New Project Management & Development cc

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EL BROCAL

16x22ft, 2800kW BALL MILL
MILL SERIAL NUMBER – BAL020

MILL INSTALLATION MANUAL

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APPENDICES

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1. GENERAL

1.1. INTRODUCTION

We wish to thank you for purchasing a New Concept Projects Ball Mill. This equipment is of the latest design with dependability and serviceability given the utmost attention. With moderate observance and regular maintenance, it will serve you both reliably and economically for the stipulated life of your operation.

All assemblies and parts have been designed for easy inspection and maintenance. It is our wish, as well as yours, that this equipment serves you well and we therefore suggest you read this manual to obtain a full understanding and thorough knowledge of this equipment. Keep this manual handy and ensure that field personnel have a copy for erection and maintenance purposes.

1.2. GENERAL

This manual is divided into numerous sections, each containing the installation and maintenance information needed for a particular assembly or item. Refer to the index for numerical listings of the sections you are interested in. Our instructions, assembly drawings and other manufacture support information will be found herein.

When writing to the New Concept Projects, or ordering replacement parts, always refer to the SERIAL NUMBER of the Mill. Also, refer to the drawing, or assembly number as well as the part number and description herein along with the quantity needed.

1.3. HAND OF MILL

Mills are designated to be either left or right handed. When standing at the discharge end of the mill and facing the mill, if the drive is on the right, it is a right hand mill. If the drive is on the left, it is a left hand mill. When both left and right hand mills are being installed, it is imperative that the parts list for each assembly of each mill be used to identify the properly handed parts.

1.4. GETTING READY

Before starting the erection of a mill, adequate handling facilities should be provided, or made available, bearing in mind the weights and proportions of the various parts and assemblies. This information can be ascertained from the sub- assembly drawings and shipping documents. Any special tools that are required should be gathered prior to erection. These items should include; large striker wrenches for the foundation bolts and trunnion bearings, as well as socket and torque wrenches for the bolts as noted on the assemblies.

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GRINDING MILLS – INSTALLATION INSTRUCTION MANUAL

Technical Information requirements

- Foundation drawing
- General arrangement drawing
- Spare parts drawing
- Trunnion bearing data sheet
- Girth gear data sheet

Mill Foundations

Reinforced Homogenous Concrete Raft having a mass approximately one and a half times the gross mass of the mill inclusive grinding media. This will minimize the possible subsidence between all component alignment and eliminate rapid drive train wear. The Foundation holding-down bolts must be checked against a certified drawing for accuracy of pitch and projection.

STEP ONE

Trunnion Bearing Sole Plates.
Mount both items on packs of mild steel shims of varying thickness and measuring 100 x 70mm wide approximately 200mm apart. Check Centres and diagonals against General Arrangement drawings. Ensure that packers are installed correctly and tightly.

Bearing Baseplate Crowning.
In order to prevent nipping of the trunnions when the mill is lowered into position, the sole plates must be Bowed / Crowned by fine shimming from the centre outward to between 0.0015”/0.04mm and 0.003”/0.07mm max per Ft/305mm between holding-down bolts. Use a suitable Straight Edge to confirm these settings.

Elevation of both sole plates must be equal to ensure that the level of Mill is correct. Use Dumpy level for this purpose.

Note: The Steel pack height is determined by Grouting required (average 50mm). Grouting to be poured prior to commissioning only, once all baseplate heights and positioned are verified.

Toque all baseplate civil bolts to the specified torques.

STEP TWO

Assemble and mount both Trunnion Bearings onto the prepared Sole plates. Install swivels into the bearing housings and Blue swivels to ensure seating is as per specification. (to be undertaken before tightening hold down bolts. Ensuring that the Bearing housing are locked by Jacking screws to the

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mill centre line (locating at discharge end). TIGHTEN Base bolts. Install bearing instrumentation and HP piping, Install bronze bearings into swivels and install hold back bolts. Ensure bronze bearings seat into swivels by checking feeler gauge settings at all points. Install beating cap

STEP THREE

Assemble Trunnion Ends to the mill shell, noting that the discharge head is the located and geared end. Torque flange bolts to specification for the specific grade bolts. No joint lubrication is needed.

STEP FOUR

Remove Trunnion Bearing Caps and Oil seals. Coat bronze bushing bore with Grade 320 oil (See Lubrication Schedule for site specific oil). Lower Mill unit into Bearings. Rotate the empty mill by hand to settle same. Install oil seals are per instructions attached. Ensure that there is no contamination of the bearing journal or bearing area during assembly and installation.

STEP FIVE

Use Data sheet attached to complete check of all feeler gauge clearances. No adjustment is provided. Machine shop inspection ensures that designed targets are met. Log for record purposes all Figures taken. Close up housings and install seals as per instructions.

STEP SIX

Install Girth Gear in accordance with girth gear installation manual attached hereto. Flog all face joint bolts tight and Torque to specification. Flange bolts to be finger tight only.

STEP SEVEN

Position pinion drive shaft assembly using similar packers as used at sole plates. Pinion drive shaft to be perfectly levelled by Spirit or laser levelling. Meshing of pinion / gear to be left until Barring gear is available with Power. Avoid creating stressing of pinion base by careful selection of steel packers. Position speed reducer / barring gear / dive motor using similar packers and taking great care to align all couplings correctly, as per coupling installation specifications provided. Barring-gear clutch must include electrical safety isolating switchgear. BARRING GEAR LIMIT SWITCHES TO BE HARD WIRED AND INTERFACE TESTED PRIOR TO CONNECTION OF COUPLINGS.

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STEP EIGHT

Install the Main Trunnion Bearing Lubrication system completely. Ensure all drain pipes have a positive degree of fall to assist rapid return oil flow, to oil reservoir. Feed piping to include flow switches wired to trip main drive motor in the event of a no-flow situation. The lube system provides for a timed high pressure low flow designed for hydraulic lifting action of the mill trunnions, thus preventing dry start-up. The high flow low pressure pump delivers a controlled flow rate to each bearing which is sufficient to both lubricate and cool the 85" by 32" bronze half bushings.

Use dial indicators to measure amount of actual high pressure lift (approximately 0.009"/0.23mm average, dependant on oil viscosity and ambient temperature).

STEP NINE

Install the Gearbox Lubrication system completely. Ensure all drain pipes have a positive degree of fall to assist rapid return oil flow to oil reservoir. Feed piping to include flow switch wired to trip main drive motor in the event of a no-flow situation. The high flow low pressure pump delivers a controlled flow rate which is sufficient to both lubricate and cool, (with the aid of the airblast cooler) the gearbox.

STEP TEN

Following the lube system commissioning, the Girth gear must be correctly set-up for Radial run-out by means of jacking screws provided, using Dial indicators.

The recommended figures for specific diameters are obtained from Girth Gear installation manual attached hereto. Diagrams are provided. Engage the Barring-gear and rotate mill to accomplish this function, stopping at equally spaced stations and allowing the mill to settle each time.

Rim flange run-out. Correct machining of the gear blank and trunnion ends will have eliminated possible wavering and run-out occurring. Torque all fixings to the specification.

Back Lash Setting:
The correct recommended figures for the specific type of gear are shown and obtained by adjusting the Mill in or out at the sole plate jacking screws. Blue and rotate mill to show evidence of correct contact pattern.

STEP ELEVEN

Direction of mill rotation.
Mills are designed to be rotated away from the driving shaft so as to impose all loads downward into the foundation. The trunnion liner scrolls are arranged to retain charge in the mill, in the case of the Overflow type mill specified. Once scats migrate into the trommel screen, the advancing

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scroll design ejects scats out of the trommel screen. Main drive motor direction should be tested prior to engagement of couplings to ensure mill rotates in the intended direction.

STEP TWELVE

Girth Gear Protection.
A fabricated steel guard is provided which includes for a system of applying suitable lubricant at a point above the pinion shaft assembly. This system must be commissioned at the same time as the mill main bearing lube system. A liberal quantity must be spread over all gear and pinion teeth prior to closure of the guard. The gear grease spray system is designed to deposit grease onto the working flank of the girth gear.

STEP THIRTEEN

Install and commission all instrumentation on the mill including PT100s and vibration probes.

STEP FOURTEEN

Check all recommended Oil grades and levels plus drive shaft plummer block grease the run the mill for an hour or two, while monitoring all components for adverse temperature readings. Main trunnion bearing temperatures are to be closely monitored during the entire run-up phase.

STEP FIFTEEN

Liner installation must be completed and Manhole covers fixed. Run the mill a further two hours while monitoring effects of increased mass. Examine meshing of Gear / pinion at pitch line for satisfactory contact.

STEP SIXTEEN

Instruct for grouting all bed-plates and check for any loose bolts. Mill can now be put on stream by adding a 20% Ball charge and further monitoring. Complete ball charge target level and monitor.

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1.5. INSTALLATION PROCEDURE

STEP	PROCEDURE
1	Suitable foundation.
2	Locate elevation reference points and scribe centrelines on the foundations.
3	Install trunnion bearing sole plates on shims and crown to specification.
4	Grout trunnion bearing sole plates.
5	Install pinion bearing sole plate, do not grout.
6	Install trunnion bearing bases with swivel and bushing.
7	Assemble shell and heads, torque all bolts.
8	Install shell and head assembly in trunnion bearings. **NOTE:** Coat trunnion journal and bushing with heavy oil (STP) before lowering into position.
9	Check trunnion bearing clearances.
10	Complete both trunnion bearing assemblies.
11	Install lubrication systems to facilitate jacking of mill.
12	Install gear.
13	Check gear, radial runout.
14	Check gear, rim face runout.
15	Install lower pinion section of gear guard to foundation.
16	Install pinion bearing assembly.
17	Check for gear backlash and tooth contact; also check for uniform contact pattern. Dowel pinion pillow blocks.
18	Install drive assembly (reducer, motor, etc.). **DO NOT GROUT.** Grout only after inspection by an NCP representative.
19	Grout pinion bearing sole plate.
20	Install trunnion liners.
21	Install head liners
22	Install shell liners
23	Complete lube system installation, if not complete at step 1 and flush out system.
24	Install gear guard assembly and gear lube system.
25	Start gear lube system.
26	Install discharge trommel screen.
27	Install feeder assembly.
28	Complete electrical connections for mill drive and other systems.
29	Complete field piping.
30	Inspect inside mill and around area for left or forgotten items such as wrenches, bolts etc.
31	All points requiring lubrication should be checked to ensure that the proper type and amount of lubricant has been used.
32	Check all mill interlocks, by simulating high temperature in bearings, lubrication and air supply failure.

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1.6. CHECK LIST

After the mill is erected, in order to avoid overlooking both obvious and obscure installation details, we recommend the use of a check list. This is particularly recommended for multiple mill installations where it is difficult to control the different phases of installation for each and every mill. Such a check list can be modelled after the list found on sheets 6 and 7 of this section.

1.7. STARTING THE MILL

Start the lubrication system per lubrication section. Check for obstruction and remove all ladders and tools prior to starting the mill.

Before starting the mill, even though it is empty, we recommend that it be barred one or two revolutions for a check as to clearance of the gear and its guard, splash rings, etc. The trunnion journal should also be checked for any evidence of foreign material which might manifest itself through the appearance of scratches on the journal. If there are any scratches, it is very possible that there is some foreign material such as weld splatter may have been drawn down into the bushing, and can be found impeded there. ANY FOREIGN PARTICLES MUST BE REMOVED BEFORE PROCEEDING FURTHER.

If everything is found to be satisfactory, then the mill should be run for about thirty minutes. The trunnion bearings should be checked for uniform oil film on the journal, the temperature detector side, for any undue temperature. The gear grease pattern can be observed for uniformity which would indicate correct alignment.

If everything is satisfactory, the mill can be filled with water and run for, from six to eight hours, observing any abnormal reactions at the trunnion bearings, pinion bearings, and gear and pinion mesh. Record bearing temperatures, see Section 10. Bearing seals should be carefully observed and adjusted if installed too tightly.

It should be noted that with an empty mill the reactions and operating characteristics of the bearings and gearing at this point are somewhat different than when operating with a charge. Gear noises will be prominent and some vibration will occur due to no load and normal backlash. Furthermore, it will be found that the mill will continue to rotate for some time after the power is shut off. Safety precautions should therefore be observed, and no work should be done on the mill until it has come to a complete stop.

We have now reached the point where ore can be added to cushion the charge and a half ball charge placed in the mill. The mill should run for another six to eight hours, feeding approximately half the anticipated tonnage. Bearing temperatures must be monitored during this period. If fresh ore and water is not added during this run period, heat will increase in the shell and bearings and the mill must be shut down early. The mill should now be stopped, and the gear grease pattern checked, and gear and pinion mesh corrected, if necessary, according to separate instructions.

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By this time it will probably be evident that some of the bolts, particularly the shell liner bolts, have become loosened. They should be thoroughly tightened again.

Be sure to check those bolts and nuts which might not manifest looseness by leakage. These would include gear and flange connecting bolts, trunnion connecting bolts and studs.

Where bolt leakage might foul the gear or bearings, stop the mill at once and take the necessary corrective steps including cleaning all pulp or sand from the vital parts.

The full charge of balls can now be added, as well as the full amount of feed, and after a run of about four to six days, ALL BOLTS SHOULD AGAIN BE RE TIGHTENED, and the gear and pinion checked again, and adjusted if necessary.

We further recommend that during the first thirty to sixty days of operation, particular attention be given to bolt tightness, foundation settlement and condition of the grouting. We suggest any unusual occurrence be recorded so that should trouble develop later, there may be records which would simplify diagnosing and rectifying the situation.

1.8. GUARDS

As a safety precaution, and in many cases in order to comply with local or national safety regulations, guards must be used to protect the operators and mechanics from contact with moving parts. Frequent inspection should be made at regular intervals with particular attention being given to the condition of the wearing parts in the mill.

In this way, you will be better able to anticipate your needs for liners and other parts in time to comply with the current delivery schedules.

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CHECK LIST PRIOR TO STARTING			
1	Sole plate crown is		
2	Difference in sole plate height is		
3	Rim face run out is		
4	Allowable run out is		
5	Recommended backlash is		
6	Check all assemblies to assure proper installation (use drawings in manual).		
7	Check to make sure that all fixed and free bearings have been properly identified and installed (remove pinion bearing caps to check position of stabiliser ring, if used).		
8	Check at least six (6) gear bolts. Torque reading is		
9	Check six (6) head to shell flange bolts. Torque reading is		
10	All other bolts and fasteners, trunnion hold down bolts, etc.		
11	If all gearing has been checked and passed by NCP representative (pinion bearings, gear and pinion bolts) pinion bearing housings must be dowelled or keyed.		
12	All sole plates grouted.		
13	Sufficient running clearance around gear guard (both sides).		
14	All lubrication lines installed properly (see drawings in manual).		
15	All electrical connections completed as required.		
17	Lubrication in pillow blocks (grease or oil as required).		
18	Lubricant flow to trunnion bearings (make sure tank is full).		
19	Lubricant in reducer and flexible coupling's.		
20	Lubricant in gear spray system.		
21	No loose objects lodged in drive train or leaning against shafts.		
22	No tools or other loose objects in mill.		
23	Check all seals around trunnion bearings, pinion bearings, pinion shaft and gear for proper fit.		
24	Check temperature detector probe for proper contact on assembly.		
25	Feeder bolts tight.		
26	Manhole cover and bolts.		
27	Clearance around shell and head bolts.		
28	No person in or near the mill.		
29	Check clutch startup procedure. N/A		
30	Start lubrication system (see separate instructions).		
31	Run mill empty for six hours to check trunnion and pinion temperatures. See Section 12.		
32	Half charge mill (balls, material, water), run for eight hours (check gear pattern, bolts etc.) with mill stopped.		
33	Full charge - monitor temperature for eight hours.		
CUSTOMER		**DATE**	
NCP REP.		**DATE**	

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2. GENERAL ASSEMBLY

2.1. GENERAL

The general assembly drawing is an overview of the ball mill and shows both plan and elevation arrangements. The hand of mill is shown (see Section 1, Paragraph 1.3.0 for explanation) as well as all assemblies being called out.

2.2. CLEARANCES

Clearance around the mill and its equipment can be determined by using the general assembly drawing. Clear distances required to remove and replace trunnion liners are required. Also, details around these flanges and feed or discharge mechanism are shown so that feed and/or discharge boxes/covers can easily be designed.

3. FOUNDATION

3.1. GENERAL

The erection of a suitable foundation is the responsibility of the customer or his appointed contractor. Since soil make-up varies greatly depending on the mill location, a complete condition analysis should be obtained to determine proper design. The foundation should be of one piece raft design and extend under both trunnion bearings, pinion area and motor area as well as the other drive components involved in the installation.

3.2. DIMENSIONS

The dimensions shown include such items as the following:

A) Minimum pier size at the sole plate locations.
B) Clearance dimensions where needed.
C) Bolt size and length of projection above the foundation.
D) Minimum grout thickness.

3.3. LOADINGS

Static and dynamic loading's are given in a foundation loading diagram. These weights include grinding charge and material.

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3.4. CENTRELINES

After the foundation has been poured and all forms removed, establish vertical and horizontal centrelines of the mill and pinion shaft. Use batten boards or its equivalent for the horizontal centrelines.

3.5. SHIMS/SUB-SOLE PLATES

Initially, large shims should be grouted into position. These are to be used to give a flat and level reference point to start the main sole plates installation. These shims can be cut from cold rolled steel approximately 100 mm to 150 mm wide by 12 mm to 25 mm thick and installed over the full width of the sole plate or base. These shims should be checked for flatness and all burrs or nicks removed. These shims are placed on approximate 457 mm centres and adjacent to the foundation bolts.

3.5.1 Setting the Shims

See Sketch "A" below and Trunnion Bearing Assembly Drawing for location of shims.
Thickest shim in shim pack, is to be grouted in place to establish a level surface. Its elevation should allow for additional shims and thickness of the sole plate.

The top surfaces of the shims must be level in both directions. Adjust until individual shims are level within 13 mm per 305 mm. The grout should be placed around the shim on all sides.
Excess grout can now be removed from around the shims tapering the side at approximately 45deg.

Shims should be rechecked for flatness in 20/30 minutes and re-adjusted if necessary.
Cover grout with damp rags or burlap for the first 24 to 36 hours. Allow the grout to cure for a minimum of 72 hours before proceeding with the installation.
Alternately: Loose stacked steel packs can be used.

3.6. TRUNNION BEARING SOLE PLATE

The trunnion bearing sole plates are set in position taking special care that the sub-sole plates or shims are not broken loose from their grout. The sole plate is now brought up to grade or level using additional shims. DO NOT use wedges, but place shims, as few thicknesses as possible, between the sole plates to obtain the desired elevation.

3.6.1 Crowning

The trunnion bearing sole plate is crowned by using thicker shims at the centre than at the ends. This crown is from 0.03 to 0.05mm per 305mm of length of the sole plate (see Sketch "A"). The crowning and levelling of the sole plates should be completed. The elevation of the two (2) trunnion bearing sole plates should be within plus or minus 1,63 mm at measured centre line of trunnion to centrelines of trunnion.

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3.6.2 Grouting

We suggest all grouting to be completed following acceptance of alignment.

After trunnion bearing sole plates have been levelled and crowned we recommend that they be grouted using data found under 3.8 Grouting also see Sketch "B".

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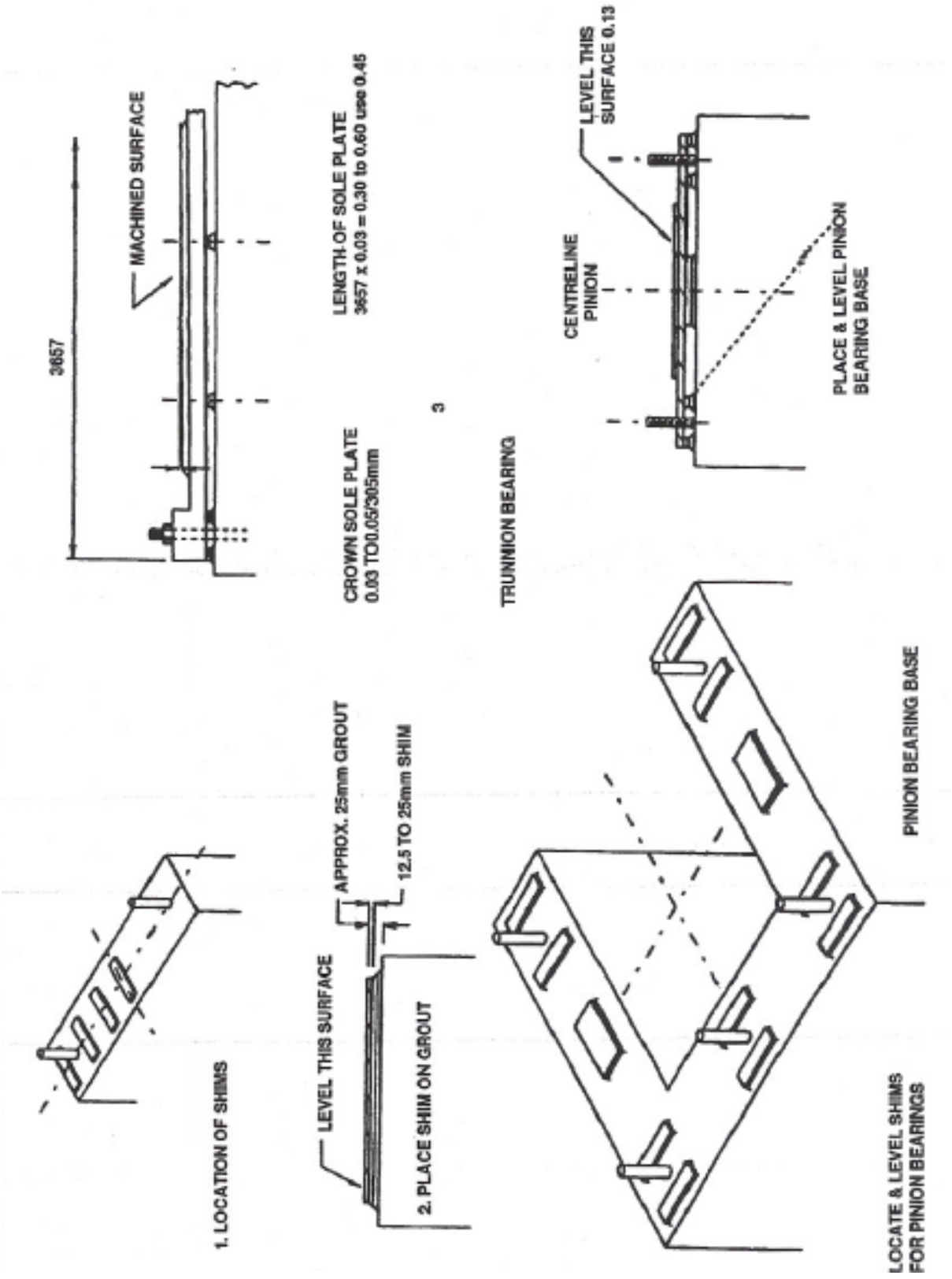

FOUNDATION SKETCH "A"

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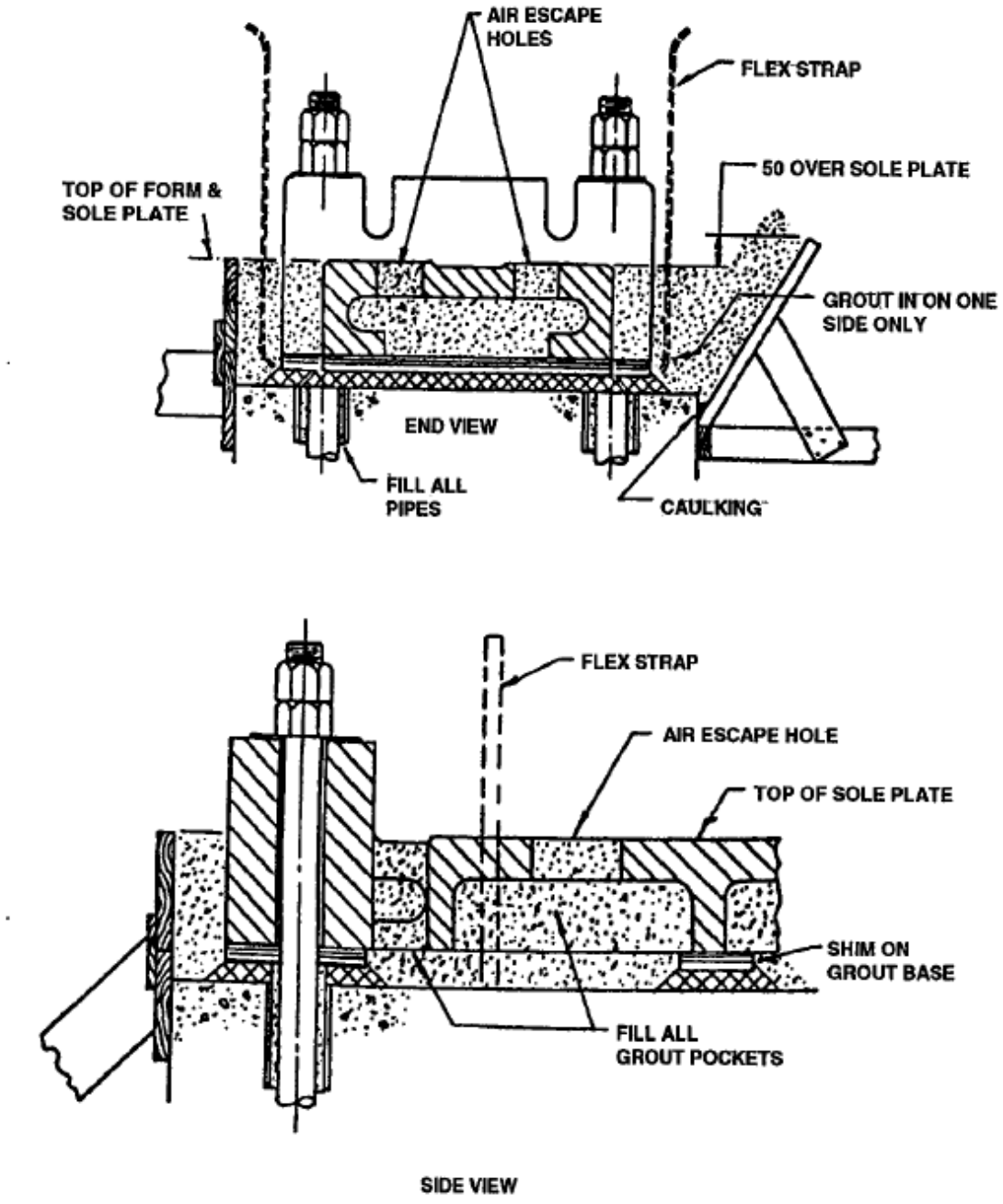

FOUNDATION SKETCH "B"

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3.7. PINION BEARING BASE

The pinion bearing base should be set in position and its location verified using the horizontal and vertical centrelines previously established. Shims could be used to bring the base up to elevation. If the foundation bolts have been threaded all the way to the concrete, a nut may be used to assist in levelling the base. It is not recommended that these nuts be used exclusively, but rather that they are worked in conjunction with the shims to maintain the elevation.

The machined pads, on the pinion bearing base, should be level within 0,13mm plus or minus in any plane and within 1,63mm in elevation (Optical Instrument readings).

DO NOT GROUT in position until the complete drive assembly has been completed.

3.8. GROUTING

The use of non-shrinking grout is necessary with preference given to a premixed grout such as **EMBECON or A.B.E.**

3.8.1 Materials and Tools

Locate all tools and materials as close to area being grouted as possible. Tools should include:

a) Mortar Box or Mortar Mixer (Not Cement Mixer).
b) Wheelbarrow and/or 22,5 buckets for placement.
c) Shovels and hoe.
d) Water measuring container.
e) Flexible steel strap for rodding grout under sole plates and bases.

3.8.2 Surface Preparation

Chip away any defective concrete leaving the surface rough and reasonable level. Surface to be free of oil, grease, dirt and loose particles. Sole plates, bases and bedplates that will be in contact with grout must be clean of all preservatives.

Clean concrete with liberal quantities of water 24 hours prior to grouting. Remove all excess water or loose material that may have fallen on the surface just prior to placing grout.

3.8.3 Forms

With sole plates, bases and bed plates in their final fixed position build strong forms, securely anchored and shored. On the side where grout is to be poured into forms allow at least 150 mm clearance and 50 mm for head above the top of the sole plate (see Sketch "B"). Caulk forms to prevent leakage of grout.

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3.8.4 Mixing

Before mixing grout, be sure mortar mixer has been thoroughly washed and excess water removed. Add the proper amount of portable Water.

For flowable grout not more than O,17/m of mix. The higher the temperature the faster the set; the lower the temperature, the slower the set. At 21°C the initial set of grout is approximately one hour. Above 32°C effort should be made to cool all materials to be used in the grouting. Mix for five (5) minutes.

3.8.5 Placing

Place grout under mill sole plates and bases by flowing. While placing grout use the flexible steel strap to move the grout by push-pulling strap until grout has risen even with the top of the sole plate and form, from side to side. The holes in the top of the trunnion bearing sole plate are to allow any trapped air to escape allowing grout to fill all pockets.
DO NOT USE HOLES IN TOP OF SOLE PLATE TO PLACE GROUT.

Start placing grout at one end and one side of the sole plate and fill form and sole plate end to end in one continuous pour, paying particular attention to anchor bolt pipes. Forms may be removed after four (4) hours and grout trimmed if desired.

3.8.6 Curing

Cure the grout by covering all exposed grout with wet rags or burlap for a minimum of 72 hours, at this time grout should have developed sufficient strength for normal use.

3.8.7 Completion

After the grout has been installed and all forms have been removed, the surfaces may be painted with an oil resistant paint. This is to protect the grout from oil contamination as well as facilitating the cleaning up of spilled materials.

3.9. REDUCERS AND MOTOR BASES

The reducer and motor bases can now be tentatively set in position; however, this operation is generally left until these units are delivered to site.

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4. TRUNNION BEARING (BRONZE BUSH BEARING)

4.1. GENERAL

The following section is to be used in conjunction with the Trunnion Bearing Assembly drawing. Thoroughly study both before proceeding with work.

4.2. CLEANING

The trunnion bearing assemblies are normally shipped to the field fully assembled. Disassemble and clean the unit of any protective coatings used for shipping purposes, except for bushing and swivel assembly. All parts should be carefully inspected to ensure that any foreign objects have been removed and that the castings are clean and free of nicks, or gouges which might interfere in their operation.

4.3. ASSEMBLY

4.3.1 Bearing Base Installation

Re-clean the bearing sole plate and base mating surfaces and remove any nicks, or gouges which will interfere with their mating. Set the bases in position and centre on the previously established mill centrelines.

4.3.2 Bushing to Swivel Assembly

Check for gap between bushing and swivel using feeler gauges in notches provided, at 6 o'clock, both sides of the bushing. If a gap of 0,07mm or more is present loosen hold-down bolts and re-seat bushing. If unsuccessful, take apart and clean.

4.3.3 Swivel Assembly Installation

The swivel with bushing attached, as well as the bearing base, should have a light coating of heavy industrial grease applied to their spherical surfaces. Before installing, re-check the high pressure hose assembly for tightness being sure that the hose and fittings are not damaged. If tip sensitive temperature probes in bushing is to be used, it should be installed at this time.

Lower the swivel into the base making sure that the high pressure hose assembly faces the mill lubrication system for further installation.

Before proceeding further, protect the bearing assembly from dirt or possible damage to the bushing.

4.3.4 Drain Lines

See lubrication system piping diagram. Install piping to drain ports in bearing. Carry piping out only to the junction of the individual bearing.

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4.3.5 Shell Assembly

See the shell assembly section for installation of the shell before proceeding further with the trunnion bearing assembly.

4.3.6 Seating of Trunnion Bearing Components

Having the shell assembly lowered into the bearings, slowly rotate the mill - using the overhead crane and a cable or by hand. Rotate one or two revolutions to seat the swivels. The oil previously applied on the journals will provide lubrication for this rotation.

WARNING
NEVER ROTATE THE MILL ON DRY BEARINGS

4.3.7 Clearances

Check bearing to journal clearances. See attachment for requirements. On the free end (the non drive end) the axial clearance between journal and bushing is greater than the fixed bearing. It is necessary to centre the free-end bearing on the journal so that the axial clearances is equal on both sides. Move the base if necessary.

4.3.8 Trunnion Cap

Before installing the cap, check to be sure that the oil reservoir overflow is correct with mill rotation.

4.4. OIL SEALS

The trunnion bearing is equipped with oil resistant double lip type seals. These seals should be uncoiled and allowed to straighten slightly before installation.

Install as follows:-

4.4.1 Seal

The seal is furnished long and must be cut to size. Place seal around journal and mark correct length, being careful not to stretch. Cut seal at 45° angle in direction of rotation.

4.4.2 Seal Split

Place split at top of journal.

4.4.3 Extension Coil

Place spring in recess of the seal. **DO NOT** stretch or cut the spring as it is furnished to the proper length. Be sure to join spring ends correctly. Springs loosening during operation may seriously damage the bearing journal.

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4.4.4 Grease

Apply a coat of grease to the area of the journal where the seal will ride. Also grease the area underneath the seal itself.

4.4.5 Installation

Slide the seal to the edge of the recess provided and place the brass seal band around the seal. Position the joint of the seal band so that it is between the stop pins on the trunnion assembly. Tighten the band only enough that light pressure is applied to the rubber seal at the journal. Slide the seal into its final position and install retaining plates. Complete remainder of installation.

4.5. MILL START UP

After the mill has been started, check seals for several hours and apply oil directly to the outside edges of the seal. If properly installed, the seal should not rotate, or bind on the journal. If the seals appear to not be installed properly, immediately stop the mill and rectify.

4.6 TRUNNION BEARING CLEARANCE

The mill trunnion bearing will operate satisfactorily if adequate lubrication and bearing clearances are present.

Not enough clearance between bushing and journal will **'pinch off'** the oil flow and cause overheating and bearing failure. Too much clearance will reduce the oil film thickness and cause bearing failure.

In order to ensure proper bearing clearance before mill start-up, follow the procedures as outlined.

4.6.1 Make sure swivel/bushing assembly seats square and aligned in base before lowering the mill into the bearings.

4.6.2 When mill is resting on the bearing, check with feeler gauges all clearances as shown on in Fig 4.7 hereunder and record. Take note that the bearing bushing is relieved towards the edges, so extra long feeler gauges must be utilized.

4.6.3 Extra long feeler gauges must be used to check the gap between bushing and trunnion. The required thickness is shown in table, to the corresponding trunnion diameter.

The proper way to measure bearing clearance is illustrated in Fig 4.7. Make sure to insert the feeler gauge square into the gap until it bottoms out. Pull out and measure obtained insertion length and record on worksheet. Repeat until all 6 readings are obtained.

Average opposite readings and record in the space provided.

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Compare the average readings to the corresponding insertion lengths shown on table. If obtained values fall between the range shown, bearing clearance is adequate. If not, contact an NCP Engineer for corrective action.

NOTE:
The final operating bearing clearance can only be obtained after the mill has been started several items and all bearing components have seated properly.

CAUTION
The mill must be at rest for at least 5 minutes to allow it to settle before feeler gauges are inserted

TRUNNION BEARING DIA. mm	BEARING BUSHING ARC	FEELER GAUGE THICKNESS mm	REQUIRED INSERTION LENGTH RANGE mm
343	180°	.05	50 - 125
508	180°	.07	100 - 203
610	180°	.07	125 - 250
762	180°	.12	125 - 280
813	180°	.12	150 - 330
864	120°	.07	50 - 178
915	180°	.15	178 - 730
1016	180°	.15	203 - 407
1118	180°	.12	356 - 580
1118	120°	.12	50 - 203
1524	180°	.2	305 - 635
1524	120°	.2	100 - 432
1905	180°	.2	508 - 838
2032	180°	.25	457 - 864
2159	180°	.25	483 - 940
2159	120°	.2	75 - 457
2540	120°	.25	125 - 508

Table 4.6: Bearing Clearances

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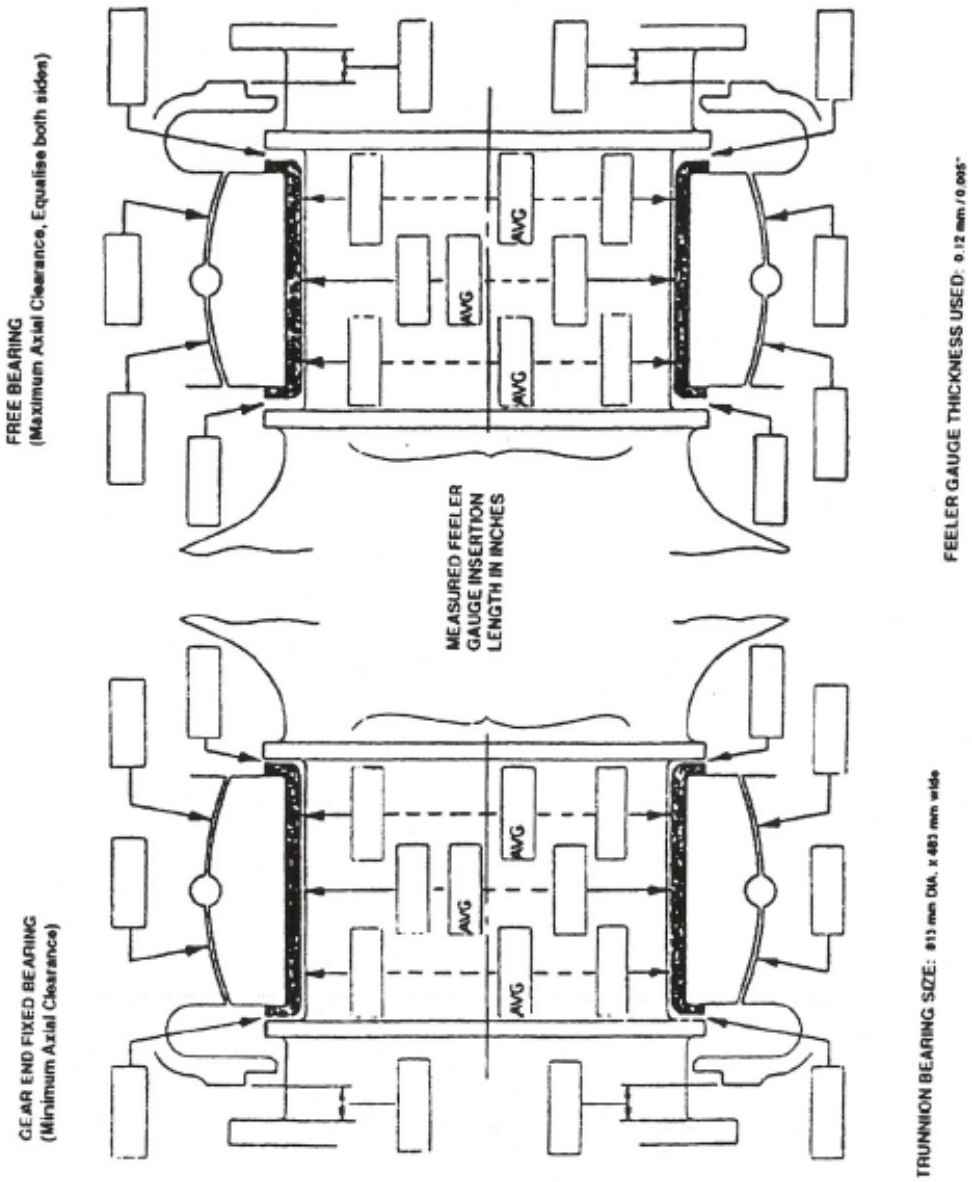

Fig 4.7: TRUNNION BEARING ASSEMBLY

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4.7. TRUNNION BEARING MAINTENANCE

The trunnion bearing, when properly lubricated, should require very little maintenance.

4.7.1 Oil Seals

Should the oil seals start to leak excessive lubricant, they should be replaced. See Section 4, "Trunnion Bearing Assembly" above for installation procedure.

4.7.2 Bushing - Swivel Type / Self Aligning

The best indicator of bearing problems is an abnormal increase in temperature. If after initial examination of the assembly, to be sure proper lubrication is being received and no other visible problems exist, it will be necessary to remove and replace the bushing, the following procedure should be followed:

- ⇨ Stop the mill and remove oil supply lines to the bearing cap.
- ⇨ Clean bearing housing to remove all loose materials.
- ⇨ Disconnect temperature detection assembly at the weatherhead, if applicable.
- ⇨ Disconnect oil level sensors, if applicable.
- ⇨ Remove high pressure line at bearing swivel.
- ⇨ Remove oil seal retaining rings from bearing cap.
- ⇨ Unbolt cap and remove.
- ⇨ Use jacks or jacking cradle to raise mill (6mm is sufficient).
- ⇨ Remove all swivel connection or hold-down devices, if applicable, to allow its removal.
- ⇨ Insert eyebolts into lifting side of swivel and connect lifting cables.
- ⇨ Protect the head journal area from damage by the cables, or lifting device with wood, rubber sheets, matting or other suitable materials.
- ⇨ Rotate the swivel around the journal using the lifting device properly located to complete operation. Approximately 100° rotation is required, or until the high pressure fitting, or lifting hole in the bottom of the swivel is exposed.
- ⇨ Remove high pressure fitting, if applicable, and insert eyebolt of approximate size.
- ⇨ Connect lifting device to eyebolt and continue rotation until swivel can be removed from journal.
- ⇨ Remove swivel and examine bearing for wear or segregation. When replacing the bushing, it may be necessary to drill and tap the hold-down bolt holes and / or temperature probe socket. (Unusual circumstances only.)
- ⇨ Examine the head journal areas for scratches and or gouges. Smooth any rough areas radially using fine emery cloth or stone.
- ⇨ Upon replacing swivel, be sure contact area with trunnion base is well greased. Be sure orientation of high pressure piping connections are corrected and tight.
- ⇨ Re-install swivel and bushing assembly in reverse order to above.
- ⇨ Before re-installing trunnion bearing cap, check oil seals for condition and possible replacement.

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4.8. BUSHING - RIGID TYPE

These units are babbitt-type bushings held in position by the trunnion bearing base and cap. The entire base is replaced when needed and the oil units can be returned to the factory for rebabbitting.

5. SHELL ASSEMBLY

5.1. GENERAL

Mills of approximately 2743mm diameter and smaller are generally shipped with the heads attached.

Mills over 2743mm diameter, as is the Apollo Mill, parts are shipped separately and field assembly will be required.

5.2. ASSEMBLY FACILITY

If the mill is received at the site disassembled, it may be assembled.

5.2.1 First

If lifting facilities are available such that the entire shell and head assembly can be lifted as a unit, then they can be assembled in close proximity to the foundation, prior to positioning onto bearing.

5.2.2 Second

Using wooden timbers construct a crib suitable for holding the mill shell in position. Its longitudinal centrelines should be approximately 50 to 100 mm above the mill's normal centrelines. Proceed with the remainder of the assembly.

5.2.3 Third

If maintenance jacking cradle assembly is available, use to hold shell in position. Additional bracing is advisable.

5.3. CLEANING

Clean the surfaces of all connecting joints or fits such as shell and head flanges, trunnion liner and feeder connections. They must be clean, free from dirt and dry. Check for nicks and burrs and remove all items that would interfere with the assembly. The flange surfaces

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must be clean and dry for installation or loosening of the joints may occur during mill operation causing bolt or flange failure.

Before lowering the heads into position, clean the journal area of its protective coating and inspect to be sure no burrs or gouges have been encountered; if so, remove, using a fine stone or emery paper.

5.4. SHELL

Refer to Shell Assembly Drawing for torque values and for any special alignment instructions before proceeding with the assembly. See pages Attachment hereto "Bolt Identification and Torque Table".

5.4.1 Heads

Assemble the mill heads to the shell. On most mills the gear is bolted to the shell flange.

Check the Assembly Drawing for size and location of bolts on the head. This will eliminate the necessity of removing bolts, at a later date, when installing the gear.

Extra care could be given to ensure that the heads seat properly and that the male/female joint is completed. **No sealer or gasket material is to be applied to these joints.**

5.4.1.1 Grate Discharge Mill (Not Apollo supply)

It is advantageous, if parts are available, to install the grate assembly in the head before placing the head to the shell. Complete assembly in accordance with the drawings furnished. Any cavities around the pan liners should be filled with grout, rubber, or other suitable material before completing the grate installation. In installing the grates, the primary objective is to draw them up tightly and equally against the centre discharge liner.

The discharge liner may be a separate piece or an integral part of the discharge trunnion liner, depending on mill design.

The tightening is done by using the grate adjusting screws or end ring liners and should be carried out in progressive steps, alternating at 180 intervals so that *centering* of the discharge liner is maintained. This adjustment should be done having the side clamp bars only loosely bolted in place. After the grates have been completely tightened, check for correct uniform positioning of the sections. The side clamp bars may be tightened, again using an alternating pattern. This should result in the side clamp bars firmly bearing against the bevelled sides of the grates. The side clamp bars should not seat against the discharge head lifter liners.

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5.4.2 Coating

Coat head trunnion journals and trunnion bushing with heavy oil (STP) and lower assembly onto the bushings.

5.4.3 Trunnion Bearing Assembly

Return to the trunnion bearing assembly instructions, and complete the assembly.

5.5. GEARING

Install mill girth gear in accordance with the Manufacturer's instructions, attached hereto.

After the gear has been properly installed and brought into acceptable alignment as to radial and rim face runout, proceed to Pinion Bearing Assembly and complete its installation.

5.6. LINERS

5.6.1 Trunnion Liners

On trunnion liners having spirals, special care should be taken to assure the correct handed units are used.

5.6.2 Head Liners

Head liners are usually installed prior to the shell liners. Consult the Assembly Drawing for liner arrangement and any special instructions.

5.6.3 Shell Liners

Shell liners should be installed in accordance with the assembly drawing or drawings furnished by the liner supplier. On liners having an even profile, attention to the mill rotation should be kept in mind. It is recommended that lining be started at the manhole (if used), thereby properly locating the correct section to fit around that opening.

5.6.3.1 Manganese Liners (Not supplied to Apollo)

Manganese liners grow dimensionally during operation causing structural shell damage.

When the gap between the liner has been closed, the liners should be removed and ground to re-establish the gaps, 10 to 12,5 mm.

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5.6.4 Fillers

Fill any large gaps especially those that run radially around the mill shell. Check carefully the area between the head and shell liners. These areas can be closed using, rubber fillers or any other suitable material.

5.6.5 Manhole Liner Cover

When installing this assembly, be sure a good fit between the gasket, cover and shell is obtained. Tighten the bolts securely and re-check installation.

5.6.6 Protective Rubber Backing

The mill shell and heads is protected by a 6mm shore 60 natural rubber backing. Before liner installation, the spiders supporting the shell should be removed. The spiders are not to be removed before the heads are attached to the shell.

6mm Rubber inserts should be installed where the shell steel has been exposed where the spiders were installed.

The rubber backing should be inspected prior to liner installation and any nicks repaired with a rubber filler.

Care must be taken not to allow any rubber on head to shell connection flanges or bearing journals.

5.7. COMPLETION

Install remaining parts such as flinger rings, mudguards, etc. Re-check bolts requiring torquing.

6. PINION BEARING ASSEMBLY

6.1. GENERAL

The bearing base has been set and levelled. If this has not been completed, refer to the Foundation section for instructions.

6.2. GEAR GUARD SECTION

The lower portion of the gear guard, which mounts to the bearing base, should be lowered into position and bolted in place.

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6.3. CLEANING

The pillow block mounting pads should be cleaned and any nicks or gouges which would interfere with the installation removed. The pinion shaft bearings should be thoroughly cleaned removing the protective coatings and materials used for shipment. The pillow blocks should be disassembled and cleaned and their bases checked for nicks or gouges.

6.4. SHIMS

It is recommended that initially a 0,25 mm full face shim be placed under the pillow blocks. This will allow for lowering of the blocks, at a later date, should it be required for alignment purposes.

6.5. ASSEMBLY

Refer to the Pinion Bearing Assembly Drawing for torque values and any special instructions before proceeding. See attachment for "Bolt Identification and Torque Table".

6.5.1. Grease Lubricated

If bearings are to be grease lubricated, pack them at this time. For more information, see the Maintenance instructions. Only recommended grease types should be utilized.

6.5.2 Pillow Blocks

Assemble pillow blocks to shaft. Be sure stabilising ring (if applicable) is installed correctly.

NOTE: Caps and bases are not interchangeable, each cap and base must be assembled with its mating part.

6.5.3 Placement

Lift assembly and gently place pinion gear. Lower into position and install hold down bolts. Check free (floating) bearing to be sure it is centered in housing.

6.5.4 Alignment

Align pinion to gear in accordance with gear installation instructions. When shimming under pillow blocks, be sure and use full face shims. Alignment can only be checked after pillow blocks are properly torqued. See assembly drawing for values. If not satisfactory, repeat procedure until correct alignment is achieved.

6.6. DOWELLING

After alignment, dowel pillow blocks in place using the taper pins provided. See Assembly Drawing for step drilling and reaming instructions.

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NOTE: All pillow blocks and bases are now keyed for positive alignment.

6.7. COMPLETION

Complete the assembly by adding any cover plates or guards as noted on drawing.

6.8 GROUT

The pinion bearing base can now be grouted in place.

6.9 INSTALLATION OF GIRTH GEAR

6.9.1 General

The life and performance of a mill-gear set depends as much on the initial installation and alignment as it does on lubrication and routine maintenance during operation.

The steps outlined herein should be studied before and followed strictly during installation.

WARNING
NEVER ROTATE THE MILL ON DRY BEARINGS

6.9.2 Cleaning

All teeth and mounting surfaces must be thoroughly cleaned before installation. Remove all burrs and bumps incurred in handling.

6.9.3 Match Marks

The split gears must be assembled with the mating surfaces in the same position as when the teeth were cut. To assure this, the gear halves have been match marked. When assembled in the correct operating position, the match marks will line up.

6.9.4 Jack Screws

Install the jack screws, if provided, in the gear counterbore before mounting the gear to the shell assembly.

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6.9.5 Special Tools Needed for the Gear & Pinion Installation

- ⇨ Machinist level 305mm - 457mm long.
- ⇨ Two dial indicators with .02mm graduation and at least 1.27mm range. Indicators should be provided with contact buttons.
- ⇨ Feeler gauges with 50mm long blades from 0.3 to 0.5mm thick.
- ⇨ Brass or steel shims .05mm and up.
- ⇨ Prussian blue pigment.
- ⇨ Flogging spanner for the gear split bolts.
- ⇨ Torque wrench for flange bolts.
- ⇨ Temple Sticks for 3160 C or a Pyrometer.
- ⇨ Bolt heating equipment.

6.10. ASSEMBLY OF GEAR HALVES TO MILL

6.10.1 Mounting First Half

Re-check mounting flanges and remove any burrs incurred in handling. Secure the gear half to the mounting flange with every fourth bolt. Rotate the mill so the gear half is positioned on the bottom with the splits in a horizontal position.

6.10 2. Mounting Second Half

Mount second gear half. Assemble so that the march marks on the gear line up. Secure the gear half against the mounting flange with three bolts, one near each split and one 90° from split. Snug these bolts to ensure metal to metal contact, but not so tight that this gear half cannot be shifted.

6.10.3 Align

Align the reamed alignment holes in the splits as accurately as possible by shifting the top half of the gear. Use the jack screws.

6.10.4 Alignment Bolt

Coat alignment bolt with lubricant and install into reamed hole. Use a lead hammer and tap alignment bolt down until both ends of the bolt protrude by the same amount. Install the heavy nuts as shown on the shell assembly and tighten snug.

Follow the same procedure to install the three (3) remaining alignment bolts. Install both bolts for one split before proceeding to the other split.

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6.10.5 Checking

With a straight edge and feeler gauges, check the alignment on the rim face of the gear halves. They should align themselves with approximately 0.6mm.

6.10.6 Clearance Bolts

Insert clearance bolts as shown on shell assembly and adjust top and bottom heavy nuts so that equal portions extend above and below the split. Remove bottom nuts, making sure they rotate freely. Slip bolts out of the hole.

6.10.7 Heating

Heat the centre unthreaded portion of the bolt with an acetylene torch (heating tip) until the surface is uniformly heated to a temperature of 316deg C. Check at frequent intervals with Pyrometer or Temple Stick during heating. Rotate bolt during heating to avoid hot spots.

6.10.8 Assembly

After proper heating, slip the bolt into the hole and quickly run a heavy nut on the bottom threads. Tighten nutwith wrench and flog. Run on top and bottom lock nuts and tighten with wrench and flog. Install remaining clearance bolts in the same manner.

6.10.9 Checking

Check gear splits with feeler gauges. They should be feeler tight, less than 0.3mm clearance.

6.10.10 Re- Tighten

Tighten alignment bolts with wrench and slug. Run on top and bottom lock nuts and tighten with wrench and slug.

6.10.11 Flange Bolts

Install every fourth flange bolt in the top half of the gear.

6.10.12 Alignment

After assembly of gear halves, proceed with the various alignment checks explained above.

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7. AUTOMATIC GEAR SPRAY DATA

7.1 SPRAY SYSTEM

For operating and maintenance procedures see lubrication manuals supplied hereto.

8. MILL MAIN BEARING LUBRICATION

8.1. TRUNNION BEARINGS RECIRCULATION OIL SYSTEM

Oil specifications are the same for both bronze and babbit bearings and should be according to the following table:

Mill Application	Ave. Ambient Temp in °F/°C	Reqd. oil viscosity in SSU at 100°F/38°C	Reqd. oil Additives
Wet Grinding	Below 60° / 15.5°	630 - 770	Extreme pressure rust prevention oxidation and foam inhibitors
	Above 60° / 15.5°	900 - 1200	
Dry Grinding	Below 60° / 15.5°	900 - 1200	
	Above 60° / 15.5°	1300 - 1600	

The lubrication system reservoir has a capacity of 630L. The oil should be changed after initial start and after 750 hours operation and thereafter every six months, depending on local conditions. Most lubricant suppliers can test oil from the unit and recommend economic oil change schedules.

8.2. PINION BEARINGS GREASE LUBRICATED

The grease lubrication of pinion bearings should be according to the following guidelines.

- ⇨ The grease should be an EP type grade No.2, sodium or lithium soap base, having a 900-1000 SSU at 38°C base oil viscosity, ASTM worked penetration at 25°C of approximately 300 and a drop point of approximately 149°C.
- ⇨ Excess grease in the pillow block will induce high bearing temperatures, therefore the quantity of grease should be kept at approximately 1/3 to 1/2 of the free air space. A safe rule is to add grease slowly as the bearing operates until the first sign of grease appears at either seal.
- ⇨ A small amount of new grease should be added every two months. The old grease should be replaced at least once a year.
- ⇨ Consult lubricant supplier for more specific information.

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⇨ The Apollo mill carries auto lubricators which can be installed to reduce maintenance requirements in terms of periodic greasing. These grease lubricators should be checked periodically and replaced as required.

8.3. GIRTH GEAR AND PINION GEAR LUBRICATION

Intermittent methods of lubrication require lubricants which will adhere to the gear teeth during mill operation. They must provide a film that will resist being rubbed or squeezed off the tooth profile during the interval of time between applications. Spray-on lubricants are furnished with dilutents so it can be applied through automatic spray system at a rate of once every 20 to 30 minutes. This will result in a runoff of 13,5 to 45 L/week depending on gear size.

The lubricants should have a viscosity range between 5,000 and 10,000 SSU at 99°C.

For more specific information, consult with the lubricant supplier.

8.4. HIGH PRESSURE PUMP·MOTOR ASSEMBLY - NOT APPLICABLE

8.5. LOW PRESSURE PUMP·MOTOR ASSEMBLY - NOT APPLICABLE

9. DRIVE AND BARRING GEAR

MAIN DRIVE

Manufacturer:	Moventas
Size:	D2PSF150
Input:	2800kW at 880rpm (60Hz)
Ratio:	7.7838:1
In/out:	113 rpm

BARRING DRIVE

Manufacturer:	Moventas
Size:	D4PSF50
Input:	30kW at 1740rpm (60Hz)
Ratio:	195.61:1
Output:	9 rpm

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10. MAINTENANCE

10.1 GENERAL

Maintenance is the key to successful and long mill operation. A formal maintenance programme should be set up to inspect the mill on a regular basis and perform the required maintenance operations.

10.2 LINERS

10.2.1 Liner Bolts

The most frequent cause of damage to a mill is loose liners. Shortly after initial startup, the impact of grinding media product on the liners causes them to become loose. Therefore their tightness should be carefully watched and the liner bolt retightened whenever necessary.

Loose shell liner bolts can rapidly cause elongation of shell bolt holes and needles expensive repairs.

10.2.2 Head and Shell Liners

A periodic measurement of the liners should be taken and records kept of profiles so that wear rates can be established and replacements ordered in time to be on hand when needed.

When replacing the liners, be sure and clean all ore from the area and check for signs of pulp race or other wear. Be sure backing materials, are in good condition and if not, replace before re- installing the new liners.

10.2.3 Grate Assembly – Not Applicable

During operation the grates should be checked for blinding and cleaned, if necessary, to maintain full production. When replacing pan liners, be very careful to check for pulp wear behind the liners and pack all void areas with grout or other suitable filler.

10.2.4 Trunnion Liners

Mill trunnion liners should be replaced as required to protect the inside head journal area and trunnion inserts.

The area of transition from the mill grinding chamber to the trunnion liner must be regularly inspected for wear and investigated for trunnion liner replacement.

On those liners having rubber seals between the liner and head, we recommend these seals be replaced along with the liner. Upon removal of the liner, the inside journal area of the head should be inspected for signs of pulp race and wear. If present, the means of entry of the pulp should be found and plugged. If the areas of wear are extensive or deep, greater

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than 12,5 mm, an NCP representative should be consulted. If only minor wear is noted, these areas should be patched with a suitable epoxy material.

10.3 BOLT IDENTIFICATION AND TORQUE

10.3.1 Torque Wrenches

- ⇨ Only calibrated torque wrenches shall be used. If calibrating equipment is not available, the torque wrench can be calibrated in the field by running tests with the turn of the nut method or measuring achieved bolt elongation.
- ⇨ Bolts and nuts must be free of dirt, oil, rust, loose scale, burrs etc.
- ⇨ The nut must be in a steady tightening motion, while the bolt is prevented from rotating, when torque is measured. Either bolt or nut can be rotated while torquing.
- ⇨ All bolts must be installed and tight before torquing operation is started. After torquing all bolts return to the first six (6) starting bolts and check torque to be sure they have not loosened.
- ⇨ Because of many interrelated variables affecting friction and joint condition, it is possible to experience as much as 25% deviation in preload between fasteners. Closer control of torque wrench calibration can reduce deviation to +/- 15%

10.3.2 Measuring Fastener Elongation Due to Pre-Loading

A micrometer is used to measure bolt elongation by taking readings before and after tightening. This method cannot be used unless both ends of the bolt are accessible to a calliper type micrometer. Bolt preload accuracy obtained is +/- 3%. To calculate the proper bolt elongation multiply the elongation factor in/in shown in table "A" by the grip length of the bolt assembly.

Example:
Flange thickness (grip length) = 204mm
Bolt grade = 5
Required elongation - see table "A" = 0,0019 mm/mm

Calculation: 204 x 0,0019 = 0,14 mm

Note: Bolt diameter not required for elongation calculation.

10.3.3 Checking of Existing Torqued Bolt Connections

The only practical way is by using a calibrated torque wrench. A calibration check should be done by using the turn of the nut method or measure bolt elongation prior to using the torque wrench.

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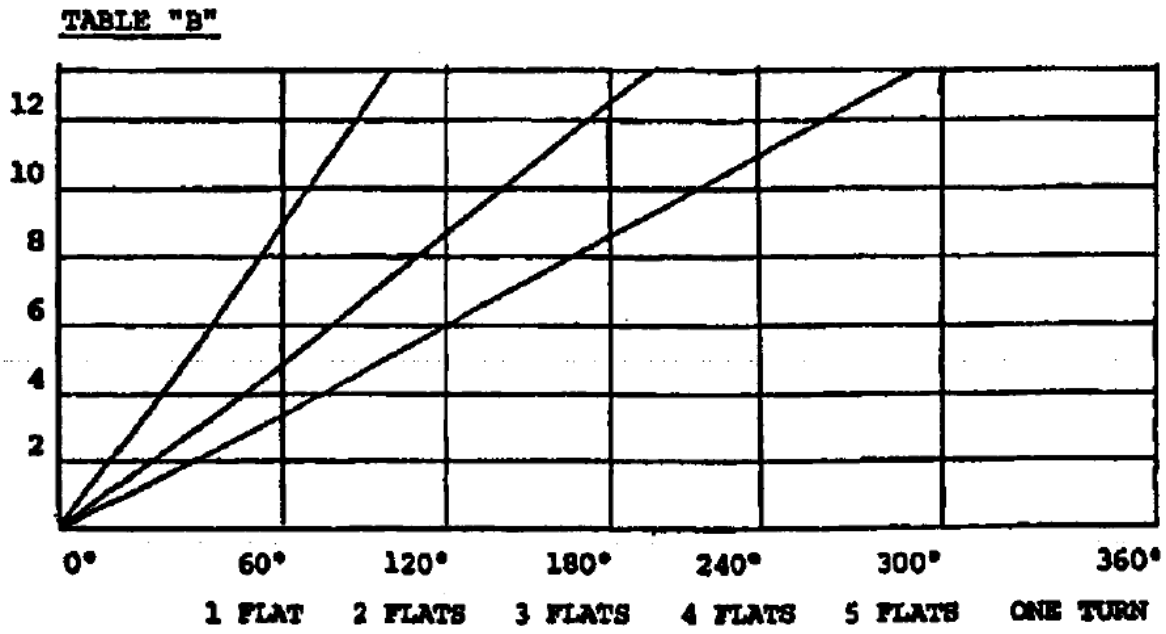
10.3.4 Turn of the Nut Method

- ⇨ All bolts must be installed and flanges tight before proceeding.
- ⇨ One by one, loosen nut and tighten "snug tight" (this is defined as tightness attained by the full effort of one man using an ordinary spud wrench).
- ⇨ Then given the nut the prescribed turn, as shown in graph Figure 10.3 while the bolt is prevented from rotating. Note: Nut or Bolt may be turned.
- ⇨ Tolerance on rotation; 1/2 flat or 30° over, nothing under.
- ⇨ Bolt preloading can be checked with micrometer. Obtained accuracy between fasteners of 15% because it eliminates the influence of all friction variables. This method cannot be used for checking already torqued bolts, unless bolt is loosened and procedure repeated.
- ⇨ Table "B" is based on 20% bolt elongation loss due to embedding in typical machined flanges.



TURN OF NUT FROM SNUG TIGHT FOR BOLTS FROM 20mm - 60mm

Figure 10.3

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10.4. TRUNNION BEARINGS

The trunnion bearing, when properly lubricated, should require very little maintenance.

10.4.1 Temperature Detection and Limitation of Bearings

It is difficult to predict the exact operating temperature of the trunnion bearings. Experience has shown that each bearing stabilises to its own temperature, ranging between 32°C and 52°C. Many factors such as ambient temperature, quantity of oil, viscosity, bearing clearance, alignment, quantity of mill water, etc., contribute to the final bearing operating temperatures.

If bearing temperatures do not stabilise within this parameter, the mill must be shut down and corrective action taken by calling the an NCP representative.

10.4.2 Setting of "ALARM" and "SHUT DOWN" Set Points on Temperature Monitoring Instrument

The instrumentation must be calibrated before starting the mill, to alarm at 60°C. The easiest and safest way to adjust the instrumentation is to monitor all bearing temperatures very carefully during startup and under normal grinding conditions. Then adjust the individual set points for each bearing to 54°C minimum and 66°C for shut down.

10.4.3 SIMPLE RULE OF THUMB: A surface temperature of 50°C to 55°C is approximately the hottest a person can hold his hand against without discomfort.

Oil film temperatures above 93°C cause rapid deterioration of the lubricant, evidenced by chemical breakdown and the formation of harmful acids.

10.4.4 Bushing - Swivel Type/Self Aligning

The best indicator of bearing problems is an abnormal increase in temperature.

If after initial examination of the assembly, to be sure proper lubrication is being received and no other visible problems exist, it will be necessary to remove and replace the bushing.

The following procedure should be followed:

- ⇨ Stop mill and remove oil supply lines to the bearing cap.
- ⇨ Clean bearing housing to remove all loose materials.
- ⇨ Disconnect temperature detection assembly at the weatherhead, if applicable.
- ⇨ Disconnect oil level sensors, if applicable.
- ⇨ Check high pressure hand pump unit to be sure it will not interfere with removal of cap. If so, remove unit.
- ⇨ Remove high pressure line at bearing swivel.
- ⇨ Remove oil seal retaining rings from bearing cap.

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- ⇨ Unbolt cap and remove.
- ⇨ Use jacks or jacking cradle to raise mill (6 mm is more than ample).
- ⇨ Remove all swivel connecting or hold-down devices, if applicable, to allow its removal.
- ⇨ Insert eyebolts into lifting side of swivel and connect lifting cables.
- ⇨ Protect the head journal area from damage by the cables on lifting device with wood, rubber sheets, matting or other suitable materials.
- ⇨ Rotate the swivel around the journal using the lifting device properly located to complete operation. Approximately 100 degrees rotation is required or until the high pressure fitting or lifting hole in the bottom of the swivel is exposed.
- ⇨ Remove high pressure fitting, if applicable, and insert eyebolt of appropriate size.
- ⇨ Connect lifting device to eyebolt and continue rotation until swivel can be removed from journal.
- ⇨ Remove swivel and examine bearing for wear or segregation. When replacing the bushing, it may be necessary to drill and tap the hold-down bolt holes and/or temperature probe socket.
- ⇨ Examine the head journal areas for scratches and/or gouges. Smooth any rough areas radially using fine emery cloth or stone.
- ⇨ Upon replacing swivel, be sure contact area with trunnion base is well greased. Be sure orientation of high pressure piping connections are corrected and tight.
- ⇨ Re-install swivel and bushing assembly in reverse order to above.
- ⇨ Before re-installing trunnion bearing cap, check oil seals for condition and possible replacement.

10.5. REPLACEMENT INSTRUCTIONS FOR SPHERICAL ROLLER BEARINGS ON PINION SHAFTS

10.5.1 Temperature Detection and Limitation of Bearings

The pinion bearing temperatures are influenced by many factors. Each bearing will stabilise to its own operating temperature, ranging between 60°C and 82°C. The mill is driven by helical gearing, which transfers thrust to the located pinion bearing. This bearing will naturally run slightly hotter.

If bearing temperatures do not stabilise within the above parameters the mill must be shut down and corrective action taken by calling the bearing supplier.

IMPORTANT
Match the complete bearing number as called out on pinion bearing assembly drawing. This will ensure the use of bearings with proper internal radial clearance.

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STEP 1: Remove Pinion Assembly from Mill Installation

Disconnect coupling and remove both pinion bearing caps, and bases.
With overhead crane, pull out complete pinion assembly.
ENSURE LOCATING KEYS ARE STORED.

STEP 2: Remove Damaged Bearing

Coupling hub must be removed if the inboard bearing is replaced. The hubs and bearings are generally installed with heavy press fits. The proper tools must be used to remove these items. Make note of exact hub location on shaft before it is removed. If the shaft journal surface is damaged during this process, carefully stone high ridges.
Do not remove excess material and undersize shaft diameters.
Excessive wear due to sleeve rotation will need to be properly repaired. Contact an NCP representative.
Clean and mic bearing housing bores to ensure housings have not experienced wear by rotating bearings. Housings worn beyond tolerance should be replaced.

STEP 3: Prepare for New Bearing Installation

The bearing should remain in its original packing until immediately before mounting. Do not remove coating from bearing. If packing has been damaged and the bearing becomes dirty, it must be cleaned with water-free kerosene. Set up pinion shaft in proper position to facilitate the bearing installation. Slide inboard triple lab ring onto shaft.

STEP 4: Install Sleeves

Install internal lab ring.
Install sleeves.
Install bearings onto sleeve taper in position as detailed on pinion shaft layout drawings.
Tighten sleeve nuts and check bearing clearances with feeler gauge.

STEP 5: Finish Bearing Installation

Slip on outboard triple ring seal.
Locating rings must be refitted to the fixed bearing.
The fixed bearing is nominated as the drive side bearing.

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STEP 6: Install Coupling

Heat the hub in clean oil to a temperature of between 121°C and 149°C and soak. Check bore with callipers. If the expansion is insufficient, raise the temperature by 38°C.

If still insufficient, freeze the shaft by packing in dry ice around the journal. Install key on shaft and mount hub quickly into its original location.

STEP 7: Check Run Out of Coupling

Place shaft in lathe or fixture and check hub runout with dial indicator. If mounting flange runout is not within 0,13 mm, TIR flange seat must be re- machined.

STEP 8: Re-Install Pinion Shaft

Clean bearings, pillow blocks and shaft. If bearings use grease lubrication, smear grease between the rolling elements and work it in. Pack lower half of pillow blocks with grease even with large shaft opening.

Lower complete assembly into pillow blocks, carefully guiding the triple seal rings into position. Check triple seal rings to be sure they rotate freely. Place stabiliser ring in its proper location, check assembly drawing and replace caps. If oil lubrication is used, flush bearings with oil before starting the mill. Re-fit locating keys.

STEP 9: Drive Train

Re-connect coupling. Re-alignment of gearing and clutch or coupling is not required but should be checked prior to mill startup.

10.6 PREVENTATIVE MAINTENANCE

DAILY	Inspect mill installation for high bearing temperatures, vibrations, excessive noise and leakage around mill. Check visual indications for flowrates and pressures on lubrication systems.
WEEKLY	Check filter indicators.
MONTHLY	Inspect wear on head liners, shell liners and trunnion liners.
	Inspect trunnion bearing oil seals.
	Inspect gear spray system and grease drum.
	Inspect gearing for abnormal wear and adequate lubricant.
BI-MONTHLY	Add small amount of new grease to pinion bearing, if grease lubricated.
ANNUALLY	Replace bearing grease.
	Replace trunnion bearing oil, flush and clean.

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10.7 TROUBLE SHOOTING

1.	**GEAR AND PINION VIBRATION**	
	Excessive Backlash	Move the mill gear toward the pinion to attain proper backlash readings.
	Insufficient Backlash	Move the mill gear away from the pinion and check for proper backlash clearances.
	Misalignment	Realign the mill gear to pinion by moving or shimming the proper bearing assemblies. Measure and check the gear alignment.
	No-Load Conditions	Normal gear backlash will create gear noise and vibration if there is no load in the mill.
	Grout Disintegration	If the grout has deteriorated or is not to specifications, the mill vibration may disintegrate the grout.
		If the grout starts to break up under the sole plate near the mill centre line, the weight of the mill will bend the trunnion bearing base and pinch the bearing bushing. The pinching action can wipe off, or reduce the oil film on the journal and dangerously inhibit bearing lubrication leading to bearing failure.
		Inspect and check the bearing clearance. Shim beneath the trunnion bearing if grout disintegration is limited. Major grout disintegration cannot be corrected by shimming. Sole plate must be reset and re-grouted.
	Inadequate Trunnion Bearing Clearances	Check bearing clearances and shim between base and sole plate as necessary.
2.	**EXCESSIVE PINION BEARING TEMPERATURE**	
	Insufficient or Improper Lubrication	Increase the lubrication flow if it is a flood oiling system and check for the proper lubricant. If the bearings are grease lubricated, do not exceed the supply recommended.
		Check temperature detector for proper operation and set points.
	Clearances	See Bearing Installation Instructions.
3.	**BEARING SEAL OIL LEAKAGE**	
	Oil Not Draining Properly	Cold Oil
		High oil viscosity will not allow oil to flow freely in the return lines. Wrap lines with heat tape or insulation.

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4.	**PULP LEAKAGE BETWEEN TRUNNION AND TRUNNION LINER**	
	Leakage	Pull liner and inspect head and trunnion area for excessive wear. Contact NCP representative if structural integrity is questionable. Inspect seal seat areas and repair with Epoxy Filler. **DO NOT WELD ON HEADS**. If trunnion liner is excessively worn, replace and seal.
	Damaged Seat	The seat between the trunnion liner and head may lose its sealing effectiveness due to impact, parts shifting and abrasive slurry wearing away the seat.
		If the trunnion liner seat still holds its position, drill two holes 180 apart in the trunnion liner and fill the void between the liner and the head with sawdust. The sawdust will absorb the moisture, expand and stop the flow of pulp. If the trunnion liner does not hold its position, replace and seal. Alternately, urethane foam filler.
	Spout Feeder Leakage	Inspect the spout feeder for worn seals, gaskets or parts. Replace them as necessary. Check that the spout is aligned to the mill.

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APPENDICES

Appendix 1 – Lubrication Schedule

Appendix 2 – Bolt Torque Parameters

Appendix 3 - Bearing Temperature Record

Appendix 4 - Girth Gear & Pinion Data

Appendix 5 - Handy Worksheet - Installing Ring Gears

Appendix 6 – Girth Gear Installation Manual

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APPENDIX 1 – LUBRICATION SCHEDULE

LUBRICATION SCHEDULE					
Part to be lubricated	**Method of application**	**Mill application**	**Ave. ambient temp °C**	**CALTEX**	**SHELL**
Main Trunnion Bearings	Flood oil circulation	Wet grinding	Above 25°	MAROPA 220	OMALA 220
		Dry Grinding		N/a	N/a
				N/a	N/a
Pinion Bearings	Grease Packed / Autolube	Wet grinding		MARFAK Multi Purpose	ALVANIA EP2 Grease
Main Drive Gearbox	Flood oil circulation	Wet grinding		MAROPA 320	OMALA 320 (Refer to manual)
Barring gear gearbox	Splash Lube Oil Circulation	Wet grinding		MAROPA 320	OMALA 320 (Refer to manual)
Low Speed geared Coupling	Grease Packed	Wet grinding			ALVANIA GL00 Grease
Barring gear Coupling	Apply before engaging barring coupling				General Purpose grease
Gear & Pinion	Grease Spray Lube	Wet grinding			CEPLATYN KG10 supplied by FUCHS
Gear & Pinion	Running in compound	Tooth Improvement	Should gear surfaces require improvement during the life of the mill, we would recommend KLUBER GRAELOSCON BSG 00 PLUS. This is not required on a new mill installation.		

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APPENDIX 2 – BOLT TORQUE PARAMETERS

BOLT IDENTIFICATION, MECHANICAL PROPERTIES & REQUIRED TORQUE

TABLE A

GRADE DESIGNATION	MIN MECHANICAL PROPERTIES IN PSI		REQUIRED TORQUE RANGE IN NM FOR DRY ISO METRIC BOLT CONNECTIONS					
			¾"	1"	1¼"	1½"	1 ¾"	2"
SAE J429 GRADE 2 ASTM A307 GRADES A & B	Tensile strength Yield strength Proof strength	60,000 36,000 33,000	175 to 200	250 to 280	500 to 980	870 to 980	1400 to 1580	2000 to 2250
SAE J429 GRADE 5 ASTM A-449	Tensile strength Yield strength Proof strength	105,000 81,000 74,000	240 to 270	580 to 530	1100 to 1240	1950 to 2200	3100 to 3430	4600 to 5130
SAE J429 GRADE 8 ASTM A-354 GRADES BD	Tensile strength Yield strength Proof strength	150,000 130,000 120,000	380 to 430	900 to 1020	1800 to 2030	3150 to 3350	-	-

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BOLT IDENTIFICATION, MECHANICAL PROPERTIES & REQUIRED TORQUE

TABLE A

GRADE DESIGNATION	**MIN MECHANICAL PROPERTIES IN PSI**		**REQUIRED TORQUE RANGE IN NM FOR DRY ISO METRIC BOLT CONNECTIONS**					
			M20	M24	M30	M36	M42	M46
GRADE 4.6 ISO R393	Tensile strength Yield strength Proof strength	60,000 36,000 33,000	166 to 185	288 to 320	570 to 633	999 to 1110	1428 to 1587	2138 to 2376
GRADE 8.8 ISO R896	Tensile strength Yield strength Proof strength	120,000 92,000 85,000	428 to 476	740 to 822	1470 to 1633	2569 to 2854	3679 to 4088	5521 to 6134
GRADE 10.9 ISO R898	Tensile strength Yield strength Proof strength	150,000 130,000 120,000	581 to 646	1008 to 1120	2002 to 2225	3492 to 3880	5012 to 5569	7523 to 8359

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APPENDIX 3 – BEARING TEMPERATURE RECORD

BEARING TEMPERATURE RECORDING CHART								
BALL CHARGE							Kg.	
TEST DATE								
MINUTES	HOURS	FEED TRUNNION BEARING	DISCHARGE TRUNNION BEARING	OIL INLET TEMP. TRUN. BRGS.	OUTBOARD PINION BEARING	INBOARD PINION BEARING	MOTOR BEARINGS	
							IN	OUT
0								
15								
30								
45								
60								
15								
30								
45								
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APPENDIX 4 – GIRTH & PINION GEAR DATA

GIRTH GEAR AND PINION DATA	
GIRTH GEAR	
Type	Single Helical
Number of Teeth	182
Pitch	34 Module
Pressure Angle	25deg
PINION	
Type	Single Helical
Number of Teeth	23
Pitch	34 Module
Pressure Angle	25deg
PINION BEARINGS	
Plummer Block	SD 3164
Bearing	FAG 23164CAK/W33/C3

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APPENDIX 5 – HANDY WORK SHEET FOR INSTALLINGNG RING GEARS

This work sheet is a summary of the Service Manual. The charts and tables have been repeated so all readings can be permanently recorded, using one Work Sheet for each set of gears.

STEP 1 CHECKING RIM FACE RUNOUT OF GEAR

Two indicators are used to check rim face runout when equipment has end float in its bearings. Place indicators 'A' and 'B' squarely against the rim face stamped (000) 180deg apart, as illustrated. Set both indicators at zero. Revolve gear and record both readings simultaneously for each stamped station for one complete revolution and record below. After one revolution, both indicators should register within 0.0004". If not, repeat the check as indicators may have moved.

Procedure for Runout Determination

The rim face runout is calculated from readings 'A' and 'B'. Record the readings from indicator 'A' on line 2 and the readings from indicator 'B' on line 4 (use the first four lines for a gear marked with 12 stations). Retabulate the 'B' readings (line $) on line 5 with plus and minus signs reversed (+ to -, - to +). Next, repeat the 'A' readings (line 2) on line 6 with signs as originally recorded. Add the values from lines 5 and 6 and record on line 7 as follows:

- ⇨ Where the (+) value is larger than the (-) value, subtract the (-) value and the result is (+).
- ⇨ Where the (-) value is larger than the (+) value, subtract the (+) value and the result is (-).
- ⇨ Where both values are (+) add the two and the result is (+).
- ⇨ Where both values are (-) add the tow and the result is (-).
- ⇨ Where the (+) and the (-) values are equal, the result is zero.

Divide the values from line 7 by 2 and record the results on line 8. These values are the true rim face run out of the gear for each of the station numbers recorded at indicator position 'A'.
They may be plotted on the graph below.

Allowable rim face runout is shown in Table 1. For gears operating at 5 rpm and less, the allowable rim face runout can be increased by 25%. If the rim face run out exceeds the allowable shown in Table 1, correct by re-machining mounting flange.

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STEP 1A Alternative Method of Checking Rim Face Runout of Gear

If gear can be rotated without end float, place indicator squarely against the rim face stamped (000) at station stamped 1 and set to zero.

Revolve gear slowly, record readings at each station on chart below. After one complete revolution, indicator should read within + 0.002". If not, recheck, or use method described in Step 1.
The allowable rim face runout is shown in the attachment. The total rim face runout is algebraic difference between the maximum plus (+) and the maximum (-) readings.

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APPENDIX 6 – GIRTH GEAR INSTALLATION MANUAL

Please find attached the Gear Installation Manual.

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