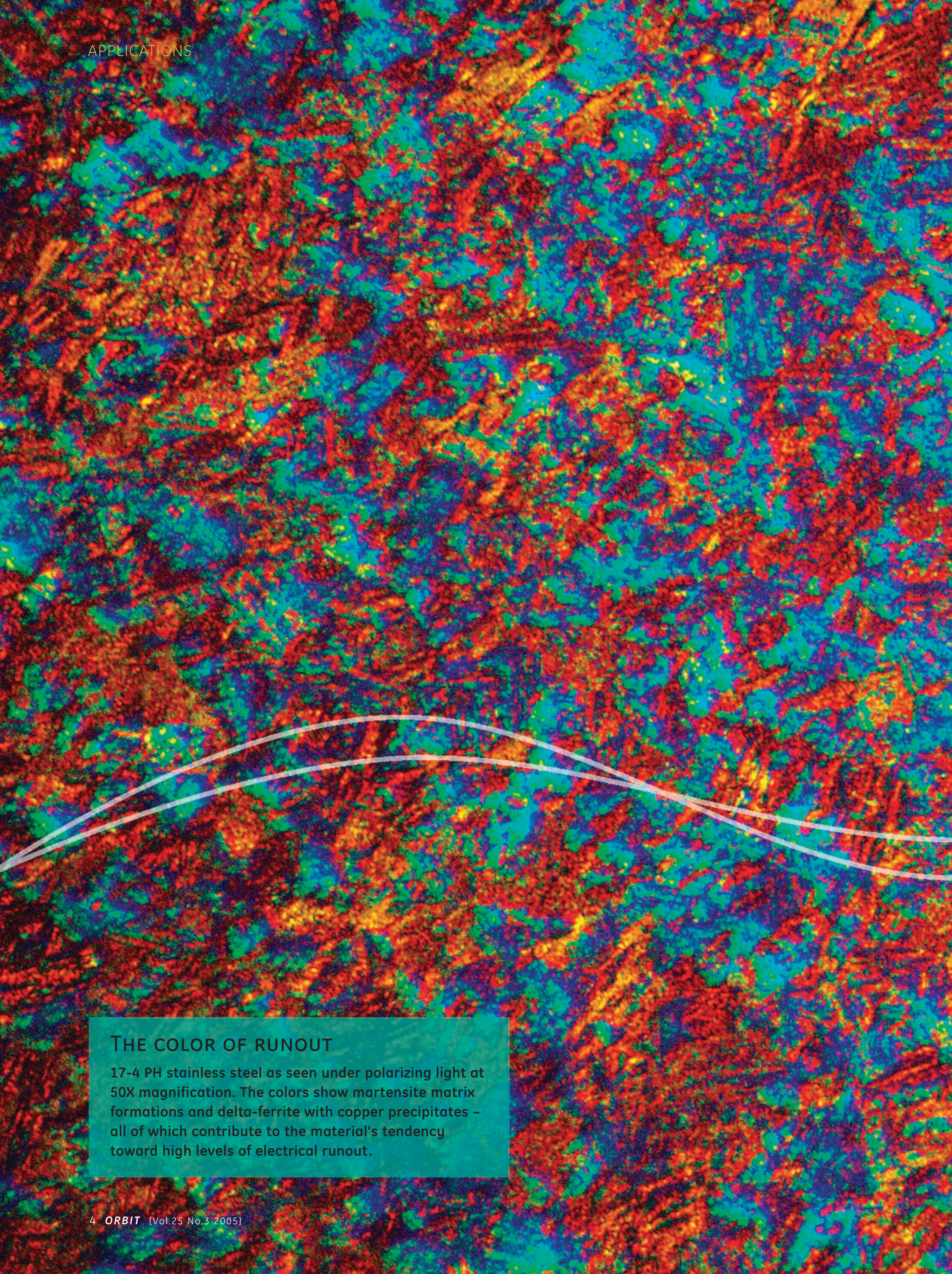

The color of runout

17-4 PH stainless steel as seen under polarizing light at 50X magnification. The colors show martensite matrix formations and delta-ferrite with copper precipitates – all of which contribute to the material's tendency toward high levels of electrical runout.

Understanding and Mitigating Shaft Runout

Introduction

This article explains what runout is, why it is important, and the root causes of runout in machinery shafts. It also outlines common methods for reducing runout to allowable levels and suggests best practices to observe during fabrication and machining to help avoid runout difficulties in the first place. While there is no guarantee that runout can be mitigated or prevented in every application, it can be managed effectively and kept to within allowable levels in the vast majority of applications. This is evidenced by the millions of successful proximity probe applications for turbomachinery around the world over the past forty years.

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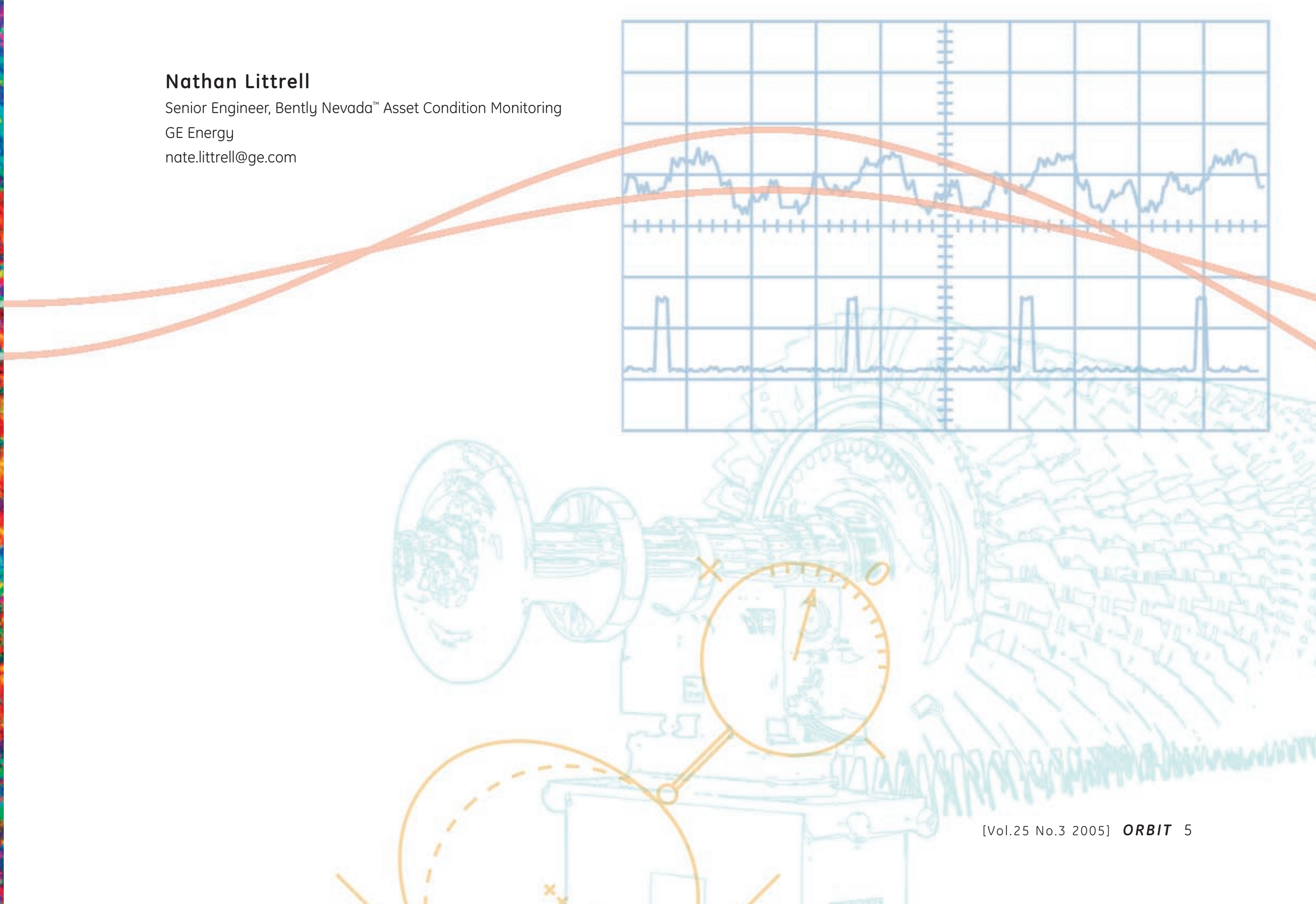


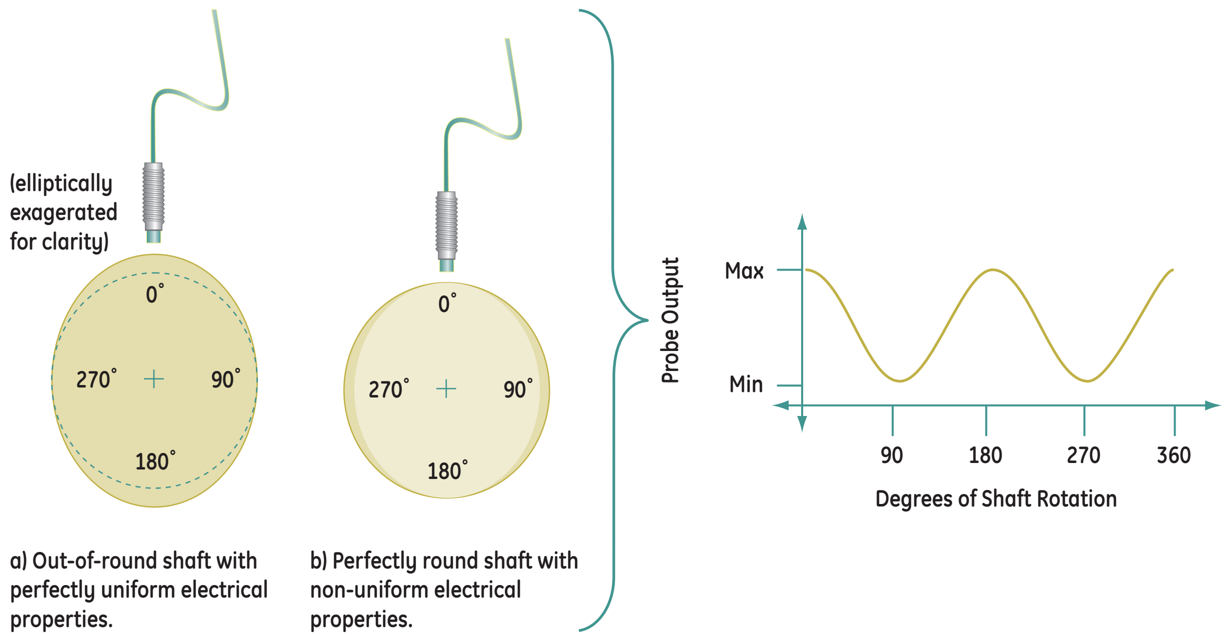


Figure 1 – **"Apparent" probe gap for a) an out-of-round shaft with uniform electrical properties and b) a perfectly round shaft with non-uniform electrical properties.**

What is Runout?

The signal from an eddy current proximity probe is a function of the gap between the probe tip and the target material. However, it is also a function of the electrical conductivity and magnetic permeability of the target material. Thus, two different materials (for example, 4140 type steel and aluminum) can be positioned with the same physical gap from a proximity probe, yet will give different outputs due to their dissimilar electrical properties.

For a rotating shaft, physical out-of-roundness results in a change in gap. This is shown in Figure 1a. However, a perfectly round shaft with non-uniform electro-magnetic properties will also result in a change in probe output, even though the physical gap is uniform. This is shown in Figure 1b. In this example, both shafts give identical probe outputs even though they have different physical shapes. In practice, mechanical runout can indeed be somewhat sinusoidal as shown in the example. However, electrical runout is rarely – if ever – sinusoidal and is generally characterized by a noisy waveform with numerous spikes. It is represented as a sinusoid in this example merely for illustrative purposes.

Notice also that these signals have nothing to do with the dynamic motion or vibration of the shaft. They are inherent properties of the shaft that will be observed regardless of whether it is stationary or rotating at high speed. These signals are known as runout. For convenience, we divide runout into two primary categories as follows:

Mechanical Runout is a measure of the shaft's deviation from a perfectly uniform radius as its circumference is traversed. This type of runout can be measured by a dial indicator.

Electrical Runout is a measure of a shaft's electrical property variations as its circumference is traversed. This type of runout cannot be measured by a dial indicator.

Because a proximity probe senses both types of runout, it is customary to speak of **Total Indicated Runout (TIR)** which is simply the sum of mechanical runout and electrical runout. In most cases, when runout is discussed in conjunction with proximity probes, it is understood to mean TIR.

BECAUSE THE RUNOUT SIGNAL IS NOT RELATED TO ACTUAL SHAFT VIBRATION, IT CAN LEAD TO ERRONEOUS VIBRATION READINGS AND MACHINERY DIAGNOSTIC CONCLUSIONS.

Why Be Concerned About Runout?

Even if a target material has non-uniform physical or electrical properties, it does not create a problem for probes observing the same location on the target at all times – such as an axial position measurement using the end of a shaft. However, proximity probes are often used for radial vibration measurements where the "track" observed by the probe is constantly changing (repeating itself every 360 degrees) as the shaft rotates. This results in a proximity probe signal composed of both actual vibration and runout. Because the runout signal is not related to actual shaft vibration, it can lead to erroneous vibration readings and machinery diagnostic conclusions. To avoid this problem, the amount of TIR must be kept to allowable levels, generally 25% or less of expected vibration amplitudes.

Many customers specify the amount of allowable runout for new or refurbished rotors as part of their purchasing documentation to their vendors. American Petroleum Institute (API) Standard 612 is one such frequently cited specification. It pertains specifically to mechanical drive steam turbines and requires the TIR to be 0.25 mil pp or 25% of allowable vibration, whichever is greater. API 617 has identical runout requirements and pertains to process centrifugal and axial compressors as well as turbo-expanders. Similar API standards exist for other machine types.

Failure to meet runout specifications can cause expensive delays and re-work, impacting both the customer and their machinery supplier. For this reason, discovering and correcting electrical runout issues early in the manufacturing process can save a great deal of cost. It is much easier to treat the problem when the shaft is on blocks or mounted on a lathe than when installed in the machine.

Sources of Mechanical Runout

- Machining processes
  - So-called "lobing" of the shaft (see Figures 2 and 3). This is particularly problematic when centerless grinding machines are used because variations in shaft hardness can result in a non-circular geometry. Grinding on centers provides a reference for the wheel to work against and is less prone to runout.
  - Tool chatter. Selection of the correct tool and holder, as well as adjustment, is critical for all machining processes. Make certain tools are not dull.
  - Improper feed rate and speed of cutting tools. Surface finish is strongly affected by cutting tool feeds and speeds.
- Dents from handling
- Rust patches
- Rotor bow due to thermal effects, gravity, or other influences/loads
- Defective or worn bearings in the machine or lathe supports

Sources of Electrical Runout

- ***Metallurgy***

The material chemical composition is fundamental to its electrical and magnetic properties. As well, the material's purity can affect runout. In general, non-ferrous materials such as copper and aluminum exhibit the fewest electrical runout problems, since they are devoid of any significant magnetic effects.

Conversely, the worst materials in terms of electrical runout are precipitation-hardened steels. Precipitation hardening is a process where clumps of different crystal states are formed in the matrix of the parent metal. The probe observes these clumps as they pass by while the shaft rotates, producing the unwanted runout signal. 17-4 PH can be particularly troublesome in this regard (see photo on page 4).

Bently Nevada™ Proximitor® sensors are calibrated to AISI 4140 type steel. However, this material is available in several grades, and variations in probe system response will vary among these grades. In general, the vacuum arc remelt (VAR) or double vacuum arc remelt (DVAR) materials possess the best homogeneity and exhibit the fewest number of problems with electrical runout.

It is recognized that the choice of shaft materials is rarely as simple as merely considering the material's runout properties. Instead, designers are faced with multiple criteria and inevitable tradeoffs. Pumps are a good example of machines that must often employ more exotic materials due to the corrosive nature of the process fluid that will be handled, whether seawater, liquefied sulfur, acids, or others. Motors are another machine type that commonly use materials other than 4140 type steels. As will be discussed later, when a designer requires certain shaft metallurgies, yet the material exhibits intractable runout characteristics, one approach is to attach a collar or coating of a different material to the shaft.

- ***Forging***

The forging process involves forming an ingot into the rough shape of the shaft using enormous hydraulic hammers and presses. During the forging process, the material flows into the shape of the shaft and gains a grain structure that is present throughout the cross section of the material. This grain structure defines a set of large scale boundaries that contain the smaller scale crystal boundaries. A non-uniform grain structure can result in electrical runout.

- ***Heat Treatment***

The purpose of heat treatment is to modify the crystal structure of a material to tailor the material mechanical properties (toughness, ductility, etc.) to the application. The magnetic properties of ferrous materials are a function of the crystal structure, so it follows that heat treatment is a factor in the resulting electrical uniformity of the shaft.

Many large shafts are quenched as part of the heat treatment process by lowering into tanks of salt water or other liquids. Most commonly, the shaft is horizontal when lowered into the quench tank, which results in an asymmetrical quench profile. It is recommended to lower the shaft vertically into the quench tank if possible to improve the radial homogeneity of the quench.

- ***Grinding***

Grinding the bearing journals to final dimensions and finish is generally the last step in the shaft manufacturing process. The grinding process generates significant heat that is localized at the point where the grinding wheel touches the shaft. It is important to have maximum coolant flow on the work piece and to start and stop the grinding process slowly. Avoid sudden increases or decreases in feed rate when grinding. It is also recommended to keep the wheel freshly dressed to limit heat build up. Because grinding results are highly dependent on the operator, it is recommended that this step be closely monitored if runout problems are occurring.

- ***Magnetism***

Residual magnetic fields in the shaft can cause significant variation in the output of the proximity probe system. Degaussing (discussed later in this article) is the recommended remedy.

- ***Stress Effects***

Stress affects the crystal structure and magnetic properties of materials. Occasionally, a shaft with runout problems can be traced back to an event that caused the probe area to undergo significant mechanical stress. It is best practice to support shafts in slings in such a way that they are not subject to significant bending stresses during installation and handling. Bead blasting or other impact-based cleaning processes create compressive stress in the surface of the shaft and can induce runout.

- ***Handling***

In addition to the stress effects mentioned above, it is possible to 'bruise' metal by hitting or dropping the shaft on the probe tracks during intermediate steps of manufacture. The external damage is erased by subsequent steps such as machining, but the damage to the crystal structure may go quite deep into the material. Thus, it is important to handle the shaft carefully at all steps in the process.

- ***Plating***

Occasionally, a rotor is refurbished by plating the bearing journal area to replace worn material. Sometimes, this surface will be intentionally "roughed up" to allow the chrome plating to adhere better. However, the probe will "see through" the plating to the rough surface underneath, resulting in runout. Also, chrome plating has very different electrical properties than typical shaft materials and strongly affects proximity probe output. In general, plating in the area of proximity probes is not recommended. However, when this is not an option, plating thickness should be at least 20 mils to prevent the "see through" effect mentioned above, and the Proximitor® sensor should be calibrated to the plating material rather than the substrate shaft metallurgy.

Measuring Mechanical Runout

The first step in dealing with runout is to make an accurate measurement of the physical profile of the shaft to determine the mechanical runout. Once the mechanical profile has been determined, electrical runout can then be inferred – generally by simply subtracting the mechanical runout from the TIR measurement made with a proximity probe.

When assessing mechanical runout, accuracy is paramount. Special care must be taken due to the extremely small dimensions being measured. This requires a measuring instrument capable of resolving increments finer than 0.1mil (.0025 mm). While there are several choices for such instruments, some are more practical, accurate, and convenient than others.

- **LVDTs (Linear Variable Differential Transformers)**

  LVDTs operate on the principle of a transformer with a movable core. As the core moves, the gain of the transformer changes and the displacement is inferred from that signal. Units are available with a resolution in the 0.01 mil (.0003 mm) range and are particularly well-suited for highly accurate mechanical runout determination.

- **Dial indicators**

  While inexpensive, reliable, and found in most every machinist's tool box, mechanical dial indicators are generally limited to increments no finer than a tenth of a mil. Analog versions use a conventional needle-type indicator that can be very difficult to read with the required resolution, and for this reason are unsuitable for runout measurements. In addition, they do not allow for automated data acquisition.

  Dial indicators with a digital display are also available, and are generally capable of providing the necessary resolution. In addition, some of the more advanced versions feature an electrical output in addition to the display, making them suitable for automatic data acquisition.

- **Form measuring equipment**

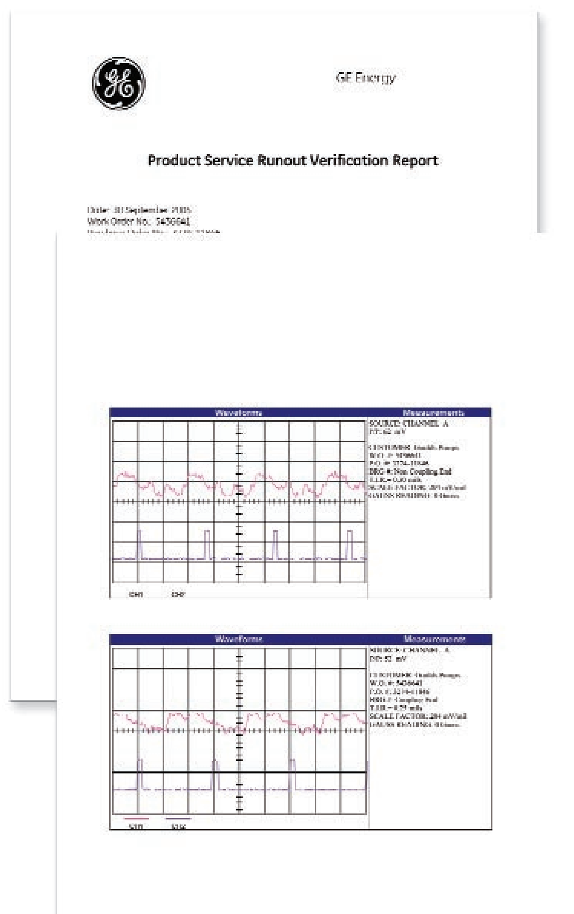
  These are specialized devices that evaluate components in terms of geometric dimensioning and tolerancing definitions. The machine typically holds the component vertically on a turntable and measures the form of the surface using a stylus. Output is the radial deviation from absolute roundness along with values describing the concentricity, eccentricity, and roundness as defined by Geometrical Dimensioning and Tolerancing (GDT) standards. Unfortunately, such equipment is of only academic interest for most rotating machinery because it cannot handle components larger than 60 kg.

Based on the foregoing discussion, only two practical choices exist for measuring mechanical runout in most instances: LVDTs and electronic dial indicators.

Measuring Electrical Runout

Since electrical and mechanical runout are remedied in different ways, it is important to obtain separate profiles of the mechanical and electrical runout. Often, it is easiest to measure TIR and mechanical runout simultaneously. The electrical runout is then found by simply subtracting the mechanical runout from the TIR, as previously mentioned. Measurements should be made at suitably small intervals (typically every 10-20 degrees) to provide sufficient detail in the profiles.

While we have already discussed several practices that can help prevent electrical runout at the manufacturing stage, there are also methods (such as diamond burnishing and degaussing) that can be used to reduce electrical runout once it is already present. These methods will be discussed later in this article. However, before attempting to reduce the amount of electrical runout, it is generally recommended that mechanical runout be addressed first, to try and bring the TIR within tolerances. This



Excerpt from a typical runout report for both coupling and non-coupling ends of a pump rotor. The top trace of each plot shows the runout waveform while the bottom trace shows the Keyphasor® pulse, indicating one complete shaft revolution between pulses.

serves two purposes. First, the processes of grinding and machining to further reduce mechanical runout can themselves introduce additional electrical runout. Thus, there is little point in proceeding to address excessive electrical runout until mechanical runout has been addressed. Second, because it is typically more difficult to address electrical runout, mitigation is generally only appropriate when mechanical runout reduction alone cannot bring the TIR to within the specified limits.

Sources of Error and Non-Repeatability

API 687 (Repair of Special Purpose Rotors) provides a very detailed description of how to measure runout. API specifications, in general, require that:

1. The shaft be supported in v-blocks;

2. The probe be perpendicular to one face of the v-block;

3. Runout be measured in terms of peak-to-peak probe output.

One of the primary reasons that v-blocks are recommended is that the runout measurement should be made in apparatus separate from that in which the machining was actually performed. For example, if a lathe has bearing wear that produces an elliptical shaft cross-section, the shaft will appear perfectly round as long as it is in that particular lathe. By moving the shaft to a separate measuring environment (i.e., v-blocks or a balancing machine), the error introduced by the lathe will not be masked.

However, while the use of v-blocks represents recognized good practice, it is not immune from its own sources of errors as detailed below.

- **Failure to mount the probe perpendicular to one face of the v-block**

  This is a common error made in the field and results in incorrect mechanical runout readings. It affects only the mechanical runout measurement (not the electrical). The maximum mechanical runout error introduced is the sine of the probe's angular deviation from block face perpendicularity.

- **Lobing Effects**

  As mentioned earlier, lobing is a common artifact of centerless grinding operations. When measuring the shaft profile in a lathe or other device where the shaft is rotated about its axial centerline, the user is measuring radial (rather than diametral) variations. As a result, there is no ambiguity in the profile measurement. In contrast, v-blocks cause the user to measure diametral variation, and can result in ambiguity regarding the shaft profile. This is easiest to visualize by way of examples, as shown in Figures 2 and 3.

  Notice that the dial indicator in Figure 2 gives exactly the same output shape (dark blue line) for both shafts and that it reflects the change in diameter (not radius) as the shafts are rotated. The user may incorrectly conclude that the one-lobed shaft had a two-lobed profile, and efforts to correct this through grinding would only exacerbate the problem. In Figure 3, notice that the three-lobed shaft provides a dial indicator output suggesting perfect roundness, when, in fact, it has three lobes. Only by examining the motion of the center of the inscribed circle for all three shafts does the user obtain the true profile. This ambiguity can be removed by making the mechanical runout measurement with a fixture that rotates the shaft about its centerline (such as a balancing machine). As previously mentioned, it is not recommended that the measurement be made on the same lathe in which the shaft is being machined, as the runout measured becomes the combined effect of the shaft and the lathe bearings, and the two can offset one another.

  Oil wedge – It is known that a film of oil builds up between two surfaces moving relative to each other. This oil film becomes part of the runout measurement and is unpredictable. A moving measurement may exhibit a dependency on shaft speed, even at slow roll. Thus, when documenting runout under slow roll conditions, it is important to record the actual shaft rotative speed.

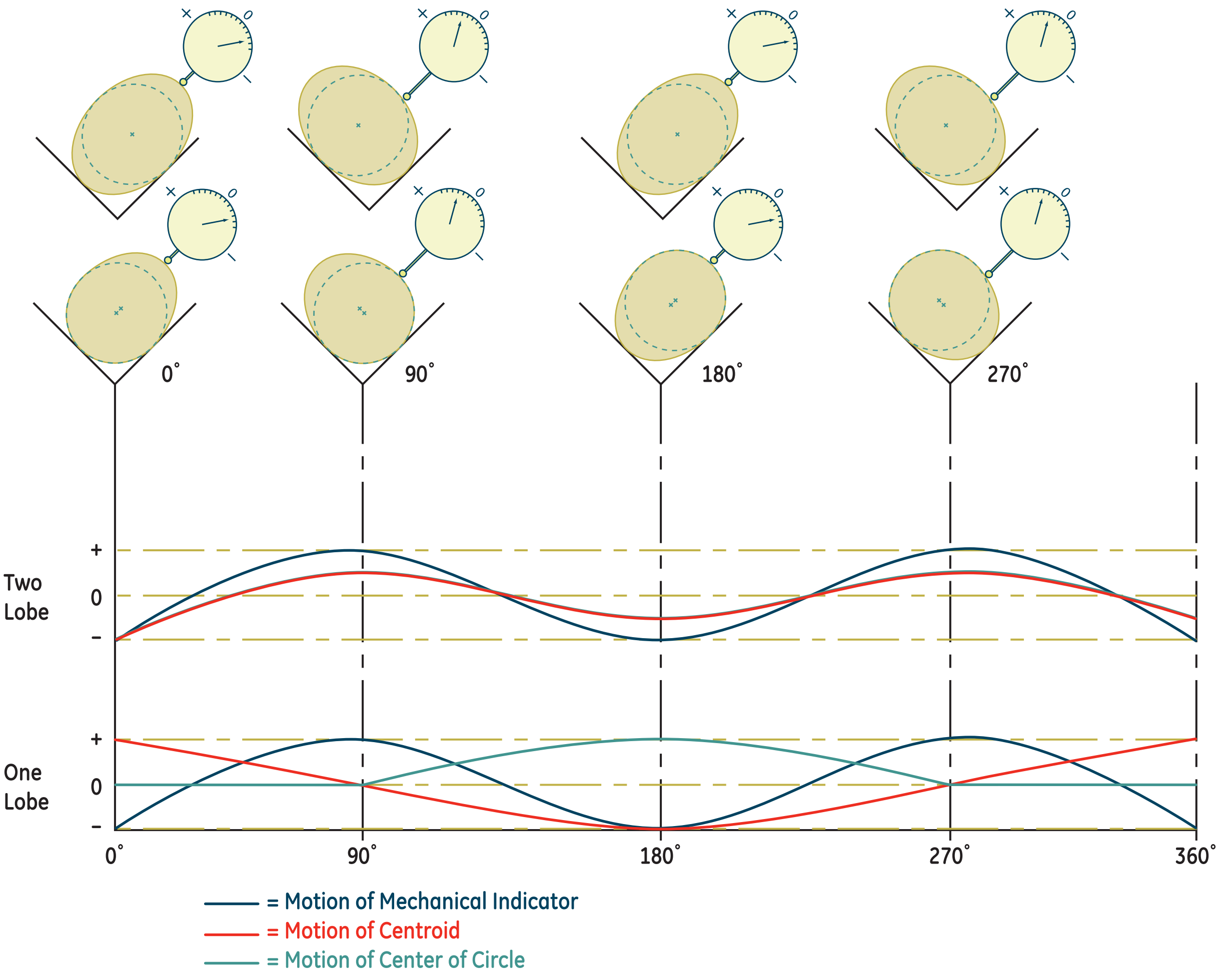


Figure 2 – When mounted in v-blocks and measured with a dial indicator, these one- and two-lobe shafts give identical dial indicator profiles. The only way to ascertain the true mechanical profile is to make the dial indicator measurements using apparatus that keeps the shaft fixed about its centerline – such as a lathe. This allows radial, rather than diametral, variation to be observed.

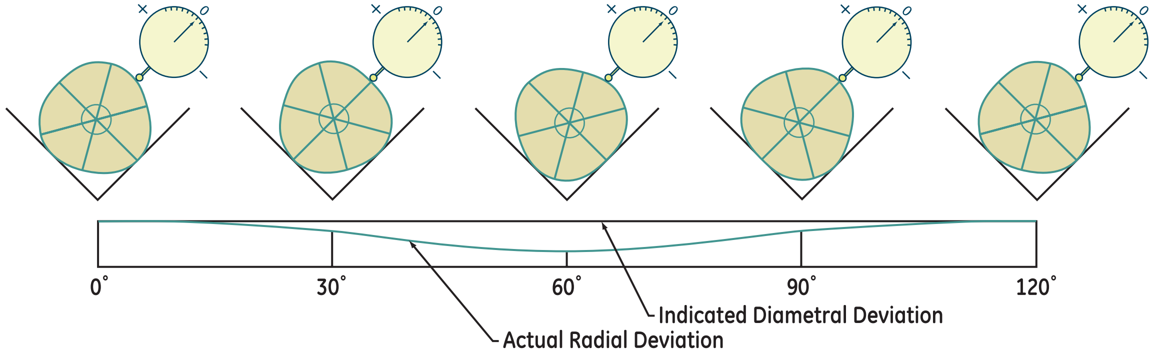


Figure 3 – This 3-lobed shaft appears to be perfectly round when mounted in v-blocks and measured with a dial indicator.

WHEN ASSESSING MECHANICAL RUNOUT,

ACCURACY IS PARAMOUNT.

Stick slip – V-block measurements will sometimes use an apparatus (such as a drive belt) that slowly rotates the shaft. However, manual barring of the shaft is most common. While API specifications recommend rotation intervals of no more than 20 degrees, this is a relatively large gap between data points. As the rotor is moved, it may not settle into position repeatably, leading to significant error. To help counteract this "stick slip" effect, smaller measurement intervals (10 degrees or less) are recommended.

Bow/sag – If a shaft has a bow or sag from gravity (and all shafts exhibit some level of this), it is possible that this will show up as runout as the shaft flexes during rotation. Anisotropic stiffness (unequal with respect to direction) will definitely cause irregularity in the runout reading due to rotor sag. To minimize this effect, make the runout measurements as close as possible to the shaft supports (e.g., v-blocks).

Inconsistent Transducer Models – When measuring TIR, it is not necessary to use the same probe in the shop as the installed probes in the field, as this is rarely practical. However, it is strongly recommended that the same probe *series* be used to eliminate possible sources of inconsistencies. For example, if the machine will be permanently monitored with Bently Nevada 3300 XL 8mm proximity probes, it is advisable to use this type of transducer system for the bench runout measurements as well. While the differences between transducer series are generally small, runout measurements are typically trying to resolve dimensions of 0.25 mils or less. As such, even the smallest sources of variation can affect the results.

Methods of Mitigating Electrical Runout

The old adage "an ounce or prevention is worth a pound of cure" is particularly true for electrical runout. In the section "Sources of Electrical Runout," we noted a variety of things that can lead to electrical runout and offered advice on how to carefully choose and handle materials to minimize the potential for electrical runout. However, if excessive levels of electrical runout exist, there are steps that can be taken to reduce them.

Degaussing (Demagnetizing)

One method of checking residual magnetic field strength is by using a small, hand-held field indicator, available in digital and analog versions from manufacturers such as Magnaflux®. Even a relatively small amount of localized residual magnetism can contribute to runout. For example, a localized concentration of 5 gauss on a rotating shaft can give electrical runout on the order of 0.5 mil. Therefore, it is always good practice to check the shaft with a field indicator and, if required, degauss in the area of the probe tracks.

A degausser emits an AC pulse of decreasing strength. The magnetic field generated "scrambles" the domains in the material to reduce the residual magnetism. While special degaussing apparatus is available, a very common field practice is to use an arc welder set to AC with the cables shorted together. The cables are waved over the area to be degaussed, or sometimes wrapped around the shaft. The current in the cables sets up a large enough magnetic field to effectively degauss the shaft.

A diamond-tipped burnishing tool. The tool is mounted in a lathe and can provide surface finishes of 10 microinches or less. When used by a skilled practitioner, diamond-tip burnishing can be effective in reducing electrical runout because it alters the shaft's crystal structure.

Probe Gap

A simple first attempt at reducing electrical runout is to gap the probes closer to the shaft. Sometimes this can change the runout measurement. However, be certain that the probes are not gapped so close that they take the probes outside their linear region or allow the probes to contact the shaft during periods of high vibration.

Burnishing

Burnishing is a technique of smoothing the surface of the shaft using a rounded diamond tip mounted on a lathe. The burnisher tip is pushed against the shaft surface by a spring loaded tool holder. This process mechanically alters the crystal structure on the surface of the shaft by plastic deformation, allowing surface finishes of less than 10 microinches to be realized. While burnishing can be an effective method of reducing electrical runout, it is more of an art than a science. Unless applied by a skilled practitioner, burnishing can actually worsen electrical runout. Further, if some burnishing is good, more is not necessarily better. Once burnishing has minimized the electrical runout, additional burnishing may increase rather than decrease the runout. For these reasons, we have deliberately chosen not to include step-by-step burnishing instructions in this article. Instead, customers are strongly encouraged to enlist the assistance of a qualified GE services professional when burnishing is required. In addition to performing the burnishing work, these individuals can provide the necessary hands-on training for those customers that prefer in-house competencies in the use of burnishing tools.

Alternate probe track material

In some instances, electrical runout can prove quite intractable. In such instances, the most expedient solution is generally to use an alternate target material for the probe to observe. The two most common methods for this are collars and coatings.

- **Collars**

  Collars can be very effective, provided they are attached to the shaft in such a way that they cannot come loose or induce additional loads or stresses on the machine. Additionally, the collar must be ground after it is shrunk onto the shaft to ensure that it is suitably concentric. However, some shaft geometries cannot accommodate a collar. In other situations, the shaft geometry may allow for a collar, but significant thermal gradients due to differential expansion problems may make use of a collar unwise.

- **Coatings**

  Depositing a layer of less runout-prone material onto a shaft can be employed successfully, and there are several technologies for this. The idea is similar to that of plating (already discussed) and many of the same considerations apply. Primary concerns are to choose a material that is non-ferrous and applies with sufficient density that inclusions do not generate a runout signal of their own. The material must also be applied in a thick enough layer to prevent the probe from seeing through to the substrate.

  Obviously, both approaches require a proximity probe system calibrated to the target material, not the shaft material.

A Word About Compensation

When performing machinery diagnostics, a common practice is to subtract a known runout signal from the overall vibration waveform to obtain a "runout-free" waveform. This is known as compensation and is a way of dealing with both mechanical and electrical runout. Many diagnostic products (such as the ADRE® System and System 1® software) allow such compensation. In addition to waveform compensation for unfiltered plots such as timebases and orbits, the signal can also be filtered to a specific frequency, such as shaft rotative speed (1X). This allows it to be characterized as a vector and used to compensate filtered plots (such as Bodé and Polar – see Figures 4 and 5).

Occasionally, users will request that we provide compensation features in our permanent monitoring hardware. Both vector and waveform compensation are valuable features when performing machinery diagnostics, and the runout signal can generally be validated and updated as needed as part of the diagnostic process. This is not the case for permanent monitoring and we strongly advise against the use of compensation for machinery protection applications. Runout signals can change over time due to factors such as surface scratches incurred during operation or maintenance, and/or changes in the amount and distribution of shaft magnetism. When compensation is embedded in a permanent monitor, the runout profile stored in the monitor

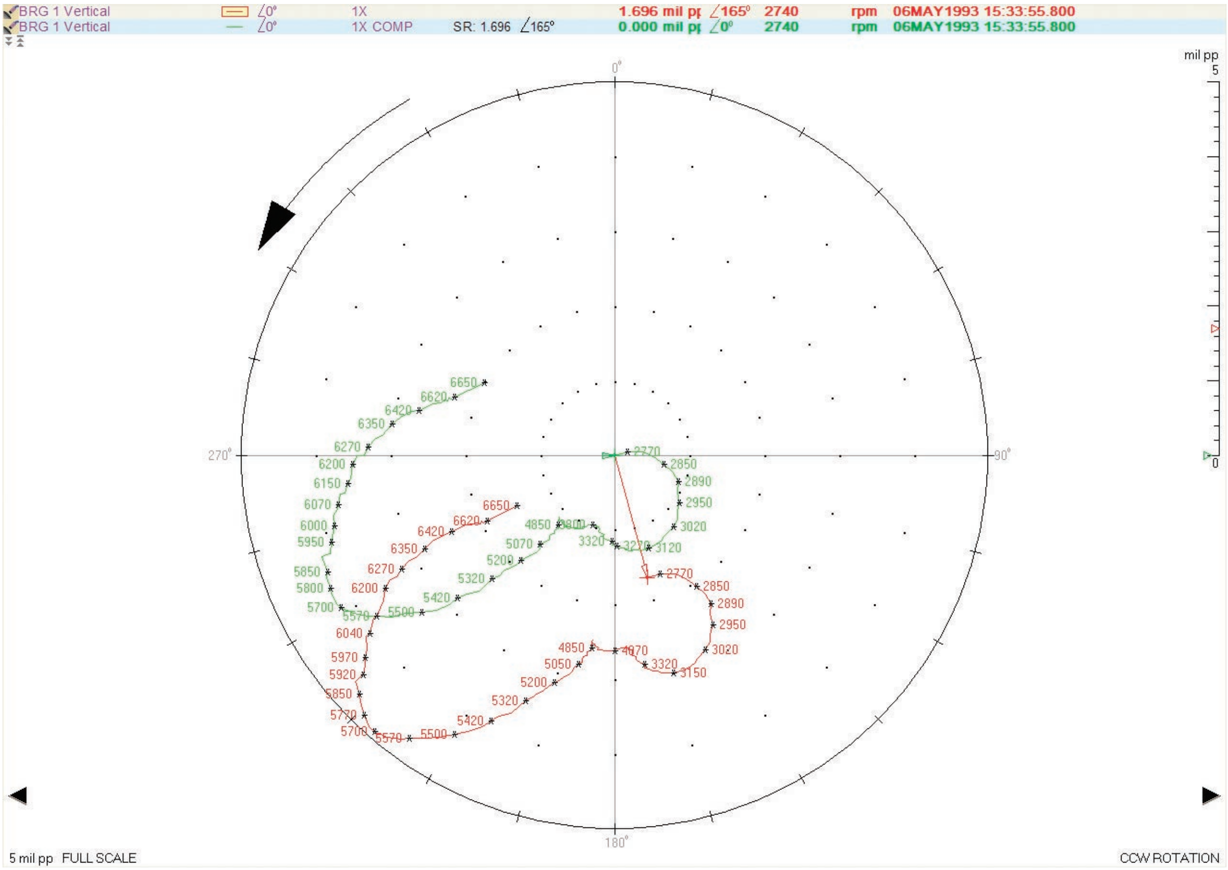


Figure 4 – **ADRE® Sxp software is one example of a diagnostic system that provides runout compensation features as shown by the compensated (green) and uncompensated (red) data in this polar plot.The red arrow denotes the 1X runout vector. For a polar plot, compensation has the effect of shifting the data to the origin at slow-roll speeds.**

remains fixed even though the actual runout may be changing over time.

The nature of combining waveforms and vectors is that they reinforce in some places and counteract in others – unlike simple scalar addition. Figure 5 illustrates this concept, showing how the runout signal increases the observed vibration signal in some places (i.e., below 6200 rpm) and decreases it in others (i.e., above 6200 rpm).

In this case, the vibration is changing while the runout remains fixed. However, the same effect can occur when the runout is changing, regardless of whether the vibration levels are stable or changing. Changes in runout may make the vibration look worse than it actually is, or they may mask legitimate high vibration problems, phase changes, or other conditions indicative of an emerging machinery malfunction.

Back when Bently Nevada™ monitoring hardware utilized analog meter movements, users would sometimes want to "compensate" for runout by using the offset adjustment potentiometer in the meter. For example, if the peak-to-peak amplitude of the runout signal was 0.5 mils, they reasoned that they could simply offset their meter by 0.5 mils. Thus, a meter that would normally indicate 3.2 mils of vibration would indicate only 2.7 mils. This approach was particularly faulty because it not only failed to recognize that runout can change over time, but

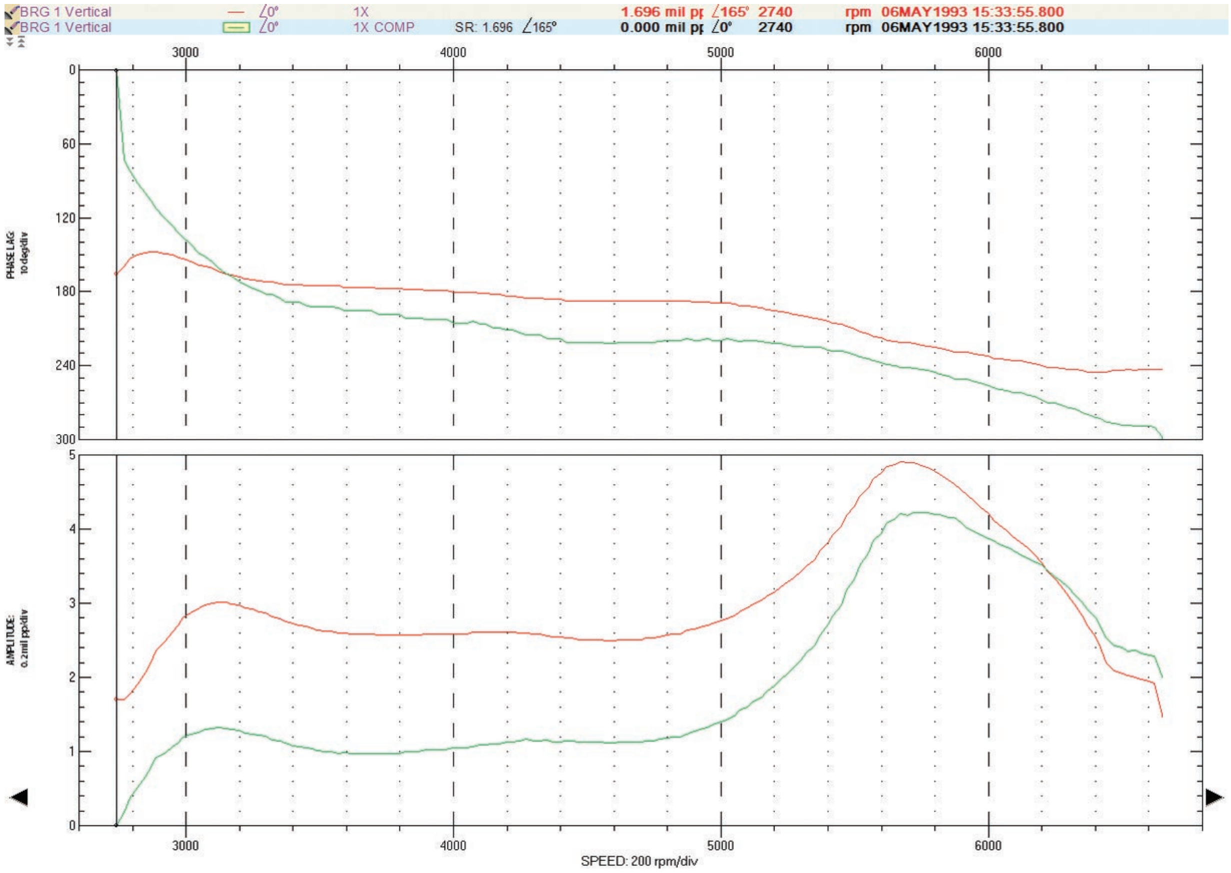


Figure 5 – **Bodé plot of same data as in Figure 4. Notice how the compensated data (green) has lower amplitude than uncompensated data (red) below 6200 rpm, but this is reversed for speeds above 6200 rpm. The complex nature in which vectors and waveforms combine can cause runout to either increase or decrease the actual vibration amplitude.**

Slow Roll Runout as a Diagnostic Tool

As pointed out in this article, runout can change, and for this reason, embedded compensation in a permanent monitoring system is not recommended. However, runout can vary for more reasons than just shaft scratches or changes in shaft magnetism. One of the most serious malfunctions that can result in a runout change is a shaft crack. While this is not the only symptom of a crack, any time the slow roll (typically less than 400 rpm) runout amplitude/phase vectors change, it is imperative to understand why.

Our first rule of shaft cracks states that, “If a shaft is cracked, it is almost certainly bowed.” This bow can change the 1X slow roll runout vectors once crack propagation takes place. Thus, if the shaft is bowed, it may simply be gravity sag, or it may be more serious. The 2X slow roll runout vector should also be checked. Cracks can cause stiffness asymmetry if they propagate in an uneven pattern, creating a characteristic twice-per-revolution flexing. Certain rotor designs are inherently asymmetric – such as 2-pole generator rotors, – where “normal” shaft asymmetry will yield a noticeable 2X component, but its amplitude and phase should not change over time.

The moral of this story? Always remember to treat runout data as a valuable source of diagnostic information – not merely “noise” that interferes with the true vibration.

You can read more about the topic of shaft crack in the January 1986 issue of ORBIT.

that runout is a complex waveform and does not follow the rules of scalar subtraction.

The inherent problems in using embedded compensation in machinery protection systems was addressed a number of years ago in American Petroleum Institute Standard 670. It specifically prohibits the use of compensation in permanent monitoring systems. Consistent with API 670, it has long been our practice to provide compensation in systems used for diagnostic purposes, but not machinery protection purposes.

Summary

As we have shown, many factors can influence the amount of runout present in a shaft. The best approach is to prevent runout – rather than mitigate it after the fact – through appropriate diligence at all stages of the manufacturing process. However, mitigation will still sometimes be necessary and this article has discussed several methods that can be employed with good success, ranging from degaussing and burnishing to the use of alternate materials for the probe tracks. In all situations, runout can be effectively managed and should not preclude users from using proximity probes on machinery with fluid-film bearings, as these transducers afford the most sensitive and reliable machinery condition measurements available.

For those experiencing runout-related problems or desiring to prevent such problems from occurring in the first place, an excellent approach is to enlist the service of GE Energy’s field professionals. They can develop a runout mitigation plan specific to your operations as well as provide the necessary training for your personnel.

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