Shaft Voltage Monitoring

The shaft of a rotating machine ideally should have no voltage end-to-end or shaft to ground. However, such voltages do exist on almost all shafts due either to electrostatic charge build up or residual magnetism and, in electrical machines, to asymmetry in magnetic fields of the stator and/or rotor. Electrostatic charge build-up can come from charge separation in connection with steam or oil flow. Residual magnetism is often left in the unit from such causes as welding, magnetic particle inspection, plus permanent magnets or electromagnets possibly employed for holding, transport, etc. Magnetic asymmetries in the stator and/or rotor of electrical machines come from causes such as air gap eccentricity, shorted core laminations, broken rotor bars, winding shorted turns and/or ground faults, plus transients and harmonics from variable frequency or PWM power supplies or from blown diodes or fuses in excitation systems. So long as the shaft peak voltage to ground does not exceed 1 Volt, there should be no consequential effects to the bearings. When the peak shaft voltage exceeds 1 volt, there is a possible risk that current discharge will occur across that bearing, depending upon the magnitude and frequency of the voltage, the bearing loading, its alignment, shaft vibration and the condition and cleanliness of the oil film. The effect of the shaft voltage on bearings is electrical spark erosion, spark tracking or welding at shaft journals and bearing babbitted surfaces. Where the bearing, seal and coupling are insulated, such as, at the outboard end of an electrical machine, up to 50 volts, or more at power frequency, is often tolerated. Bearing and seal failures occur in many instances despite efforts to insulate the bearing pedestals, or bracket bearing keeps and hydrogen seals. Possible explanations for this are accidental bridging of the insulation, and the presence of harmonics or voltage spikes on the shaft from excitation or other power system electronics. Bearing currents generally lead to bearing failures unless the cause is detected and corrected at an early stage.

Maintaining shaft voltages to below one volt on all bearings (except those properly insulated and/or protected) should be considered a requirement for positively preventing shaft current damage to bearings, seals couplings and gears. The common practice of using conventional current carrying brushes composed of graphite, composite, babbitt or copper straps, for shaft grounding is often unreliable in maintaining low shaft voltage because of dirty and oily atmospheres and because the relatively low shaft grounding current is insufficient to sustain a conducting shaft film necessary for reliable shaft grounding. Regular and frequent maintenance is necessary and is often inadequate to maintain reasonable brush performance. Since shaft ground currents are normally relatively low and shaft-grounding brushes must be reliable in presence of dirt and oil, special consideration must be given to their design and application. Certain bristle-type brushes meet these requirements as they perform very well for both shaft grounding and shaft voltage measurements.

Continuous monitors not only ensure continued and reliable brush performance but can also provide “Early Warning” of developing unit and train problems. Shaft monitors, and/or monitoring may not be available from OEMs, however they are available from independent suppliers. Retrofitting of shaft grounding and condition monitoring is usually possible without having to disassemble the unit. There is at least one vendor that specializes in monitoring of shaft current and voltage profiles, called Shaft Condition Monitoring. The system consists of shaft riding brushes and a monitor. The system claims to detect and identify a number of problems and conditions listed in the first paragraph and which, if not corrected, would eventually lead to: shaft, bearing and/or frame vibrations, bearing over-temperatures, shaft displacements, ground faults, shorted turns, blown diodes and fuses, AC impedance changes, etc.