



Single-Bearing MTBM's with Bearing in the End Bell (Formula Method)

For Firmware ver. 2.04

Introduction and Overview

This technote is designed to facilitate the alignment of single-bearing machines like generators and exciters which have only one shaft bearing housed in the end bell, behind the back feet of the stator housing. The objective is to align the shaft of the generator to the stationary shaft while at the same time preserving the proper clearances between the stator and rotor assemblies. This is often a challenging undertaking, since the shaft (and rotor) is only supported by the rigid coupling at one end and by the bearing on the other end. The coupling must therefore be loosened prior to taking misalignment readings. The feet of the generator support both the stator and the rotor bearing; therefore, moving and shimming the feet affects both the alignment and the air gap between rotor and stator. The procedure to correct both the alignment and air gap simultaneously is straightforward and involves only simple arithmetic.

The idea is to take alignment readings with the coupling slightly loosened to permit flexibility, then measure the air gap at 12, 3, 6 and 9 o'clock at the front of the stator and at the back. Now derive the shimming and moving corrections for the stator with the simple formulas described in the procedure. Refer to the sketch.

The dimensions used in this procedure are shown in the sketch.

A = Location where front gaps are measured

C = Location where back gaps are measured

X = Bearing centerline

F = Stator front foot

B = Stator back foot

D = Coupling diameter

CR = Coupling center to Receiver

RF = Receiver to front foot, right machine.

FB = Front foot to back foot

AC = Front gap location to back gap location

BX = Back foot to bearing center

VFG = Vertical front gap

VBG = Vertical back gap

HFG = Horizontal front gap

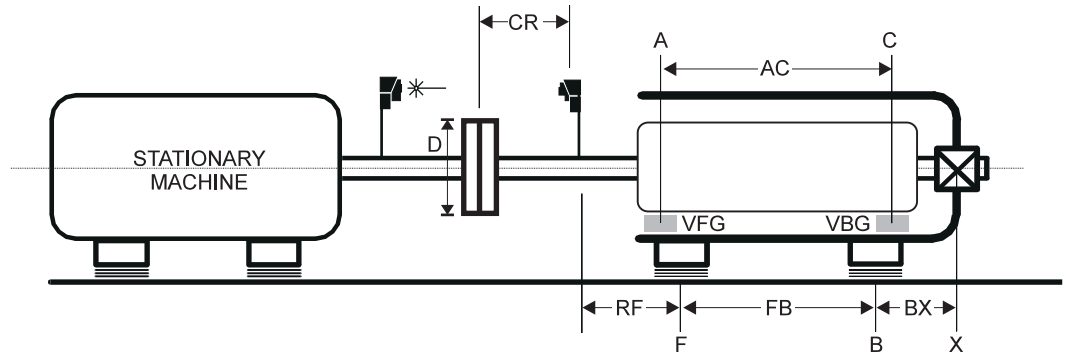
HBG = Horizontal back gap

VFP = Vertical front foot position

VBP = Vertical back foot position

HFP = Horizontal front foot position

HBP = Horizontal back foot position



Alignment and Air Gap Correction Procedure

1) The first step is to loosen the rigid (usually rabet fit) coupling's bolts only to the point where the shaft still rests in the rabet, in order to allow sufficient flexibility to accurately measure the angularity of any existing misalignment. Run a feeler gage between the solid hubs all the way around the coupling. A gap of .010" or .020" is usually enough.

If the coupling is loosened to the point where the rabet disengages its seat and is held only by the bolts, the rotor shaft will drop by the amount of clearance in the fit of the bolts. This will produce a negative vertical offset which is preferable to avoid. Taper fit rabbets will unavoidably produce offset as you slightly separate the hubs. Some single-flex plane couplings will also register offset. This does not matter since the offset will go away again when you tighten the coupling back up, after alignment. If you have a *flexible* single-plane coupling (such as a diaphragm type) the coupling need not be loosened at all to measure misalignment, since this type of coupling will readily permit angularity while keeping offset at zero.





2) Using feeler gages, now carefully measure the air gap between rotor and stator at the front end and back end of the stator where convenient (Locations A and C), at 6 o'clock. (Alternatively, measure the gaps at 12 o'clock). These gaps are shown in the sketch and in the formulas as VFG

(Vertical Front Gap), and VBG (Vertical Back Gap)*. Also measure carefully the distance between these locations (AC). Record these gaps and distance for later use in the calculations. *Note: If you can measure the gaps at only one location along the shafts (either the front or the back) but not both, then you cannot continue with this procedure. Refer instead to ROTALIGN Tech Note 1 (Single-Bearing Machines, Graphical Method).*

* *Caution: Measuring gaps can be tricky as rotor surfaces are uneven and varnish thicknesses may vary. Measure the gaps at least four times with the rotor turned to a different position each time, and average your gap readings.*

3) Carefully measure the air gap between rotor and stator at the front and back ends of the stator, at 9 o'clock. (Alternatively, measure the gaps at 3 o'clock). These gaps are HFG (Horizontal Front Gap), and HBG (Horizontal Back Gap). Also measure carefully the distance between these locations (AC). Record these gaps and dimensions for later use in the calculations. *Note: If you can measure the gaps at only one location along the shafts (either the front or the back) but not both, then you cannot continue with this procedure. Refer instead to ROTALIGN Tech Note 1 (Single-Bearing Machines, Graphical Method).*

4) Install the ROTALIGN Laser on the Stationary Machine shaft and the Receiver on the MTBM shaft.


- Turn ROTALIGN on. 
- Select Horizontal Machine Alignment .
- Press . Press  to *not* save existing file.


5) Enter machine dimensions as follows:
D = 10".

CR = Coupling Center to Receiver

RF = Receiver to Front Foot of stator housing

FB = Front Foot to Back Foot of stator

6) Press , adjust the beam, and take alignment readings.

7) Press  to obtain results. Record the Vertical Front Foot Position (VFP), Vertical Back Foot Position (VBP), Horizontal Front Foot Position (HFP) and Horizontal Back Foot Position (HBP) for use in the calculations.

8) Now calculate shimming and moving corrections using the following formulas:

For Gaps Measured at 6 and 9 o'clock:

Front Foot Shimming:

$$\frac{(VFG - VBG)}{AC} \times (FB + BX) - VFP$$

Back Foot Shimming:

$$\frac{(VFG - VBG)}{AC} \times BX - VBP$$

Front Foot Move:

$$\frac{(HFG - HBG)}{AC} \times (FB + BX) - HFP$$

Back Foot Move:

$$\frac{(HFG - HBG)}{AC} \times BX - HBP$$

For Gaps Measured at 12 and 3 o'clock:

Front Foot Shimming:

$$\frac{(VBG - VFG)}{AC} \times (FB + BX) - VFP$$

Back Foot Shimming:

$$\frac{(VBG - VFG)}{AC} \times BX - VBP$$


Front Foot Move:

$$\frac{(HBG - HFG)}{AC} \times (FB + BX) - HFP$$

Back Foot Move:

$$\frac{(HBG - HFG)}{AC} \times BX - HBP$$

9) Monitor horizontal corrections with dial indicators. Recheck the alignment.

10) Retighten the coupling bolts to the correct torque values. 

A = Location where front gaps are measured

C = Location where back gaps are measured

X = Bearing centerline

F = Stator front foot

B = Stator back foot

AC = Front gap location to back gap location

FB = Front foot to back foot

BX = Back foot to bearing center

VFG = Vertical front gap

VBG = Vertical back gap

HFG = Horizontal front gap

HBG = Horizontal back gap

VFP = Vertical front foot position

VBP = Vertical back foot position

HFP = Horizontal front foot position

HBP = Horizontal back foot position

Be careful with the signs (+ & -) and observe the rules of algebra when applying the formulas: Items within parenthesis are calculated first. Multiplication and division are carried out before addition and subtraction.

Example

Front Foot Shimming:

$$\frac{(VFG - VBG)}{AC} \times (FB + BX) - VFP$$

Where gaps were measured at 6 o'clock

AC = 45" VFG = 230 mils

BX = 10" VBG = 365 mils

FB = 30" VFP = -48 mils (from Rotalign)

$$\frac{(230 - 365)}{45} \times (30 + 10) - (-48)$$

$$\left(\frac{-135}{45}\right) \times 40 + 48$$

$$-120 + 48 = -72 \text{ (remove shims)}$$

Back Foot Move:

$$\frac{(HBG - HFG)}{AC} \times BX - HBP$$

Where gaps were measured at 3 o'clock

AC = 45" HFG = 380 mils

BX = 10" HBG = 290 mils

FB = 30" HBP = +36 mils (from Rotalign)

$$\frac{(290 - 380)}{45} \times 10 - 36$$

$$\left(\frac{90}{45}\right) \times 10 - 36$$

$$20 - 36 = -16 \text{ (move toward 9 o'clock)}$$