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 pulverization of lime stone in flue gas De-sulphurisation plant.

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 - 1870 KW, 1500 RPM

Pinion speed - 120 RPM connected through main reducer to motor

Gear speed - 16 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 Shell Gadus S4 OGH160 grease or equivalent.

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

4. **MATERIAL SPECIFICATION**:

The girth 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 Max	0.60 Max.	1.00 Max	0.80-1.20	0.035 Max	0.04 Max.	0.15-0.35

MECHANICAL PROPERTIES

UTS N/mm^2, Min	0.2% YS N/mm^2 Min	A % Min	KV J. Min	Z % Min	Hardness (BHN)
750	520	12	20	20	205-235

PINION Material: **30CrNiMo4**

CHEMICAL COMPOSITION (BY LADDLE ANALYSIS)

C %	Si %	Mn %	Cr %	S %	P %	Mo%	Ni%
0.26-0.33	0.10-0.40	0.30-0.60	1.80-2.20	0.025 Max	0.035 Max.	0.30-0.50	1.80 – 2.20

MECHANICAL PROPERTIES IN TANGENTIAL DIRECTION:

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

5.0 **MANUFACTURE**:

5.1 GIRTH GEAR:

The precision class for machining and cutting according to ISO Standard 1328 class 8 Minimum.

As the Girth Gear is in two parts, every precaution shall be taken to guarantee the joints, geometrical and dimensional tolerances, during the following processes.

- Machining consists of a rough- turning, rough cutting (for any module) and a final-machining and cutting.

- The quality heat treatment is carried out either on the part as cast, or after rough machining.

- Repairs, if any or carried out:

    - In all cases after quality heat treatment

    - After rough cutting to limit their number.

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.

- Stress relief is carried out after rough cutting and repair and before final machining.

5.2 REPAIRS OF GIRTH GEAR:

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.

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 Girth Gear 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)

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

5.3 PINION:

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

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 polyethene sheet.

7.0 **PACKING:**

The gear teeth shall be covered by wooden plank to avoid damage in transit. The pinion should be packed in wooden box.

8.0 Based on the Quality plan BHEL/ BHEL customers will indicate the hold points for inspection.

9.0 **ERECTION and ALIGNMENT**.

The supplier shall depute experienced engineer to supervise erection & alignment of girth gear onto the mill. Supplier representative may have to stay at site for about 7 days per gear. Delays due to issues at supplier end will not be considered in above man days.

APPENDIX A (INSPECTION AND ACCEPTANCE CONDITIONS)

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 Girth Gear 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	Each Girth Gear and pinion
Aspect		Visual	No. Sharp edge, deep scratches undercuts chisel impact and no cracking	Each Girth Gear and Pinion
Surface condition		Visual or Viso-tactile or surface finish Tester.	According to drawings the zones left as cast on the Girth Gear must be better than RA 25.	Each Girth Gear and pinion
Chemical analysis	Product Standard	Spectro-chemistry	Accordingly to this product standard	Each heat (Girth Gear and pinion)
Mechanical characteristics -Tensile - Impact test -Hardness	Drawings/ product standard	As indicated in product standard	Results shall confirm 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 2. Specimen 4 pts Evenly Distributed on the teeth zone
UT test (After rough) for Girth Gear and Pinion.		Criteria Appendix-C & D Class B for the whole pinion (bottom Echo method)	Teeth Zone Other Zone 2 4	Each Girth Gear and Pinion.
Pinion (M.P Test)	Present specification	Linear Non-Linear	Not permissible 8 defects Max. 1.5 Equ. Dia 3 In a Frame of 105 x 140 mm	Pinion

APPENDIX –A (Cond.)

(1) Graphic recordings of individual and cumulated pitch. Profile and distortion errors on the first pinion and first Girth Gear of series (maximum of 6 pieces). For Girth Gears, 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 with 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	BA9789138016
02	PINION	36222100049	BA9789138024

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

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

APPENDIX-C

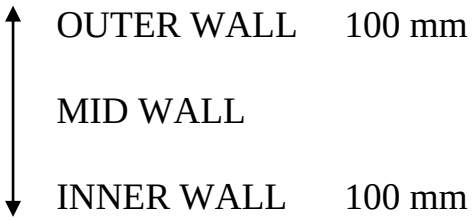
STEEL CASTINGS HEAT TREATED (EXCEPT AUSTENITIC AND AUSTENO-FERRITIC STEEL) FROM ASTM A 609

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^2	50	75	100	125	150	200	250
THICKNESS OF DEFECT (%) WALL THICKNESS	10% IN OUTER OR INNER WALL (3) WITH A MAX SIZE OF 25 MM. 15% IN MID WALL WITH 50 MM. MAX (3)					15% 25%	

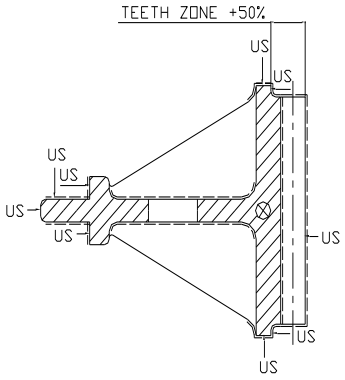
1. No indication equal to or greater than the DAC over an area and length specified for the applicable quality level.

2. 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.



APPENDIX D



LEGEND:

US FACES TO BE CHECKED BY ULTRASONIC TEST.

↓

⊗ UT ON JOINT FACE.

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

RECORD OF REVISIONS

REV .NO	DATE	REVISION DETAILS	REVISED	APPROVED