |
| 2    | OUTLET PITCH | PT1    |              |        |        |        |        |        |         |         |
|      |              | PT2    |              |        |        |        |        |        |         |         |

#### NOTE:

FOR MEASURING INLET PORT AREA MENTIONED AT SECTION F-F IN THE DRAWING, TEMPLATE SHALL BE PREPARED. THIS AREA WILL BE INSPECTED FOR EACH VANE PASSAGE.

IMPELLER SHALL HAVE A TOTAL OF FIVE (5 No's) EQUALLY SPACED VANES

AVERAGE RESULTS SHALL BE COMPARED WITH THE DESIGN VALUE.

|                                                                                                                                                                                                                           |                                                                                                |                                               |             |              |         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------|--------------|---------|
| TD-106-1<br>Rev No.5<br>Form No.                                                                                                                                                                                          | <br>HYDERABAD | PRODUCT STANDARD<br>PUMPS<br>HYDERABAD        | FP50710     |              |         |
|                                                                                                                                                                                                                           |                                                                                                |                                               | Rev No. 00  |              |         |
|                                                                                                                                                                                                                           |                                                                                                |                                               | Page 8 of 9 |              |         |
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|                                                                                                                                                                                                                           | S.No                                                                                           | PARAMETER                                     | SYMBOL      | DESIGN VALUE | REMARKS |
|                                                                                                                                                                                                                           | 1                                                                                              | INLET OD                                      | D1          |              |         |
|                                                                                                                                                                                                                           | 2                                                                                              | INLET ID                                      | D1'         |              |         |
|                                                                                                                                                                                                                           | 3                                                                                              | STEP OD                                       | D1''        |              |         |
|                                                                                                                                                                                                                           | 4                                                                                              | OUTLET DIAMETER                               | D2          |              |         |
|                                                                                                                                                                                                                           | 5                                                                                              | OUTET DIAMETER AT HUB                         | D3          |              |         |
|                                                                                                                                                                                                                           | 6                                                                                              | OUTLET WIDTH                                  | B2          |              |         |
|                                                                                                                                                                                                                           | 7                                                                                              | VANE HEIGHT                                   | H           |              |         |
|                                                                                                                                                                                                                           | 8                                                                                              | VANE TIP                                      | T           |              |         |
|                                                                                                                                                                                                                           | 9                                                                                              | BACK SIDE VANE LENGTH (HUB)                   | VLH         |              |         |
|                                                                                                                                                                                                                           | 10                                                                                             | FRONT SIDE VANE LENGTH (OUTER)                | VLO         |              |         |
|                                                                                                                                                                                                                           | 11                                                                                             | FRONT SIDE TRAILING EDGE VANE HEIGHT          | VTL         |              |         |
|                                                                                                                                                                                                                           | 12                                                                                             | BACK SIDE LEADING EDGE VANE HEIGHT            | VLL         |              |         |
|                                                                                                                                                                                                                           | 13                                                                                             | LEADING EDGE VANE BACK SIDE LENGTH III TO V   | XL1         |              |         |
|                                                                                                                                                                                                                           | 14                                                                                             | TRAILING EDGE VANE FRONT SIDE LENGTH III TO V | XT1         |              |         |
|                                                                                                                                                                                                                           | 15                                                                                             | BACK SIDE PITCH AT LEADING EDGE I             | PL1         |              |         |
|                                                                                                                                                                                                                           | 16                                                                                             | BACK SIDE PITCH AT LEADING EDGE III           | PL2         |              |         |
|                                                                                                                                                                                                                           | 17                                                                                             | BACK SIDE PITCH AT TRAILING EDGE V            | PT1         |              |         |
| 18                                                                                                                                                                                                                        | BACK SIDE PITCH AT TRAILING EDGE III                                                           | PT2                                           |             |              |         |
| NOTE: TOLERANCE ON MEASURED DIMENSIONS IS INDICATED ON THE DRAWING.                                                                                                                                                       |                                                                                                |                                               |             |              |         |
| Ref. Doc                                                                                                                                                                                                                  |                                                                                                |                                               |             |              |         |



|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
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| TD-106-3<br>Rev No. 5<br>Form No.                                                                                                                                                                                        |                     | PRODUCT STANDARD<br>PUMPS<br>HYDERABAD |                  |            | FP50710     |
|                                                                                                                                                                                                                          |                     |                                        |                  |            | Rev No. 00  |
|                                                                                                                                                                                                                          |                     |                                        |                  |            | Page 9 of 9 |
| 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. | RECORD OF REVISIONS |                                        |                  |            |             |
|                                                                                                                                                                                                                          | Rev. No.            | Date                                   | Revision Details | Revised By | Approved By |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
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|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |
|                                                                                                                                                                                                                          | Ref. Doc.           |                                        |                  |            |             |
|                                                                                                                                                                                                                          |                     |                                        |                  |            |             |

