JACKSHAFT SAG

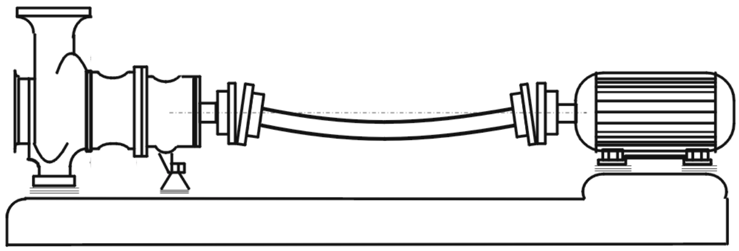

Figure 1

Introduction

A long jackshaft connecting two machines that is unsupported may sag due to gravity. The question is, should this sag be taken into consideration when aligning the machines or not? The answer depends on whether the sag goes away or stays when the machines are running at normal operating speed. This is decided by whether or not the machines operate at above or below the rotor's first critical speed of rotation. To know this you must know what the sag is in the static condition. The procedure to measure the sag and determine what the critical speed of rotation is, in order to make the decision on whether or not to target for the sag, is given below.

Overview

Sagging jackshafts that are made to spin at speeds of rotation greater than their so-called "rotor critical speed of rotation" will have their sag disappear. In other words, the jackshaft will almost completely straighten out as it runs because gravity is no longer strong enough to make the shaft bend as it spins above this critical speed. Below that speed the sag will remain, and ought perhaps to be targeted for, particularly if the angularity generated by the sag at the couplings on either end exceeds the allowable angularity tolerance for the operating speed. Calculate the critical speed of rotation with the following formula:

$$\text{Critical Speed} = 188\sqrt{1/\text{SAG}}$$

This formula applies to any shaft supported only at both ends. The only variable in the equation is the sag, which *must be entered in inches* (not mils!)

The first step is to measure the sag. Set up the laser and receiver components at opposite ends of the jackshaft and take alignment readings between them (see Fig. 2). The sag will cause a vertical angular misalignment to exist between the tangential centerlines of the locations where each component is mounted. The offset projected by this vertical angularity will be four times the sag at each end.

Once the sag is known it is entered in the formula above and the critical speed determined. If the machines operate at a speed below the calculated critical speed, align to the sag of the jackshaft. If the machines operate above critical speed, ignore the sag and align the machines directly shaft to shaft. Proceed to perform the alignment of the machines as usual. There are two alignment setups you can choose from, depending on the length of the jackshaft and the existing misalignment— the "Single Shot" setup (see Fig. 4), and the "Two-Step" procedure (see Fig. 7). Calculate the targets to align to the sag (operating speed below critical speed), or to *not* align to the sag (operating speed above critical speed) as follows, and remember to adjust your targets for any thermal growth targets that may also be needed. (Also make certain that you enter the targets in your Rotalign® Pro in the appropriate format, for instance “Gap/Offset at Right for the ‘Single Shot’ procedure, with coupling type ‘spacer coupling’ selected.)

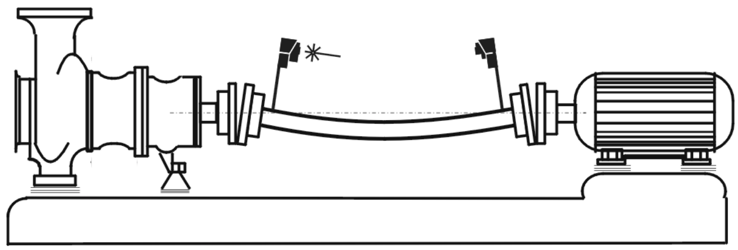

Figure 2

Procedure to Measure Sag (see Fig. 2)

1) Mount Laser at one end of jackshaft. Mount Receiver at the other end.
2) Set up a file with a Stationary Left Machine, a short flex coupling and a Right Machine with ‘Two-Feet’ support.
3) Enter dimensions as follows: Diameter 10", Receiver to Coupling = 0, Coupling to feet = 0.
4) Zero the beam and take readings by rotating the jackshaft.
5) Press 
.
6) The Vertical Offset result (VO) is 4 times your sag. (i.e., sag is ¼ of the displayed Vertical Offset value.) (See Fig. 3.)

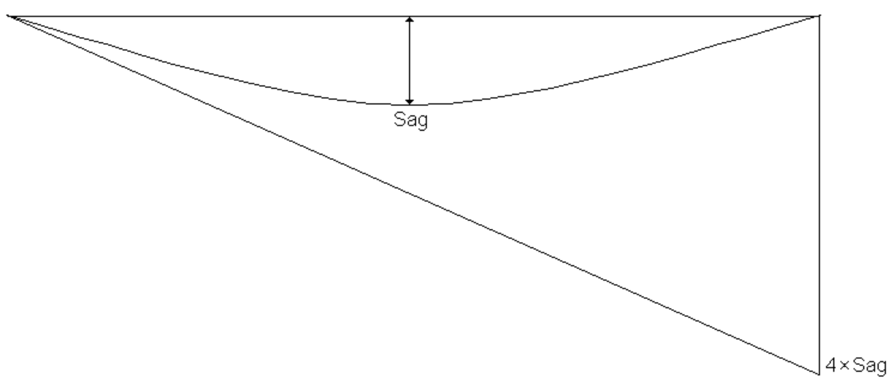

Figure 3

7) Proceed to calculate the critical speed of rotation using the formula described in the Overview, and decide whether or not you wish to target for any sag. (See numerical example in Appendix A).

Calculating Targets for Sag

Set up for the alignment in either the "Single-Shot" configuration (Figure 4) or the "Two-Step" procedure (Figure 7) and enter targets accordingly.

"Single-Shot" Setup:

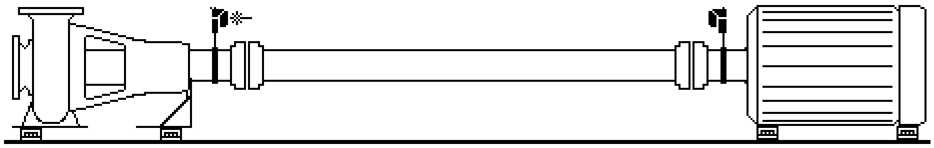

Figure 4

Target formula variables:

L = Length of jackshaft; **VA_T** = Vertical Angularity Target; **VO_T** = Vertical Offset Target

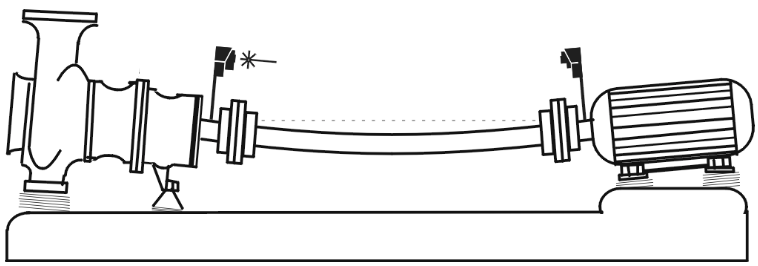

Figure 5

Operating speed *below* critical speed— align to the sag (Fig. 5):

Targets: $VA_T = -\left|\frac{8 \times SAG}{L}\right|$ and $VO_T = \left|4 \times SAG\right|$.

Note: You should have 'spacer shaft' selected as your coupling type for this setup. If so, choose Target Format "Gap/Offset at Right" to input these targets.

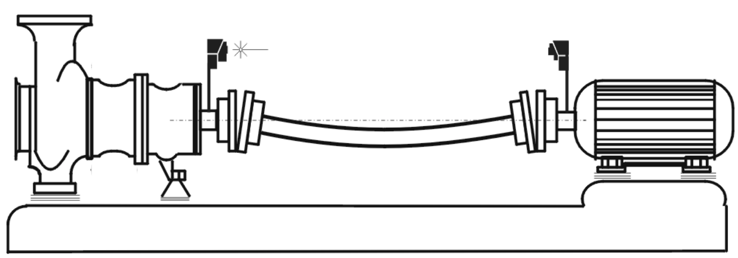

Figure 6

Operating speed *above* critical speed: Align shaft-to-shaft; do *not* target for the sag (Fig. 6):

Targets = zero.

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"Two-Step" Procedure*:

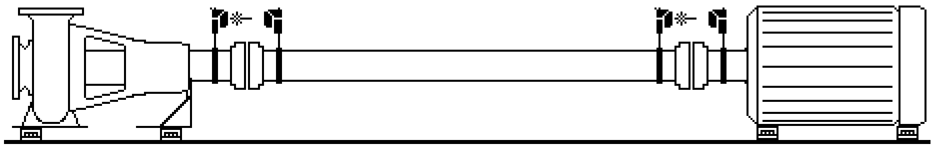

Figure 7

Operating speed *below* critical speed— align to the sag:

Targets = zero.

Operating speed *above* critical speed— align shaft-to-shaft:

Targets (for each setup): $VA_T = \left|\frac{4 \times SAG}{L}\right|$ and VO_T = zero.

Appendix A

Numerical example of critical speed calculation:

From step 6 of the procedure to measure sag on page 2, let's say the VO result is 20 mils. Sag is one quarter of that, so:

SAG = 5 mils, or 0.005".

Critical Speed = $188\sqrt{1/SAG} = 188\sqrt{1/0.005} = 188\sqrt{200} \approx 188 \cdot 14.142 \approx 2659$ RPM.

Thus, if the operating speed of your machines is 1800 RPM, it is below the calculated critical speed and you would choose to align to the sag of the jackshaft, since the sag is expected to remain as the machines run. If the operating speed is 3600 RPM, you would choose to align shaft-to- shaft and ignore the sag, since the sag will disappear when the machines run. ◙

**For more information on the Two-Step Procedure, see TechNote #10.*