GRINDING ELEMENTS FOR BHEL XRP/HP BOWL MILLS

1.0 GENERAL:

This specification governs the procurement of grinding elements consisting of Grinding Rolls and Bull Ring Segments meeting the technical requirements / performance requirements for the Bowl mills.

2.0 QUALIFYING REQUIREMENTS

The bidder shall satisfy the following minimum qualifying requirements by submitting documentary evidences along with the technical offer, failing which the offers shall be summarily rejected.

2.1 Proven Experience: Documentary evidence to be submitted for the followings.

Evidence of the established performance of wear life of minimum 6,000 hours (without repair or rebuild of the wear area) for 50" to 72" size Grinding Rolls with matching bull ring segments.
The above should be for XRP1003 to HP 1203 type BHEL make or other similar design (Raymond Mill) coal mills for power plant applications with typical high ash Indian coal as given in Annexure I.
Wear life established with smaller size rolls in the above range will be sufficient to qualify for larger size rolls.

2.1.1 Bidder should have supplied minimum of 13 sets of Grinding rolls & Bull ring segments in the above range in India and must have achieved a proven life of 6000 hours under the coal condition of Annexure I, under following conditions

2.1.1.1 From four different sites

2.1.1.2 Located at least at two (out of five) geographically different locations (North/East/South/West/Central)

2.1.1.3 Preferably with coal from different collieries.

2.1.1.4 Data from last five years from the date of issue of the present enquiry.

2.1.1.5 The evidences shall be submitted in the following format.

Name of Site	Mill type	Size of grinding roll	Date of supply	Life achieved in hrs.	Coal Type as Per Annexure I

2.1.2 Bidder should have capacity to manufacture rollers of size up to 72".

2.2 Manufacturing facilities and proven process:

2.2.1 Vendors to note that at present BHEL is using the Grinding elements as per the following details:
Rolls and Bull ring segments manufactured using the proven process of sinter cast. The Insert of the rolls are made up of hard metal matrix composite, of high chrome iron having following Chemical composition:
C = 2.5-3.4 %, Cr = 18.0-27.0 %, Mo= 05-1.3 %, Ni-0.3-1.3%,
Mn = 0.5 - 1.5 %, Si = 1.0 % max., S-0.1% Max, P-0.1% Max

This High-Chrome alloy is reinforced with ceramic particles, evenly distributed. The hardness of inserts is in the range of 58 – 66 RC.

These inserts are embedded into a ductile iron (SG iron) supporting base forming a roll by centrifugal process with overall dimensions as per BHEL drawing.

The Chemical composition of SG iron: C- 3.2-3.5%, Si-2.5-3.0%, Mn-0.3% max. Mg-0.04-0.07%.

Any bidder following the above manufacturing process will be qualified subject to meeting the clause 2.1.
However, the above Chemical Composition does not absolve the supplier from guarantee responsibility. The Heat treatment procedure shall be established by the vendor and shall be indicated in Quality Plan.

2.2.2 ANY OTHER PROCESS FOLLOWED & MEETING THE CLAUSE 2.1

In case the bidder having a manufacturing process different from 2.2.1, the bidder shall have all the necessary facilities for the manufacture of Grinding rolls and bull ring segments. The process used for manufacture shall be a proven one and the evidences as submitted in 2.1 above shall be for the same process of manufacture. Details of their manufacturing facilities shall be submitted.

In case any of the process is out sourced / subcontracted, the tie-up letter with the agency along with details of their facilities and capabilities shall also be submitted for acceptance by BHEL.

The information given by the bidder is liable for evaluation by BHEL

2.2.3 Traders / stockiest / mediators are not allowed to quote. Only manufacturers who are having relevant facilities, proven process and experience will be considered for the supply.

2.3 Infrastructure for providing Technical Services for:

Bidder shall have the sufficient infrastructure in India for after sales services

- Supervision of erection and commissioning.
- Performance monitoring with respect to wear life, output, fineness, coal characteristic etc.

Documentary evidences/ confirmation for the above shall be submitted.

3.0 MATERIAL CODE: See Table

4.0 QUANTITY REQUIRED PER MILL(One Set)

1) 3 Nos. Grinding Rolls.
2) 1 set of matching Bull Ring Segments.

5.0 GRINDING ROLL & BULL RING SEGMENTS:

5.1 Dimensions: The overall dimensions of the Grinding Roll and Bull Ring Segments shall be as per BHEL Drawings.

5.2 No mill internals / components are required to be changed / modified with reference to BHEL drawing. However for meeting the guarantees as mentioned in clause 7.0, the vendor is permitted to do minor modifications. The modification shall be accepted after thorough scrutiny and assessment for need by BHEL. The modifications suggested shall ensure that the functionality provided by the removed BHEL component is achieved by the replaced component/ components. The following aspects will be looked into for approval

5.2.1 No adverse effect of the proposed modification on mill performance.
5.2.2 No adverse effect of the proposed modification on other mill components especially on the life.
5.2.3 Feasibility of the modification in the existing arrangement.
5.2.4 Feasibility of the future engineering modifications by BHEL.
5.2.5 Possibility of and feasibility of the proposed modified components with standard BHEL design components or any other design that would have been possible with standard BHEL design, in future.

However, bidders to note that no modification is applicable for HP 1103 & HP 1203 Mills.

5.3 **Manufacturing Process:** The manufacturing process and chemical composition is left to the discretion of the supplier with the following conditions (the relevant documents shall be submitted along with the technical offer for review and acceptance by BHEL) provided it meets the requirements of clause 7.0

5.3.1 A detailed manufacturing process (along with the process control parameters) and manufacturing and test facilities data shall be submitted for review by BHEL.

5.3.2 Material used for the manufacture of the Grinding rolls and Bull ring segments shall be specified along with the technical details. The specifications shall be submitted for acceptance by BHEL. The details of the patented portion of the technology need not be provided, however the generic name of the proven patented technology along with the broad details shall be provided.

5.3.3 A Quality plan with stage wise inspection and acceptance criteria shall be submitted for approval by BHEL and/or customer.

6.0 INSPECTION:

6.1 The inspection of items will be as per the approved Quality plan.

6.2 Inspection of the material will be based on the applicable process of manufacture acceptable to BHEL. The tests like chemical composition, microstructure, hardness and NDT etc as applicable will be part of the approved Quality plan.

6.3 The overall dimension of the grinding roll, bull ring segments and any other component/item of the package shall be as per BHEL drawing.

6.4 The bullring segments shall be assembled in Check Bowl. After assembling of the segments, final gap should not be more than 20 mm. The drawing for the check Bowl and the arrangement for segment assembly on Check Bowl shall be furnished by BHEL.

6.5 The number of segments i.e. Plain, Half, Quarter, Keyed & Shim for each size of the mill shall be shown on Check Bowl drg. However, additional shims/ segment to fill the gap upto 20 mm shall be supplied by the vendor which may be required at site during assembly.

7.0 GUARANTEES:

7.1 **Wear Life:** The minimum guaranteed wear life shall be 6000 hours, with Indian coal having 40-50% ash and the shale and sand stone content of coal may be as high as 20% with alpha quartz contamination up to 5.0 mm size.
Supplier shall prove the mill capacity and performance with originally installed worn out grinding elements after the guaranteed wear life during the Performance Guarantee (PG) test of mills along with BHEL team as per the customer approved PG test procedure and guarantees given there off.
Guaranteed wear life is considered to have been met with only when the mill PG test results are achieved. Typical Mill PG Test requirement is as per **Annexure II**.

7.2 The supplier shall give back to back guarantee as applicable for each of BHEL customer for wear life of grinding elements as per terms and conditions of this contract. (A typical customer clause is given in Annexure-III – which gives calculation for replacement of grinding elements as part of Mill Warranty Shortfall Part Settlement).

7.3 Consistency in mill output to minimum 90% of capacity and pulverized fuel fineness of minimum 70% through 200 mesh and 99% through 50 mesh.

7.4 Failure due to manufacturing defects (generally leading to breakage/ catastrophic failure of grinding elements) shall be replaced and installed immediately.

7.5 Supplier to confirm the supply these of grinding elements in the Guarantee Trial Period (GTP) of the project, which normally varies from 3 to 5 years.

8.0 INSPECTION AT SUPPLIERS WORK

Tests and inspection are to be conducted in the presence of BHEL/ customer representatives as per approved Quality plan. The representatives shall have free access at all times while the work on the contract is being performed. The supplier shall offer all reasonable facilities without charge to satisfy the Inspection Agency that the items are conforming to this specification.

9.0 TEST CERTIFICATE:

All the rolls shall be identified with a serial number punched. The Bull ring segments set shall be numbered by paint for each set. Supplier shall supply 3 copies of Test certificates with following information for rolls and bull ring segments.

1. BHEL order number
2. Supplier's reference and name.
3. Heat No. / Roll no.
4. Results of chemical analysis, Hardness Test and all other tests or any other tests as per approved QAP
5. Drawing no., Material Code
6. Consignment/ Identification no

10.0 ACCESSORIES

Wear measurement gauge for project site, and any other items/consumables required shall be supplied by the supplier at no extra charge to BHEL.

11.0 DOCUMENTS

11.1 Three Copies of test certificates are to be provided.

12.0 PACKING:

All components are to be suitably packed set wise to prevent Corrosion and damage during transit. Machined/ Ground surfaces shall be properly protected with suitable anti-corrosive compound. Each package shall be legibly marked with following information.

1. BHEL Order No.
2. Consignment/ Identification No.
3. Roll No./ Set No.
4. Drawing no., Material Code
5. Weight in Kg
6. Suppliers Name

13.0 SUPERVISION & SERVICES:

13.1 Supervision for Erection and commissioning shall be deputed with one week notice period from BHEL.

13.2 Mill performance shall be monitored for the guaranteed period and supplier shall visit the site periodically (approximately after every 2000 hours of operation) and record the grinding elements wear life along with BHEL/ CUSTOMER.

13.3 Supplier shall prove the mill capacity and performance with originally installed worn out grinding elements after the guaranteed wear life during the Performance Guarantee (PG) test of mills along with BHEL team.

13.4 Coal quality (including rejects) shall be monitored for the guaranteed period and supplier shall visit the site periodically and record the coal quality along with BHEL/ Customer. In case BHEL is not able to visit site periodically, vendor will be given clearance to visit site on his own to monitor & record coal quality. The data so collected and visit report shall be submitted to BHEL.

14.0 NEW PROCESS INTRODUCED DURING RATE CONTRACT PERIOD:

Whenever a new process is introduced by the vendor to improve the grinding elements performance or to meet the guarantees, the vendor must inform BHEL with justification.

On approval by BHEL a new material code shall be adopted, to avoid mix up with items given in this spec. However the rate contract rate valid for the existing material code will automatically become valid for the new material code also.

TABLE FOR MATERIAL CODE

Var No.	Mill Type	Item Description	Drawing No.	Material Code
01	1003 XRP	Grinding Roll	16100090057	BA9735018012
02	1003 XRP	Bull ring segment set	26110090116	BA9735018020
03	1043-1103 XRP	Grinding Roll	16100401317	BA9735018039
04	1043-1103 XRP	Bull ring segment set	26110402603	BA9735018047
05	HP 1103	Grinding Roll	26111002902	BA9735018055
06	HP 1103	Bull ring segment set	16111001564	BA9735018071
07	HP 1203	Grinding Roll	26112002903	BA9735018080
08	HP 1203	Bull ring segment set	16112001565	BA9735018098

RECORD OF REVISION

REV. NO	DATE	REVISION DETAILS	REVISED	APPROVED

ANNEXURE – I TO SPECIFICATION No. BA35018

TYPICAL COAL ANALYSIS (INDIAN COAL):

Parameter	Unit	Coal Analysis Data (as available)					
Proximate Analysis (as recd)		Coal 1	Coal 2	Coal 3	Coal 4	Coal 5	Coal 6
Moisture	%	18	14	18	16	15	15
Ash	%	46	45	38	45	45	45
Volatile Matter	%	16	20	20	19	20	19.5
Fixed Carbon	%	20	21	24	20	20	20.5
Hard Grove Index		45	47	60	50	47	42
Abrasion Index (YGP)	mg steel/ kg coal	85	80	80	80	80	80
Ash Analysis (as recd)							
Silica (SiO_2)	%	64.86	62.4	59.79	59.54	62.5	59.6
Alumina (Al_2O_3)	%	23.8	27.31	25.36	29	27.3	30.75
Iron Oxide (Fe_2O_3)	%	6.52	4.96	7.2	6.42	4.9	6.5
Balance	%						

Remark: Sometimes, due to open cast mining, the shale and sand stone content of coal may be as high as 20% with alpha quartz contamination up to 5.0 mm size. The effect of these shale, sand stone and alpha quartz content shall be considered for wear life guarantees of Mill wear parts.

ANNEXURE – II TO SPECIFICATION No. BA35018

TYPICAL MILLS PG TEST REQUIREMENT:

Coal Pulveriser Capacity at Rated Fineness

Performance testing shall be conducted on coal pulverisers toward establishing their guaranteed capacity meeting the specification requirement. Corrections may be applied for the variation in coal characteristics i.e. HGI & Total Moisture of test coal with respect to specified design coal.

Capacity demonstration test shall be carried out for the following conditions.

(a) The Contractor shall demonstrate capacity output on one coal pulverizer (of Employer's choice) of each Steam Generator for establishing its capacity at 100% mill loading at rated pulverized coal fineness with specified design coal with new set of grinding elements.

(b) Further, Contractor shall also demonstrate capacity output on four coal pulverizers (of Employer's choice) of each Steam Generator, not less than the 90% of guaranteed value of (a) above, at 100% mill loaiding with the originally, installed grinding elements in after the guaranteed wear life of grinding elements.

Capacity test as mentioned at (a) & (b) above shall be demonstrated at the following condition occurring simultaneously during testing:

Rated pulverised coal fineness	i) Not less than 70% through 200 mesh and
	ii) Not less than 99% through 50 mesh screen
Test coal	Any available coal from the specified range

In case the Contractor successfully demonstrates the guaranteed capacity of coal pulverisers as stated above remaining coal pulverisers of corresponding steam generator will also be considered to have successfully met the above capacity guarantee requirement. However, in the event of any of the coal pulverizers not meeting the guarantee test, all the coal pulverizers of corresponding steam generator will have to be tested by the contractor to demonstrate guaranteed capacity.

During the demonstration of the mill capacity output, manufacturer's operating instructions will be followed and mill will be operated with the specified range of coals without any such readjustment that requires a shutdown of the mill or reduction of the load and / or any replacement of any mill wear parts.

For the purpose of testing to demonstrate the capacity, if HGI (grindability) and total moisture vary from those given in coal characteristics, the above pulverizer measured capacity shall be corrected using the capacity correction curves furnished by the Contractor and approved by the Employer. HGI versus coal pulverizer capacity curve shall be furnished for HGI variation upto a value above which the capacity remain constant.

ANNEXURE – III TO SPECIFICATION No. BA 35018

COAL MILL WEAR PART WARRANTY (TYPICAL)

1. The Contractor (Vendor) shall warrant the wear life of all wear parts of the mill when grinding the specified range of coal(s). Mill wear parts are defined as those parts of the mill which are in contact with coal or coal dust and are likely to wear out during the operation of the mill. The guarantee/warrantee shall be demonstrated on each mill during the Guarantee Trial Period (GTP) commencing after establishing successful operation of the mill continuously for a period of not less than twenty four (24) hours, at or near its warranty rated capacity. The GTP for the respective wear part(s) shall be at least three years or the wear life of that wear part(s), whichever occurs later.

The establishment of the warranty will be based on equivalent running hours of the mill regardless of the specified coal. The average wear life (AWL) of the mill wear parts during GTP shall, however be corrected for the variation in GTP.

2. Minimum Guaranteed Life for various coal mill wear parts shall be as indicated as mentioned in the Cl. 7.0 Page 4 of 7, of BHEL Standard BA35018.

3. The wear parts shall be considered to have passed their warranted operating life when they have successfully demonstrated their capability to meet the full load rated capacity of the mill during the guaranteed life of the wear part. No weld build up or reversing of grinding elements will be permitted for achieving the guaranteed wear life. In case any of the wear part has worn out to such an extent that either the normal or safe operation of the mill is jeopardized if this part is not replaced/repaired, or continuous use with this part may lead to exposure or wear of other parts which are not meant for the purpose of checking the shortfall in wear life, even if there is no reduction in mill rated capacity, then the part shall be deemed to have outlived its wear life. If any of the wear parts fail to meet the warranted life, additional quantities of these wear parts shall be supplied on pro-rated basis as defined in Clause 7 below.

Computation Of Credit For 3 Years GTP

4. Owner at the rate of one and a half times the shortfall worked out on item wise prorated basis. For example should an individual wear part or set of wear parts taken together have a price of Rs. 10,000 (rupees ten thousand) and any of the wear part or any part of wear parts set that failed to meet the warranty test lasts only 6000 hrs, a credit of 1.5 times of 2000 hrs out of guaranteed 8000 hrs or Rs. (10000x1.5x2000)/6000 would apply towards Owner and shall be provided by the contractor. This credit shall be worked out for each replaced wear part/wear part set, throughout the GTP. This credit shall apply to all the affected mandatory spare parts purchased under original contract.

Computation of Liquidated Damages For Remaining Plant Life

5. On the expiry of GTP (minimum 3 years), deficiency in the life of each wear part that has not fulfilled the warranty will be worked out on an item wise basis and shortfall so established due to reduced wear life and its implications for the remaining plant life shall be worked out. The contractor at no extra cost to the Owner shall provide one and half times the wear parts needed to make good the shortfall in the wear life during the plant operation period of 22 years from the successful completion of GTP or the remaining of 25 years of plant life period after completion of GTP for the respective wear part.

6. The shortfall part settlement shall be calculated based on the actual wear life at the parts that have worn-out in the GTP on a mill-by-mill basis. In this connection the procedure given in below in clause 7 shall be followed.

Mill Warranty Shortfall Part Settlement (SPS) Procedure

7. **For all wear parts of each vertical coal pulverizer:**

Sl No	Description	Procedure	Example
i)	Guaranteed wear life of wear part (say X hours)		X=15000 hrs.
ii)	Total life achieved by failed wear part for similar parts 1&2 (say X1 & X2 hours)	X1=12000 hrs X2=13000 hrs	Life of wear parts replaced during 3 years guarantee trial period (GTP)
iii)	Average wear life (AWL) of failed wear part	AWL= $(X1+X2)/2$	AWL=$(12000+13000)/2$
iv)	Short fall in hrs	S=(X-X1) + (X-X2)	(15000-12000) + (15000-13000) = 5000
	Total shortfall for wear part during 3 years GTP		
v)	Shortfall part settlement (SPS)	$= Sx(25-GTP)/AWLxGTP$	$5000(25-3)/12500x\ 3$ =2.93 = 3.0 To be rounded off the next higher whole number

The contractor (Vendor) shall provide to the Owner either the wear parts of original or better quality material in number equivalent to one and a half times the quantity worked out based on the method explained in the above example so as to compensate for the shortfall in wear life for a plant life of 25 years as has been established above, or the cost of such number (i.e. one and half times the quantity worked out as per the above example) of wear parts based on the prices agreed for mandatory spares. The final mode of compensation for such shortfall viz by means of additional quantities of spares worked out or by cost thereof shall be as per Owner's discretion. The total cost of such replacements shall be without any limit to the maximum amount recoverable as per Appendix 1:

Average wear life (AWL) during GTP, to be considered for mill wear part warranty shall be as arrived at from the station record for each mill, and as corrected for variation in YGP index of the coal being fired during GTP. For this purpose the coal YGP shall be the average tested value during GTP. The contractor shall collect the coal samples and get them tested for YGP index at recognized, Owner's approved test lab, periodically. (The frequency of sampling and testing shall be mutually agreed between contractor & Owner). The YGP index testing shall be done as per standard.
A jointly signed record shall be maintained during GTP.

Owner: Customer of BHEL
Contractor/Bidder: BHEL
Vendor: Agency who is supplying Grinding Elements to BHEL as per BA35018.

APPENDIX 1
LIQUIDATED DAMAGES PER UNIT AND ACCEPTABLE SHORTFALL LIMITS

Sl. No.	Particulars	Evaluation / LD Factor	Value (Rs in Million)	Acceptable shortfall limits
1.	For every 1 t/h decrease in steam flow at SG super heater outlet for each Steam Generator	LD factor	**5.282**	(-) 1% from the guaranteed capacity
2.	For every 1 kW shortfall in gross power output.	LD factor	**0.144**	(-) 1% from the guaranteed capacity
3.	For every 1 kW increase in auxiliary power consumption	evaluation factor / LD factor	**0.241**	(+) 1% of the guaranteed value
4.	For every 1 kCal /kWh increase in weighted average gross unit heat rate	evaluation factor / LD factor	**25.00**	(+) 1.0% points from the guaranteed value
5.	For every 1 m increase in cooling water pressure drop across condenser	evaluation factor / LD factor	**69.80**	(+) 1.0 mWC from the guaranteed value
6	For wear of coal mill parts	LD factor	Refer Appendix-2 below	(-) 500 hours
7.	For the delay beyond the specified completion period indicated in the tender specification	evaluation factor / LD factor	0.5% of the Contract Price per each week of delay limited to a maximum of 10 % of contract value	

(Appendix 2) Aggregate liability for Liquidated Damages:

Aggregate liability for liquidated damages for Performance (sum of items 1 to 6) shall be limited to maximum of 15%.

Aggregate liability for liquidated damages for Performance and delay in completion (Sum of items 1 to 6 and item 7) shall be limited to maximum of 20% of contract price.

More details can be provided for specific project as required by the Vendor on request.