





TD-106-1 Rev No. 5	Form No.		<b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b>		<b>Product</b> <b>STD no</b>	<b>BA 55099</b>
					<b>Rev No. 01</b>	
					<b>Page 1 of 10</b>	


  

COPYRIGHT AND CONFIDENTIAL  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 align="center"><b><u>PLANETARY GEAR BOX</u></b></p> <p align="center"><b><u>FOR HP 1103 AND HP1203 BOWL MILLS</u></b></p>					
	<b>1.0 <u>TECHNICAL DETAILS:</u></b>					
	<b>1.1 <u>INTRODUCTION</u></b>					
	<p>The gear box consists of Spiral Bevel (curved tooth) first stage reduction and a vertical planetary final stage. Pulveriser grinding loads will be transmitted to gear unit. The gear unit shall accept these loads through a hydrodynamic bearing on the output and transmit to the Gear Box foundation. The Gear units would be insulated against the vertical loads and shocks of the grinding. Included in the scope is the lubrication system, interconnecting piping and spare parts essential for commissioning. Any special tools and tackles required shall also form a part of the supply with relevant details.</p>					
	<b>1.2 <u>PRIME MOVER:</u></b> Electric Motor as per Table-1.					
<b>1.3 <u>DRIVEN EQUIPMENT:</u></b>						
<p>Vertical Axis Pulveriser (Bowl Mill) of Raymond Type (XRP / HP Model)</p> <p><b>Speed</b> (Gearbox Table Speed) : as per Table-1</p> <p><b>Rotation</b> : Clock wise as viewed from the top of the gear box vertical output shaft</p>						
<b>1.4 <u>DIMENSIONS :</u></b> REFER TABLE 2 & FIGURE 1 & 2						
<b>1.5 <u>LOADING DETAILS &amp; LOADING POINTS:</u></b> TABLE 3A & 3B						
<b>2.0 <u>OPERATING CONDITIONS:</u></b>						
<p>Gear box is used as part of Bowl Mill for pulverizing coal in thermal power station. Gear box is connected between horizontal shaft of drive motor and connecting flange of vertical axis of coal pulveriser. It shall work in dusty environment and gear box design should be such that bearings and gear box internals are protected from dust contamination. It shall operate continuously at various loads and semi outdoor conditions of Thermal Power station.</p>						
<p>The pulverisers work in a semi-enclosed area. It is relatively protected from direct sun and rain. However it is exposed to draughts (natural as well as otherwise). The surrounding air is likely to contain significant concentration of abrasive particulates, fine as well as slightly coarse (coal powder, ash, sand etc.).</p>						
<p>The ambient temperature in India may reach above 50°C in summer and near 0°C in winters. The bearings and lubrication system must be designed accordingly. The cooling water temperature in summer season may be around 45°C.</p>						
FOR REVISIONS REFER TO RECORD OF REVISIONS		<b><u>PREPARED BY</u></b> AMAN SURIN		<b><u>CHECKED BY</u></b> S GHATGE		<b><u>DATE</u></b> 25.05.2013

TD-106-1 Rev No. 5	Form No.		<p style="text-align: center;"><b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b></p>	Product STD no  Rev No. 00  Page 2 of 10	BA 55099
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">           COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company.         </p>		<p><b>3.0 SCOPE OF SUPPLY.</b></p> <p><b>3.1 COMPLETE GEAR BOXES WITH/WITHOUT LUBRICATION SYSTEM.</b></p> <ol style="list-style-type: none"> <li>Lube oil system with standby coolers, pump &amp; motor and filter arrangement with necessary C&amp;I requirements (Scheme shall be supplied for approval), if the order is including the Lubrication system.</li> <li>If the order is including the Lubrication system, the inter connecting piping between gear-box and lube oil system are also in the scope of the supplier.</li> <li>Local instruments panel &amp; Terminal box with provisions/ facilities for external connections.</li> <li>Two hard copies &amp; one soft copy of each of Erection manual, operation &amp; maintenance manual, lube oil schematic, logic diagram with set point. External connection diagrams and panel OGA drawings and bill of materials.</li> <li>Performance test certificate of the manufacturer after testing at manufacturers test bed.</li> <li>Test certificates as required in the approved Quality Plan.</li> <li>List of spares proposed for two year operation with break up price.</li> </ol> <p><b>3.2 SUGGESTED INTERNALS OF PLANETARY GEARBOX (Ref FIG. No.3)</b></p> <ol style="list-style-type: none"> <li>Bevel Pinion Shaft</li> <li>Bevel Gear</li> <li>Shaft of Bevel Gear</li> <li>Coupling Sleeve</li> <li>Sun Gear (Helical pinion shaft)</li> <li>Planetary Gears (<b>3 per mill</b>)</li> <li>Internal toothed Gear</li> <li>Axial thrust sliding bearing set.</li> </ol> <p><b>4.0 DESIGN INPUTS:</b></p> <p><b>4.1 GEAR BOX</b></p> <ol style="list-style-type: none"> <li>4.1.1 The Pulveriser transmits grinding loads to the gear unit. The loads are not steady and vary in level, frequency and direction. For load locations, refer Gearbox Loading schematic and for values, refer to Table-3A &amp; Table-3B. The output thrust and radial bearing must be designed to accept these loads.</li> <li>4.1.2 Extreme Imbalance Loading Case: The Grinding process could produce a load on the gear unit equal to the tramp iron moment inducted by a point load (Roll Force) acting normal to the Bowl at the location indicated in Figure on Page 6. This could occur with the 50% axial (tramp iron load) acting at the same time. The gear unit and thrust bearing must be able to accommodate this load case as an intermittent impact load.</li> <li>4.1.3 The gear Box will be designed and tested as per ISO/ AGMA/ DIN standards. The test procedure and the acceptance norms shall be submitted for approval.</li> <li>4.1.4 The gears and bearings shall be designed for a minimum life time of 1,00,000 hours of trouble free operation/ 8000 hours a year, under maximum mill HP. load.</li> <li>4.1.5 Shaft position and main gear box foundation position shall be strictly as per B.H.E.L. approved drawings of supplier.</li> <li>4.1.6 Gear box casing shall be of fabricated type &amp; applied with oil resistant paint on the inside surfaces after leak proof test.</li> <li>4.1.7 The gearing to have a service factor of 2.5 min. for strength and durability as per AGMA/DIN standard</li> </ol>			

TD-106-1 Rev No. 5	Form No.		<p style="text-align: center;"><b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b></p>	<b>Product</b> <b>STD no</b>  Rev No. <b>00</b>  <b>Page 3 of 10</b>	<b>BA 55099</b>
<p style="text-align: center;">COPYRIGHT AND CONFIDENTIAL</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>		<p>4.1.8 Gearing must be designed to handle two starts per day at the drivers max torque for 10 years without failure.</p> <p>4.1.9 The bevel gear, bevel pinion shaft, helical pinion shaft (sun), planet gearing must be AGMA class 11 or better. The Internal toothed gear shall be AGMA Class 9 or better.</p> <p>4.1.10 All anti-friction bearings shall be of Standard bearings from M/s SKF, FAG, TIMKEN and KRW make only.</p> <p>4.1.11 Planetary gear box will have white metal lined hydrodynamic Tilting Pad axial Thrust bearings.</p> <p>4.1.12 External surface of gear box and lube oil system shall be painted with 2 coats of alkyd zinc phosphate primer (DFT 40 micron) and 2 coats of synthetic enamel paint (DFT 40 microns) shade Grey RAL 9002 (or as approved by BHEL).</p> <p>4.1.13 The Thrust bearing and also the Lubrication system would have a hydrostatic start-up (jacking) mechanism for the HP1203 Gear Boxes. The hydrostatic pump should be cut-off when the required speed is achieved and then the Gear Box should operate on hydro-dynamically supported tilting pads.</p> <p>4.1.14 The thrust bearing pads are to be designed to ensure that the pads cannot be dislodged vertically in the event the output table lifts or wobbles in operation.</p> <p>4.1.15 The thrust pad bearing must be large enough to be stable for all the load cases defined above. The following ratio must be maintained:  <math display="block">R/A \text{ must be less than } 1.77</math>           Where <math>R</math> = mean roll radius  <math>A</math> = thrust pad pivot radius</p> <p>4.1.16 The input shaft assembly (shaft, pinion, bearing and housing) must be removable without having to disassemble other portions of the Gear unit.</p> <p>4.1.17 The Gearbox shall be designed for Normal operation, preferably with Minerals oils. Supplier to indicate the specific ISO Viscosity index. In case specific brands are required, equivalent brands from Indian oil suppliers (IOC, HPCL, BPCL) must also be mentioned.</p> <p><b>4.2 LUBRICATION SYSTEM</b></p> <p>4.2.1 The gearbox must be lubricated with a closed circuit lubrication system.</p> <p>4.2.2 The lubrication system shall be capable of maintaining a maximum bearing temperature of 65 °C for an ambient temperature of 50° C and cooling water temperature of 45 °C (quality of cooling water is clarified water).</p> <p>4.2.3 The lubrication system will have standby cooler and pump-motor assembly as well as a duplex filter. All these would be designed to have a capability to change-over without interruption.</p> <p>4.2.4 The pumps must be Positive displacement type (Preferably screw pump).</p> <p>4.2.5 The drive motors for the screw pump should be for 415V, 50 Hz supply, dust proof to IP 55 (IS 4469).</p> <p>4.2.6 The Motors should be of standard IEC Frames.</p> <p>4.2.7 The Required data sheet of</p> <ul style="list-style-type: none"> <li>• Pump</li> <li>• Filter and</li> <li>• Cooler</li> </ul> <p>must be provided.</p>			

TD-106-1 Rev No. 5	Form No.		<p style="text-align: center;"><b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b></p>	<b>Product STD no</b>  <b>Rev No. 00</b>  <b>Page 4 of 10</b>	<b>BA 55099</b>
<p style="text-align: center;">COPYRIGHT AND CONFIDENTIAL</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>		<p>4.2.8 The necessary Control and Instrumentation details of the Lubrication System (including auto cut-off of the hydraulic pump in case of starting jacking oil of thrust pad) must be provided with all details integrating the lubrication system to the Gear Box.</p> <p>4.2.9 Lube oil system shall be placed on a rigid channel frame for easy handling and installation. It shall be provided with lifting arrangement and enclosure to avoid dust entry. The lube oil unit foundation details shall be provided for approval.</p> <p><b>4.3 DRIVE &amp; COUPLING</b></p> <p>4.3.1 The pulveriser is driven by a 3 Phase, Induction Motor of sufficient capacity, having synchronous speed of 1000 RPM.</p> <p>4.3.2 The Motor is coupled to the input shaft of the Gear Box with a coupling.</p> <p>4.3.3 The coupling will have an extension shaft with flexible couplings at both ends.</p> <p>4.3.4 BHEL currently uses Spring-Loaded (Bibby Type) Coupling with Gear Coupling or Flexible disc coupling.</p> <p>4.3.5 Supplier to provide details about the coupling envisaged including the maximum unbalances considered in the design of the Gear Box.</p> <p><b>4.4 GENERAL REQUIREMENTS:</b></p> <p>4.4.1 The bearings shall have provision for fixing duplex type PT100 RTDs (1/2" NPT connection) or along with temperature transmitters as per customer requirement.</p> <p>4.4.2 Quality plans for the planetary gear box shall be submitted for approval by BHEL. Gear data sheets shall be submitted along with Quality plan. The quality plan should detail the tests carried out on the Gear boxes as well as on various components of the gear boxes including the tests on Gear Raw materials (forgings) as well as in-process.</p> <p>4.4.3 The relevant standards (Details of tests and acceptance norms) must be provided to BHEL for review of material certificates and acceptance of the supplies. BHEL might have to make these acceptance norms available to its end customers.</p> <p>4.4.4 Based on the Quality plan BHEL will indicate the hold points for inspection, testing of the gear box and lubrication system.(for the Gear Boxes procured as assembled from the bidder)</p> <p>4.4.5 The primary responsibility of design, manufacturing and performance lies with the supplier. The approval of the design documents and drawings shall in no way relieve the successful bidder of their responsibility.</p> <p>4.4.6 Provision for fixing gear box removal fixture to be provided for withdrawing the gear box from under the mill. Gear box removal skate/ roller assembly, for one gear box requirement shall be supplied for the Gear Boxes procured as assembled from the bidder.</p> <p><b>5.0 INSPECTION REPORT AND TEST CERTIFICATES:</b></p> <p><b>5.1</b> Chemical and mechanical properties, mill test certificates for gears and shafts, UT report, heat treatment charts and heat treatment details of case-carburising etc., MPI/ LPI on gear teeth &amp; shafts.</p> <ul style="list-style-type: none"> <li>- Details about case hardening depth and gears dimensions report.</li> <li>- Kerosene/ hydro leak test report of gear box casing.</li> <li>- Lube oil pump characteristic test.</li> <li>- Details about gear assembly, backlash contact pattern, center distance etc.</li> <li>- Balancing report of gears &amp; shafts, applicable standards- acceptance norms etc.</li> <li>- Profile report.</li> </ul>			

TD-106-1 Rev No. 5	Form No.		<h2 style="text-align: center;">PRODUCT STANDARD</h2> <h3 style="text-align: center;">PULVERISERS</h3> <h3 style="text-align: center;">HYDERABAD</h3>	<b>Product STD no</b>	<b>BA 55099</b>
				<b>Rev No. 00</b>	
				<b>Page 5 of 10</b>	

COPYRIGHT AND CONFIDENTIAL  
 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.

**5.2** Testing on no load should be carried out with force lubrication system for 4 hours on rated full speed on continuous basis for at least the following parameters.

a	Temperature rise of oil	$< 8^{\circ} \text{C}$
b	Noise level	$< 85 \text{ db}$
c	Oil leakage	no oil leakage or seepage is permitted
d	Vibration levels	0.5 mm/s (maximum)
e	FFT of Vibration	No abnormal Gear mesh & mechanical rubbing frequency shall be observed.
f	No load run	No abnormal knocking sound shall be observed during no load run
g	Hydrodynamic lift of the Table	$> 0.3 \text{ mm}$ while running
h	The temperature rise of the high speed shaft bearings from of the lube oil	$< 15^{\circ} \text{C}$
i	Visual inspection report after no load test, of gear teeth bearing and filters, blue contact pattern etc	


**5.3** Supplier must submit the detailed test procedure for approval.

**5.4** The test procedure should ensure that the gear meshing, bearing and any other defect the designer considers critical are identified. The diagnostic method (including the instrument specifications) and the acceptance level must be clearly brought out in the specification.

**5.5** Since testing at supplier's works is only on no-load, in case any problem faced at full load test in operation at site, supplier shall depute service engineer free of cost.

**6.0 PACKING:**

Items shall be packed in wooden casings and GI sheet covering (either inside or outside the wooden casing) for seaworthy transportation, road transportation followed by two to three years storage at site in out-door location in tropical weather conditions. The supplier must specify any special preservation that is to be followed in the period. The method of re-preservation should be user friendly and should not involve elaborate mechanism or equipment.

TD-106-1 Rev No. 5 Form No.		<b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b>	Product STD no	BA 55099
			Rev No. 00	
			Page 6 of 10	


COPYRIGHT AND CONFIDENTIAL

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.

**7.0 VARIANT TABLE & MATERIAL CODE FOR PGB COMPONENTS**

Variant No	Mill Description	Material Code
01	HP 1103 Planetary Gear Box	
02	HP 1103 Planetary Gearbox in CKD Condition	
03	Bevel Pinion Shaft for HP 1103 Planetary Gear Box	
04	Bevel Gear for HP 1103 Planetary Gear Box	
05	Shaft for Bevel Gear for HP 1103 Planetary Gear Box	
06	Coupling Sleeve for HP 1103 Planetary Gear Box	
07	Sun Gear for HP 1103 Planetary Gear Box	
08	Planetary Gears for HP 1103 Planetary Gear Box	
09	Internal Toothed Gear for HP 1103 Planetary Gear Box	
10	Axial Thrust Sliding Bearings for HP 1103 Planetary Gear Box	
11	Lube Oil System with Connected Piping for HP 1103 Planetary Gear Box	
13	Coupling Gear Box – Motor for HP 1103 Planetary Gear Box	
15	Complete set of Internals for HP 1103 Planetary Gear Box	
21	HP 1203 Planetary Gear Box	
22	HP 1203 Planetary Gearbox in CKD Condition	
23	Bevel Pinion Shaft for HP 1203 Planetary Gear Box	
24	Bevel Gear for HP 1203 Planetary Gear Box	
25	Shaft for Bevel Gear for HP 1203 Planetary Gear Box	
26	Coupling Sleeve for HP 1203 Planetary Gear Box	
27	Sun Gear for HP 1203 Planetary Gear Box	
28	Planetary Gears for HP 1203 Planetary Gear Box	
29	Internal Toothed Gear for HP 1203 Planetary Gear Box	
30	Axial Thrust Sliding Bearings for HP 1203 Planetary Gear Box	
31	Lube Oil System with Connected Piping for HP 1203 Planetary Gear Box	
33	Coupling Gear Box – Motor for HP 1203 Planetary Gear Box	
35	Complete set of Internals for HP 1203 Planetary Gear Box	

- Complete set of Internals means one set of gears and thrust pad bearing required for a gear box (eg items 03 to 10 or items 23 to 30)

TD-106-1 Rev No. 5  Form No.		<b>PRODUCT STANDARD</b> <b>PULVERISERS</b> <b>HYDERABAD</b>		<b>Product</b> <b>STD no</b>	<b>BA 55099</b>
				<b>Rev No. 00</b>	
				<b>Page 7 of 10</b>	

**COPYRIGHT AND CONFIDENTIAL**  
 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.

<b>TABLE – 1</b> <b>DRIVE MOTOR DETAILS</b>		
MILLS	HP1103 with DC	HP1203
<b>POWER - KW</b>	810	1010
<b>MILL RPM</b>	33.93	30.97
<b>MOTOR RPM</b>	985	985
<b>HEAT LOAD FROM MILL - KW</b>	27	29

<b>TABLE 2:</b> <b>REFERENCE DIMENSION OF PLANETARY GEAR BOX</b> <b>(REFER FIG. NO.1)</b>		
DIMENSION	HP1103 with DC	HP1203
A	1168.27	1320
B	1625.6	1910
C	1900	2100
D	1600	1700
E	1525	1670
H	535	590
M	2000	1940
N	2000	1940
P	1473	1660
Q	130 n6	140 n6
R	1220	1350
S	210	250



# PRODUCT STANDARD

## PULVERISERS

### HYDERABAD

Product  
STD no

BA 55099

Rev No. 00

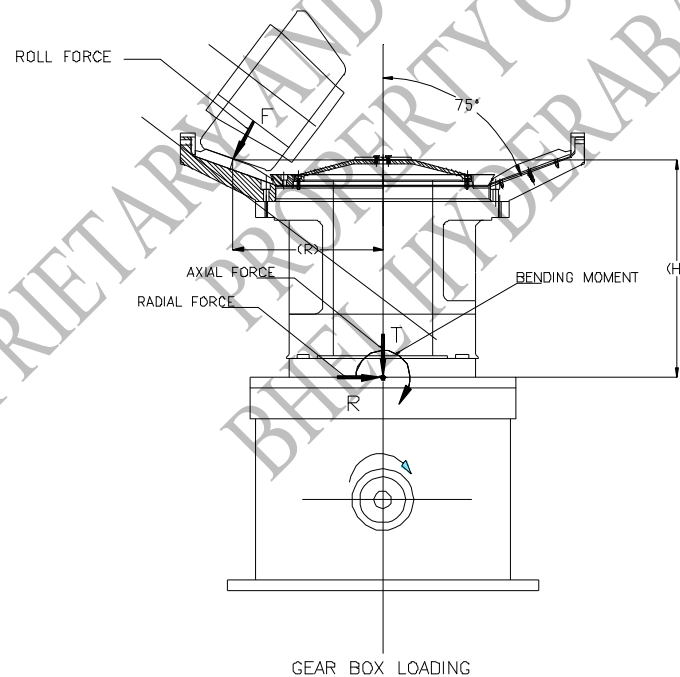
Page 8 of 10

**TABLE-3A**

	AXIAL FORCE (KN)		BENDING MOMENT (KNM)		RADIAL FORCE (KN)	
MILL SIZE	HP 1103 (DC)	HP 1203	HP 1103 (DC)	HP 1203	HP 1103 (DC)	HP 1203
MOTOR KW	810	1010	810	1010	810	1010
FULL LOAD	1735	2416	362	555	218	294
LOW LOAD	935	1341	565	900	218	294
TRAMP IRON	1602	2217	1130	1773	365	489
BROKEN SPRING	1735	2416	565	1683	365	420

**TABLE-3B**  
**LOADING POINTS**

MILL SIZE	BOWL MEAN RADIUS (R) mm	BOWL TO GEAR BOX DISTANCE (H) mm	BOWL AND HUB WEIGHT (Kg)
HP 1103 DC	1143	1588	20412
HP 1203	1288	1933	30844



COPYRIGHT AND CONFIDENTIAL

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.





# **PRODUCT STANDARD** **PULVERISERS** **HYDERABAD**

**Product**  
**STD no**

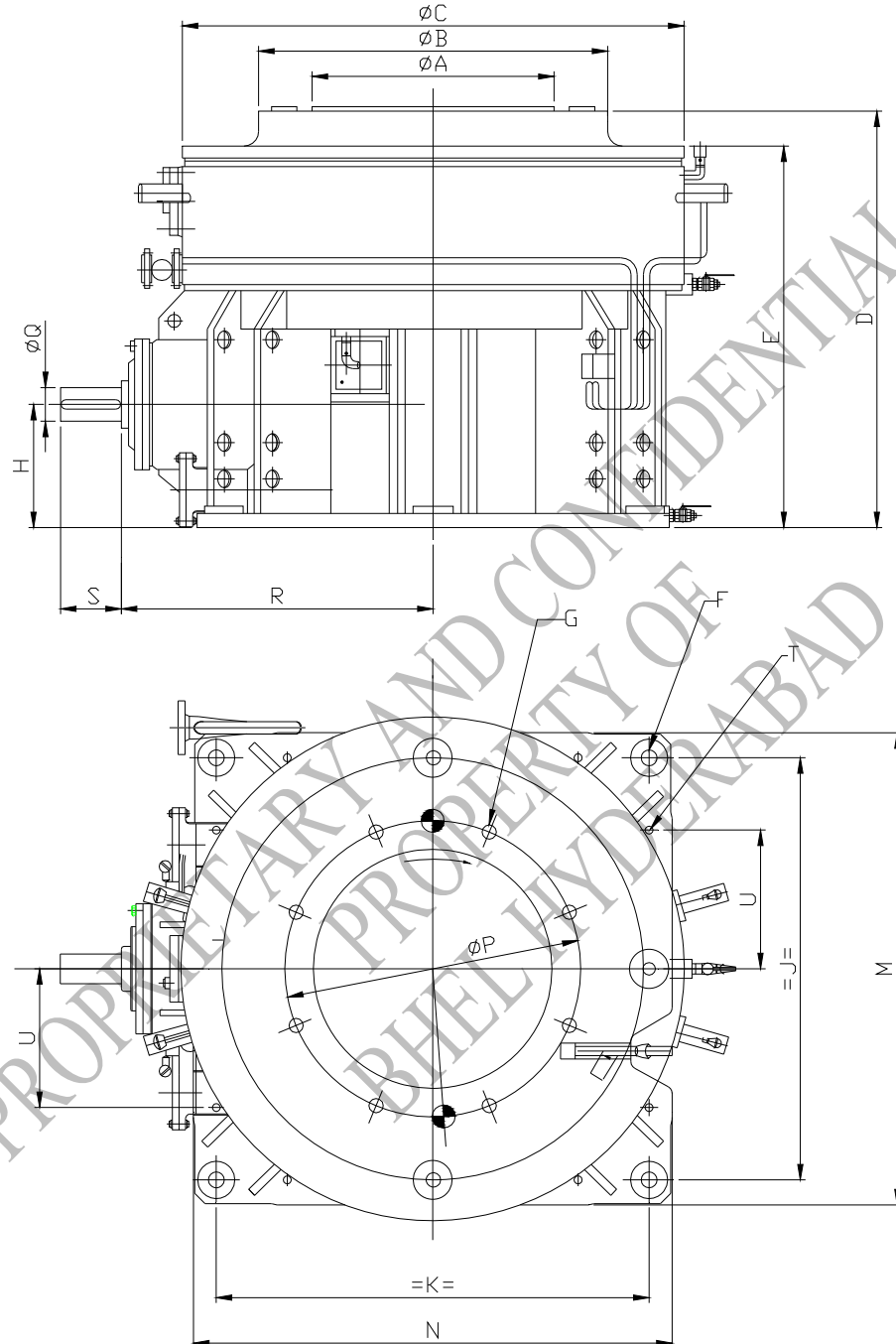
**BA 55099**

**Rev No. 00**

**Page 9 of 10**

**COPYRIGHT AND CONFIDENTIAL**  
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.

FIGURE 1.



[illegible]