Lifetime Reliability • Solutions
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TOP FOUR MACHINE FAULTS

FAULT	MECHANICAL DESCRIPTION	VA IDENTIFIERS	LIKELY CAUSES	POSSIBLE SOLUTIONS
UNBALANCE	Rotor centre of mass is displaced from centre of rotation. Result is a radial force proportional in magnitude to eccentricity and shaft speed squared.	Dominant shaft x1 radial. Phase at x1 rock steady. Horizontal and vertical displacement will usually be similar. Amplitude usually stable. Axial vibration usually low.	1. Rotor was not correctly balanced when new or rebuilt. 2. Rotor wear, corrosion or build-up of solids. Loss of balance weights. 3. Shaft may not be straight. 4. Machine could be operating close to a structural or shaft natural frequency.	1. In-situ balance, or remove for shop balancing. 2. Clean and rebuild rotor. 3. 'Clock' shaft and straighten or replace. 4. Do impact tests or take amplitude/phase data on rundown.
MISALIGNMENT	In a perfectly aligned and precision made coupling assembly, the transfer of torque from one shaft to the other takes place without any radial or axial forces being developed. This is never realised in practice and the degree in which axial and radial vibration forces are developed is a measure of the errors of machining and alignment.	Identifiers vary, but these are often observed. Parallel Misalignment Shaft x2 Phase at x1 or x2 is 180^{o} shifted radially across coupling. Angular Misalignment Shaft x1, x3, x5 Phase measurement may not be helpful. Axial vibration always higher than radial. Vibration of similar spectral shape is usually observed on BOTH machines.	1. Poor alignment procedure or incorrect tolerances. 2. Poor bedplate or sub-frame condition or design. 'Soft-Foot' conditions may be present. 3. Incorrect allowances for thermal growth. Note: Poor coupling condition or fit on shafts can often give symptoms similar to misalignment.	1. Realign to tolerance with new shims and clean surfaces. 2. Check vibration at mounting points to observe any weakness or looseness. 3. Check alignment immediately after hot shutdown. Then again when cold. Note the differences.
LOOSENESS	Looseness is seen as a non-linear response to the absorption of forces in a machine. Can be 'Gravitational' (such as broken motor foot), or 'Rotational' (such as loose bearing in housing).	'Gravitational' Looseness – Shaft x2 dominant. Steady phase. 'Rotational' Looseness – Shaft x2, x4, Steady phase. Coupling Looseness – Shaft x3, x5, x7 etc. Time Domain usually truncated or offset from centre.	1. Mountings loose or broken. 2. Shaft loose in bearing, or bearings loose in housing. 3. Coupling looseness can produce a 'square wave' effect, hence the odd orders.	1. Check and tighten. Use vibration meter while machine is running to find looseness. 2. Do lift test if possible to confirm. Dismantle and inspect. 3. Look for fretted keyways and other signs of 'working' If in doubt re-fit to ensure tightness.
ROLLING ELEMENT BEARING FAILURE	Bearings can fail in numerous ways. The two most common are: Pitting or marking of the rolling elements or raceways is preceded by low amplitude shocks in the bearings. Abrasion of the cage, raceways and elements results in looseness, sometimes without any discernible high frequency vibration or shock.	Best identifier of 'pitting' and similar conditions are proprietary high frequency bearing fault detection systems. Bearing wear is harder to identify and may first manifest as an increase in harmonics of shaft speed. Note that velocity measurements should always be examined for signs of looseness.	1. Pitting may be caused by fatigue, false brinelling or incorrect fitting. 2. Ingress of abrasive material or corrosive liquids into bearing. 3. Bearing overheated. 4. Bearing overloaded. Note: Axial thrust overload is a common cause of failure.	1. Replace bearing. Conduct Root Cause Analysis on removed bearing. 2. Examine/upgrade seals. 3. Installation or lubrication faults. 4. Study failure mode and re-design bearing system.