

|                                   |                                                                                   |                                                                   |                    |         |
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| TD-106-1<br>Rev No. 5<br>Form No. |  | <b>PRODUCT STANDARD</b><br><b>PULVERISERS</b><br><b>HYDERABAD</b> | Product<br>STD no. | BA50133 |
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**TECHNICAL SPECIFICATION FOR GIRTH GEAR & PINION**  
**(FOR WET BALL MILL)**

1. **PURPOSE :**

This specification is for manufacturing of quality girth gear & pinion used in Wet Ball Mills. The gear & pinion is used for rotation of mill shell meant for pulverisation of lime stone used in FGD system.

2. **SCOPE OF SUPPLY :**

- a. Girth gear in two halves
- b. Gear halves connecting bolts, nuts & pins
- c. Matching Pinion

As per enclosed drawings.

3. **OPERATING DATA :**

|              |                                                   |
|--------------|---------------------------------------------------|
| Motor        | - 1710 KW, 1000 RPM                               |
| Pinion speed | - 125 RPM connected through main reducer to motor |
| Gear speed   | - 15.62 RPM                                       |

The mill will be operating 24 hrs./day for 360 days a year. There will be occasionally 3 to 4 starts a day. The gear teeth will be lubricated by spray of SERVOTAK 40, Indian Oil Corporation or equivalent grease.

The gear set must be able to transmit an exceptional torque equal to 4 times nominal resisting torque without suffering damage.

|                                   |                                                                                   |                                                                   |                    |         |
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**4. MATERIAL SPECIFICATION:**

The gear will be manufactured by fine quality cast steel in two halves while the pinion will be forged steel through treated

GIRTH GEAR Material: 42CrMo4

CHEMICAL PROPERTIES (BY LADDLE ANALYSIS)

|           |              |           |           |              |               |           |
|-----------|--------------|-----------|-----------|--------------|---------------|-----------|
| C %       | Si %         | Mn %      | Cr %      | S %          | P %           | Mo%       |
| 0.38-0.45 | 0.40<br>Max. | 0.60-0.90 | 0.90-1.20 | 0.035<br>Max | 0.035<br>Max. | 0.15-0.30 |

MECHANICAL PROPERTIES

|                                |                                  |            |              |            |                   |
|--------------------------------|----------------------------------|------------|--------------|------------|-------------------|
| UTS<br>N/mm <sup>2</sup> , Min | 0.2% YS<br>N/mm <sup>2</sup> Min | A %<br>Min | KV<br>J. Min | Z<br>% Min | Hardness<br>(BHN) |
| 550-750                        | 520                              | 12         | 20           | 20         | 205-235           |

PINION Material: 30CrNiMo4

CHEMICAL COMPOSITION (BY LADDLE ANALYSIS)

|           |           |           |           |              |               |           |             |
|-----------|-----------|-----------|-----------|--------------|---------------|-----------|-------------|
| C %       | Si %      | Mn %      | Cr %      | S %          | P %           | Mo%       | Ni%         |
| 0.26-0.34 | 0.10-0.40 | 0.30-0.60 | 1.80-2.20 | 0.035<br>Max | 0.035<br>Max. | 0.30-0.50 | 1.80 – 2.20 |

MECHANICAL PROPERTIES IN TANGENTIAL DIRECTION:

|                                |                                  |            |                        |                   |
|--------------------------------|----------------------------------|------------|------------------------|-------------------|
| UTS<br>N/mm <sup>2</sup> , Min | 0.2% YS<br>N/mm <sup>2</sup> Min | E %<br>Min | K CU (20° C)<br>J. Min | Hardness<br>(BHN) |
| 1100-1200                      | 800                              | 10         | 40                     | 320-365           |

|                                                                                                                                                                                                                                                                                                                                           |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        |                    |         |
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|                                                                                                                                                                                                                                                                                                                                           |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        | Rev No. 01         |         |
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| <p style="writing-mode: vertical-rl; transform: rotate(180deg);">           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.         </p> |          | <p><b>5.0 <u>MANUFACTURE:</u></b></p> <p><b>5.1 <u>GIRTH WHEEL:</u></b></p> <p>The precision class for machining and cutting according to ISO Standard 1328 class 8 Minimum.</p> <p>As the girth wheel is in two parts, every precaution shall be taken to guarantee the joints, geometrical and dimensional tolerances, during the following processes.</p> <ul style="list-style-type: none"> <li>- Machining consists of a rough- turning, rough cutting (for any module) and a final-machining and cutting.</li> <li>- The quality heat treatment is carried out either on the part as cast, or after rough machining.</li> <li>- Repairs, if any or carried out:               <ul style="list-style-type: none"> <li>- In all cases after quality heat treatment</li> <li>- After rough cutting to limit their number.</li> </ul> </li> </ul> <p>The defects revealed during inspections after rough-turning are subject to an establishment of a check, their elimination during rough-cutting. See 5.2 in particular, the welding and welder qualifications and the inspections.</p> <ul style="list-style-type: none"> <li>- Stress relief is carried out after rough cutting and repair and before final machining.</li> </ul> <p><b>5.2 <u>REPAIRS OF GIRTH GEAR:</u></b></p> <p>Surface defects can be removed by grinding within the limit of dimension tolerances. A liquid penetrant test must be carried out to make sure that defects have completely disappeared.</p> <p>The possible repairs shall be carried out after quality heat treatment and after rough-cutting to limit number (See 5.1). However, if significant defects are revealed before rough cutting, the foundry has to carry out repairs at this step of manufacture. In this case, the wheel shall be subject to a stress relief after repair and before rough cutting. A map of defects shall be established. The welding repair procedure shall be as per ASME IX. The personnel shall be also qualified according to ASME IX or equivalent. The repaired zones shall be checked by ultrasonic and magnetic particle test with the criteria required for these tests (See Appendix A)</p> <p>No repair shall be carried out without written permission from BHEL.</p> |                                                                                                        |                    |         |

|                       |          |                                                                                   |                                                                                                        |                    |         |
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### 5.3 PINION:

The precision clause for machining and cutting as per ISO: 1328 is at least identical with that of the wheel.

The pinion is procured after skin removal and heat treatment. Hardness is adjusted according to the value desired. The pinion is rough machined on a lathe and then machined and cut.

The last operation is the machining or rectification if necessary of the boring and of the keyway. If necessary, the pinion is rectified to meet the surface condition requirement defined on the drawing.

The steel shall be made by the basic process (Electric furnace or martin furnace if the chemical requirements are satisfactory)

The quality heat treatment can be carried out on the base material or after rough machining (hardness shall be defined depending on the result required on the finished part).

The identification of each part shall be made at the steel- foundry in a zone which shall remain as cast (Heat Mark, Drawing and Grade Number)

### 5.4 FORGED STEEL PINION:

The grade, product standard and guaranteed characteristics are according to the drawing.

The quality level required for procurement shall permit to satisfy the inspections of the table in Appendix-A.

The Identification of these parts are required (Heat mark, drawing and grade numbers)

### 5.5 REPAIRS:

Only the surface defects removed by grinding are permitted. A liquid penetrant should disappear.

No repair shall be carried out without written permission from Pulv. Engg. Department.

### 6.0 PAINTING AND PRESERVATION

The un-machined casting shall be painted with two coats of blue enamel paint after cast surface grinding for smooth surface. Machined area should be preserved by corrosion resistive grease and protected by polythene sheet.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |                                                                                   |                                                                   |                                  |                |
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| <div><p><b>7.0 <u>PACKING:</u></b></p><p>The gear teeth shall be covered by wooden plank to avoid damage in transit. The pinion should be packed in wooden box.</p><p>8.0 Based on the Quality plan BHEL/ BHEL customers will indicate the hold points for inspection.</p></div> <div><p><b>COPYRIGHT AND CONFIDENTIAL</b></p><p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company.</p></div> |          |                                                                                   |                                                                   |                                  |                |

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| <div style="display: flex; align-items: center; justify-content: space-between;"> <div style="text-align: center;">  </div> <div style="text-align: center;"> <h2>PRODUCT STANDARD</h2> <h3>PULVERISERS</h3> <h3>HYDERABAD</h3> </div> <div style="text-align: right;"> <b>Product<br/>STD no.</b>      <b>BA50133</b> </div> </div> |                               |                                                                                     |                                                                                                                                                                                                  |                                                                                     | Rev No. 01            |
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| <b>APPENDIX A (INSPECTION AND ACCEPTANCE CONDITIONS)</b>                                                                                                                                                                                                                                                                                                                                                              |                               |                                                                                     |                                                                                                                                                                                                  |                                                                                     |                       |
| NATURE OF INSPECTIONNS                                                                                                                                                                                                                                                                                                                                                                                                | REFERENCE                     | INSPECTION METHODS                                                                  | CRITERIA AS PER TYPE OF PART AND PER ZONE                                                                                                                                                        | INPSECTION FREQUENCY                                                                |                       |
| Dimensional                                                                                                                                                                                                                                                                                                                                                                                                           | Drawings                      | Instruments                                                                         | According to the indication & Tolerances mentioned on the drawing                                                                                                                                | Each wheel and Pinion                                                               |                       |
| And Geometrical                                                                                                                                                                                                                                                                                                                                                                                                       | ISO 1328                      | Instruments and geometrical testing equipt.                                         | According to the tolerances of the ISO class 8. Individual and cumulated pitch & distortion errors are checked on the cutting machine. Buckling and out of roundness can be checked on a lather. | Each wheel and pinion                                                               |                       |
| Aspect                                                                                                                                                                                                                                                                                                                                                                                                                |                               | Visual                                                                              | No. Sharp edge, deep scratches undercuts chisel impact and no cracking                                                                                                                           | Each wheel and Pinion                                                               |                       |
| Surface condition                                                                                                                                                                                                                                                                                                                                                                                                     |                               | Visual or Viso-tactile or surface finish Tester.                                    | Accoridng to drawings the zones left as cast on the wheel must be better than RA 25.                                                                                                             | Each wheel and pinion                                                               |                       |
| Chemical analysis                                                                                                                                                                                                                                                                                                                                                                                                     | Product Standard              | Spectro-chemistry                                                                   | Accordingly tot his product standard                                                                                                                                                             | Each heat (Wheel and pinion)                                                        |                       |
| Mechanical characteristics<br>-Tensile<br>- Impact test<br>-Hardness                                                                                                                                                                                                                                                                                                                                                  | Drawings/<br>product standard | As indicated in product standard                                                    | Results shall conform to those shown in this product std. Test specimens are taken from adjoining samples or exists lengths which must follow the same heat cycle as the part.                   | 1. specimen<br>2. Specimea<br>n<br>4 pts Evenly<br>Distributed on<br>the teeth zone |                       |
| US test (After rough ) wheel<br>-pinion                                                                                                                                                                                                                                                                                                                                                                               |                               | Criteria<br>Appendix-D ,& E<br>Class B for the whole pinion (bottom<br>Echo method) | Teeth Zone<br>2<br>Other Zone<br>4                                                                                                                                                               | Each wheel                                                                          |                       |
| Liquid penetrant or Magnetic<br>part test<br>-wheel                                                                                                                                                                                                                                                                                                                                                                   | Appendix C<br>Appendix B      | Indications<br>Linear                                                               | Machined surfaces<br>Appendix B/C<br>As cost surfaces<br>Appendix B/C                                                                                                                            | Each wheel<br>Appendix E                                                            |                       |
| Pinion (M.P Test)                                                                                                                                                                                                                                                                                                                                                                                                     | Present<br>specification      | Linear<br>Non-Linear                                                                | Not permissible<br>8 defects Max. 1.5 Equ. Dia<br>3 In a Frame of 105 x 140 mm                                                                                                                   | Pinion                                                                              |                       |

|                                   |                                                                                   |                                                                   |                    |         |
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**APPENDIX –A ( Cond.)**

(1) Graphic recordings of individual and cumulated pitch. Profile and distortion errors on the first pinion and first wheel of series (maximum of 6 pieces). For Wheels, which are not in several parts. The following documents shall be presented. Periodical inspection recordings of machine-tool and dimensional recordings of tools used.

(2) If the results do not comply, 2 additional tests shall be carried out for each incorrect test. The item shall be rejected if one of the retests does not meet the requirements (except the impact test). The average with 3 new specimens and the 3 old specimens shall conform to the requirements.

(3) This test procedure shall be submitted to BHEL for approval.

(4) For M.P. test and L.P test. The defects within criteria existing on working faces of teeth shall be ground on an area of few 1/10 mm of depth and 5 to 10 mm round the defect. But do not remove 10% of the teeth width.

**VARIANT TABLE**

| VAR NO. | DESCRIPTION     | DRG.NO.     | MATL.CODE    |
|---------|-----------------|-------------|--------------|
| 01      | SPUR GIRTH GEAR | 06222100003 | BA9750133005 |
| 02      | PINION          | 36222100004 | BA9750133021 |

**PRODUCT STANDARD  
PULVERISERS  
HYDERABAD**

|         |  |
|---------|--|
| Product |  |
| STD no. |  |

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~~APPENDIX B (MAGNETIC PARTICLE TEST CRITERIA-STEEL CASTINGS, ASTM E125)~~

| Equivalence ASTM E 125                         |                                         |                                  |     |     |                       |          |           |          |           |           |    |
|------------------------------------------------|-----------------------------------------|----------------------------------|-----|-----|-----------------------|----------|-----------|----------|-----------|-----------|----|
| LEVEL                                          |                                         |                                  |     |     |                       |          |           |          |           |           |    |
| Size of the indication taken into account (MM) |                                         |                                  |     |     |                       |          |           |          |           |           |    |
| SR (2)<br>Non linear indications               | (1) Maximal no. of indications          |                                  |     | 1   | 2                     | 3        | 4         | 5        |           |           |    |
|                                                | Maximal size of indication              |                                  | 001 | 01  | 2                     | 3        | 4         | 5        |           |           |    |
| LR (2)                                         |                                         | Ordering of indications          | 0.3 | 1.5 | 2                     | 3        | 4         | 5        |           |           |    |
|                                                |                                         |                                  |     | 10  | 35                    | 70       | 200       | 500      |           |           |    |
|                                                |                                         |                                  | 1   | 1   | 2 (4)                 | 4 (4)    | 6 (4)     | 10 (4)   | 16(4)     |           |    |
|                                                |                                         |                                  |     |     | Isolated or cumulated | Isolated | Cumulated | Isolated | Cumulated | Cumulated |    |
| AR (2)<br>Liner and aligned indications        | Maximal lengths of indications (mm) (1) | “a” (3) thickness T ≤ 16 mm      | 0   | 1   | 2                     | 4        | 4         | 6        | 10        | 16        | 25 |
|                                                |                                         | “b” (3) thickness 16 < T < 50 mm | 0   | 1   | 3                     | 6        | 10        | 16       | 25        | 40        |    |
|                                                |                                         | “c” (3) thickness T > 50 mm      | 0   | 2   | 5                     | 10       | 16        | 25       | 40        | 63        |    |

(1) In a frame of 105 x 148 mm.

(2) The indication is liner if  $>3$  1 with L : length and 1: width of the indication.

The indications are aligned if numbering of 3 or more and if the distance between them is less than 2 mm- non linear –or if less than the greatest of the indications. The length taken into account is the distance between the beginning of the first indication and the end of the last one.

(3) Thickness of the casting



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| APPENDIX B (MAGNETIC PARTICLE CRITERIA – STEEL CASTINGS, ASTM E125 |                                     |                                |          |           |          |           |          |           |    |    |    |    |  |
|--------------------------------------------------------------------|-------------------------------------|--------------------------------|----------|-----------|----------|-----------|----------|-----------|----|----|----|----|--|
| LEVEL                                                              |                                     | 001                            | 01       | 1         | 2        | 3         | 4        | 5         |    |    |    |    |  |
| Size of the indication taken into account                          |                                     | 0.3                            | 1.5      |           | 2        |           |          | 3         |    |    |    |    |  |
| SR (2)<br>Non linear indications                                   | (1) Maximal no. of indications      |                                | 5        | 8         | 8        | 12        | 16       | 20        |    |    |    |    |  |
|                                                                    | Maximal size of indication          | 1                              | 1        | 3         |          |           |          |           |    |    |    |    |  |
| LR (2)                                                             | Ordering of indications             | Isolated or cumulated          | Isolated | Cumulated | Isolated | Cumulated | Isolated | Cumulated |    |    |    |    |  |
|                                                                    |                                     |                                |          |           |          |           |          |           |    |    |    |    |  |
| AR (2)<br>Liner and aligned indications                            | Maximal lengths of indications (mm) | “a” (3) thickness<br>T < 16 mm | 0        | 1         | 2        | 4         | 4        | 6         | 10 | 16 | 25 | 40 |  |
|                                                                    |                                     |                                | 0        | 1         | 3        | 6         | 6        | 10        | 16 | 25 | 40 |    |  |
|                                                                    |                                     |                                | 0        | 2         | 5        | 10        | 10       | 16        | 25 | 40 | 63 |    |  |

(3) In a frame of 105 x 148 mm.

(4) The indication is liner if  $> 3$  1 with L : length and 1: width of the indication.

The indications are aligned if numbering of 3 or more and if the distance between them is less than 2 mm—non linear—or if less than the greatest of the indications. The length taken into account is the distance between the beginning of the first indication and the end of the last one.

(3) Thickness of the casting

|                                   |                                                                                   |                                                                   |  |                                  |  |                |  |
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**APPENDIX-D**

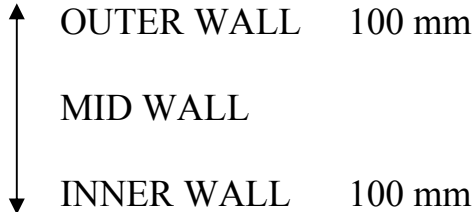
**STEEL CASTINGS HEAT TREATED (EXCEPT AUSTENITIC AND AUSTENO-FERRITIC STEEL) FROM ASTM A 609**

| QUALITY LEVEL                           | 1                                                                                                                  | 2  | 3   | 4   | 5   | 6   | 7   |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------|----|-----|-----|-----|-----|-----|
| HOLE DIAMETER FOR THE DAC (MM)          | ACCORDING TO CALIBRATION BLOCK OF ASTM A 609 FOR LOGITUDINAL ANGLE BEAM EXAMINATION AND DUAL ELEMENT SEARCH UNITS. |    |     |     |     |     |     |
| REDUCTION OF BACK REFLECTION            | 75% (12 DB) (2)                                                                                                    |    |     |     |     |     |     |
| MAX. LENGTH OF DEFECT (MM)              | 35                                                                                                                 | 55 | 75  | 100 | 125 | 150 | 175 |
| MAX. AREA OF DEFECT (MM)                | 5                                                                                                                  | 10 | 20  | 30  | 50  | 75  | 100 |
| MAX. WHOLE AREA FOR 100 CM <sup>2</sup> | 50                                                                                                                 | 75 | 100 | 125 | 150 | 200 | 250 |
| THICKNESS OF DEFECT (%)                 | 10% IN OUTER OR INNER WALL(3) WITH A MAX SIZE OF 25 MM. 15% IN MID WALL WITH 50 MM. MAX (3).                       |    |     |     |     |     | 15% |
| WALL THICKNESS                          |                                                                                                                    |    |     |     |     |     | 25% |

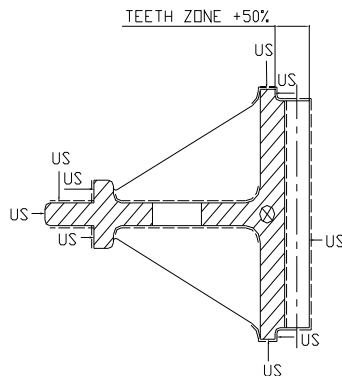
- No indication equal to or greater than the DAC over an area and length specified for the applicable quality level.
- No reduction of back reflection of 75% or greater over an area and length specified for the applicable quality level.

Definition of mid wall, outer wall and inner wall.



|                       |          |                                                                                   |                                                                                                                                                                      |                    |         |
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## APPENDIX E



### LEGEND:

US FACES TO BE CHECKED BY ULTRASONIC TEST.



UT ON JOINT FACE.

---- FACES TO BE CHECKED BY MP TEST AND LP TEST.

