

## TECHNICAL INFORMATION LETTER

### DANGERS OF BEARING REFURBISHMENT

#### APPLICATION

This TIL applies to all Load and Compressor Gearboxes

#### PURPOSE

This TIL is to provide customers with information regarding the dangers of using refurbished bearings in load gearbox or compressor gearbox applications.

#### COMPLIANCE CATEGORY

<b>O</b>	-	<b>Optional</b>	Identifies changes that may be beneficial to some, but not necessarily all, operators. Accomplishment is at customer's discretion
<b>M</b>	-	<b>Maintenance</b>	Identifies maintenance guidelines or best practices for reliable equipment operation
<b>C</b>	-	<b>Compliance Required</b>	Identifies the need for action to correct a condition that, if left uncorrected, may result in reduced equipment reliability or efficiency. Compliance may be required within a specific operating time.
<b>A</b>	-	<b>Alert</b>	Failure to comply with the TIL could result in equipment damage or facility damage. Compliance is mandated with a specific operating time.
<b>S</b>	-	<b>Safety</b>	Failure to comply with this TIL could result in personal injury. Compliance is mandated within a specific operating time.

#### TIMING CODE

- 1** Prior to Unit Startup / Prior to Continued Operation (forced outage condition)
- 2** At First Opportunity (next shutdown)
- 3** Prior to Operation of Affected System
- 4** At First Exposure of Component
- 5** At Scheduled Component Part Repair or Replacement
- 6** Next scheduled Outage
- 7** Optional

## BACKGROUND DISCUSSION

Following a lubrication issue and/or a high vibration level, slide bearings can be damaged. The white metal (Babbitt) being the area suffering from the damages.

Bearings will also wear due to normal operation, and need to be replaced at the recommended service intervals as noted in the user manual of your gearbox (if you do not have this manual please contact FG or your local service representative)

Assuming bearings have to be replaced, either due to wear after a long period of operation, or due to exceptional damages due to poor oil quality or vibration issues, there are two possibilities to put the gearbox back to operation:

- To replace the damaged bearing by a new one
- To repair the bearing (same technology as the one used for the turbine/generator bearing)

## TECHNICAL DISCUSSION – BEARING DESIGN

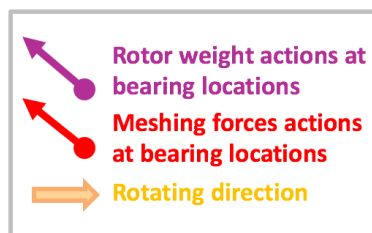
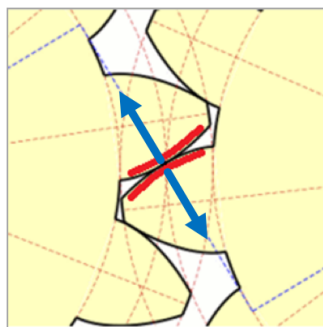
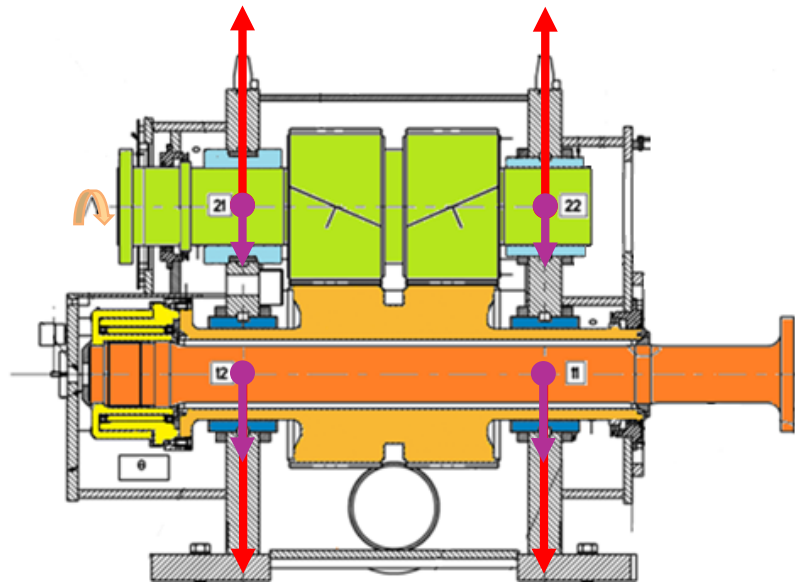
Due to the high loads and high velocities requirements, Flender-Graffenstaden gearboxes are fitted only with hydrodynamic sleeve bearings. The torque coming from the driving

machine is transmitted via the gearbox to the driven machine. This results in tangential, radial and axial forces in the gear teeth, known as reaction forces.

Axial forces are supported either by axial thrust bearings or by the toothing itself for double helical gears configurations. Tangential and radial forces are supported by the gearbox radial bearings. These

loads are much higher than only shaft weights and they can have variable amplitudes depending on the operating conditions.

For this reason, gearbox bearing loads cannot be compared to other rotating equipment bearing loads like turbines or generators. Some of these other rotating machinery bearings do not even reach the half of the allowable load limit used for gearboxes.

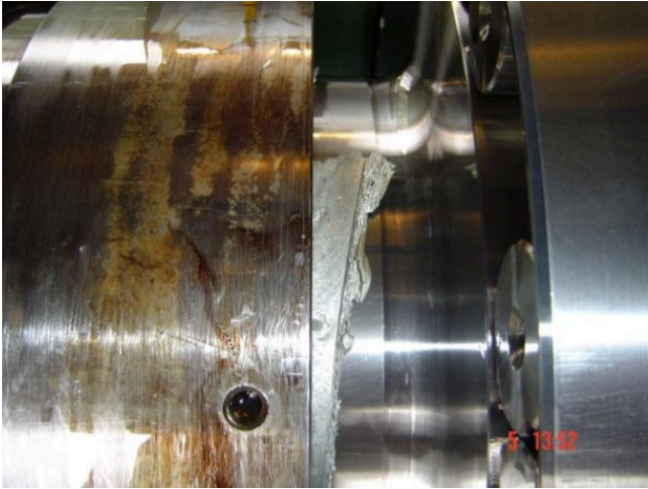


## RECOMMENDATION

Based on our experience we **DO NOT RECOMMEND** to repair the used or damaged bearings.

## TECHNICAL DISCUSSION – FAILURE MODES OF REFURBISHMENT

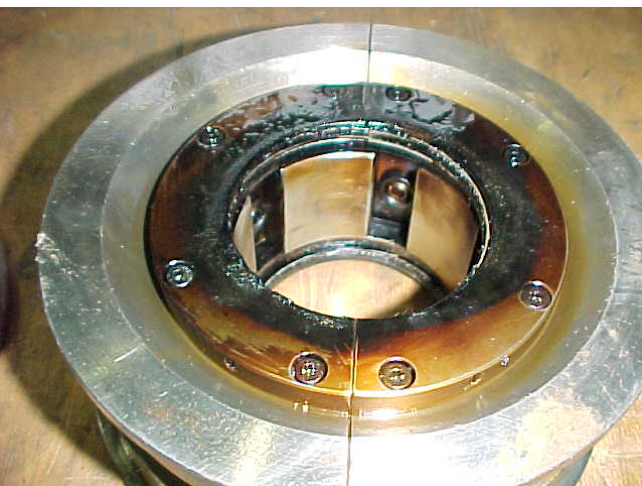
The reasons for this are both technical and practical.



**Figure 1: Sliding of white metal**



**Figure 2: Damage to white metal**



**Figure 3: Failed refurbished Bearing**

When refurbishing a bearing you can only do so when the inner part of the bearing is damaged and the outer diameter being in the required tolerances (in the range of 0,05mm)

The different steps for the repair are the following:

- Removal of the white metal by machining
- Preparation of the surface (inner diameter) – Babbitting.
- Machining of the inner diameter

During the above outlined operations the bearing is machined, heated up, cooled down and machined again which has the consequence of a build up internal stress in the steel of the bearing surface.

The metal body of the bearing goes through deformation and gets twisted i.e. the outer diameter is still within the dimensional tolerances, but it will fail its geometrical tolerances.

**The bearing geometry defined by Flender-Graffenstaden ensures appropriate oil film thickness as well as proper stiffness and damping characteristics required and calculated for the good dynamical behavior of the gear train.**

**The last machining operation doesn't allow the bearing to remain within the tolerances for the concentricity AND the parallelism.**

At the time of putting a refurbished bearing into place inside the casing, the outer diameter goes back to its previous position, leading to a deformation of the inner diameter.

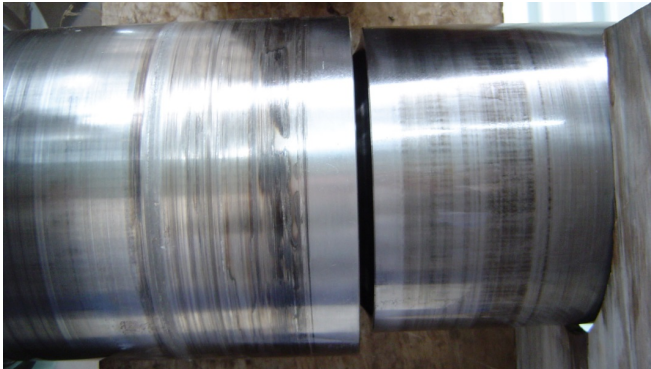
As a consequence, the contact pattern of the shaft inside the bearing is partial and would lead to a significant disturbance of the dynamic behavior of the bearing generating:

- Risk of damage at the start up
- Risk of damage of the bearing area of the shaft
- Risk of unsatisfactory tooth contact pattern with possible complete breakdown of the gearbox.

## CONSEQUENCES

The practical consequence of refurbishing bearings is not just the replacement of the bearing – this is a best case scenario.

The final damages can range from damages to the shaft journals, as well as the tothing of the gears necessitating replacement of the entire gear set.



**Figure 4: Damage to the journal area after failure of refurbished bearings**



**Figure 5: Damage to the teeth after refurbished bearing failure**

From an initial time and/or money saving, financial impact might be disastrous considering the cost for new spares supply, and above that the extended downtime due to their long lead time.

Worst case might be a catastrophic failure that leads to the total destruction of the installation, injured personnel or even death of personnel.

Below examples are from a site in Saudi Arabia which required our intervention and RCA.



**Figure 6: Gearbox explosion due to failure of bearing at load**



**Figure 7: Total destruction of the gearbox**



**Figure 8: High Damage to surrounding equipment**

**PLANNING INFORMATION****Compliance**

- Compliance Category: C
- Timing Code: 3

**Manpower Skills**

N/A

**Parts**

N/A

**Special Tooling**

N/A

**Reference Documents**

- Gearbox User Manual
- FGM 003 Gearbox Maintenance Schedule

**Previous Modifications**

N/A

**Scope of Work**

N/A

**Contact your local FG Service Representative for assistance or additional information**

NOTE: If you would like to receive future TILs by email, contact your local FG Service Representative for assistance

**TIL COMPLIANCE RECORD**

Compliance with this TIL must be entered in local records. FG requests that the customer notify FG upon compliance of tis TIL

Complete the following TIL Compliance Record and email it to:

TIL Compliance  
 flencomm@flender-graff.com

<b>TIL COMPLIANCE RECORD</b>			
For internal records only #			
Site Name:		Customer Name:	
Customer Contact Information		FG Contact Information	
Contact Name:		Contact Name:	
Address:		Address:	
Email:		Email:	
Phone:		Phone:	
Fax:		Fax:	
INSTALLED EQUIPMENT		TIL Completed Date	
		100% TIL Completed	
Description:			
Unite Numbers	Part Description	Part Number	Drawing Number
Comments			

