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### Translation


This document is a translation from Swedish of LKAB Technical Instruction LKT 1550.540.001. In the event of disagreement concerning the interpretation and content of this text, the Swedish version shall have priority.

### Latest revision

The latest revision of this instruction can be obtained from e-mail address: [tekadm.krn@lkab.com](mailto:tekadm.krn@lkab.com)

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## Background and scope

LKAB has a large number of machines with heavy rotating shafts that require accurate adjustment and alignment, which is a prerequisite for achieving operational reliability of the entire plant. This instruction is used during tender procedures as well as for the purchasing and assembly of machinery.


## Alignment and assembly of rotating units

### Alignment and assembly of rotating units such as mills, fans, pumps, engines, gear boxes, etc.

1. Accuracy of alignment: Within LKAB facilities, alignment accuracy should fall within the 'good' range unless otherwise stated during the purchasing procedure. See Appendix 1.
2. Coupling – A flexible coupling is no excuse for an incorrectly aligned unit. The recommended distance between the coupling halves should be specified by the machine supplier. Adjustment should be carried out in accordance with these specifications.

Gear drives with herringbone teeth should be checked prior to adjustment to ensure that the herringbone teeth are centred before the distance is adjusted.

3. Alignment specification – Must exist if there is a risk of thermal expansion, that is, if there is a difference in temperature of more than 40° C between the units. Unit temperature should be specified. The machine supplier will submit these details to the buyer. Alignment should be carried out in accordance with these specifications.
4. Alignment aids – Alignment should preferably be carried out using computer-assisted laser alignment devices. If alignment is carried out using a dial indicator with a measurement stand, any pendulum effect of the measuring stand should be taken into consideration.
5. Adjustability – There should be an adjustment screw for radial and axial adjustment.
6. Shims– Must be made of acid-proof material when the unit is placed in a corrosive environment. The shims of a positioned unit should cover the whole positioning surface of the unit's base and have correct contact.
7. Foundations – If the machine supplier places specific demands on the levelness and construction of the foundation, instructions and drawings should be submitted to the buyer.
8. Protocol – For each alignment an alignment protocol should be drawn up in accordance with Appendix 2 and submitted to the buyer. When aligning open gear drives, gears should have at least 90% surface contact, whereas closed gear drives should be aligned so as to maintain 100% surface contact. This is stated in the protocol in the section 'further information'.

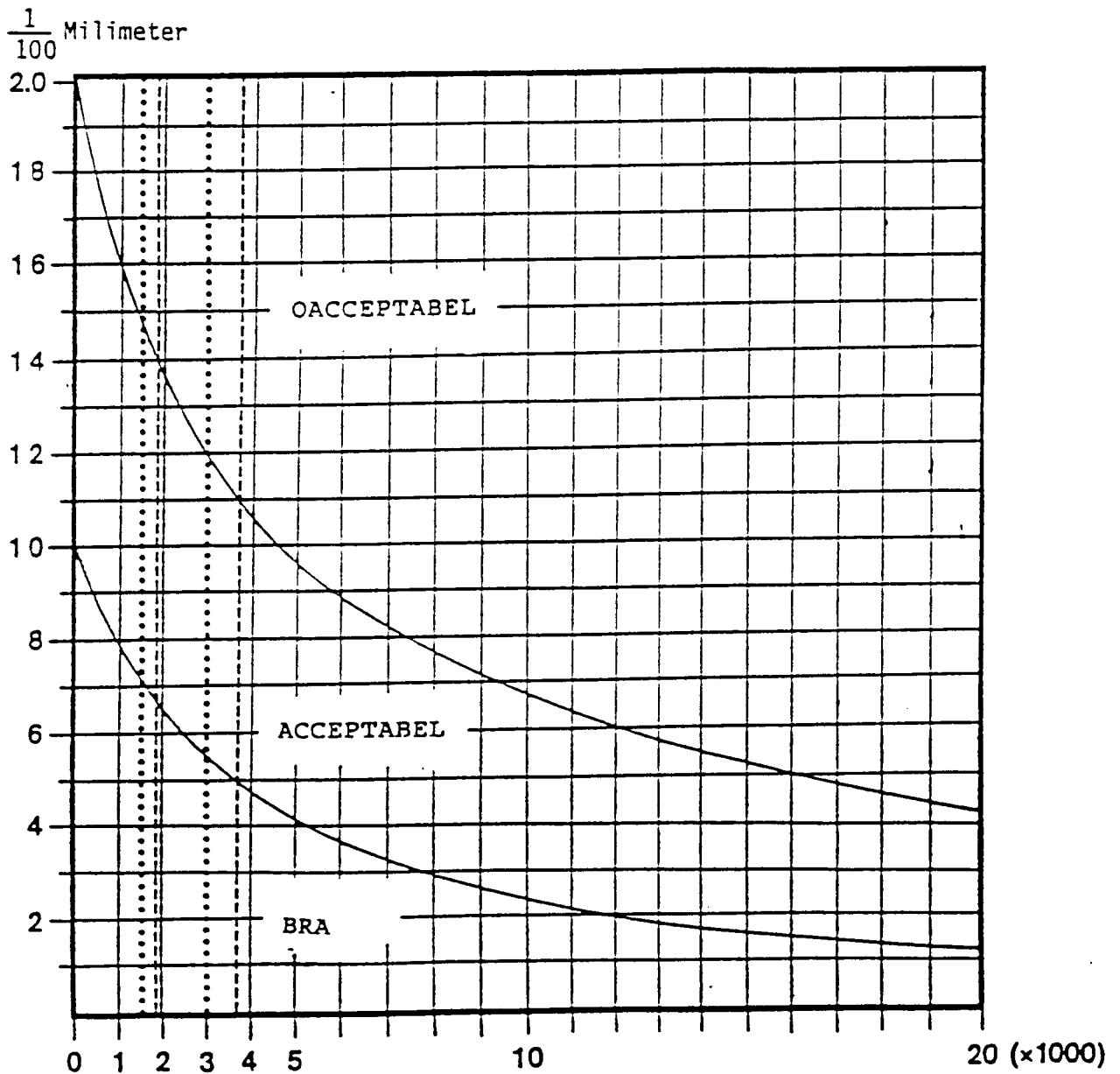
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**Alignment and assembly of rotating units**


**Appendix 1**

**Title: Alignment precision in relation to shaft speed**

UPPRIKTNINGSNOGGRANNHET I FÖRHÅLLANDE TILL VARVTAL



Labels in Graph: Oacceptabel=Unacceptable, Acceptabel =Acceptable, Bra= Good

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## Alignment protocol

Alignment protocol must have the following information:

- Assigner
- Assigner's reference
- Order No.
- Date
- Plant
- Object
- Test location
- Position before correction, measured in 1/100 mm
- Position after correction, measured in 1/100 mm
- Acid-free shims Y/N
- Number of shims
- Dimension and thickness of shims
- Type of measuring instrument
- Operator

## Alignment of crown wheels

### Alignment protocol for LKAB's open or semi-open gear drives

This protocol shall be used when aligning or checking LKAB's open or semi-open gear drives.

### Data for gear drive


Table 1 and Table 2 show general data and physical data for the gear drive.

**Table 1. General data**

Plant (KK, KA, etc.):	
Date:	
Company:	
Contact person:	
Telephone:	
Customer:	

**Table 2. Data for the gear drive**

Type of operation (mill, kiln, etc.):	
Object designation:	
Manufacturer:	
Width, crown wheel:	
Diameter, crown wheel:	
Width, pinion:	

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### Measuring axial true and radial true

Measuring the axial true and radial true can be done with a dial indicator or laser. The measurement shall be made on 12 different positions on the crown wheel at 30° intervals, as in Figure 1. Only the maximum deviations are reported in

Table 3, that is, from a median line one adds the absolute value of the positive and negative deviations.

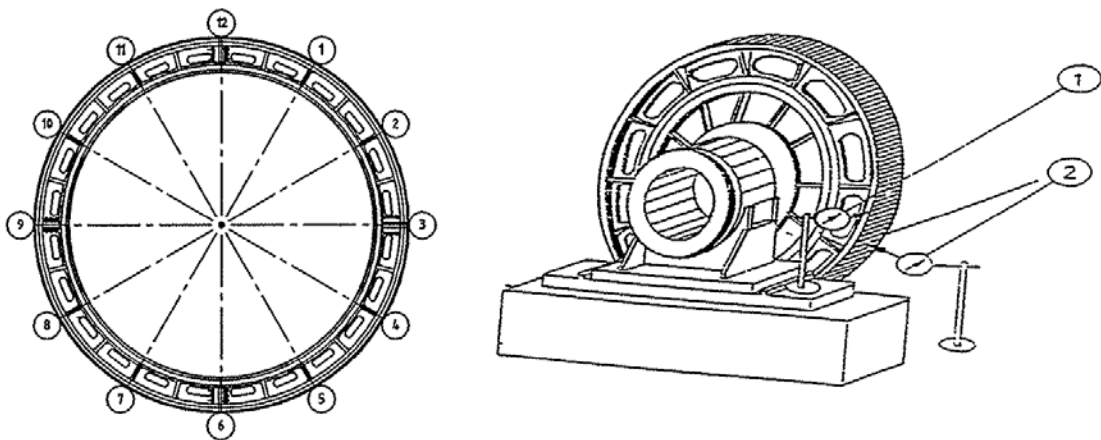



Figure 1. Measurement of axial and radial true

**Table 3. Measurement of axial and radial true**

<i>Position</i>	<i>Radial true</i>	<i>Axial true</i>
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
<b>Typ3</b>	<i>Current maximum value</i>	<i>Allowable maximum value</i>
Radial true:		
Axial true:		

Allowable values of axial and radial true are specified by the supplier of the gear drive.

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### Measurement of gear play between the pinion and the crown wheel

Measurement of the play between the pinion and the crown wheel is performed when the gear tooth contacts are on the pitch circle. The following shall be measured:

- C – flank play, contact side
- B – flank play
- S – bottom play

The following designations are also used:

- Tol – permitted tolerance
- L – left side seen from the pinion
- R – right side seen from the pinion

The play should be measured at four different places on the crown wheel at 90° intervals, as in Figure 2, and reported in Table 4.

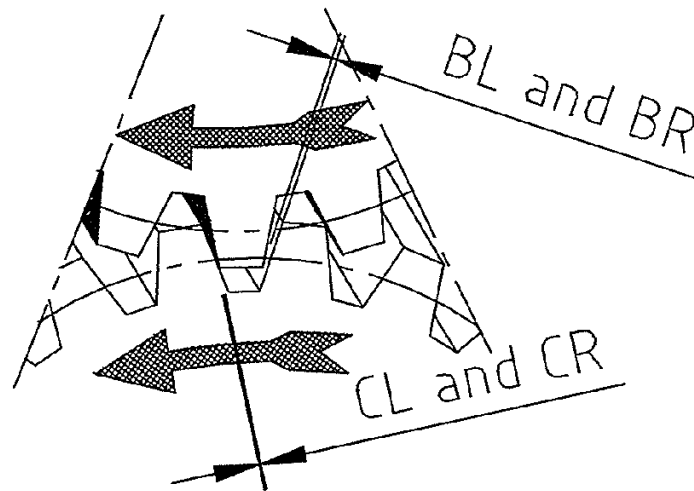



Figure 2. Measuring the play along the pitch circle

Table 4. Measuring the play between the pinion and the crown wheel

Crown wheel position	Contact side			Flank play			Bottom play		
	CL	CR	Tol	BR	BL	Tol	SL	SR	Tol
0°									
90°									
180°									
270°									

Tolerances are specified by the supplier of the gear drive.

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### Contact impressions using gear tooth dye test

When the mill has been in operation for a t least 72 hours, a contact impression of the pinion and crown wheel should be made with the help of a gear tooth dye test. At least three contacts between the pinion and crown wheel should be checked, using the following procedure:

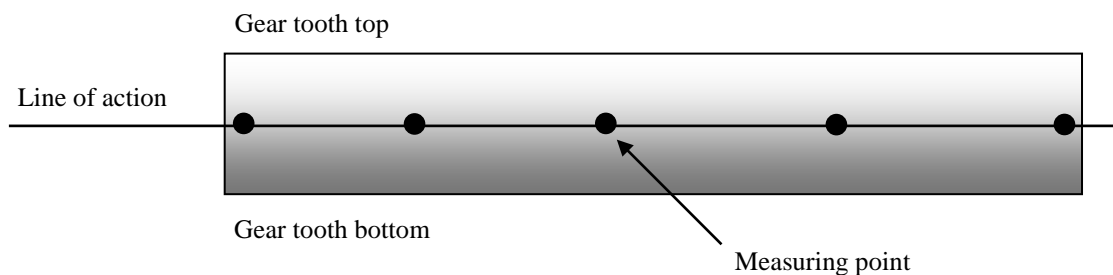
1. After thoroughly cleaning the gear teeth to enable the test dye to stick to the surface, the contact surfaces of the pinion and crown wheel should be photographed. The depth of any surface damage should be estimated or measured.
2. Dye the gear flanks and mark their positions.
3. Operate the equipment for 5 minutes, preferable under a full load, and then stop it. Document the contact surfaces with a photo.

Dye on the contact surface should be evenly distributed between the teeth tops and bottoms and be >85% distributed over the width of the teeth. If the contact surface is less than this, a new alignment should be performed. If it is not possible to reach the criteria above, contact a maintenance engineer as well as the supplier of the gear drive for recommendations for further action. For a more detailed procedure, see "*Advanced gear and lubrication technology*" from Geartech, for example.


### Temperature measurements using IR

The following procedure shall be used when the gear tooth contact is to be documented using an IR instrument.

1. Set the instrument for the emission factor for steel or for the factor recommended by the manufacturer.
2. Measure fie positions evenly distributed over the tooth width of the pinion (two of these at the edge of the pinion). The instrument shall be held, if possible, at the same distance for every measurement, as in Figure 3.
3. Document the values in Table 5.
4. Use Table 6 to document the date and time of measurement as well as the current power requirement. Note also how long the mill has been in operation since it was last shut down, as well as the permitted maximum temperature deviation along the gear tooth flank (Tmax).



**Figure 3. Gear tooth flank with positions for IR measurement**

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**Table 5. Temperature measurement along the gear tooth flank of the pinion**

Measuring point:	1	2	3	4	5	T <sub>max</sub>
Temperature:						

**Table 6. Data for IR measurement**

Date of IR measurement:	
Time:	
Current power requirement:	
Operational time since latest shutdown:	

The allowable temperature deviation along the gear tooth flank is specified by the supplier of the gear drive. When larger deviations are noted, a new alignment should be performed. If it is not possible to reach the criteria above, contact a maintenance engineer as well as the supplier of the gear drive for recommendations for further action.

### Final reporting

The protocol should be sent in digital form to the maintenance engineer for the plant in question.

### Suggestions for improvements

LKAB carries out continual improvements in accordance with the LKAB quality policy (SS-ISO 10006, sections 8.2 and 5.2.7) and this also applies to instructions and codes of practice. Comments and suggested improvements are welcome at the following e-mail address: *instructions@lkab.com*

LKAB's internal address in Lotus Notes: *Anvisningar LKAB*