Orbit Magazine

# Throwback Thursday :: Subtleties in Rotor Thrust Position Measurements

**Date :** April 2, 2015

Bently Nevada has a rich history of machinery condition monitoring experience and has always placed a high priority on educating and helping our customers manage & maintain their equipment better. Every week, we will highlight an article or Application Note that was published by Bently Nevada ‘back in the day’. Although the format may be dated, the information is still valid and we hope you’ll find it helpful.

*Originally published in 2007*

Accurate rotor thrust position measurements requires a consistent method for setting the axial proximity probes, and relating physical rotor position to the Thrust Monitor, data acquisition system, and DCS. In some cases, the relationship between displayed rotor position and actual rotor position is influenced by other conditions, and a definitive relationship is difficult to establish. The following document reviews the details of setting up thrust measurements on horizontal machines to recognize and avoid most of these subtle thrust setup problems.

**Proximity Probe Calibration:**

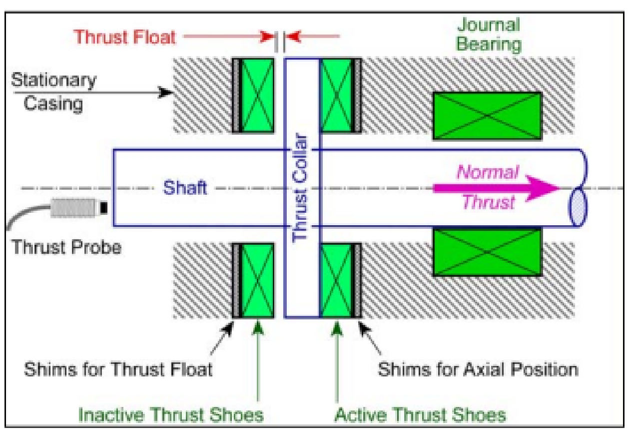
Thrust position measurement is based upon a linear relationship between the Proximitor output voltage and the average distance between the probe tip and the observed surface. The slope of the calibration curve is the transducer system sensitivity in units of Millivolts/Mil (or micrometer). The industry standard is 200 mv/Mil (7.87 mv/ µm) with a ±5% tolerance. This is equivalent to a range of 190 to 210 mv/mil. The linear range is typically required to be a minimum of 80 mils. It is useful to note that the inverse sensitivity is 5 mils per volt (=1/0.2). Specifically, every 5 mil change in probe gap should produce a 1.0 volt change in DC voltage. This makes it convenient to evaluate the linearity of a calibration curve during acquisition of the calibration data.

It is highly desirable to run calibration curves on each thrust probe on the observed material before attempting to setup thrust position measurements on a machine in the field. In all cases, it is mandatory to document the model and serial number of each Probe-Cable-Proximitor set. This identification information should be saved with the calibration curve for future reference. During calibration, the distance between the probe and the target is advanced in 5 mil increments, and Proximitor output voltage readings are logged at each step. At the end of the linear range it is desirable to recheck several data points by reducing the gap between the probe tip and the circular target. This step verifies the repeatability of the position measurement

Typically the transducer system sensitivity is computed across an 80 mil linear range. In the vast majority of the cases, the sensitivity or scale factor will fall between 190 and 210 mv/mil. If this scale factor is outside of the normal range, then components of the transducer system should be sequentially replaced until the required scale factor is obtained. For the remainder of this discussion, a sensitivity of 200 mv/mil or the reciprocal of 5.0 mils/volt will be used.

**Thrust Bearing Configuration and Loading:**

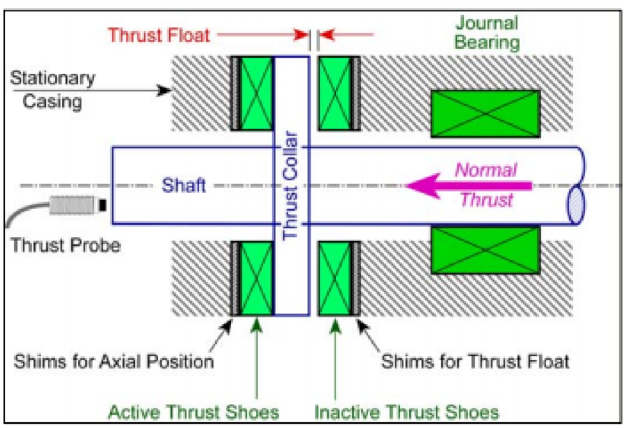
It is necessary to understand the thrust bearing configuration and loading. In the majority of cases the thrust assembly consists of a single thrust collar as shown in the diagram at the top of the next page. This is typical for a steam turbine where the thrust bearing is mounted on the governor end, and the steam flow and differential pressure provide a normal thrust force towards the exhaust. In this configuration, the inboard thrust shoes would be the active shoes, and the outboard shoes would be the inactive shoes. Shims would be ground and installed behind the active shoes to establish a specified machine clearance. For a steam turbine, this would be the distance between the first stage buckets and the inlet nozzle block. Depending on the turbine, this distance could be anywhere between 35 and 60 mils (0.035 and 0.060 inches).




The thrust float zone is the distance between the active and inactive thrust shoes. It is adjusted by grinding shims that are placed behind the inactive thrust shoes. These shims must be precision ground flat, and they must not interfere with any internal housing shoulders or radiuses. The thrust float zone is typically specified to be between 10 and 20 mils (0.010 and 0.020 inches). For many steam turbines, the thrust probes are located on the governor casing, and observing the end of the shaft or an intermediate collar. In other cases, the thrust probes are mounted on internal brackets, and observe the backside of the thrust collar. In all installations, the thrust probe should be mounted within 6.0 inches axially of the thrust collar. Although API-670 specifications allow a maximum of 12 inches between the thrust probes and the thrust collar, a closer distance reduces the differential thermal growth of thrust bearing versus probe mounting location, and measurement accuracy is improved.

With the active thrust shoes on the inboard side of the bearing, and normal thrust load acting away from the probe mounted on the end of the shaft, it is easy to define axial movement directions. Specifically, increasing probe gap voltage is indicative of normal thrust position on the active shoes. Conversely, a decreasing gap voltage is indicative of counter thrust motion towards the inactive thrust shoes.

On other machines, such as centrifugal compressors, the thrust bearing is often mounted on the suction end of the compressor as shown in the adjacent diagram. In this configuration, the gas flow and differential pressure provide a normal thrust force towards the outboard. Hence, the outboard thrust shoes are the active shoes, and the inboard shoes are the inactive shoes. Shims would be ground and installed behind the active shoes to establish a particular machine clearance. For a compressor, this would be the distance necessary to obtain axial coincidence between an impeller and a stationary diaphragm.




Once again, the thrust float zone is adjusted by grinding shims that are placed behind the inactive thrust shoes, and the thrust float varies between 10 and 20 mils. For many compressors, the thrust probes are located on the bearing housing end cover, and observing the end of the shaft or an intermediate collar. In other cases, the thrust probes are mounted on internal brackets, and observe the front side of the thrust collar. Once again, it is desirable to mount the thrust probe within 6.0 inches axially of the thrust collar.

With the active thrust shoes on the outboard side of the bearing, and normal thrust load acting towards the probe mounted on the shaft end, it is easy to define axial movement directions. Specifically, decreasing gap voltage is indicative of normal thrust direction on the active shoes. Conversely, an increasing gap voltage indicates of thrust motion towards the inactive thrust.

The preceding discussion has been for a single thrust probe. In most applications, two thrust probes are installed to provide redundant measurements. This is mandatory for systems that are armed for automatic thrust position shutdown. In these applications, both thrust probes are connected to a common thrust position monitor, and various schemes of voting logic are used to trip the machine. Some users require both thrust probes to indicate trip, and others include thrust bearing temperature into the trip ladder. Obviously, multiple schemes are possible, and the end user should standardize on trip logic for the critical process machinery.

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