



American
Gear Manufacturers
Association

Technical Resources

13FTM04

AGMA Technical Paper

Best Practices for Gearbox Assembly and Disassembly

By J. Bello, David Brown Gear
Systems, USA Inc.

Best Practices for Gearbox Assembly and Disassembly

Jodi Bello, David Brown Gear Systems, USA Inc.

[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

When industry is looking at the best ways to increase efficiency, reduce downtime and increase profitability, gearbox performance and reliability are key factors. In most applications gearbox reliability is critical to the productivity of the overall plant operation. Repair is often required with a swift turn around, as down time is very expensive. Designing for repair, and writing effective repair procedures, can speed the service time, and provide a quality refurbishment. Minimizing down time and extending service life will contribute significantly to achieving the lowest overall operation costs.

The best practices listed below are proven, effective methods used to install and remove bearings, seals, gears, couplings and shafts within a gearbox. These techniques are not new, and are usually obtained by hard won experience. Collecting them in one location is an attempt to document the best practices and provide a reference for design engineers. Engineers write the procedures for assembly and disassembly, they also dictate to the rest of the design team the design intent. Including features to facilitate disassembly, minimizes repair cycle time and helps to prevent damage to components that could radically compromise their design life or performance.

Copyright © 2013

American Gear Manufacturers Association
1001 N. Fairfax Street, Suite 500
Alexandria, Virginia 22314

September 2013

ISBN: 978-1-61481-061-2

Best Practices for Gearbox Assembly and Disassembly

Jodi Bello, David Brown Gear Systems, USA Inc.

Introduction

When industry is looking at the best ways to increase efficiency, reduce downtime and increase profitability, gearbox performance and reliability are key factors. In most applications gearbox reliability is critical to the productivity of the overall plant operation. Repair is often required with a swift turn around, as down time is very expensive. Designing for repair, and writing effective repair procedures, can speed the service time, and provide a quality refurbishment. Minimizing down time and extending service life will contribute significantly to achieving the lowest overall operation costs.

The best practices listed below are proven, effective methods used to install and remove bearings, seals, gears, couplings and shafts within a gearbox. These techniques are not new, and are usually obtained by hard won experience. Collecting them in one location is an attempt to document the best practices and provide a reference for design engineers. Engineers write the procedures for assembly and disassembly, they also dictate to the rest of the design team the design intent. Including features to facilitate disassembly, minimizes repair cycle time and helps to prevent damage to components that could radically compromise their design life or performance.

Basic types of component and assembly interfaces

First we should examine the basic methods of attachments. Figures 1 through 4 illustrate some basic diagrams for the different types of common connections.

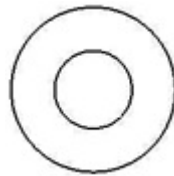


Figure 1. Straight bore

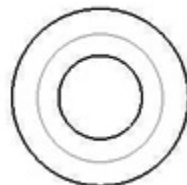


Figure 2. Tapered bore



Figure 3. Splined bore

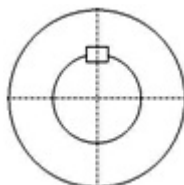


Figure 4. Keyed bore

Components that have sustained damage in operation may not retain their original dimensions. The design intent of the fit will have to be determined to appropriately determine the values for the repaired component. There are technical documents for designing each of these types of fits. Please see the references for some of the relevant technical specifications for more detailed information.

Each of these interfaces can be made with different types of fits, clearance or interference. To determine which fit type you have, calculate the fit using the equation 1.

$$F = d - D \quad (1)$$

where

- F = maximum fit;
- d = smallest diameter of bore;
- D = the largest shaft diameter.

Measure the bore and shaft at several locations, and use the smallest diameter bore and largest diameter shaft. If the shaft and bore tolerances are available, the entire expected fit range can be calculated. (To calculate the minimum fit, you would use the largest bore diameter minus the smallest shaft diameter.)

If this value is positive, the fit is clearance, if it is negative, the fit is interference. If the value is zero the parts could theoretically slide together, but in practice a small amount of force or thermal difference is needed for assembly. The clearance value needed to slide parts together easily is generally assumed to be at least 0.001 inches. For long fits and large diameters more clearance may be required, evaluating the tolerance and run out of the parts will help determine an appropriate value.

Clearance fits

Clearance fits are used for easy assembly, in typically low speed applications. Set screws can be used to connect the shaft to the hub and transmit torque.

Straight bore clearance fits slide together easily. There is no axial location control with this fit alone, and limited radial location. Shoulders, setscrews and pins can be used to control axial locations.

Splined connections fit multiple tooth internal teeth against external teeth. There is clearance on both the sides and diameters of the teeth.

Keyways transmit the torque between the shaft and hub. Parts assemble easily. Setscrews can be used to fix the key and shaft in the bore.

Interference fits

When assembled the bore expands and / or the shaft contracts so that the interface is in compression. Interference fits can transmit more torque than clearance fits. There are several different methods for assembly which will be discussed later. These fits are typically used to control location of the components, axial and radial, as well as transmit torque. Interference fits are also used to maintain balance of components in high speed applications.

- **Straight.** A straight interface transmits torque while maintaining both axial and radial location control of the components.
- **Tapered.** A tapered shaft and bore under compression can be used to transmit the friction torque. The compression can be obtained by drawing the shafts together using a shaft nut or by thermal differential assembly.
- **Keyways.** Keys with interference fits do not shift and alter the balance of the components. They also can transmit more torque than a straight or tapered interface with the same interference, because the key helps ensure the joint will not slip.
- **Splines.** Usually these are interference fit on the outside diameter of the splines. These are typically used when radial position needs to be controlled.
- **Bushings.** There are various mechanical devices that can be used to create an interference fit. They slip on to the shaft with clearance, but when engaged create an interference fit between the shaft and hub. Tightening these devices is best done in a star pattern for proper centering of the parts.