Exercise E208-S04.wpd

Locating and Correcting Soft Foot

Objective

3 Given the DAC Coupling/Shaft Alignment Trainer, hand tools, a magnetic base/dial indicator set and coupling alignment tools, measure and correct for equipment soft foot using two methods.

Performance Standard

3 Reduce soft foot on the motor element to less than .003" at all foot locations, while following the indicated procedures in the proper sequence.

Foundation Competencies

3 Use of hand tools.
3 Use of a dial indicator (Exercise E208-S02).
3 Understanding of coupling alignment and coupling terminology (Exercise E208-S01).

Required Background Reading


Tools Required

3 Combination wrench set.
3 Hex wrench set.
3 Rule, 6".
3 Socket wrench with a 9/16" socket.
3 Magnetic base/dial indicator set (DAC, #208-015 suggested).
3 Thickness gage.
3 Tin snips.
Components Required

- DAC Coupling / Shaft Alignment Trainer, #208.
- Coupling / Shaft Alignment Trainer Use Guide, #208-500.
- Elastomeric element coupling (DAC, #208-007 suggested).
- Shim kit (DAC, #208-003 suggested).

Introductory Discussion

One of the most important pre-checks to be performed prior to precision coupling alignment is the measurement and correction of equipment “soft foot”. Soft foot, also called short foot, short leg, angular foot, and bent foot, is a term applied to a machinery condition where all the supporting feet of an equipment component are not in complete contact with their respective mounting pads. Uncorrected soft foot can result in several equipment problems including: the loosening of hold-down bolts, metal fatigue at the foot, baseplate twisting, the warping of the equipment casings causing internal misalignment and component failure, and the inability to properly align equipment due to shifting of center lines when tightening hold-down bolts. Most importantly, with regard to coupling alignment, is the tendency for shaft centerline position to change when hold-down bolts at soft foot locations are tightened.

Soft foot is often described and illustrated as a condition where one foot is simply shorter than other feet on an equipment component. Unfortunately, this simple circumstance is rare. More often individual feet are bent and therefore not parallel with their mating mounting pad, or mounting pads are warped causing all feet to be angled relative to their respective pads. Soft foot can also be caused by other factors such as: the use of too many shims; dirt or imperfections on shims, feet and baseplate; and finally, stresses from other components. The results of these circumstances are sometimes referred to with terms such as “bent foot” or “squishy foot”. There are several techniques suggested for the detection, measurement, and correction of soft foot. This exercise discusses two.

Regardless of the method chosen, soft foot correction must be performed in a deliberate and methodical way using precision measuring tools, careful craftsmanship, and all the senses. Often the measurement and correction of soft foot in preparation for alignment is more tedious and time consuming that the actual alignment itself. However, precision alignment can not be achieved without first
correcting soft foot. Lastly, many equipment failures related to bearings, shaft seals, mechanical seals, and motors can be eliminated by reducing the stresses caused to equipment casings resulting from soft foot.

Performance Steps

Warning: When performing alignment in the field, always lock out and tag out the power source before undertaking any work.

Step 1. Prepare the DAC Coupling/Shaft Alignment Trainer for use based on the instructions provided in the Use Guide.

3 Remove the motor element from its mounting pads.

3 Using a socket wrench, and 9/16" socket, loosen the hex head bolts that mount the motor mounting pads to the baseplate at one mounting pad location. The bolts need not be removed completely. From the shim set, select a .020" shim and insert it between the pad and the baseplate at a rear bolt location. The slot in the shim should engage the bolt. Re-tighten the hex head bolts with the socket wrench.

3 Locate the motor element on the motor mounting pads at position B. Remove all jacking bolt plates. Install, but do not tighten, the four motor hold-down bolts.

3 Install shafts, if not previously installed, in flanged bearings on the motor and pump elements. Do not tighten flanged bearing set screws.

3 Install the two elastomeric disc coupling hubs, with shaft keys, on the shafts with the hub faces facing each other. Position the hubs flush with the ends of the shafts. Tighten the hub set screws.

3 Position the shafts in their flanged bearings leaving approximately 3 inches between the flange faces. Tighten the flanged bearing set screws.

Step 2. Begin measurement of equipment soft foot.
Remove all existing shims. Inspect the machinery baseplate and motor element feet for burrs, or other imperfections. File or stone surfaces if necessary. Inspect the mounting pad and equipment feet for corrosion and dirt. Remove and wire brush if necessary.

Attempt to “rough align” the motor element to the pump element by centering the hold down bolts of the motor element in their bolt holes and aligning the outside rims of the coupling halves with each other. The 6" rule can be used to align the outer rims at the horizontal centerline. Do not add shims.

Check the motor element for “rocking” by moving it gently by hand. Note if the motor element rocks on two corners or from front to back. Try to establish a position where the motor element is more stable than in other positions.

Once established, hold the motor element in that position and gently tighten the hold-down bolts by hand until they are finger tight.

Using a pencil and paper make a simple sketch, similar to the one that follows, of the plan of the motor element with its four feet.

Using the thickness gage, measure the gap between the motor foot and the mounting pad at each foot location. To do so, insert the thickness gage leaves until a combination of the leaves fits snugly at each location. Take measurements at all four corners of each foot. Record all dimensions on the sketch.
Eliminate the soft foot at each foot by installing full and/or partial shims at each location to compensate for gaps. Use your sketch to visualize the most efficient combination of shims to correct each foot. If a gap exists under the entire foot, start by adding a complete shim which eliminates the gap from at least one point. Often it is necessary to use modified, “J”, “L”, or strip-shaped shims in order to correct for tapered gaps at foot locations. Use tin snips, if necessary, in order to modify each shim’s shape. See the illustration below for examples of shims that might be needed. Attempt to maintain the profile of
a full shim. If cut and installed in an organized, neat fashion, the addition of more shims, later during alignment, will be more easily accomplished. Note also, that as few shims as possible should be used to make the necessary corrections. Using large numbers of shims can lead to instability and “sponginess” when tightening hold-down bolts, due to the accumulation of oil and dirt between multiple shims.

Many coupling alignment experts suggest using stepped shim arrangements to adjust for angular differences between equipment feet and pads. Using this process, the gap difference from one side of the foot to the opposite side of the same foot is calculated and divided by the number of shims being used. For instance, if a total gap differential of .02" was measured and four steps were desired, then 4, .005" shims would be used. These shims would be inserted sequentially until they were snug. This results in a stepped effect both under the equipment foot and at the outside of equipment foot.
While effective in some limited circumstances, often this technique does not compensate for the four unique measurements often found at each corner of the foot.

3 Test the soft foot correction at each foot location by gently tightening each hold-down bolt with a wrench. If, after being finger tight, the bolt tightens with 1/8 turn or less, the shim correction has probably been successfully accomplished.

Step 3. Verify soft foot correction using a dial indicator.

3 Tighten all of the motor element foot hold-down bolts.

3 Install a magnetic base/dial indicator set on a steel pad in the area of the motor element mounting pads, on the side where the greatest soft foot condition was found.

3 Position the dial indicator tip on the specific foot where the greatest error was found, as close as possible to the bolt hole. “Zero” the dial on the indicator.
Slowly loosen the bolt where the indicator is located and at the same time watch the dial for movement. If movement of more than .002" is present then soft foot remains at this location. Make a note of your findings.

Most industry experts suggest that soft foot should be corrected to within .002" to ensure accurate coupling alignment.

Without tightening the first bolt and without moving the dial indicator, loosen a second bolt while watching the dial indicator. If more that .002" of movement is present then soft foot remains at that new bolt location. Make a note of your findings.

Continue to loosen the remaining bolts while checking the indicator dial for movement. Make notes regarding your findings.

If more that .002" of movement occurred at any location, remove all shims from that location, re-measure and install new shims.

Once corrected, recheck again using a dial indicator.

Note that several variations of this technique for verifying soft foot corrections are used. Others using dial indicator measurement at equipment feet include: using four indicators (one at each foot) and sequentially loosening bolts as above, as well as a procedure requiring the movement of the dial indicator to each foot location and loosening and re-tightening each bolt. Finally, some suggest using a indicator to detect shaft movement while each bolt is sequentially loosened. An
example of this technique follows.

**Step 4.** Prepare the training aid for a second exercise in soft foot correction and measurement.

3 Remove the motor element and all shims.

3 Loosen the motor mounting pad and remove the single shim installed previously.

3 Install .015" shims at both bolt locations under one motor mounting pad. Using the socket wrench re-assemble and tighten the motor mounting pad. Loosen the opposite motor pad using the socket wrench and add a .01" shim under the pad at the rear bolt location. Re-tighten these motor pad attachment bolts.

**Step 5.** Begin soft foot correction.

3 Following all steps outlined in step 2 above, measure and create shim packs to correct for soft foot.

3 Once all shims have been installed, perform a preliminary test by tightening each bolt.

**Step 6.** Begin correction verification using the shaft movement technique.

3 Tighten all motor element hold-down bolts.

3 Attach the shaft mounting clamp from the coupling alignment tool kit to the motor element’s shaft. Position attachment bars, clamps and the dial indicator in order to indicate the outer rim of the pump element coupling half. Once positioned, “zero” the dial indicator.

3 Loosen the motor hold-down bolt at the position where the greatest shim correction was required, while watching the dial indicator. If more than .002" of movement is present soft foot may still exist at that foot location.
Leaving the first bolt loose, loosen the remaining bolts in sequence. If more than .002" of movement results at any location, soft foot has not been fully corrected.

Where necessary, remove all shims, remeasure and install new shim packs.

Verify results again if necessary.

**Step 7.** Disassemble all components, including all shims installed beneath the motor element mounting pads, and return the training aid to its standard configuration.

**Summary**

You have just successfully measured and corrected a soft foot condition using hand tools and a dial indicator. You have found that soft foot correction requires, careful analysis, measurement, and craftsmanship to be successful. Also you have learned that soft foot rarely can be corrected using only complete, u-shaped shims. Because most soft foot conditions are angular in nature, partial shims and stepped shims must be used in order to make accurate corrections. Finally, you have learned that the establishment of a stable equipment footing is essential in performing accurate coupling alignment as well as being important to the long life of equipment components.

**Optional Tasks**

None.
Follow-on Exercises

None.

Resources


