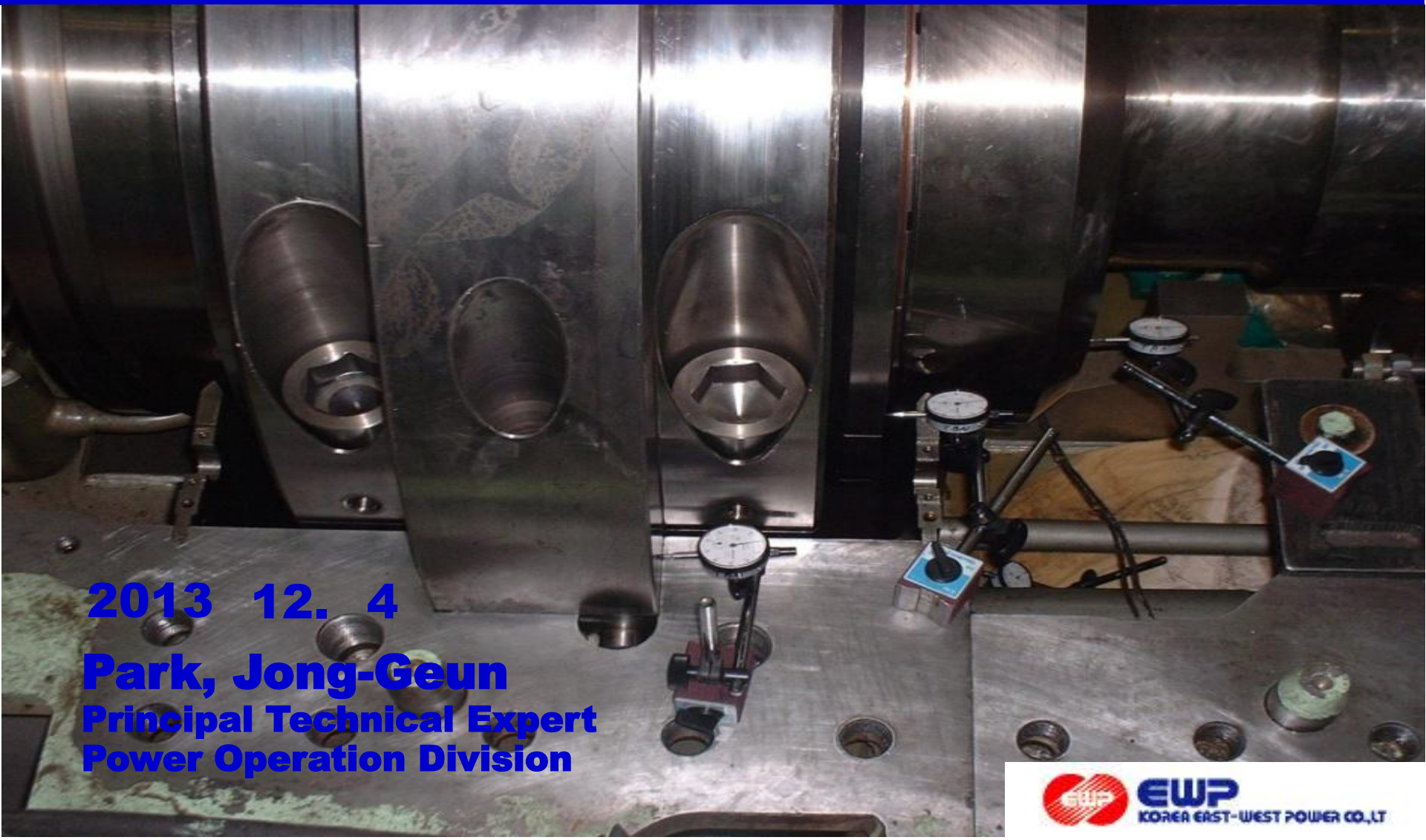
TURBINE BEARING MAINTENANCE



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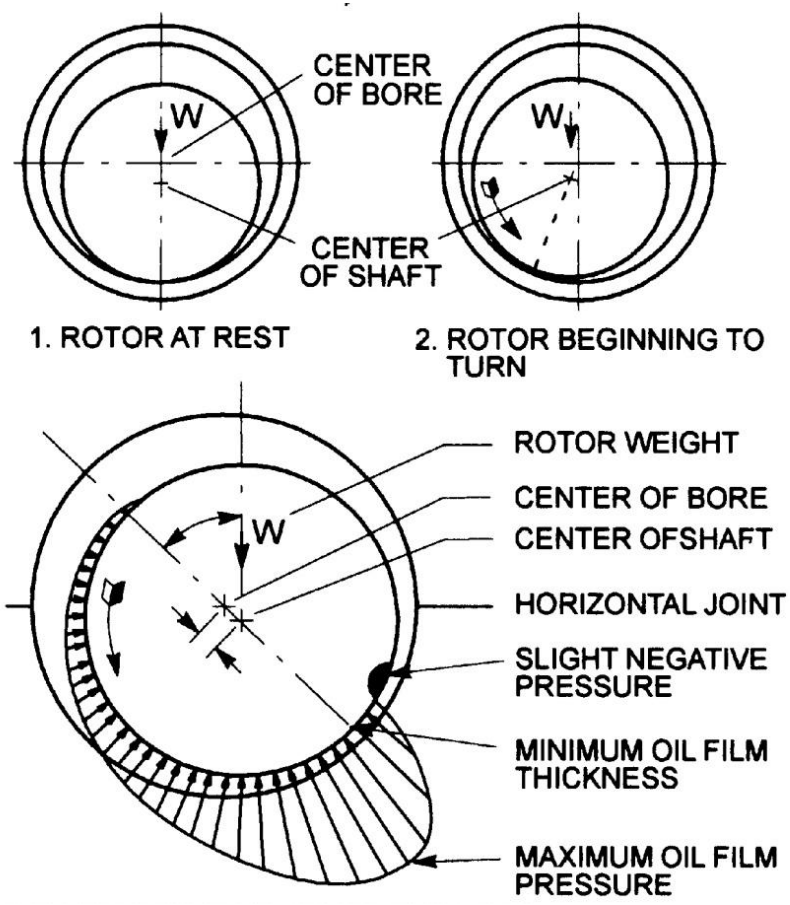
Contents

1. Journal Bearings in General

1.1 Introduction

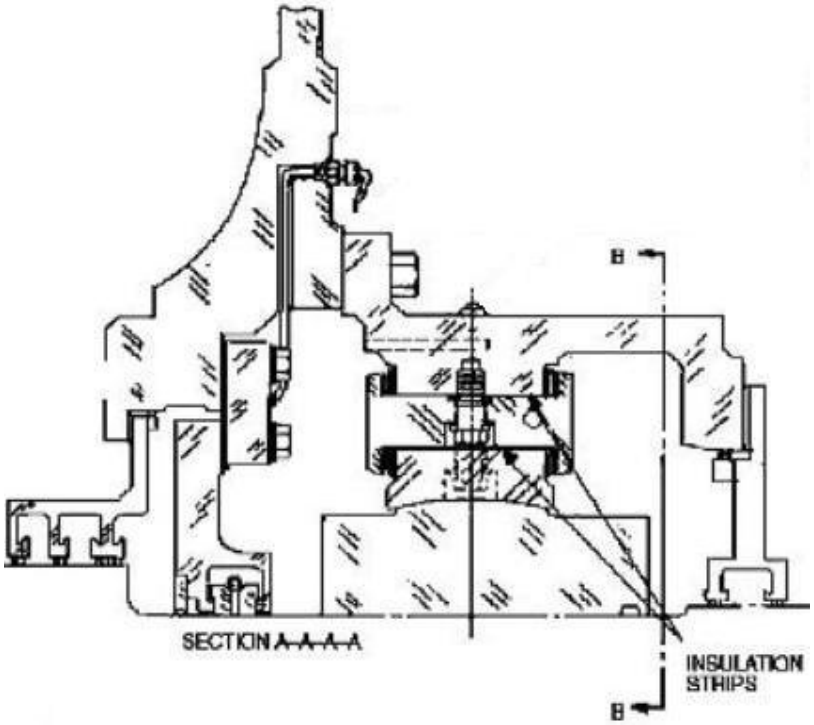
- Turbine-generator main journal bearings are designated as No. 1, 2, 3, 4, etc. **starting with the turbine-end bearing at the front of the machine**
- All bearings are oil-cooled, with a pressurized oil supply to maintain suitable operating temperatures.

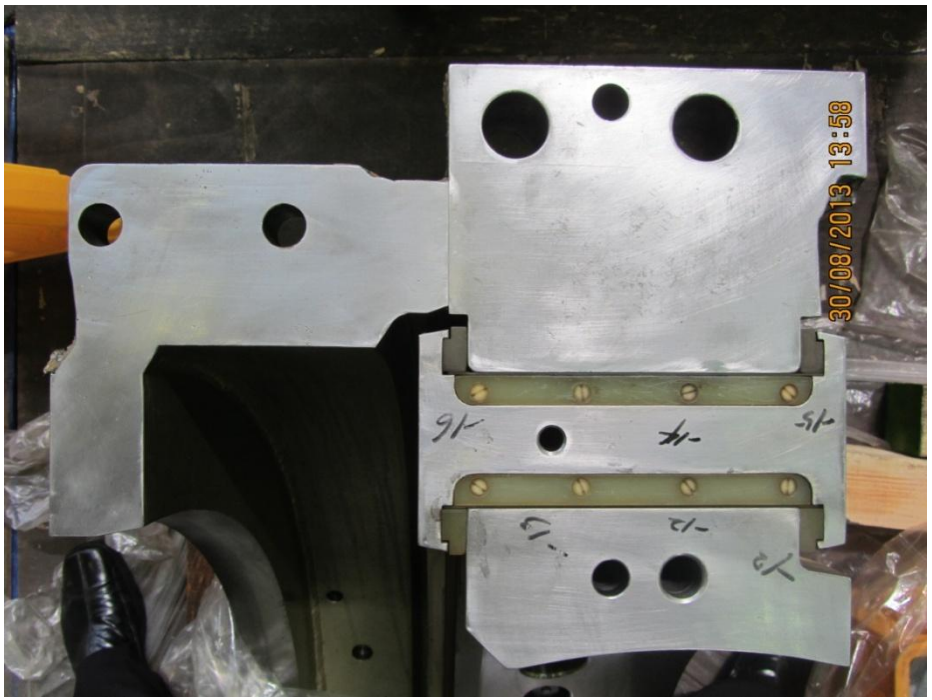
- Support the rotor
- Utility turbines use journal bearings instead of ball or roller bearings
- Journal bearings have a smooth surface of a soft material called babbitt



[Action of Cylindrical Sleeve Bearings]

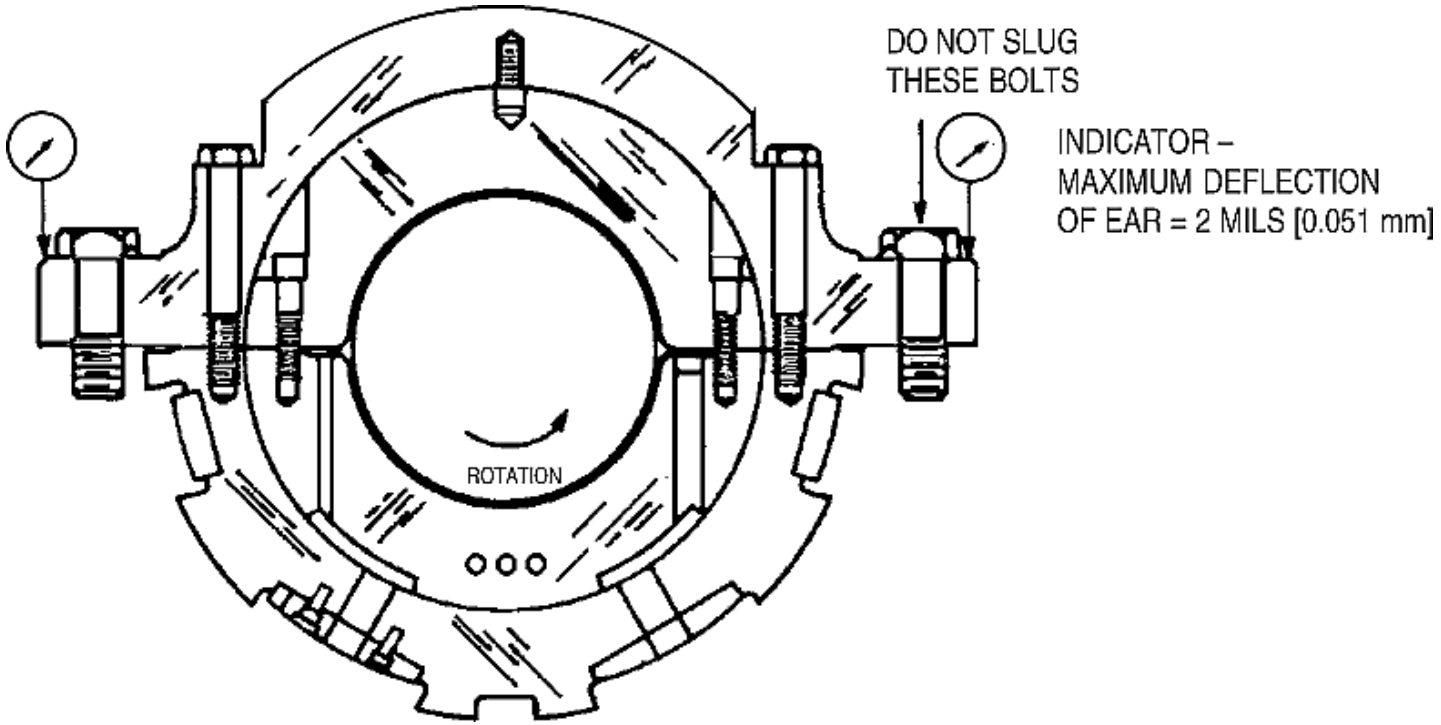
- The bearing ring at the ***collector end of the generator is insulated*** from the end shield to avoid the possibility of **stray shaft currents** circulating through the bearings





[Generator Insulated Bearing Ring]

- Shimmed pads are provided on the bearing or ring OD to adjust bearing alignment
- For the fixed bore bearings an anti-rotation pin is located in the ring and extends into the bearing shell to prevent bearing rotation



[Tightening Bearing Strap Bolts]

1.2 Maintenance Recommendations

- In the event that any of the babbitt surface is ***scored*** or ***smeared***, ***upset portions of metal*** may be carefully scraped off. Excessive scraping of the bore, however, should be avoided

- Any indications of cracks in the babbitt should be investigated with a ***liquid penetrant test***; if cracks actually exist the bearing should be ***re-babbitted*** at the earliest opportunity

1.2 Maintenance Recommendations

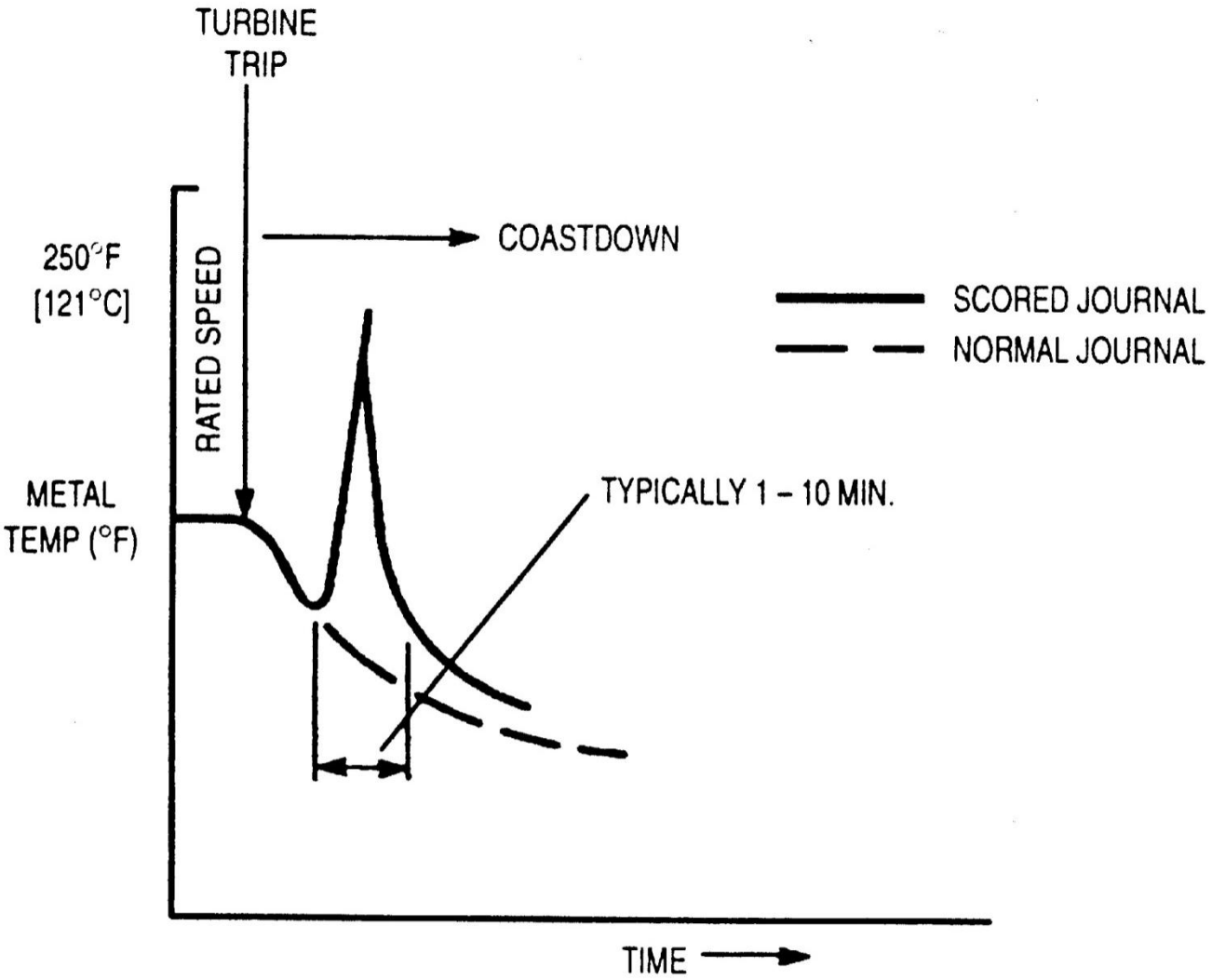
- The curvature of the pads of tilting pad bearings should be checked by ***bluing to a mandrel of diameter equal to shaft diameter plus diametral clearance***

- Any sharp ridges or upset metal may be carefully smoothed with a ***fine stone*** or by lapping with ***very fine emery cloth***
- No attempt should be made, however, to completely remove such imperfections, because ***hand operations may change the contour of the journal sufficiently to adversely affect the balance of the rotor***

TURBINE BEARING MAINTENANCE

- Each journal should be measured in two planes, 90° apart, at 1 in. (25.4 mm) intervals along the active surface

- If diameter measurements ***vary by more than 0.004 in. (0.1 mm) from each other***, or if there is more than one ***major score mark, i.e., one which is greater than 1/64 in. (0.397 mm) in depth per in. (25.4 mm),*** it should be restored by complete ***re-machining***



[Characteric Temperature Spike]

TURBINE BEARING MAINTENANCE

- The fit between alignment pads and the standard should have a minimum of ***80% contact*** (***100% around feed and drain holes***)

- Be sure the shims placed under pads containing feed and drain holes are provided with openings to pass oil

- After making contact checks and completing assembly of the bearing a ***feeler check*** should be made between alignment pads and the supporting fit to ***be sure the bearing is not riding on a burr***

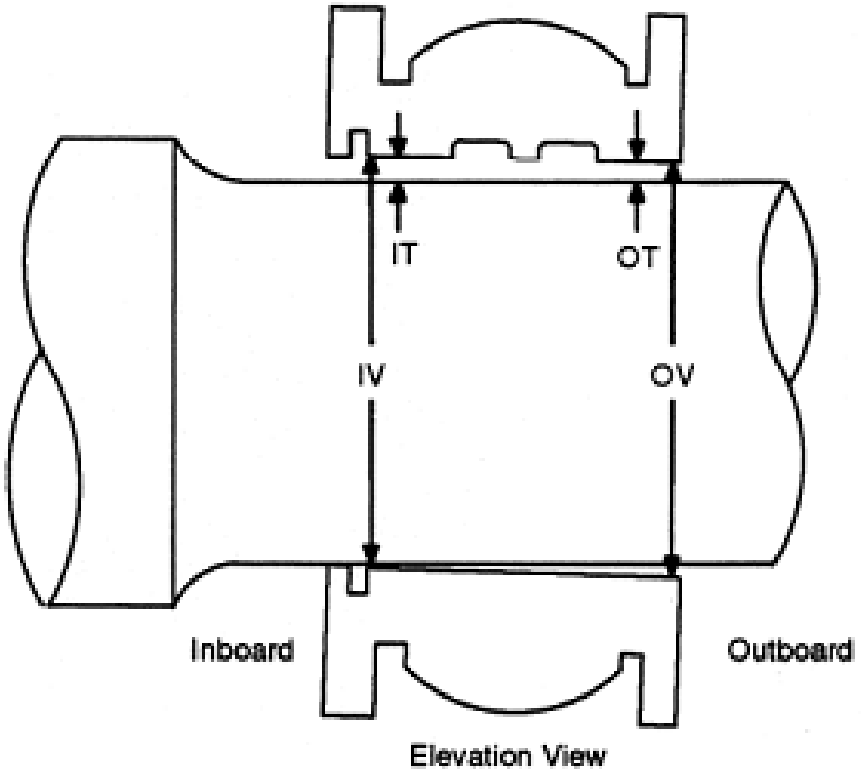
- For this check a ***0.0015 in. (0.038 mm) feeler should not fit*** between the parts

- On bearings with a ball seat it is necessary to measure '***TWIST***' & '***TILT***', and make comparisons to allowable limits

- ***'TILT' limits for hood bearings*** are established such that with proper alignment, the ***bearing outboard end is set slightly low***.
  When vacuum is drawn the bottom of the bearing becomes more nearly parallel to the journal

- The ***double tilt pad type bearing (no ball seat)*** is the only journal bearing design with ***truly self-aligning capability***, and ***it does not require 'TWIST' & 'TILT' measurements***

TURBINE BEARING MAINTENANCE



Elevation View

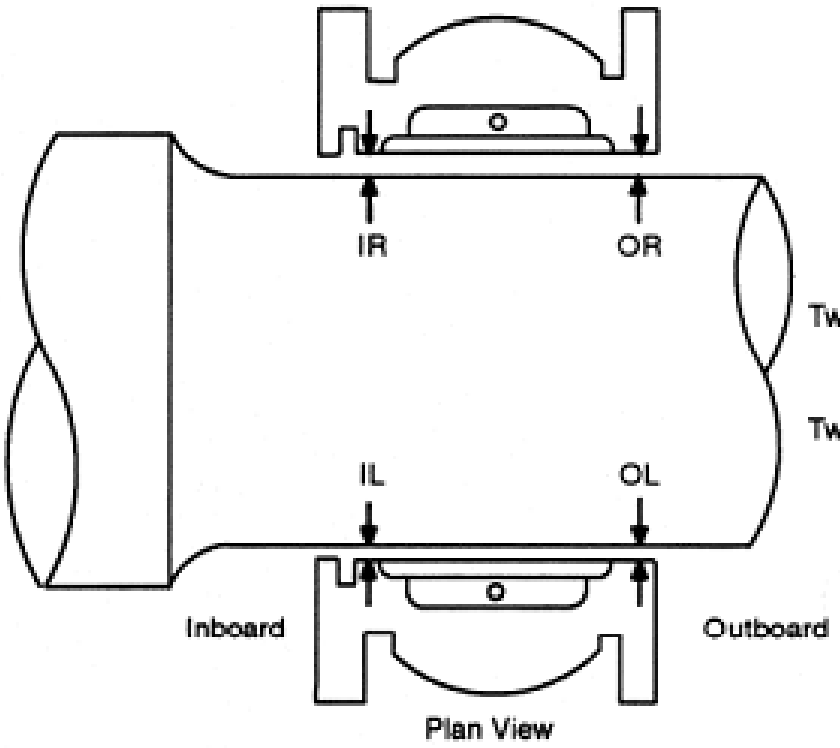
Date _____
Brg # _____
By _____
OV = _____ in.
IV = _____ in.
OT = _____ mils
IT = _____ mils

Tilt; (OV–IV)–OT+IT
= _____ mils

Tilt Alignment Limits (mils)
=0 To + 0.1 X Brg. Dia (in.)
= _____ mils
(NOTE: Outboard End Set Low)

Example: Same 20 in. Dia Brg; OV = 20.025 in., IV=20.026 in., OT=27 mils, IT= 28 mils
(OV–IV) = 20.025 in. – 20.026 in. = –1 mil (NOTE SIGN)
Tilt = –1–27+28 = 0 mils
Max. Tilt Allowable = 0 to +0.1x20 in. Dia.= 0 to +2, mils: ∴ Tilt OK

[Tilt]



Tb. #
Date_____
Brg #_____
By _____
OL=_____ mils
IL= _____ mils
IR= _____ mils
OR=_____ mils

Twist; (OL–IL+IR–OR)/2
=_____mils

Twist Alignment Limits
=±0.3xBrg. Dia(in.)
=_____mils

Recheck

Date_____
Brg #_____
By _____
OL=_____ mils
IL= _____ mils
IR= _____ mils
OR=_____ mils

Twist; (OL–IL+IR–OR)/2
=_____mils

Twist Alignment Limits
=±0.3xBrg. Dia(in.)
=_____mils

Example: Say 20 in. Dia Brg; OL = 24 mils, IL = 26 mils, IR = 20 mils, OR = 22 mils

$$\text{Twist} = \frac{24-26+20-22}{2} = -2 \text{ mils}$$

Max. Twist Allowable = ± 0.3 x 20 in. Dia. = ± 6 mils. ∴ Twist Ok

[Twist]

1.3 Repairing Bearings

- As the ***maximum allowable vertical bore clearance*** is approached, consideration should be given to repairing the bearings

- When the babbitt-to-steel bond is sound, welding via the ***TIG-welding*** process, followed by ***remachining***, may be used to restore the bearing bore

- Whenever a bearing or bearing ring is repaired, it is essential that these parts be ***blue checked*** and fitted together so that ***the area of contact is at least 80 to 85%***

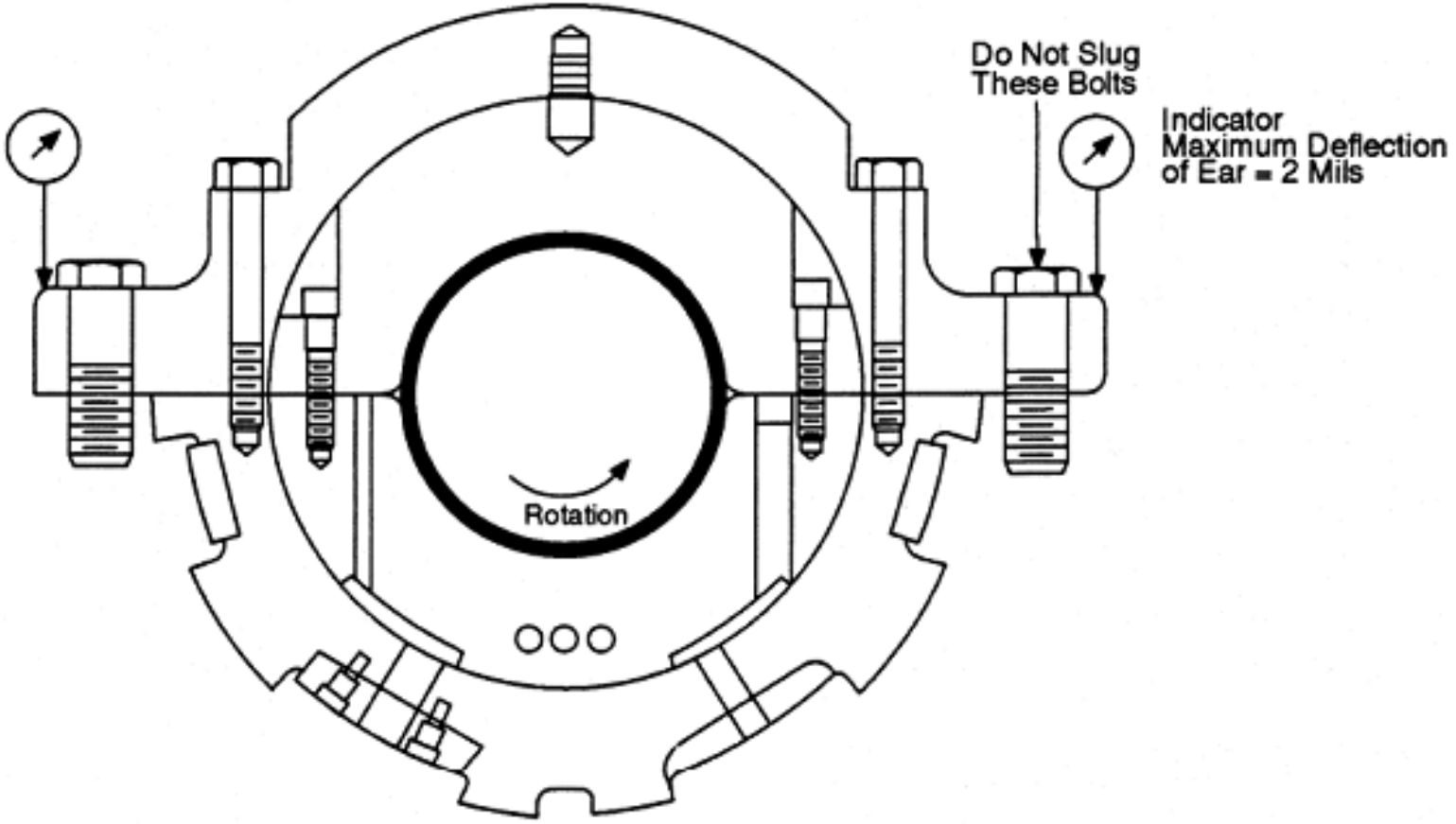
2. Elliptical Journal Bearing

2.1 Design Features

- The two types of elliptical bearings used are the ***standard elliptical*** and the ***short elliptical***. The bore of these bearings is an ellipse with the ***major axis horizontal*** and the ***minor axis vertical***

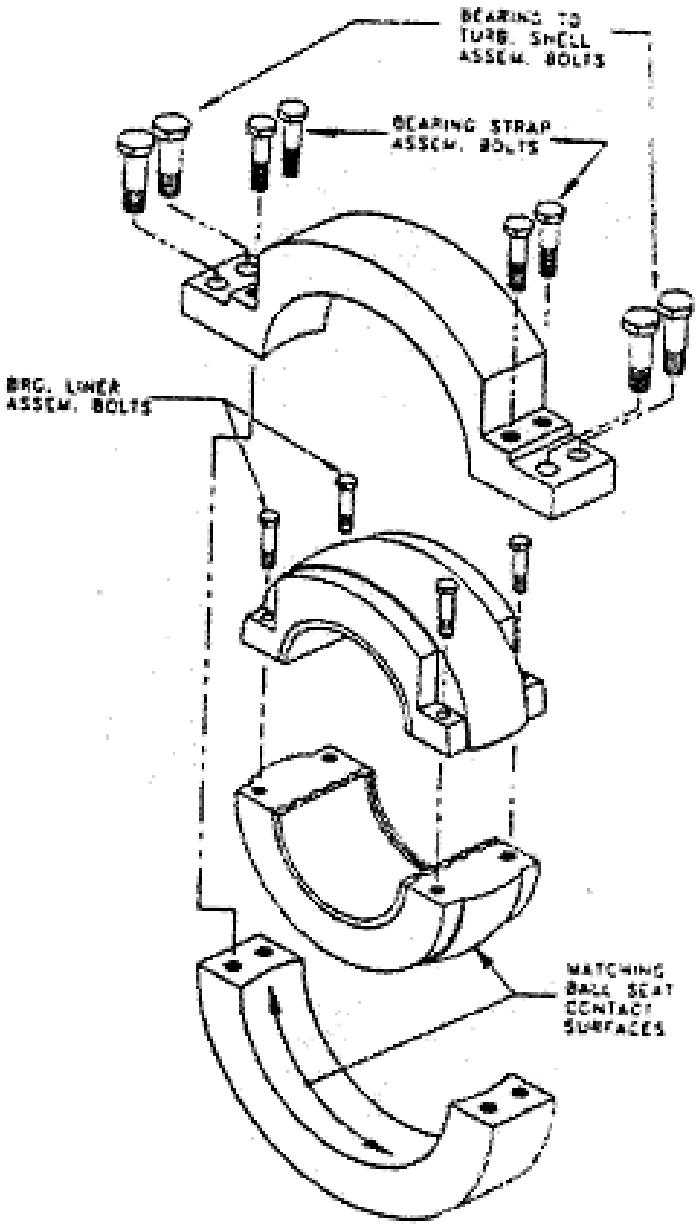
- After babbitting, ***both halves are machined as a unit*** and must be kept together as a matched set.

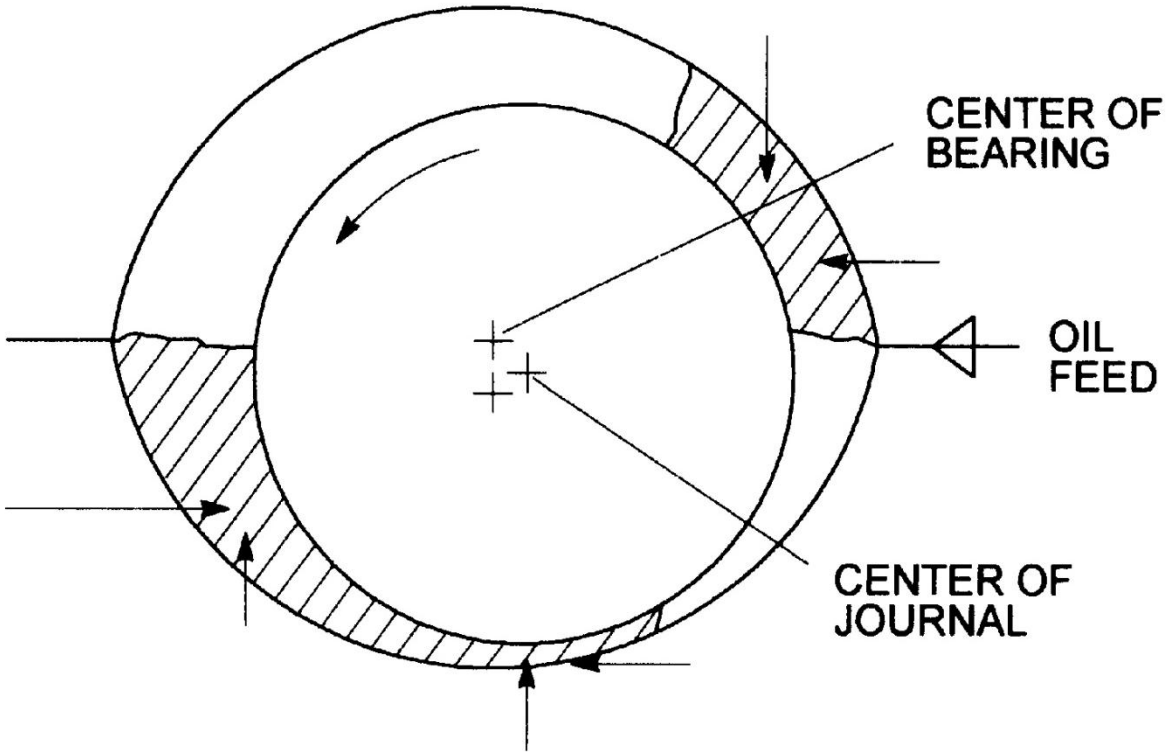
- A ***dowel*** projecting radially from the lower-half bearing engages a slot in the bearing bracket to prevent the bearing from rotating



[Elliptical Journal Bearing]

TURBINE BEARING MAINTENANCE





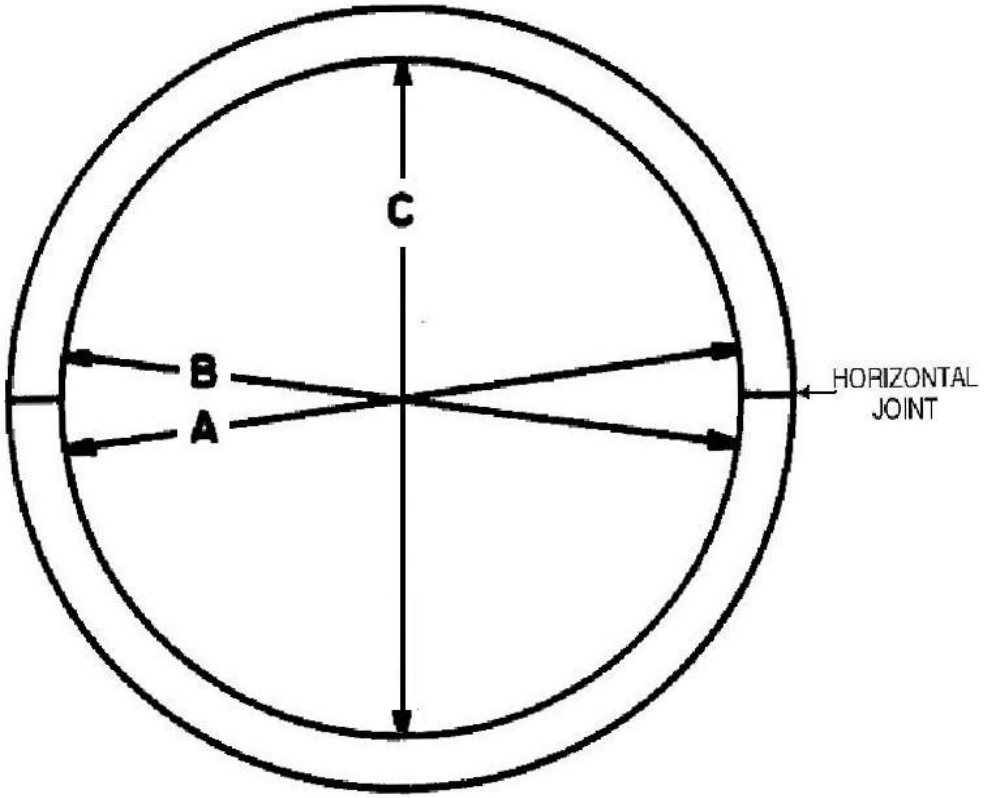
[Operating Characteristics of the Elliptical Bearing]

➢ Inspection

- ✓ It is usually not necessary to inspect a turbine journal bearing between regular overhaul or inspection periods unless there is some indication that such an inspection is necessary

- ✓ At the regular overhaul period, each journal bearing should be inspected for ***condition***, ***clearance*** and ***alignment***

- **Measuring Bearing Clearance**
  - ✓ Clearance measurements should be taken with the bearings and turbine rotor **at ambient temperature**



[Elliptical Journal Bearing]

2.2 Maintenance

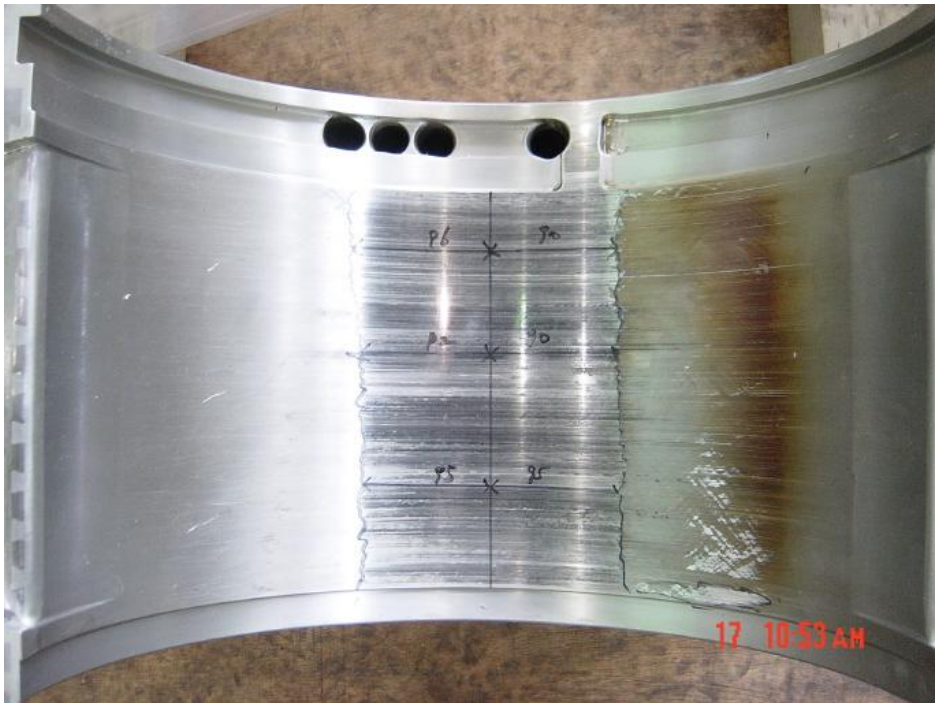
➢ Aligning a Bearing

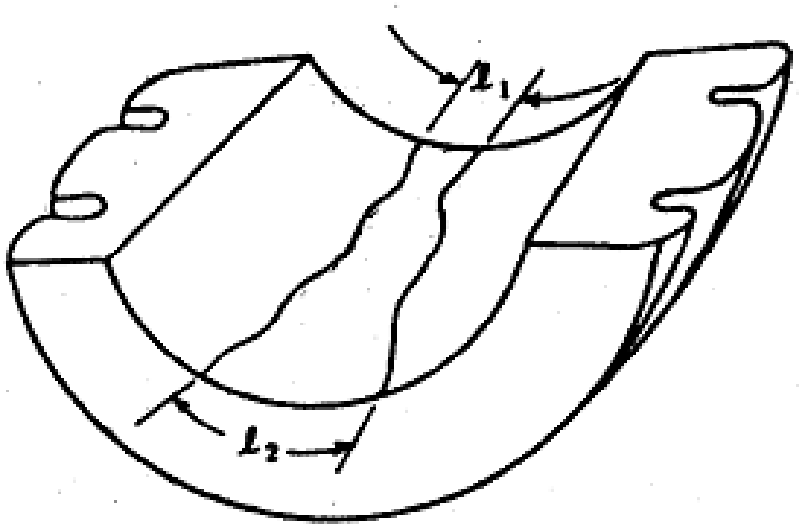
- ✓ When a journal bearing is installed, ***it is essential that the bore be aligned parallel and perpendicular with the axis of the journal***. It cannot be assumed that because the bearing has a ball seat it will align itself automatically with the shaft
- ✓ When a bearing is ***misaligned***, the unit loading is increased and the maximum oil film pressure may increase considerably, ***resulting in higher oil-film temperatures***

2.2 Maintenance

- Rotor Journal Contact Check

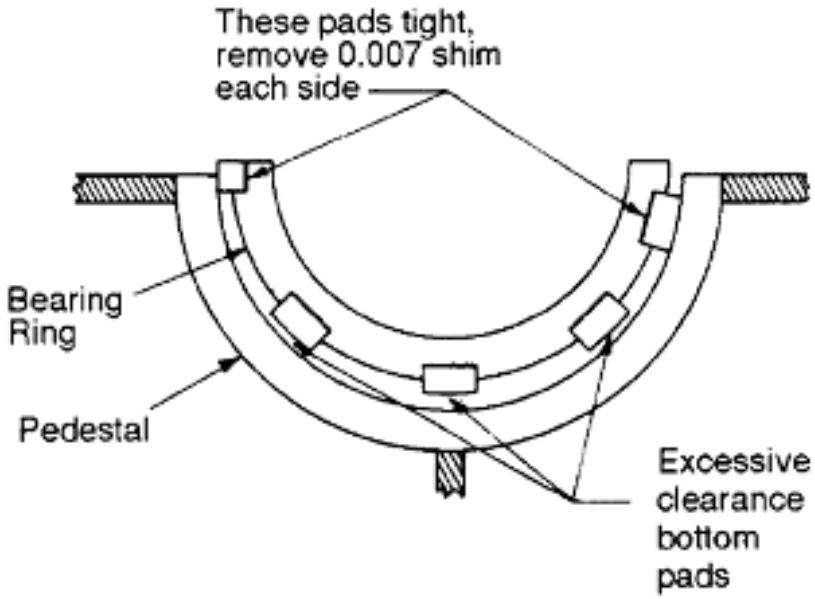
  * *L1 : L2 Must not Exceed 1:3*

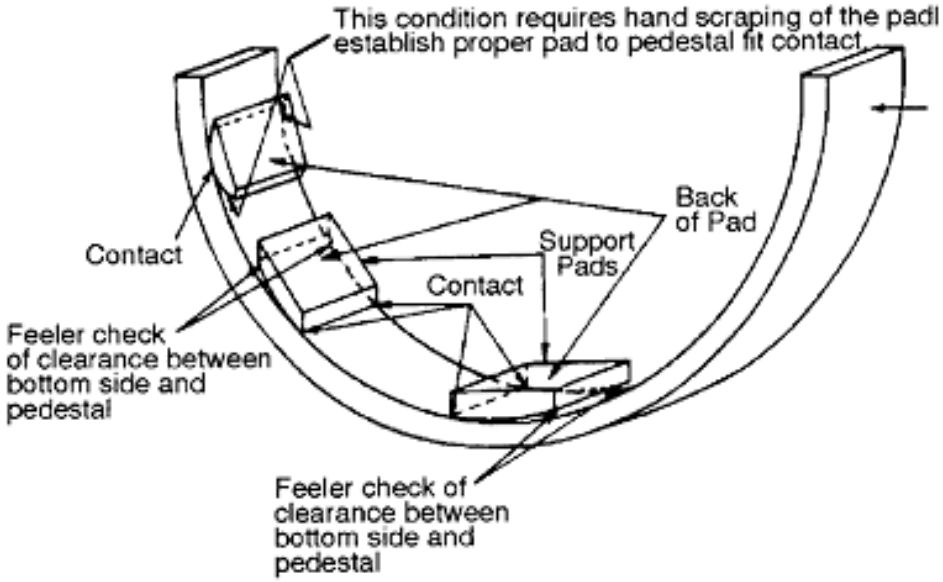




2.2 Maintenance

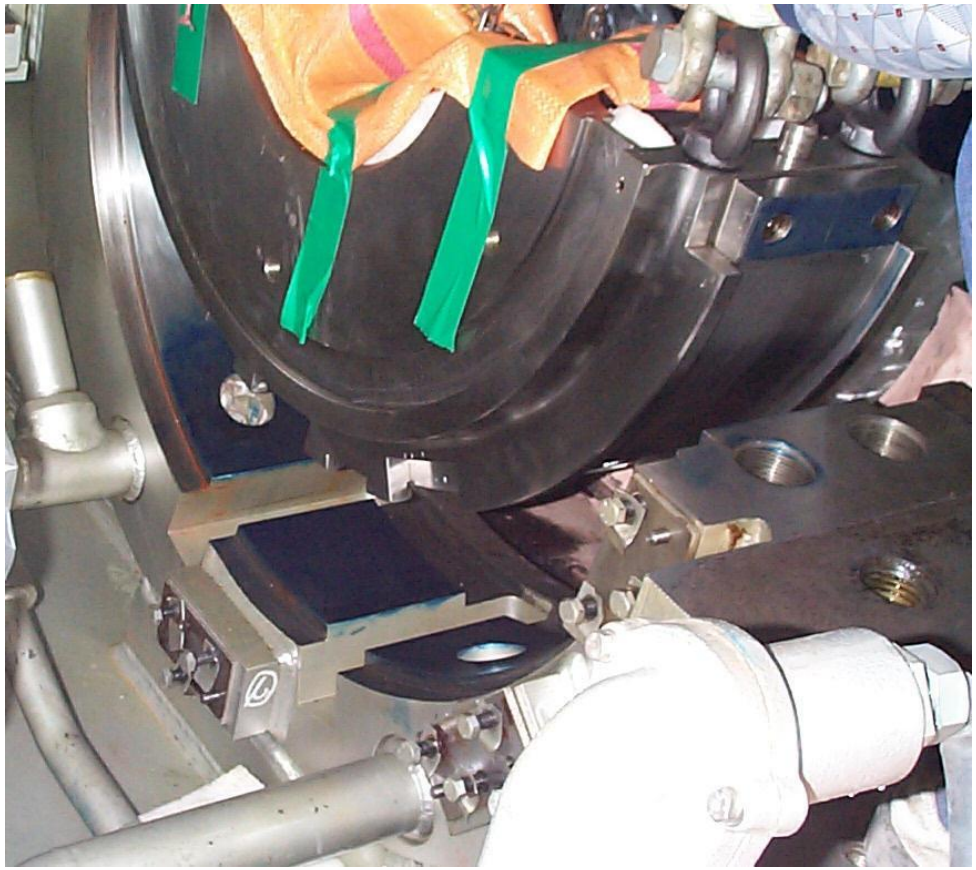
- **Bearing Ring Fitting to Pedestal**





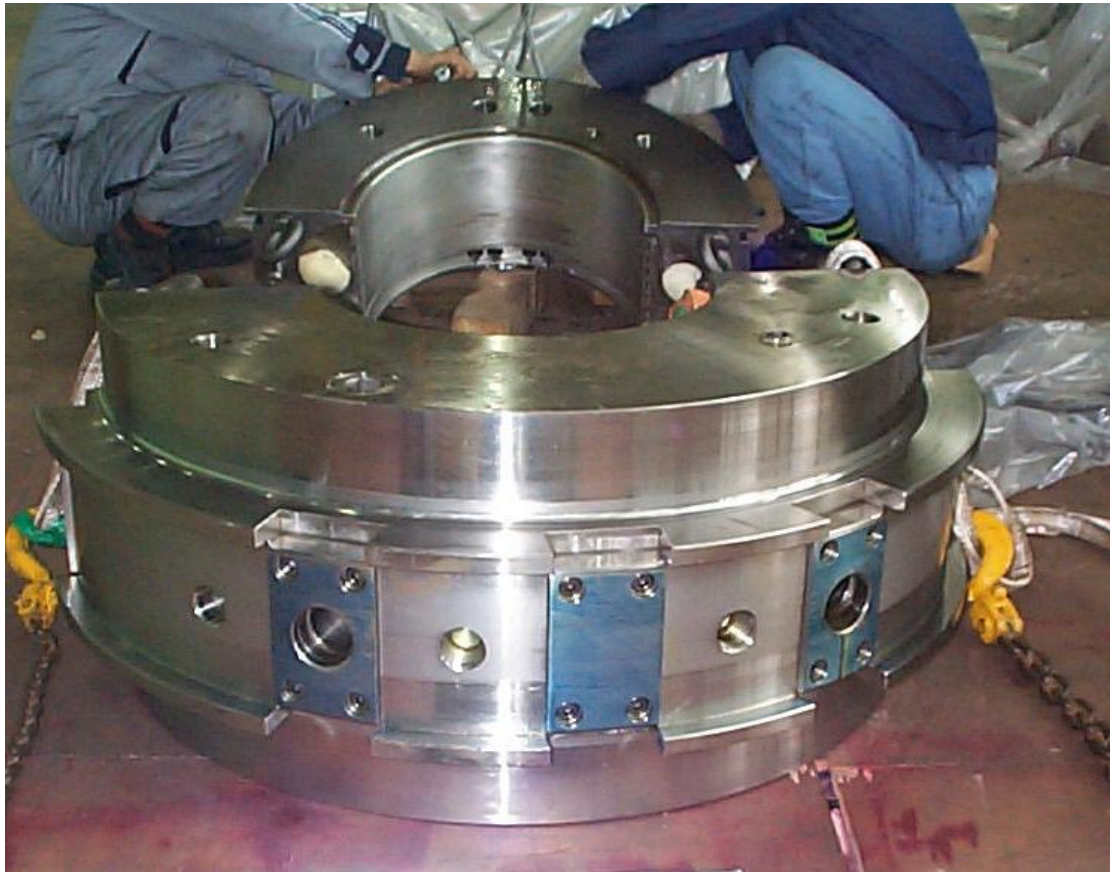
2.2 Maintenance

- Bearing Ring Contact to Pedestal Check



2.2 Maintenance

- Bearing Ring Contact to Pedestal Check

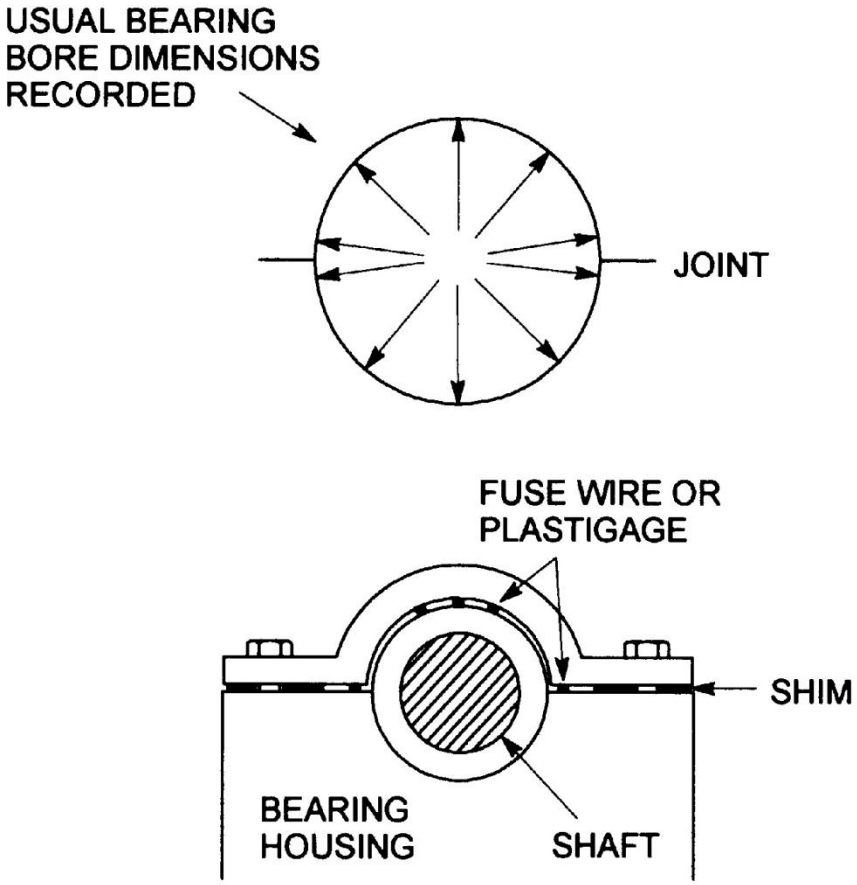


2.2 Maintenance

- Bearing Ring Contact to Pedestal Check

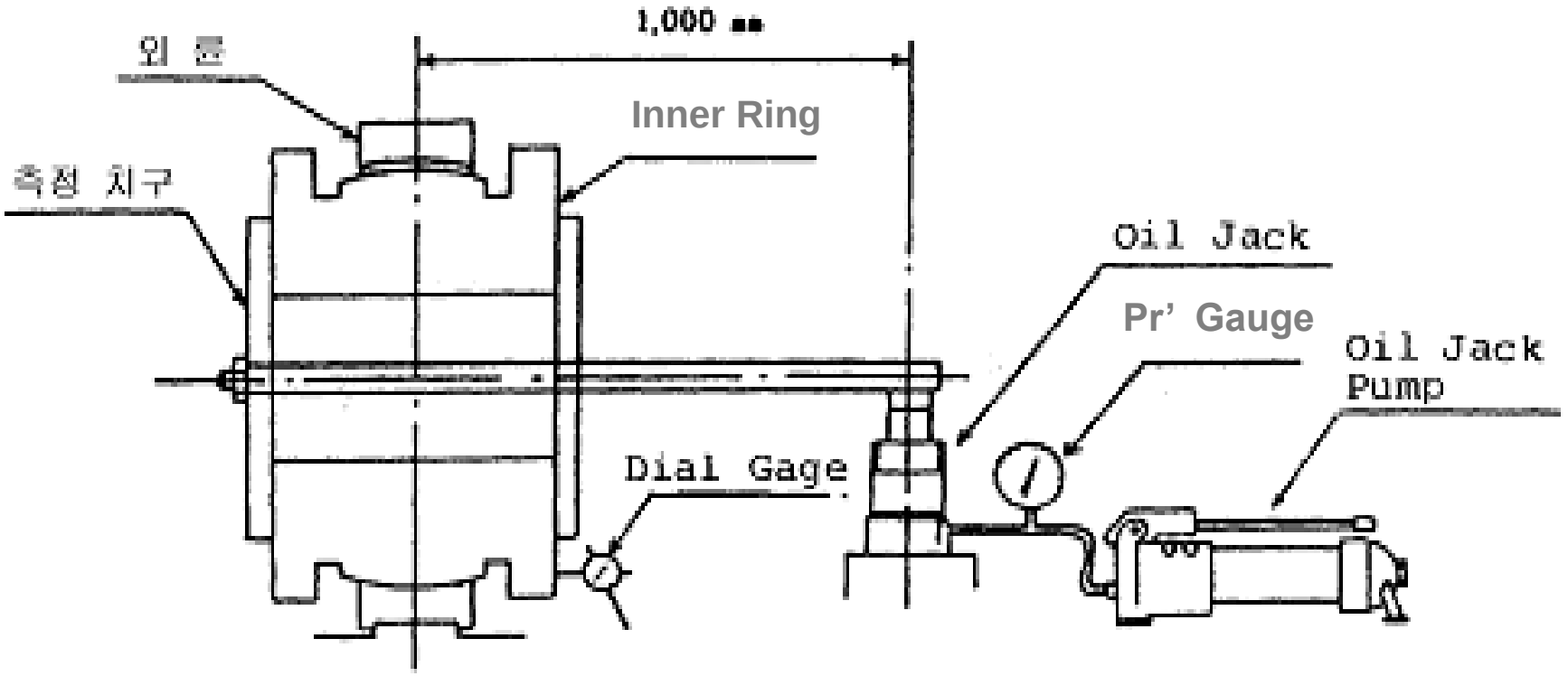
2.2 Maintenance

➢Pinch Check



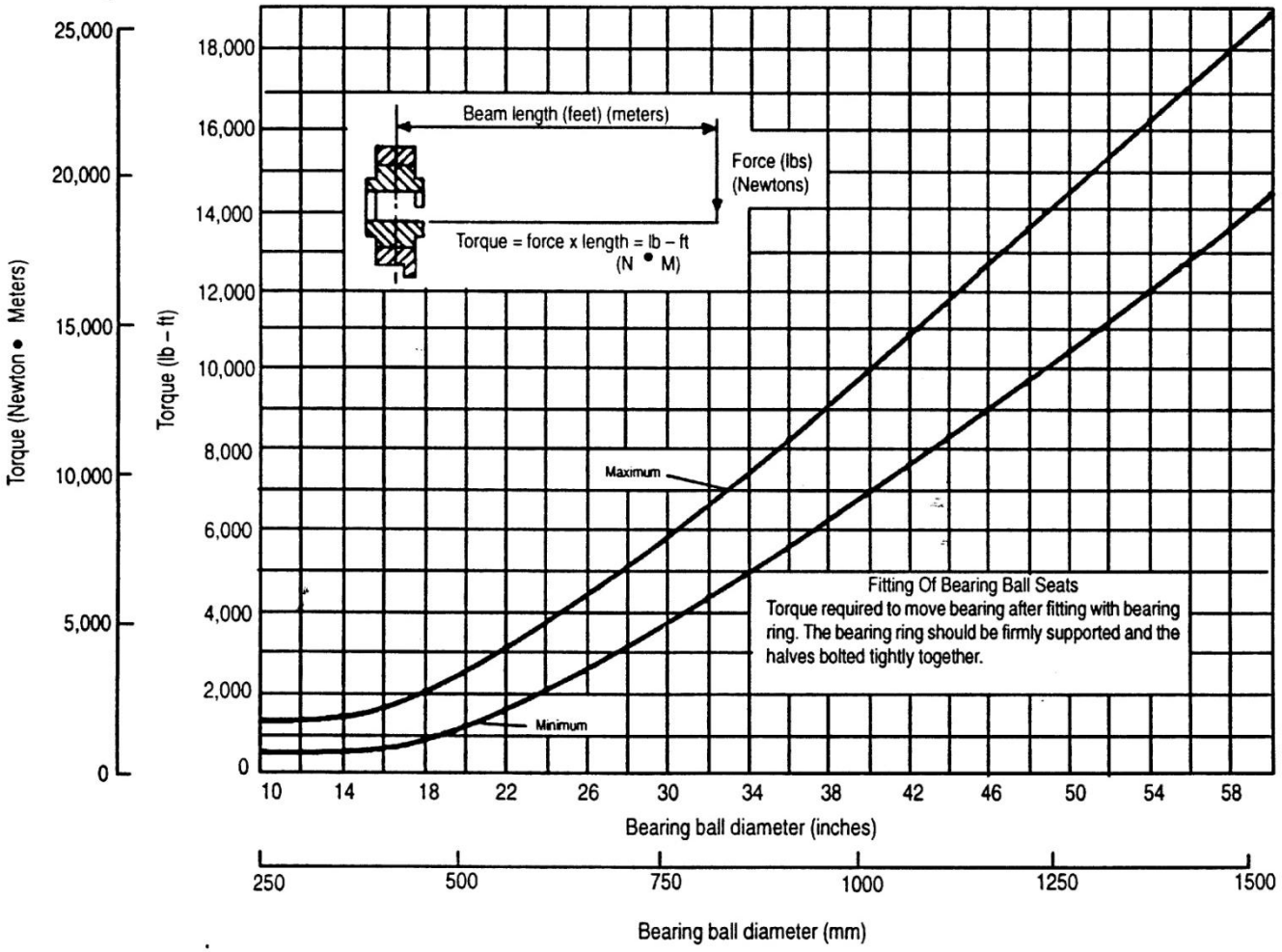
2.2 Maintenance

- **Ball Seat Torque Check**



2.2 Maintenance

- **Ball Seat Torque Check**



3. Double Tilting Pad Bearing

3.1 Introduction

- ✓ Certain bearings on turbines see relatively light rotor weights and can be lightly loaded under some conditions

- ✓ To prevent shaft instability in these cases, Double Tilt Pad (DTP) bearings are used. These bearings are normally used to support the **high-pressure (HP)** and **reheat (RH) elements** of such turbines

- ✓ Recently, new units have been shipped with a ***DTP bearing at the first hood position*** also.

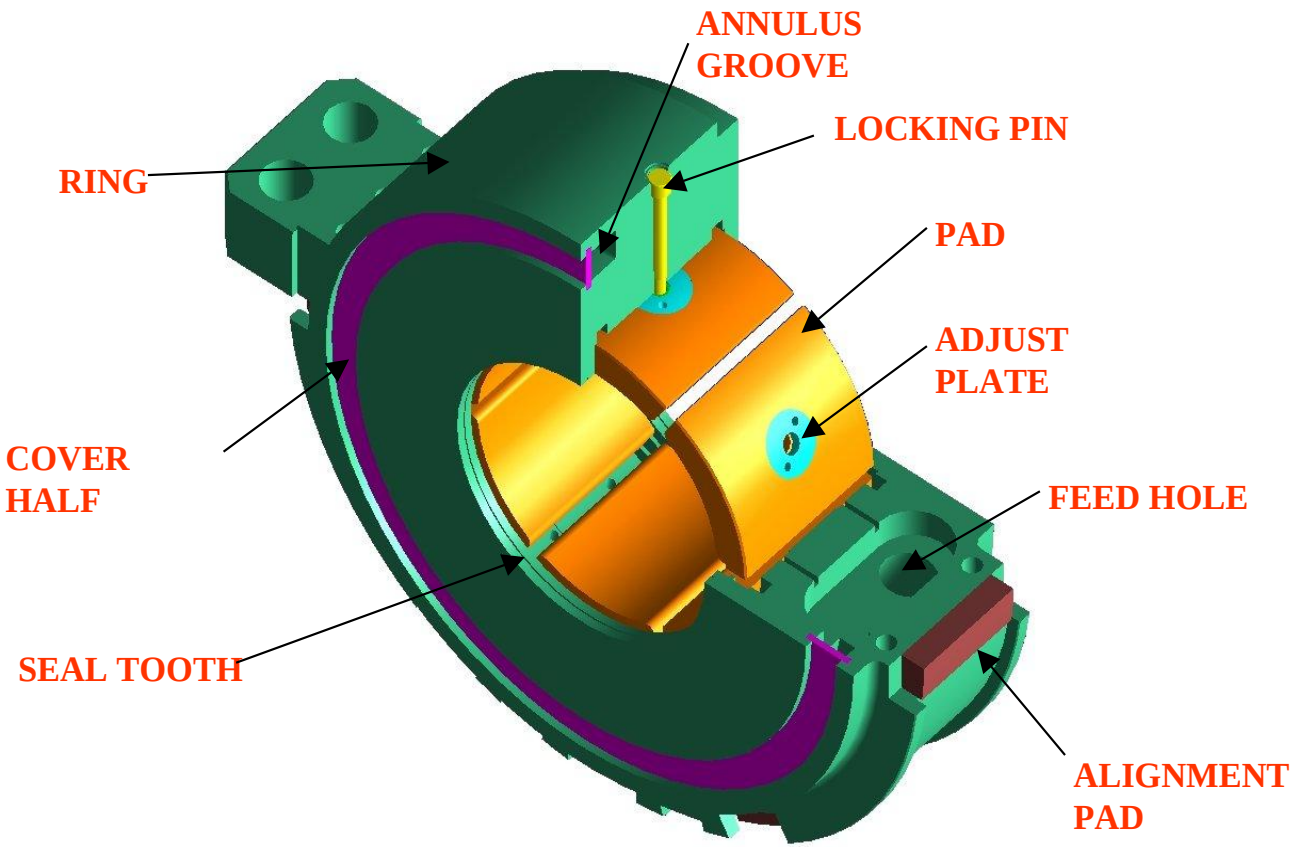
3.2 General Design

- The back of each pad has a ***smaller radius of curvature*** than the casing bore, so as to ***be free to pivot in the direction of shaft rotation***. This allows each pad to assume an ***optimum oil film wedge***

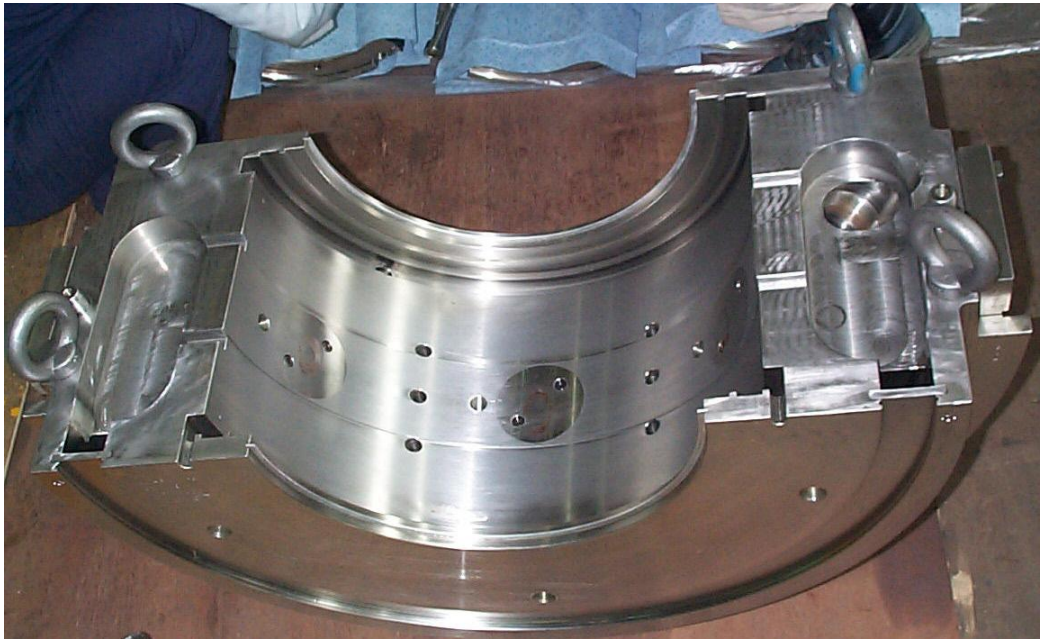
- ***A large radius*** is also machined on the back of each pad ***in the axial direction to allow the pads to align themselves to the journal***

- ***Hook fits*** on the casing retain the pads during handling and each pad is prevented from rotating by means of a ***loose fitting locking pin***

3.2 General Design



3.2 General Design



3.3 Maintenance Recommendations

➢ Antirotation Pin

- ✓ Check the condition of the pin visually and with liquid dye penetrant.

  Worn, ***bent***, or ***cracked*** antirotation pins must be ***replaced***

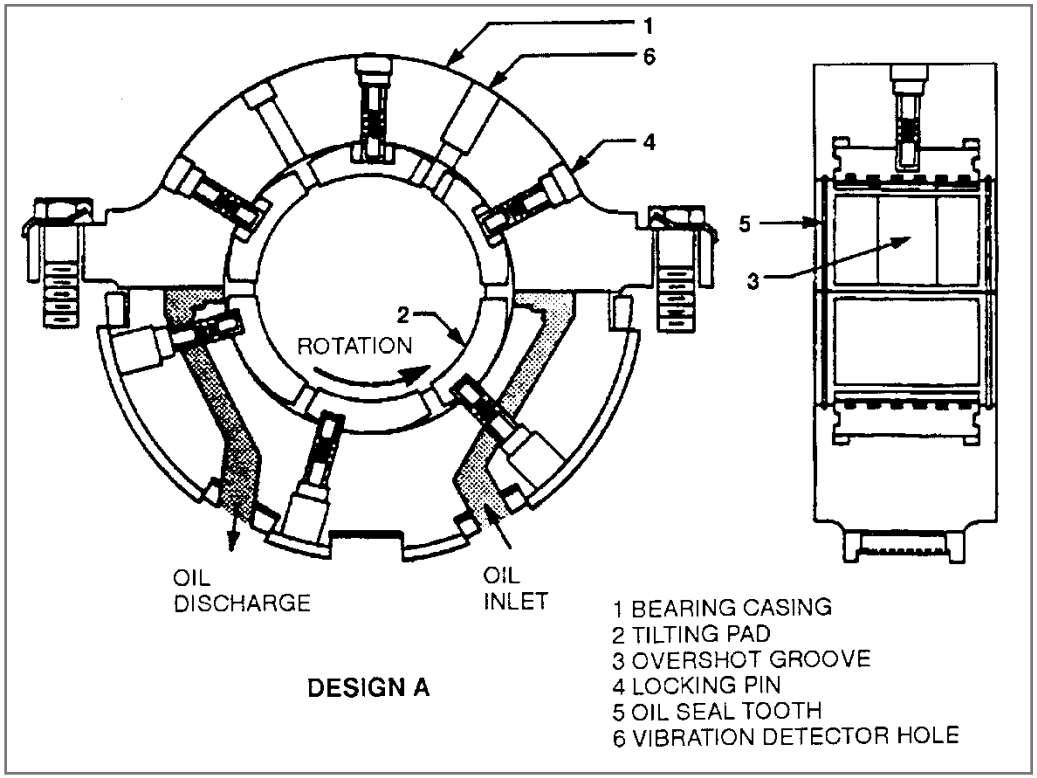
- ✓ These are ***specially hardened pins*** and only factory replacements should be used

➢ Pivot Surface

✓ Inspect the back of the tilt pads for **excessive wear** or ***fretting***

➢ Pivot Surface

✓ Measure the location of the pivot point from the leading and trailing edges of the pad. ***Generally, the pivot point will be located .50-.70 times the circumferential length of the pad from the leading edge*** and .50 times the axial width of the pad from either side



- ✓ Inspect the antirotation pin holes in the back of the pads. These should be round

TURBINE BEARING MAINTENANCE

- ✓ Any of the ***hardened bushings*** located in the upper half pads should be replaced if worn to a depth exceeding ***0.010 in (0.25 mm)***
- ✓ Any holes in the lower half pads that have worn more than ***0.125 in (3.18 mm)*** deep should be bushed and redrilled

➢ Babbitt Surface

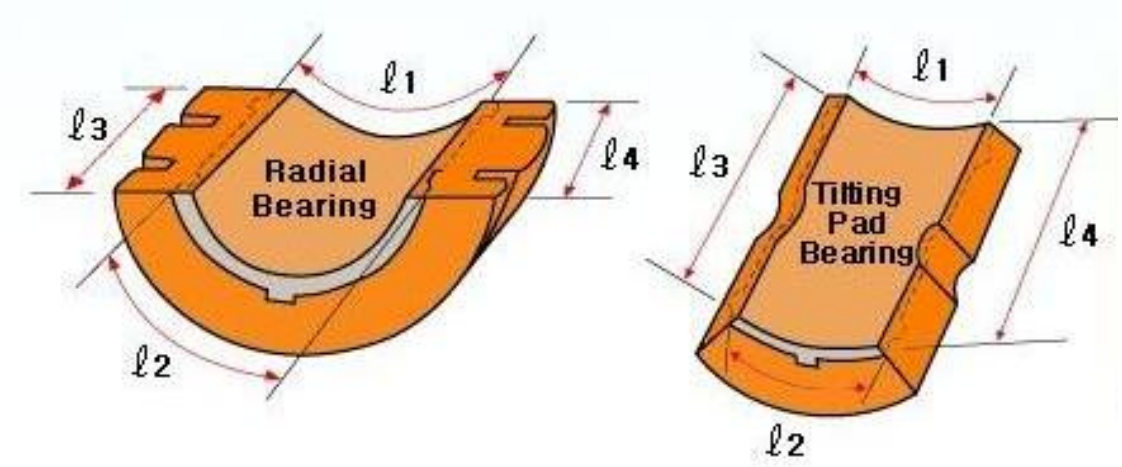
- ✓ Pads having ***loose***, ***cracked***, or ***heavily pounded babbitt*** should be replaced.

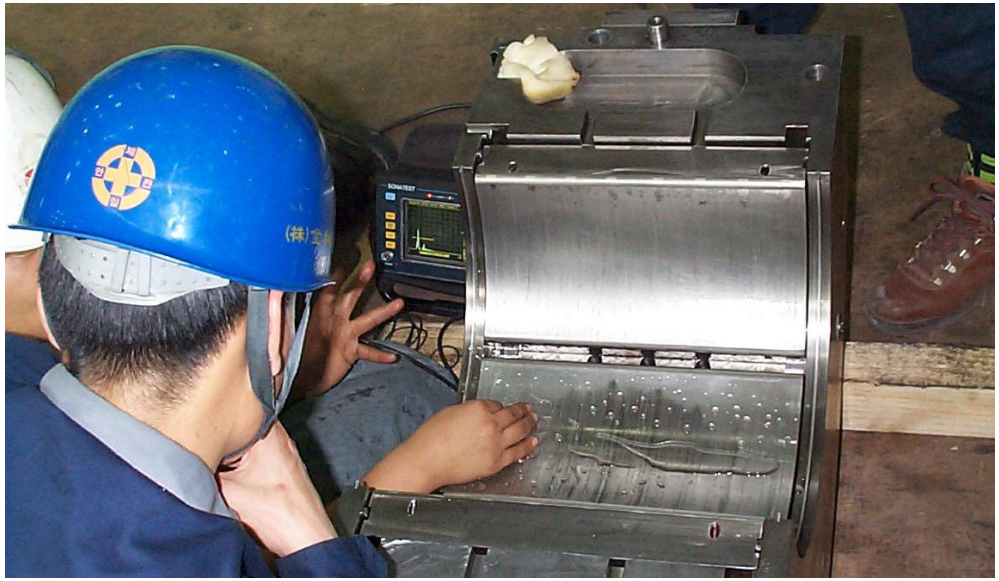
- ✓ Pads should be replaced if any one has more than ***35% of the babbitt-steel interface area unbonded*** at the top of the dovetail, when checked ultrasonically

- ✓ Pads that pass ultrasonic testing but possess surface damage such as ***scoring***, ***smeared babbitt***, or ***heavy wear*** should either be replaced by new pads or restored, removing the damage by welding babbitt using the TIG process, and machining to original design

➢ Babbitt Surface

✓ Exfoliation rate must be below 20% of total babbitt area





➢ Pad Contour

- ✓ Tilting pads with only light wear, not requiring babbitt welding or replacement for other reasons, must be ***individually blue contact checked against a mandrel*** of proper curvature

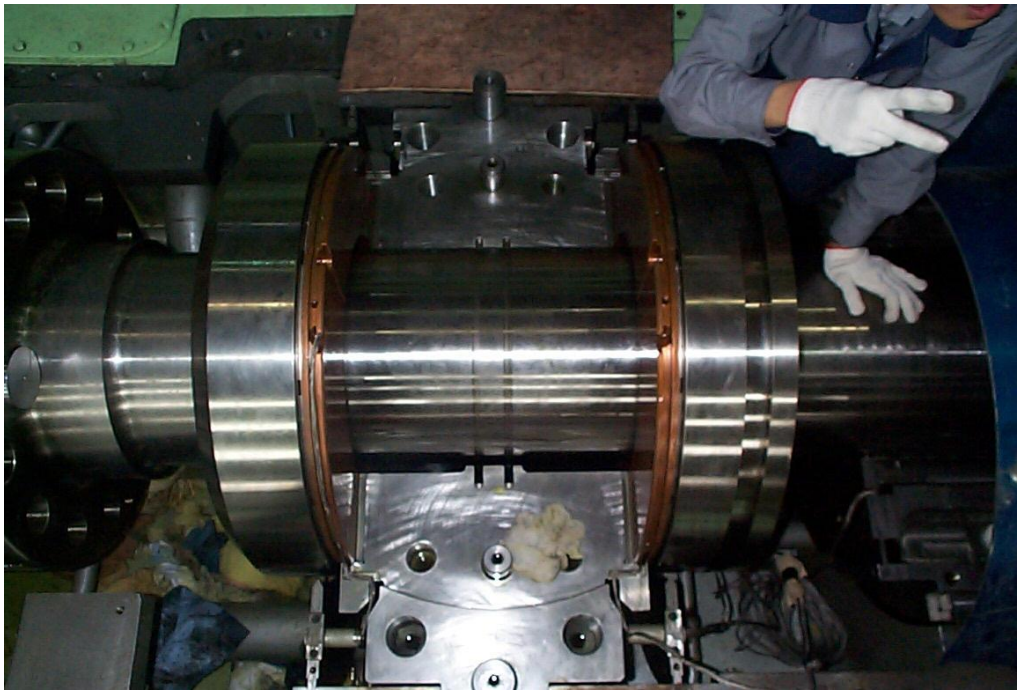
- ✓ The mandrel should be straight and round within 0.001 in (0.25 mm), with at least a 63 rms surface finish. Each pad should have a ***minimum of 80% contact to the mandrel***

- ✓ ***Under no circumstances should the tilt pads be blued against the shaft***. It is permissible to wrap a shim of suitable thickness around the shaft to arrive at the correct curvature for a blue check

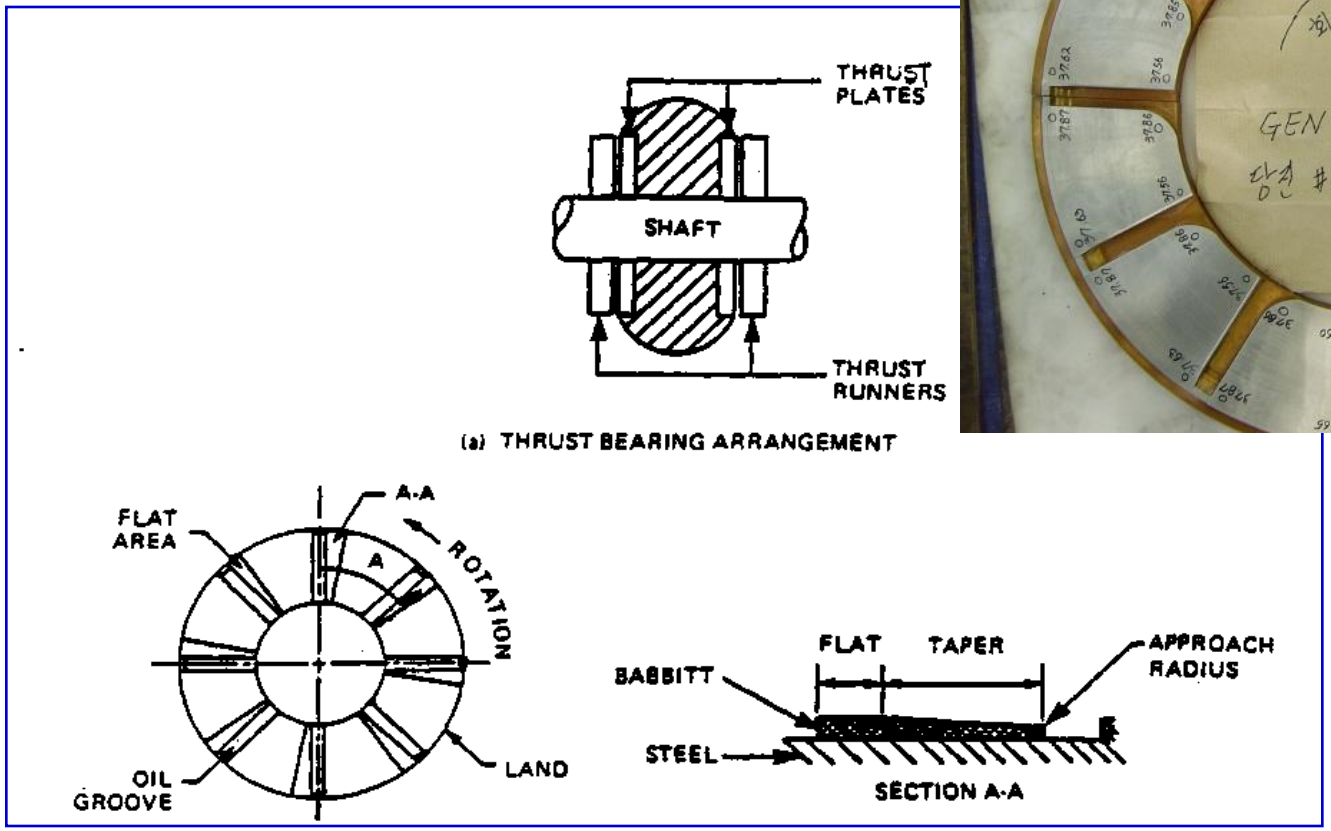
➢ Pad Contour

4. Thrust Bearing

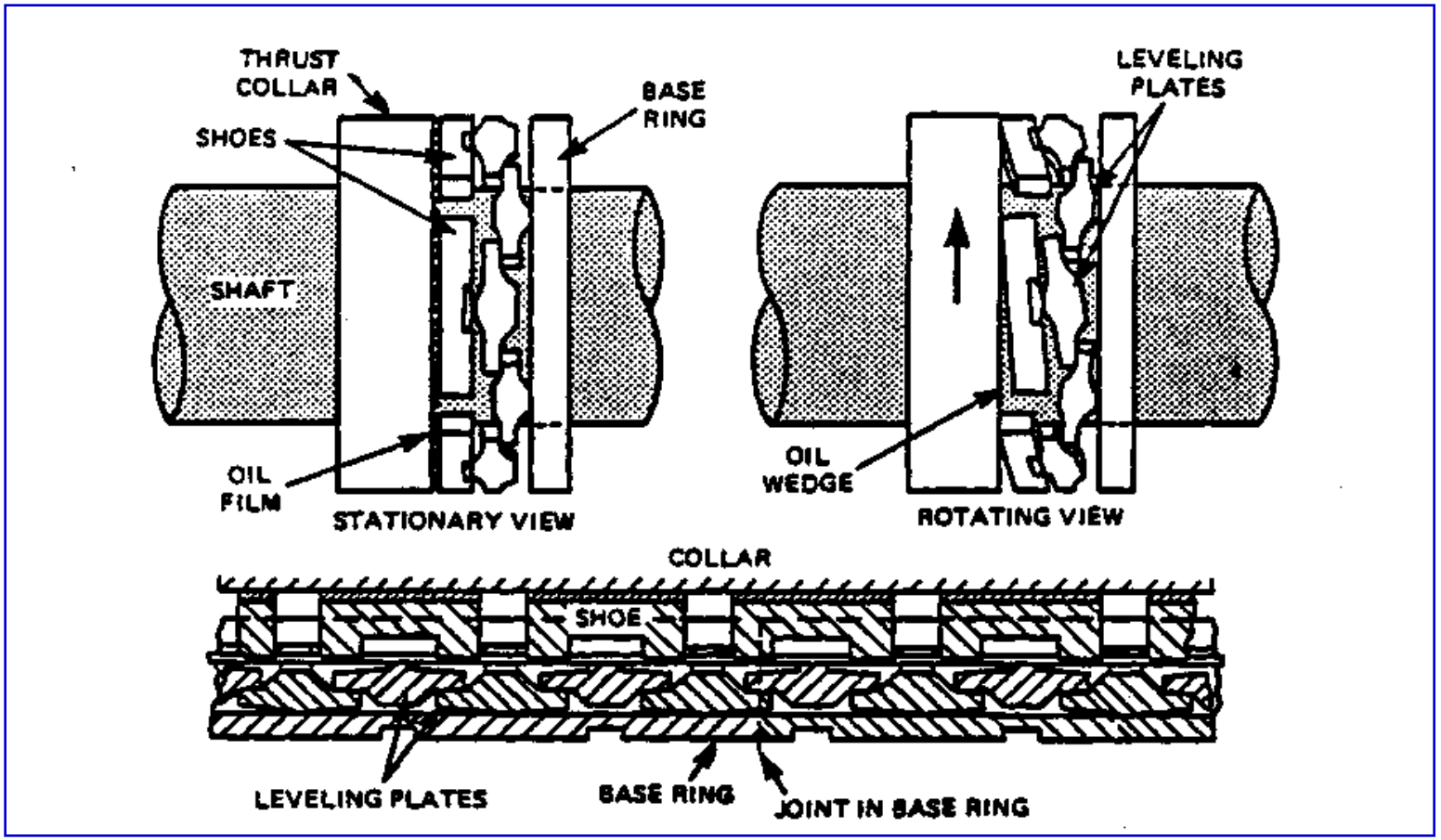
- **Absorbs axial forces**
- Like the journal bearing, the thrust bearing builds up a thin film of oil between the bearing and a thrust runner on the rotor.
- Thus the rotor never touches the bearing surface in normal operation.



4.1 Tapered Land Type



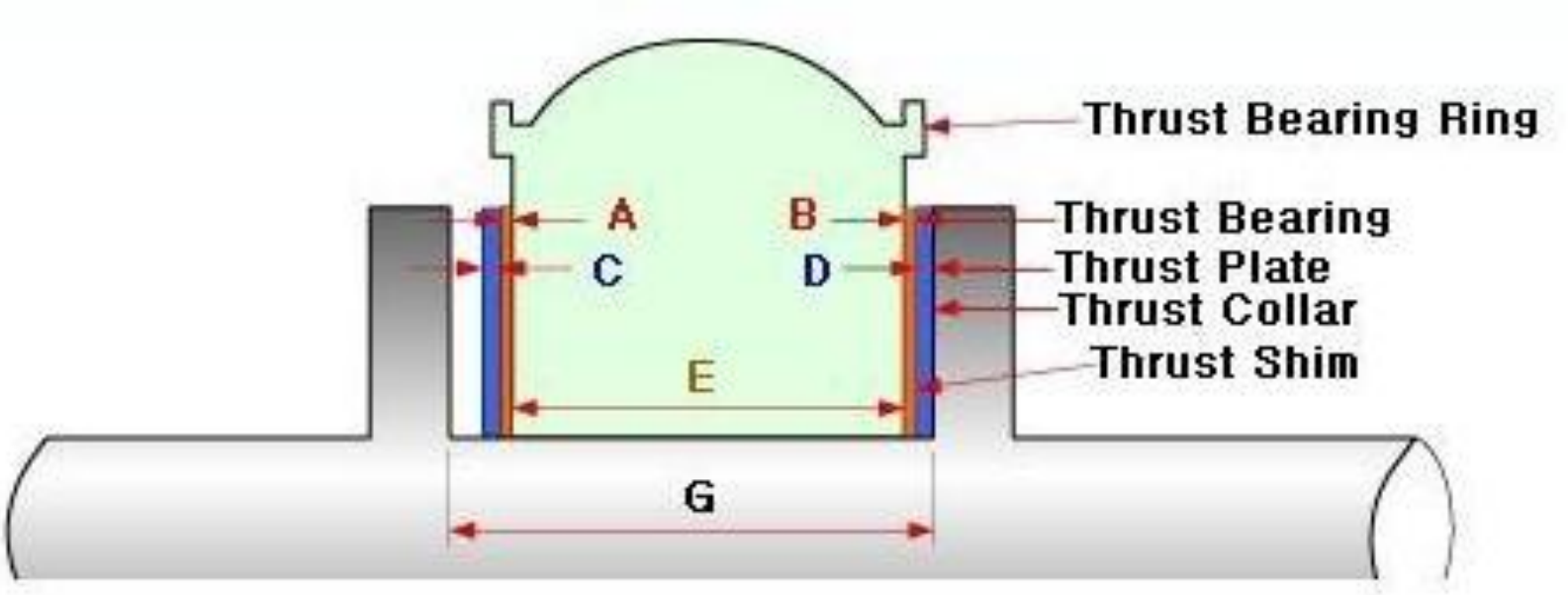
4.2 Kingsbury Type



4.3 Maintenance Recommendations

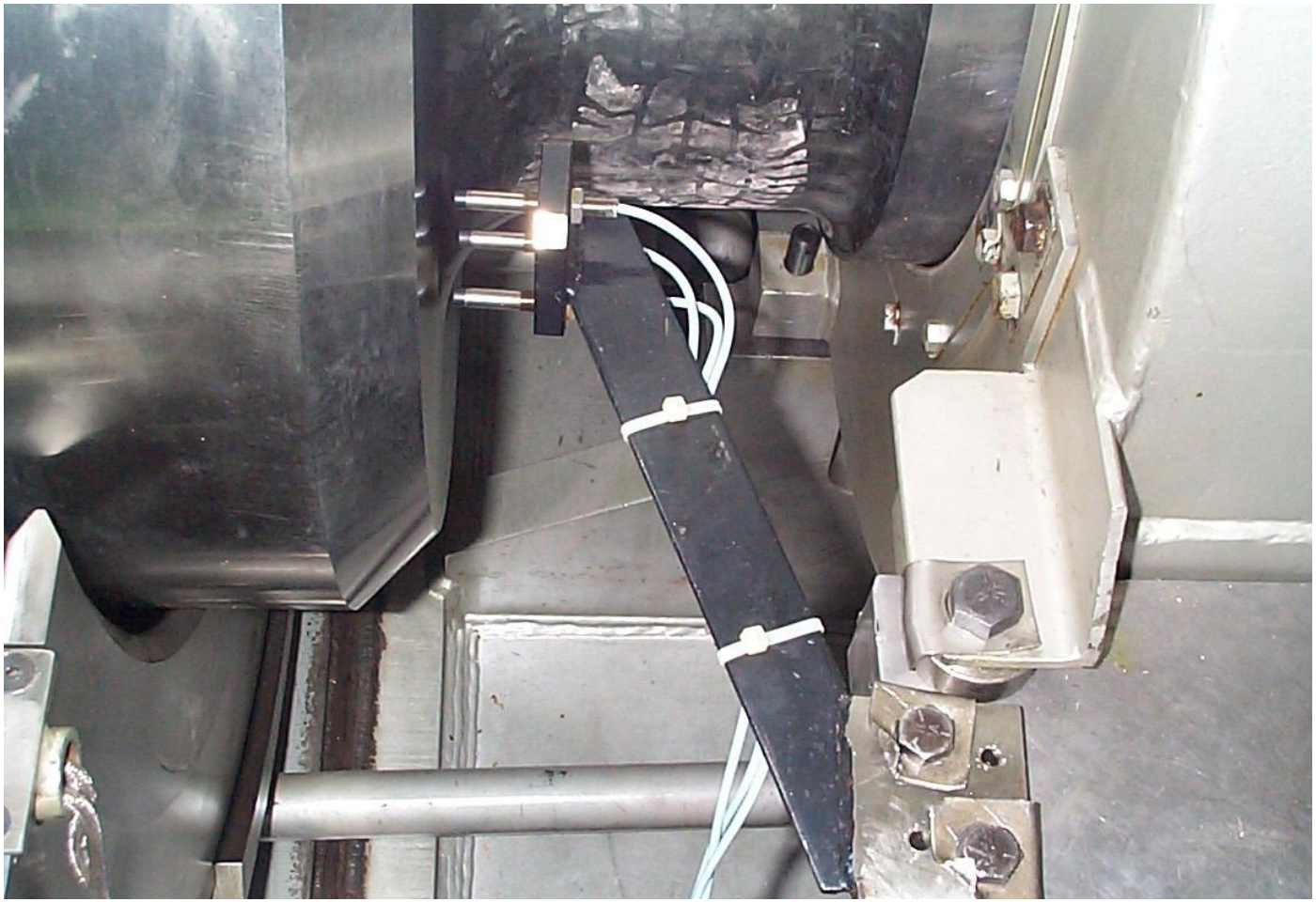
- **Bump Test**

➢ Stack up check



- The difference between the result of Bump test and stack up check should be below 0.05mm

➢ Thrust wear detector



THANK YOU !