7.5 BEARING FAILURE MODES AND MECHANISMS

The two main failure modes of a bearing are wear and fatigue. Ball and roller bearings which are well lubricated, perfectly sealed and running at moderate load and speed, will not exhibit sufficient wear that will cause a failure even after long service. In this case the bearing will eventually end its service life due to fatigue. Fatigue is the failure mode that normally creates the L₁₀ bearing life. The operating conditions found in practice will almost certainly be less benign and wear must therefore be considered as a potential failure mode. Wear will be exhibited at the contact surfaces of the rings and rolling elements, at the sliding surfaces of the cage, and in roller bearings on the lip and roller faces. The process of wear begins with an increase in surface roughness of the raceway due to detached material particles. As additional material is removed from the contact area, the form of the raceway will be altered. Foreign particles may also enter the bearing through insufficient or worn seals, lubrication contaminants from other parts in a common lubrication system, or corrosion of the rolling and sliding surfaces due to water condensation as a result of temperature changes and corrosive liquids.

Roller bearings usually provide ample warning before complete failure by increasingly noisy operation and will usually fail from fatigue. Sliding bearings, on the other hand, often perform well up to moments before a catastrophic failure. It is very important to evaluate all bearing failure modes since a bearing failure emitting particles can cause severe shaft damage or other parts associated with the total design.

Common bearing failure modes, mechanisms and causes are listed in Table 7-1. One common mechanism of bearing failure is spalling, which is defined as subsurface chipping or breaking. The failure is usually caused by loading of the bearing exceeding the design load. Surface fatigue or peeling is a cracking and peeling of the surface metal. It is usually the result of poor lubrication or surface damage which interrupts the lubricant film. Scores and scratches are usually caused by hard particles being trapped in a bearing. This failure mechanism may also be caused by inadequate sealing, contaminants in the lubricant, or installation damage.

Smearing is surface damage resulting from unlubricated sliding contact within a bearing. Brinelling is the actual indentation of a rolling element under excessive load or impact that causes stresses beyond the yield point of the bearing material.

Fretting wear is usually caused by an improper fit between the bearing and the shaft or outer surface of the bearing. This allows movement of the race in relation to the housing or shaft. The surfaces then wear or score, thereby damaging the surfaces and preventing a firm, fixed contact.

Roller and tapered bearings have an additional failure mode defined as scuffing of the bearing surfaces. This failure mode is usually caused by bearing exposure to an excessive load for an extended period of time. The surfaces of the moving parts are