Laser Alignment Standards & Procedures

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Introduction

MMS Ltd, can provide precision alignment of all rotating machinery were component shafts are coupled together. The approved method of laser alignment at various locations by MMS Engineers is Laser Alignment.

Laser Alignment will provide these long term benefits:

- Improved machine reliability and productivity.
- Reduced machine repair costs
- Reduced labour costs
- Reduced power consumption of machinery
- Minimization of machine installation and repair time.
- Allow verification of machine performance throughout the machine life.

These Standards provide MMS Engineers with specific guidelines for the installation and repair of rotating equipment assemblies.

1.0 Laser Alignment Standards

1.1 Precision Alignment Definition:

Laser shaft alignment is the procedure of positioning two or more machines so that the rotational shaft centerlines are perfectly collinear. This may for example include several assets such as motor, gearbox and pump.

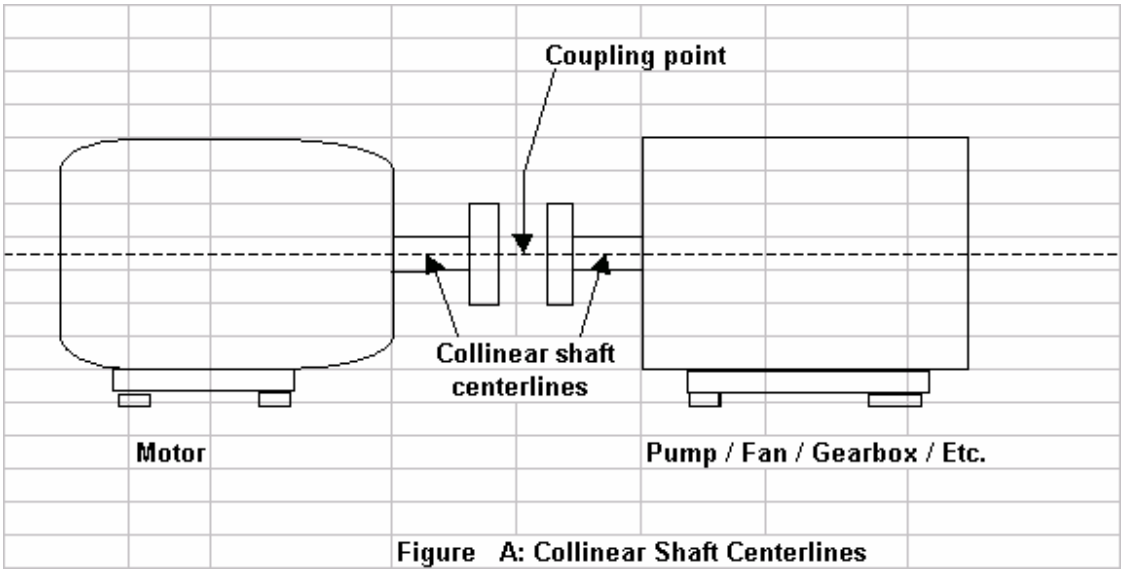

Figure A: Collinear Shaft Centerlines

1.2 Shaft Alignment Tolerances

Shaft to shaft alignments shall be carried out to within the tolerances specified in the table below, unless more a more precise tolerance is specified by the manufacturer or because of special conditions depicted by a customer's process.

The tolerances specified are the maximum allowable deviations from Zero-Zero specifications or an intentional targeted offset and/or angularity.

Vertical & Horizontal Offset						Angularity (Gap)				
						Coupling Diameter				
RPM			OFFSET			10 in. (250 mm) or less			10 in. (250 mm) or greater	
E	M		E	M		E	M		E	M
600	600		.005"	0.13 mm		.005"	0.13 mm		.0005" / in.	0.05 mm/100 mm
900	750		.003"	0.08 mm		.003"	0.08 mm		.0003" / in.	0.03 mm/100 mm
1200	1000		.0025"	0.06 mm		.0025"	0.06 mm		.00025" / in.	0.03 mm/100 mm
1800	1500		.002"	0.05 mm		.002"	0.05 mm		.0002" / in.	0.02 mm/100 mm
3600	3000		.001"	0.03 mm		.001"	0.03 mm		.0001" / in.	0.01 mm/100 mm
7200	6000		.0005"	0.01 mm		.001"	0.03 mm		.0001" / in.	0.01 mm/100 mm

Table 1: Shaft Alignment Tolerances

1.3 Misalignment Types:

Shaft misalignment can occur in the following ways, Parallel and angular misalignment. These are the two basic types of conditions that can exist in either the vertical or horizontal directions. Misalignment can occur in any combination of parallel and angular or both.

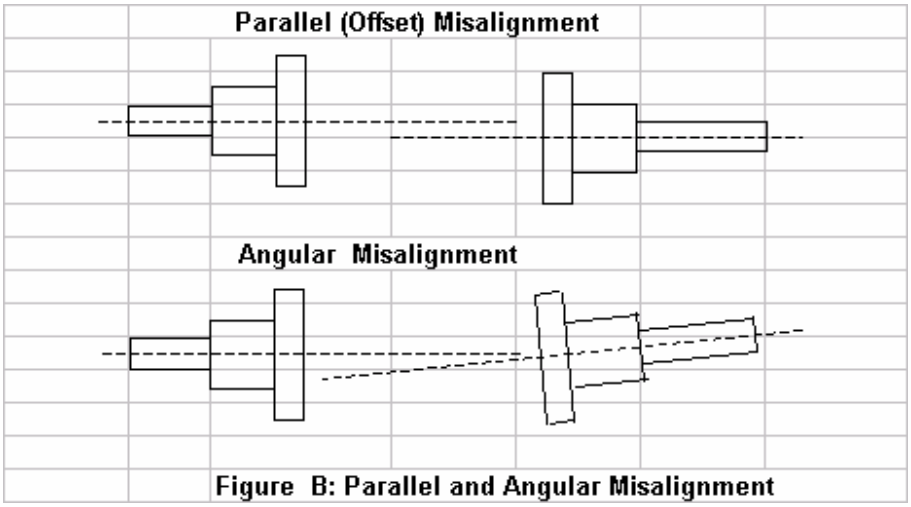

Figure B: Parallel and Angular Misalignment

1.4 Excessive Run-out Conditions:

When carrying out coupling laser alignment any non-perpendicular run out in the shafts must be considered. There are three types shown below and any combination of the two may occur at any time. The permitted tolerances are shown in the table below.

RPM		MAXIMUM ALLOWABLE TIR (Total Indicator Runout)	
		E	M
0-3600		.002”	0.05 mm
3600 and up	less than	.002”	0.05 mm

Shaft Runout Tolerances

Excessive run out situations usually fall into one of three categories:

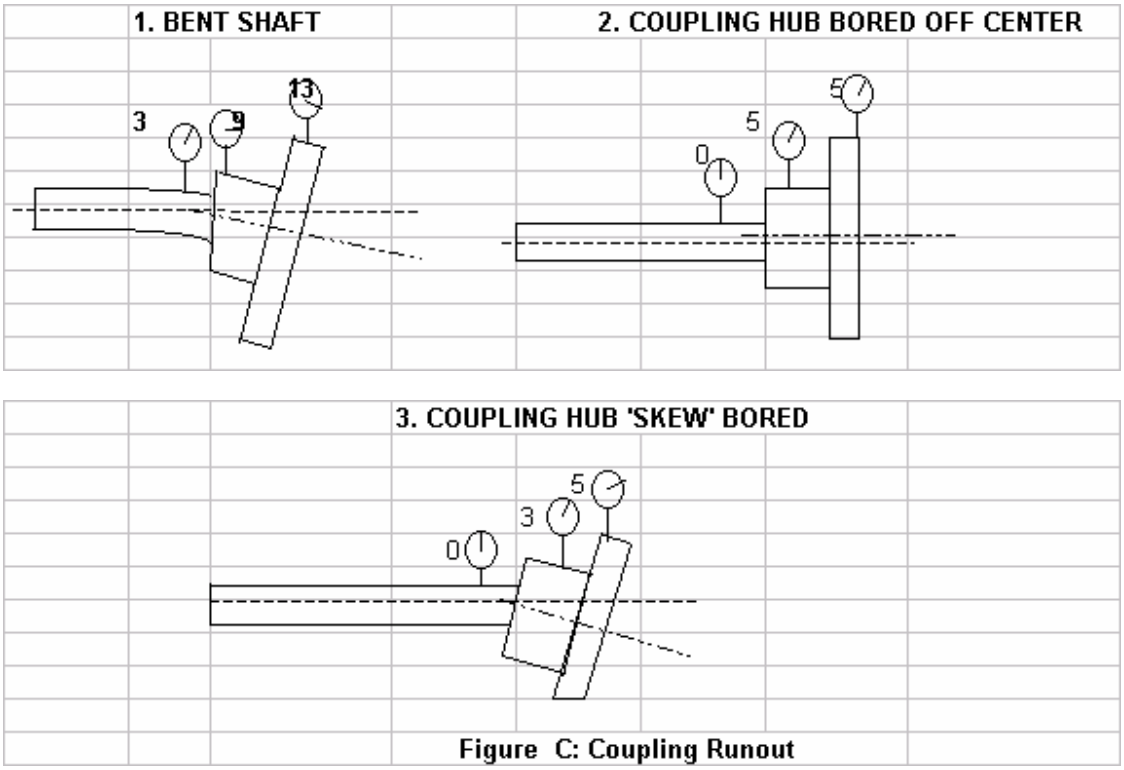

Figure C: Coupling Runout

1.4 Casing To Base plate Interface Problems ("Soft foot")

Soft foot is the term used to describes the condition where poor surface contact is being made between the underside of the machines base or feet and the contact with the base-plate or frame. Or where there is an unequal quality of contact on all feet.

RPM		Maximum Tolerance	
		E	M
All		0.002 in.	0.05 mm
Soft Foot Tolerances			

There are four steps to identify 'soft foot';

1. Eliminate all stress in the unit by loosening mounting bolts, removing existing shims and clean the mating surfaces of the machine and base.

2. If physically possible check the unit for any obvious rocking or instability. Try this corner to corner and end to end. Also check and measure all gaps are equal use feeler gauges.

3. Rectify the soft foot under each foot by installing complete shims (if the gap under the foot is equal at all four points around the bolt hole) or by constructing a stepped shims and installing them under each foot that needs correction. **Never use old shims.**

4. Confirm that the soft foot has been corrected by one of the following preferred methods:
   a. Shaft movement via laser
   b. Multiple bolt - multiple indicator

- **Shaft movement via laser method:**

Soft Foot can be checked using the soft foot function in a laser alignment system. With the laser and receiver mounted on the shaft in the usual position, the laser alignment system is able to sense any machine movement when the machine foot bolts are loosened individually. The laser system can calculate from the shaft movement how much each foot has raised. Correct machine dimensions must be input into laser alignment system for correct calculations. Once foot movements have been established, the results need to be interpreted and translated into shim thicknesses needed to correct any soft foot situation.

- **Multiple dial indicator method:**

Ensure all holding down bolts are secure at start. Then place DTI needle on first foot, loosen the bolt and record the reading from the dial indicator. Repeat this with all bolts and then review findings. Correct the soft foot using shims in exactly the same way as if using lasers.

MMS Ltd Engineers will only use ISO recognised shims and they must meet the following specifications:

a. Commercially die cut.
b. Made of corrosion and crush resistant stainless steel which is dimensionally stable when subjected to high compression over long periods of time.
c. Consistent over the whole shim area, without seams or folds from bending
d. Clean, free from burrs, nicks and dents of any kind.
e. Size numbers or trademarks etched into the shim, not printed or stamped
f. The smallest commercial shim that will fit around the hold down bolt without binding shall be used.
g. The overall shim pack shall not exceed a total of four (4) shims
h. Shims must rest on bare metal, not paint or other coatings

1.6 Excessive Static Piping Strain (Stress)

MMS Engineers must be aware of and consider excessive forces on a machine from pipe work. If the force of the pipe work exceeds the levels shown below they may over time distort the alignment of the machine

Pipe stress tolerance shall not exceed (0.05 mm) in any direction.

Identifying pipe stress.

1. Does alignment go out when pipe work is connected?
2. Does alignment go out if pipe work is disconnected?
3. Using dial indicators is there big changes when pipe work or foot bolts are loosened?
4. Remember it may be possible to adjust position of machines to fit pipe work.

1.7 Pre- Alignment check

The following criteria should be followed prior to any alignment. The purpose of the list is to assess and prepare the asset for alignment.

1.7.1. Be aware of the pre-operational shaft positions to allow for any known thermal expansion.

1.7.2. Before commencing work, observe proper lock-out, tagging and isolation procedures. This may include purging of pumps and eliminating all stored energy.

1.7.3. Ensure all tools are in good condition and correct for the job, decide on correct method of alignment to be used.

1.7.4. Carryout initial alignment readings.

1.7.5. Carryout an inspection of all base's and supports, remove burrs and repair as necessary.

1.7.6. Ensure all shims to be used are in good condition.

1.7.7. Loosen all holding down bolts prior to moving any machine.

1.7.8. Replace any missing or broken bolts, washers etc.

1.7.9. Ensure all dowels have been removed and when put back in at end of alignment are in good condition.

1.7.10. Check and eliminate excessive pipe stress.

1.7.11. Prior to alignment ensure shafts can rotate freely, lubricate if necessary.

1.7.12. Examine the shafts of both machines for excessive play, any run out and all surfaces are good.

1.7.13. Inspect the condition of the coupling for any faults such as poor fit, eccentricity, key etc. Repair as necessary.

1.7.14. Ensure the gap between shafts and coupling in the axial plane is correct.

1.7.15. Check for and eliminate soft foot on all feet of both machines.

1.8 Final Precision Alignment Verification

Final coupled shaft alignment shall be accomplished by using either the Laser or the Reverse dial indicator methods and shall be with in specified tolerances. Only trained competent staff that are fully converse with both techniques and procedures may carryout alignments.

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2.0 Precision Alignment Training Guidelines

All MMS engineers carrying out laser alignments have been fully trained in the use of the equipment and are understanding of the fundamentals of alignment and rotating machinery principles. All are also qualified vibration analysts adding to their knowledge and understanding of machine mechanics including:

- Thermal growth
- Soft foot
- Tolerance's
- Engineering fundamentals
- Measurement
- Analysis
- Inspection & correction
- Equipment & software
- Risk & Method statements
- Site safety & induction