



Field Services Report

Alignment of Ball Mill Using Optical and LASER Methods

Abstract

WARMAK Inc. was commissioned by A Fertilizer manufacturer to determine the feasibility and facilitate the alignment of ball mill train. It was determined from preliminary alignment measurements that a significant reduction of the misalignment across the clutch and between the pinion and bull gear could be realized from movement of the pinion only.

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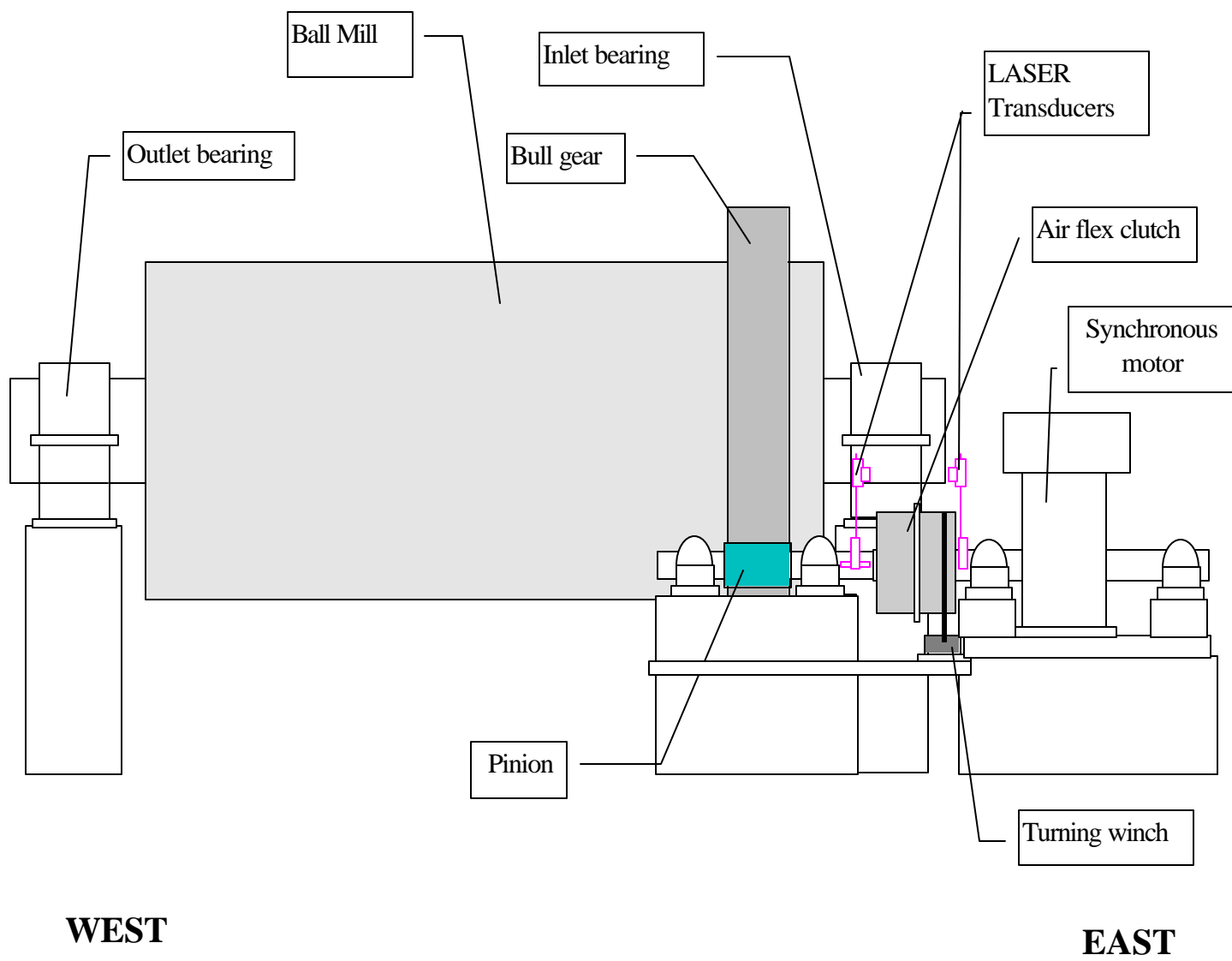
Scope

WARMAK Inc. was to provide labor and resources for the measurement and recording of relative alignment between components of the ball mill train

Background

Plant personnel stated that they had been experiencing clutch failure problems due to misalignment. Three coils on the motor were bad and would be replaced during the next shutdown.

Machine Configuration



Summary of Work

Warmak met with Plant personnel on 99/11/12 To discuss the feasibility and scope of work. The long-term plan is to develop and design an adjustable motor base to eliminate the need for movement of the mill. The short term plan is to measure the relative positions of the components and reduce the alignment as much as possible without moving the mill, if possible.

Warmak went to the facility on 99/11/29 and measured the relative alignment of the ball mill. A small move of 0.040 inch horizontally was made to the pinion by plant personnel. The relative, as found, position of the pinion to the bull gear and the pinion to the motor was such that the misalignment could be reduced with out moving the mill.

Warmak returned to the facility on 99/12/09 for a scheduled shut down and measured the relative alignment of the pinion. It was decided that the final moves of the pinion would be made. Moves in the horizontal and vertical directions were made to the pinion. The final alignments of the components were measured and recorded.

The as found and final positions of the components were graphically demonstrated to plant personnel.

Data

The elevation of the mill shaft centerline at the inlet and outlet was measured using optical methods.

The pinion crown to bull gear root and the pinion to bull gear backlash were measured using thickness gage methods.

The pinion shaft to motor shaft alignment across the clutch was measured using LASER methods. The pinion shaft was not rotated. A special fixture was utilized for this procedure. The motor shaft was rotated using a cable wrapped around the clutch and pulled by a winch mounted to the access deck frame.

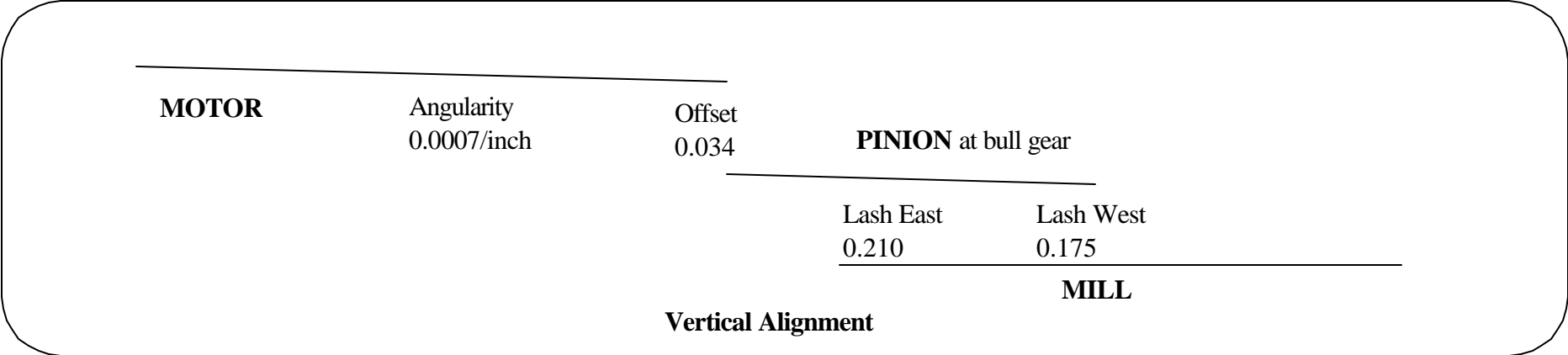
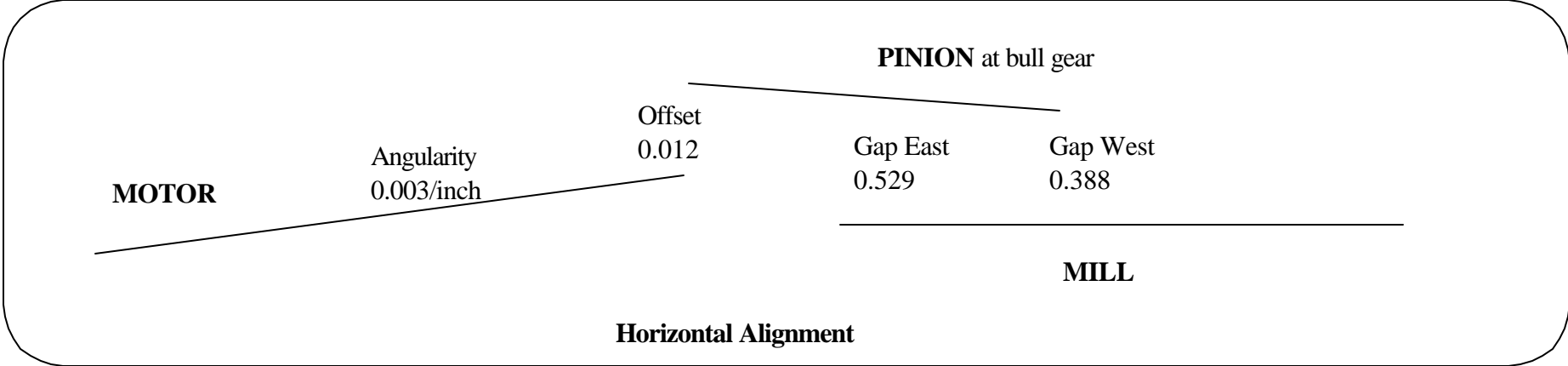
It is assumed that the bull gear teeth are parallel to the centerline of the mill and that the alignment must be done with the mill loaded.

The mill is assumed to be fixed and all other components are referenced to the mill position.

*All measurements are in inches and at the centerline unless noted.
(TIR is 2X centerline).*

All measurements were repeatable.

Ball Mill As Found Alignment 99/11/29

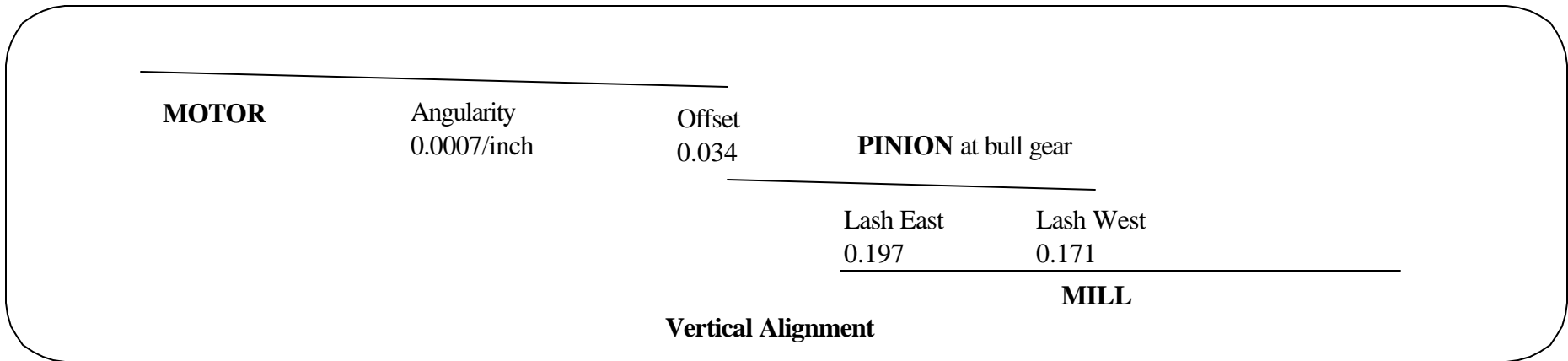
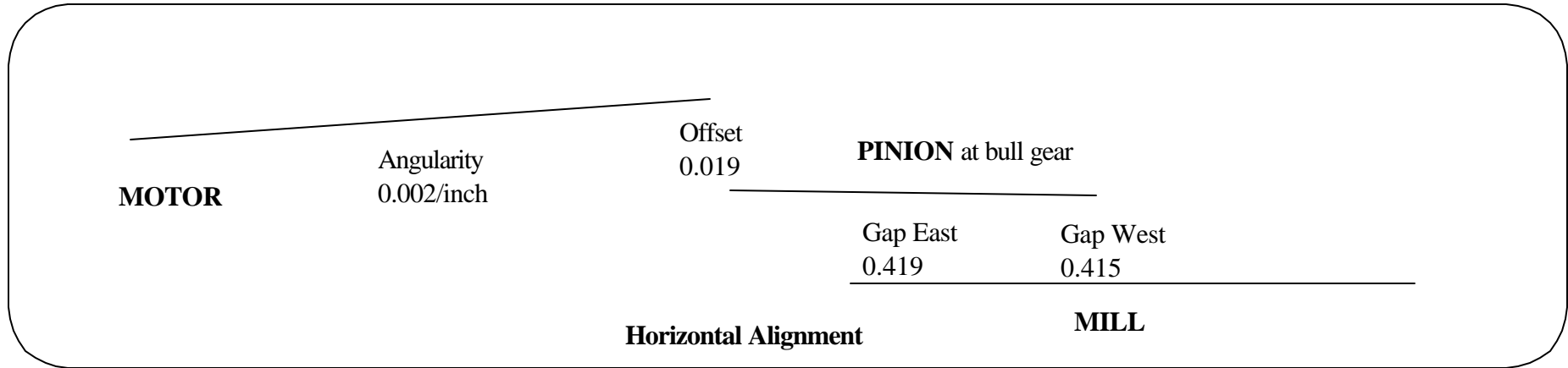


Drawings are not to scale and angles are exaggerated for clarity.

The relative elevation of the mill bearings was measured with two setups, one at each bearing, with a common benchmark reference.

The inlet (east) bearing elevation was 1.771. The outlet (west) bearing elevation was 1.790.

Ball Mill After 0.040 Pinion Move 99/12/09



Drawings are not to scale and angles are exaggerated for clarity.

A 0.040 inch move south of the west pinion bearing resulted in the above relative alignment positions.

Ball Mill Final Alignment 99/12/09

| | | | |
|--------------|---------------------------|-----------------------------|----------------------------|
| <hr/> | | | |
| MOTOR | Angularity 0.0012/inch | Offset 0.004 | PINION at bull gear |
| | | | Gap East Gap West |
| | | | 0.457 0.467 |
| | | Horizontal Alignment | MILL |

| | | | |
|--------------|---------------------------|---------------------------|----------------------------|
| <hr/> | | | |
| MOTOR | Angularity 0.0002/inch | Offset 0.0045 | PINION at bull gear |
| | | | Lash East Lash West |
| | | | 0.215 0.205 |
| | | Vertical Alignment | MILL |

Drawings are not to scale and angles are exaggerated for clarity.

Vertical Corrections: 0.025 inch of full length stainless shim was added under the east pinion bearing. 0.020 inch of full length stainless shim was added under the west pinion bearing.

Horizontal Corrections: an iterative process of moving the pinion and measuring the gap and back lash was used while observing the pinion to motor alignment with the LASER system. This method resulted in the above final horizontal alignment positions.

Summary of Data

The target alignment across the clutch was ± 0.005 inch offset at centerline and 0.0005 inch/inch angularity. The target alignment of the pinion to the bull gear was ± 0.010 inch difference between east and west root gap, ± 0.010 inch difference between east and west back lash. The target root gap was 0.450 to 0.475 inch gap.

The as found alignment of the pinion to the bull gear was 0.141 inch difference east to west. The back lash was 0.035 east to west. The alignment across the clutch was 0.012 inch offset with 0.003 inch/inch angularity in the horizontal direction and 0.034 inch offset with 0.0007 inch/inch angularity in the vertical direction. An elevation difference of 0.020 inch was measured from the mill bearings.

The final alignment of the pinion to the bull gear was -0.010 inch difference east to west. The back lash was 0.010 east to west. The alignment across the clutch was 0.004 inch offset with 0.001 inch/inch angularity in the horizontal direction and 0.005 inch offset with 0.0002 inch/inch angularity in the vertical direction.

Overall the misalignment has been significantly reduced.

The angularity of the pinion to the motor in the horizontal direction was reduced by 66 % but still is greater than the target angularity. This can only be corrected with movement of the mill or motor.

Some spalling was visually observed on the pinion teeth on the west half of the pinion gear. This was probably from misalignment to the bull gear. An increase in vibration at the pinion bearings will result from the alignment corrections until the pinion gear wears in.

A method for jogging the bull gear should be developed. This would improve the accuracy of the back lash and root gap measurements used during alignment of the pinion to the bull gear.

Appendix A (Equipment Used)

K&E One Arc Second Level with Micrometer Head

K&E Optical Scales with Magnetic Base

8 foot and 16 foot Tripods with Tubular Extensions

Combi LASER Measurement System

WMK Extended Radius Fixtures

WMK Turning Winch

Assorted Hand Tools

Shim Stock was provided by Cargill