Industrial Fans & Blowers

Presented to API

Presented by Joe Faillace

SKF Applications Engineer

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Agenda

1. Industrial Fan Overview
2. Fan Types
3. Fan Rules of Thumb
4. Bearing Selection (Held Vs. Flo
5. Lubrication
6. Common Fan Problems
7. Minimum Loading
8. Special Air Handling (AH) Products

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Industrial Fan Overview

What are Fan Bearings?

High speed, at least 75% of the grease speed limit

Low radial load

- Possible high thrust load

Rotating inner ring and shaft

No intentional unbalance

Where and Why are Fans Used?

Every occupied space requires some type of fan.

- Restaurants, offices, cars, submarines, tunnels, mines, greenhouses, electrical appliances, oil refineries, etc.

Fans are used for a variety of reasons.

- Ventilation (moving air)
- Moving material (wood chips, fibers)
- Circulating gases
- Moving dirty air through filtering equipment

Industrial Fan Jargon

Fan – moves large volume of air at relatively low velocity

Blower – moves moderate volumes of air at high velocity

Centrifugal Fan – pull air in axially and fling it out radially

Axial Fan – force air through by the rotating action of the blades

Impeller – fan wheel in a centrifugal fan, also called the wheel or rotor

Scroll – housing around the impeller on a centrifugal fan

Industrial Fan Jargon (cont.)

Variable Pitch – axial fans with blades whose angle of attack can be adjusted

Single Width – centrifugal fan designed for pulling air in from one side of the scroll only (high axial loads, single inlet)

Double Width – pulls air in from both sides of the scroll (low axial loads, double inlet)

AMCA – Air Movement and Control Association

ASHRAE - American Society of Heating, Refrigeration, and Air-conditioning Engineers

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Fan Types

Common Fan Types

Axial Flow or Centrifugal

Overhung or straddle mounted

Direct drive or belt driven

Single inlet or double inlet

Axial Fans (Belt & Direct Drive)

Centrifugal Fans (Belt and Direct Drive)

Overhung vs. Straddle Mount

Overhung fans - impeller beyond both bearings on the shaft

Overhung fans can have very lightly loaded bearings

- Sensitive to unbalance, fretting, minimum load

Straddle mounted fans – impeller between the bearings

Straddle mounted fans typically have large thermal expansion of the shaft (hot air/gas)

Direct vs. Belt Drive

Direct drive couplings can apply load in any direction depending on alignment.

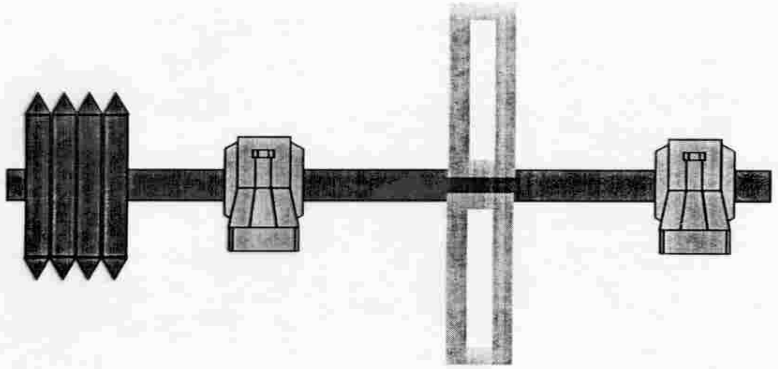
Coupling can add unbalance

Coupling can apply a thrust load

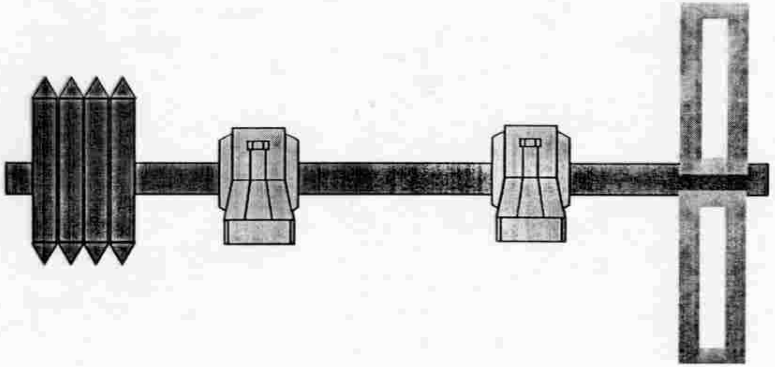
Belt drives add a highly variable radial load that can often yield a lightly loaded bearing opposite the belt side

Belts and their pulleys can also be out of balance

Belt Drive

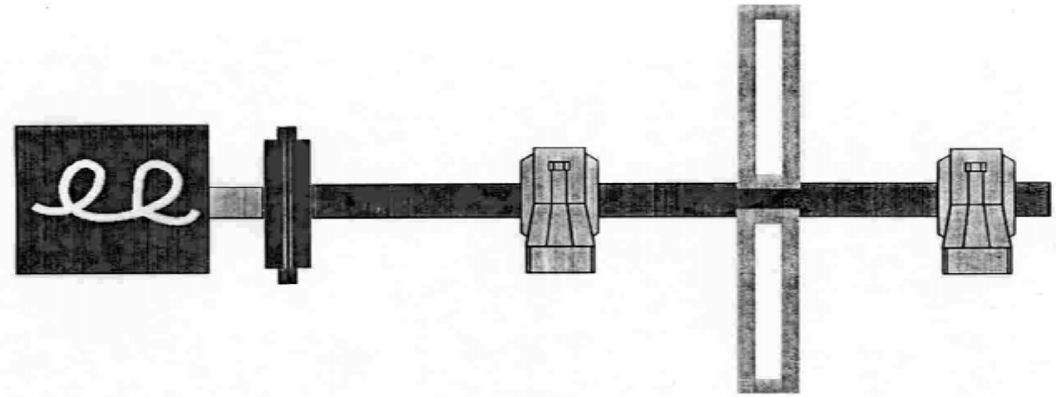


Center hung, belt driven

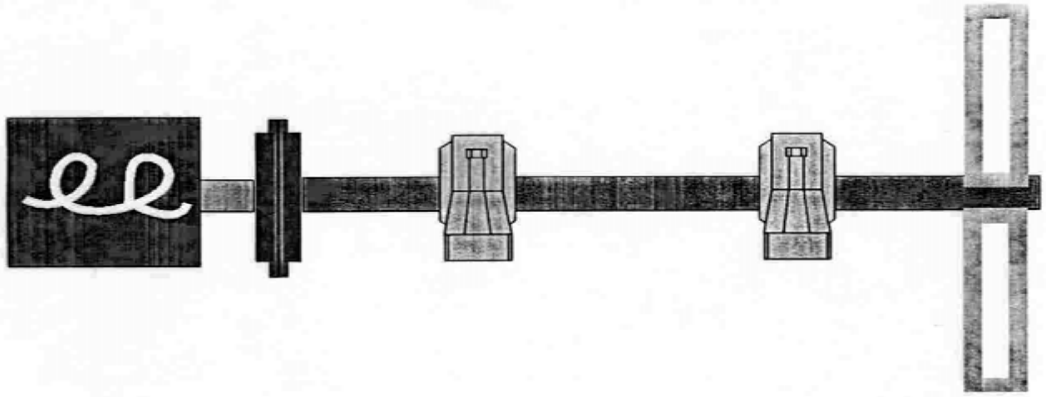


Over-hung, belt driven
(Most Common)

Direct Drive



Center hung,
direct driven



Over-hung,
direct driven

Fan Types – Single vs. Double Inlet

Single inlet fans typically have high thrust loads (axial fans are single inlet)

Double inlet fans usually have no thrust load if adjusted properly

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Rules of Thumb

Fan Rules of Thumb

Almost always use “C3” radial internal clearance

In general, do not reduce oil viscosity to lower bearing operating temperature

In general, Fa/Fr should not be above 1 for 222xx SRB’s (lubrication must be evaluated), but only 0.25 for SABB’s

Fan Rules of Thumb (cont.)

Lubricants containing Molybdenum are generally not necessary in fans

- No real benefit - solid can cause wear, Moly + moisture can result in acidic reaction.

When fan bearings start out running cooler then heat up rapidly, it is likely that there is inadequate lubrication or the “free” bearing is not adjusting to shaft thermal expansion.

Labyrinth seals are usually required due to high speeds.

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Bearing Selection (Held vs. Free)

Selecting the “Held” bearing

Fan manufacturer has the final say

- The preferred arrangement for two SRBs is to make the bearing with the highest radial load “held”. If the lightly radial loaded bearing is held, a significant thrust load can unload one row of rollers.

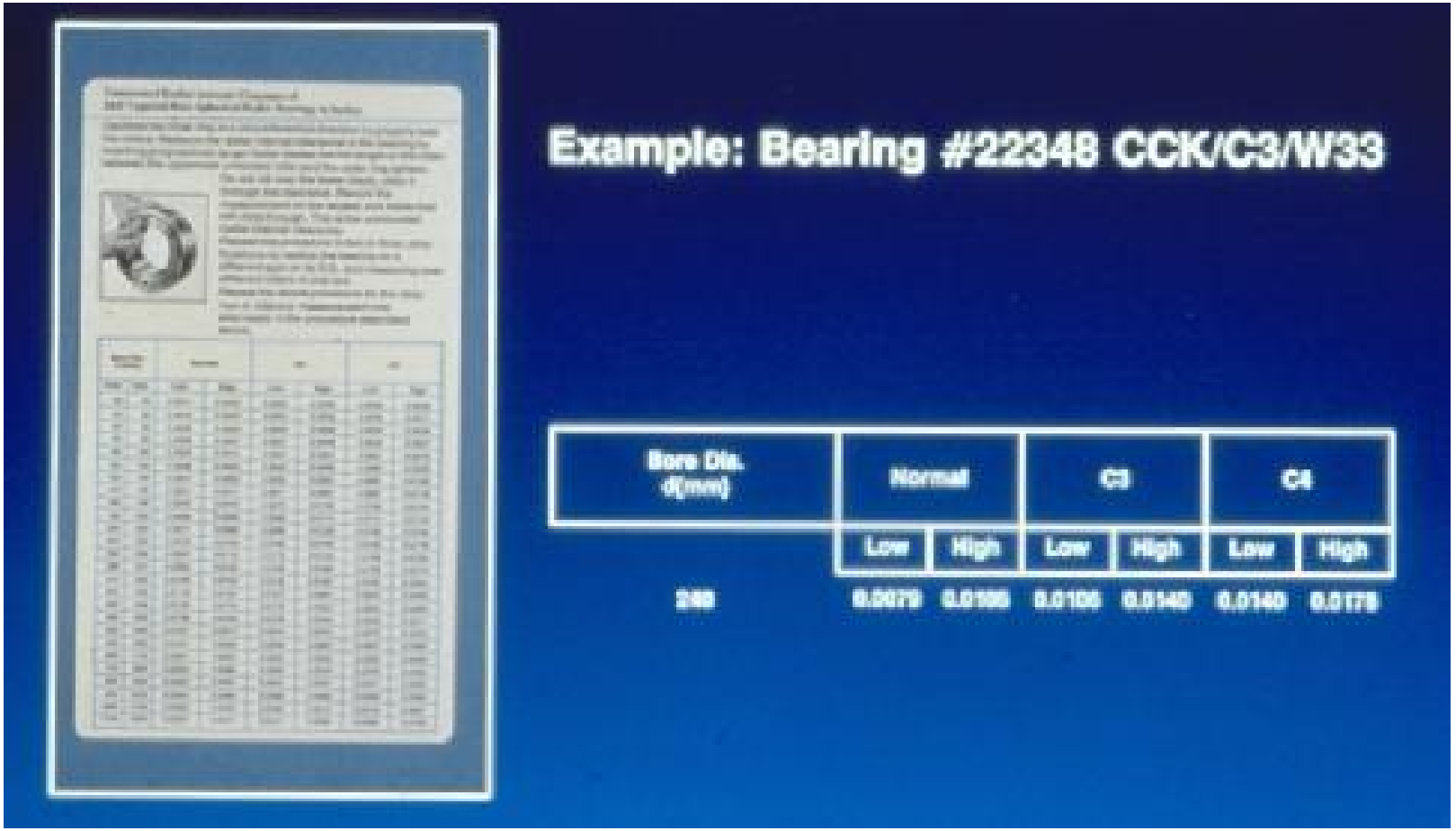
General guidelines for overhung fans

- If close axial tolerances are required for the impeller or seals, the fan side bearing should be “held”

Straddle mounted fans

- Usually the drive side bearing is “held” to prevent axial expansion near the pulley or coupling

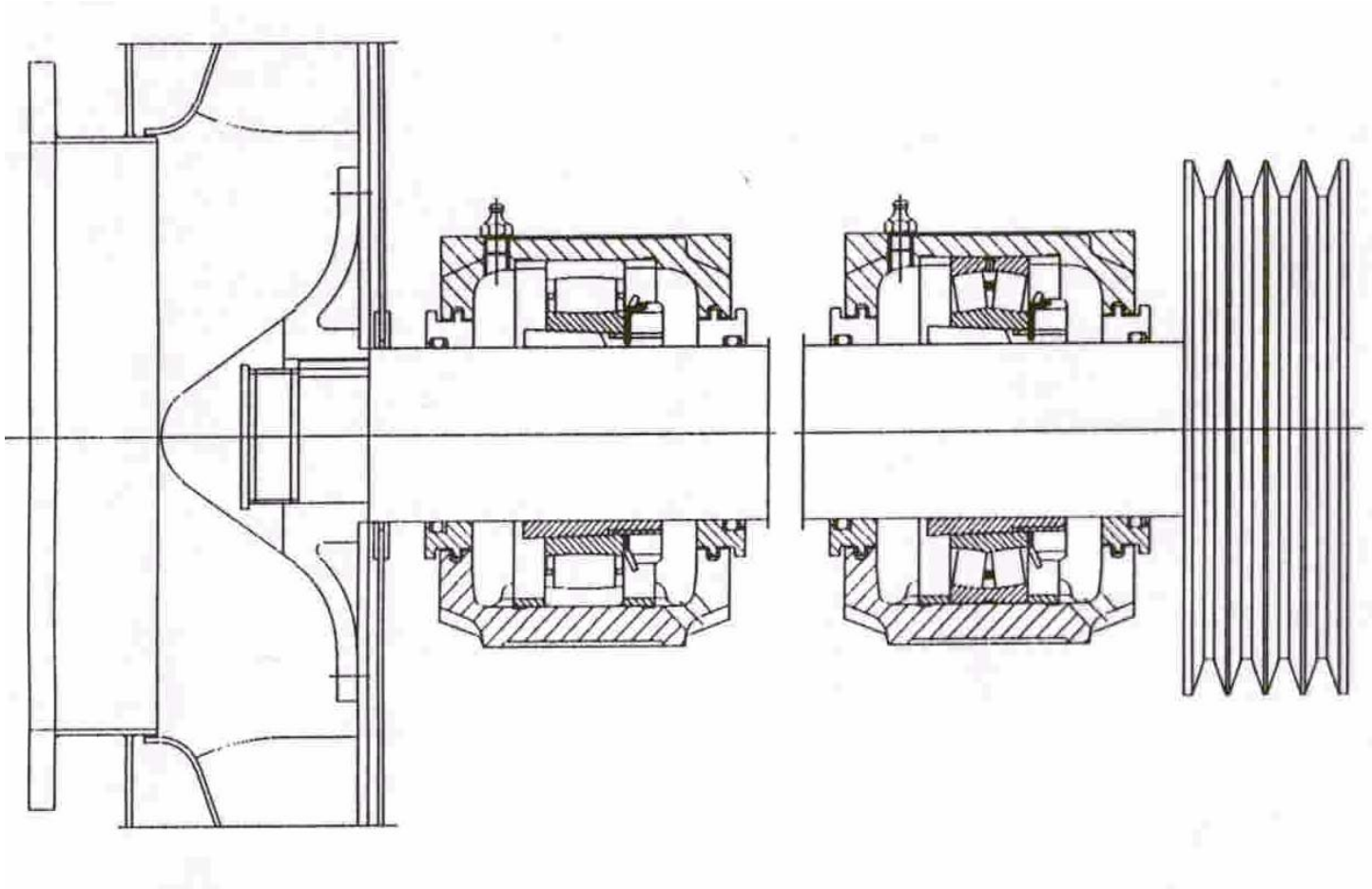
Installation/Clearance Reduction



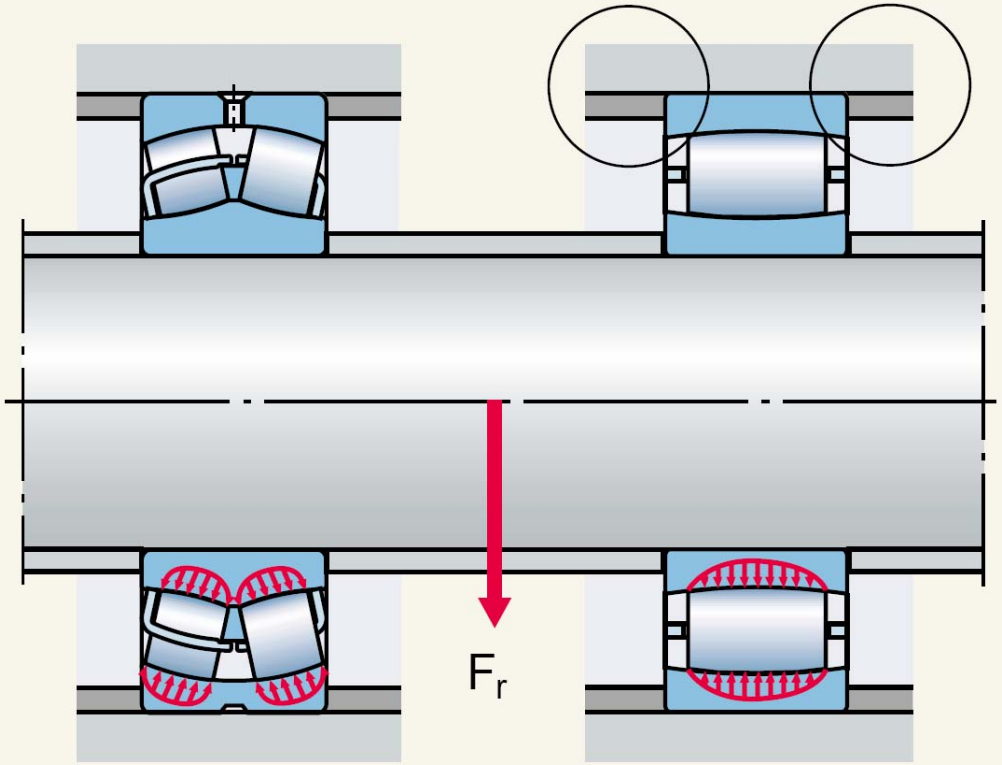
Example: Bearing #22348 CCK/C3/W33

Bore Dia. d(mm)	Normal		C3		C4	
	Low	High	Low	High	Low	High
240	0.0079	0.0130	0.0106	0.0140	0.0140	0.0178

SKF CARB™ in Fan Applications

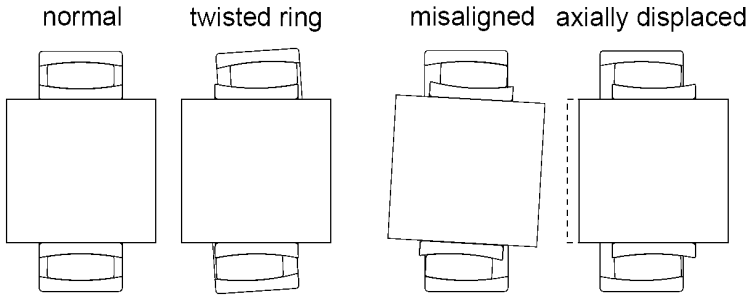


SRB/CARB™ Bearing Arrangement



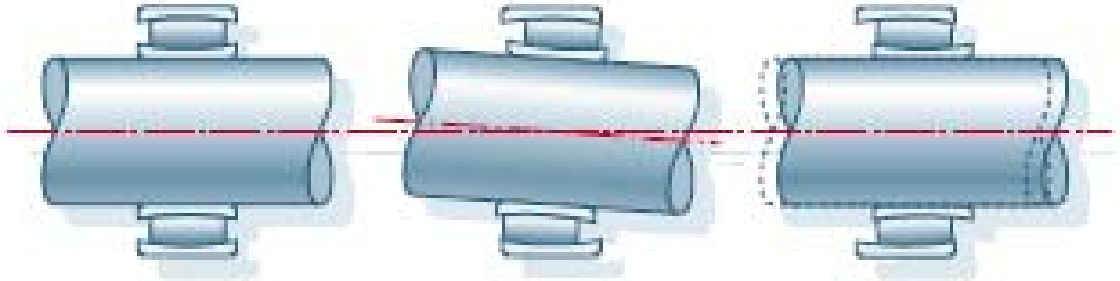
Please note that when using CARB, the outer ring of the non-locating bearing must also be fixed!

- Free dynamic displacement with misalignment
  - More even load sharing
  - Less heat and vibration

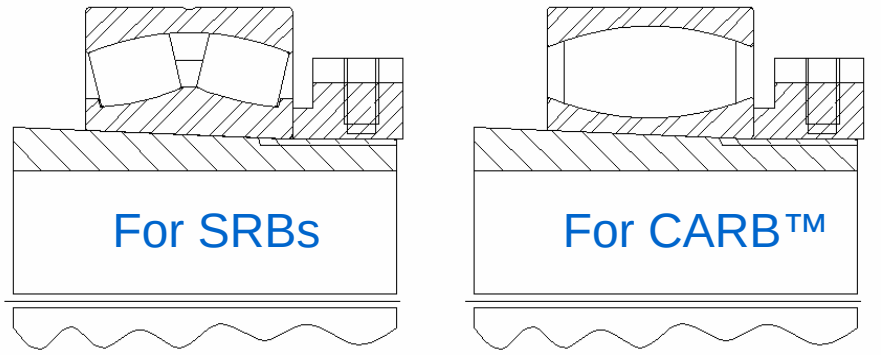


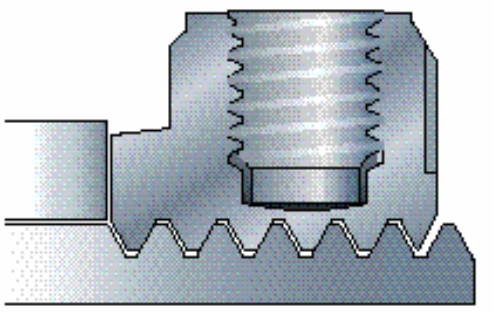
SRB/CARB™ Bearing Arrangement

The total fan shaft solution can significantly reduce operating temperatures, enabling you to increase fan speed and throughput without upgrading the lubrication system.



Air Handling Sleeves





- Improved tolerances
- Tighter running accuracy when compared to conventional sleeve
- Narrow slot width
- KMFE lock nut (using set screw for locking)
- No lock washer
- No worries about roller stick out when using CARB

Size range 22207 to 22226 bearing sizes

Nomenclature: HA 317 E

E = KMFE nut

Air Handling Sleeves for use with SRB & CARB

Two Types

Range 22207 to 22226

HA ### E or H ### E = Air Handling Sleeve with KMFE Locknut – Mounting instructions included in each box.

Range 22228 and up

HA ### L and H ### L = Standard HA or H sleeve with KML locknut and MBL lockwasher. The “L” in KML and MBL signifies low section design

Shaft & Housing Fits

- S1 = adapter sleeve tolerance
- S2 & S3 = seal tolerances for cylindrical mount bearings.

(see SKF Mounted Products Catalog pg 260 for details)

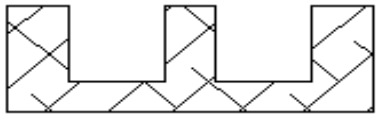
Nominal Dia. Inches		Dia. Tolerance Limits Inches	
Over	Including	S-1	S-2 & S-3
1	2	0.000 –0.003	0.000 –0.003
2	4	0.000 –0.004	0.000 –0.003
4	6	0.000 –0.005	0.000 –0.003
6	10	0.000 –0.006	0.000 –0.004
10	15	0.000 –0.006	0.000 –0.005
15		0.000 –0.006	0.000 –0.006

CARB Advantages in Fans

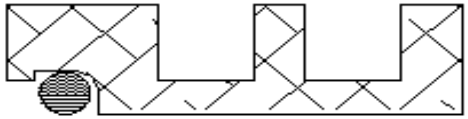
- True Held / free bearing arrangement
- Lower vibration levels (w/ ***K7 transition*** housing fit)
- Reduced risk of bearing outer ring binding in housing bore
- Minimizes risk of creeping or turning outer rings caused by unbalanced loads
- Lower minimum load requirement compared to SRBs
- Less sensitive to housing distortion from poor mounting surfaces

SAF Labyrinth Seals

•Positrac (LOR) - New standard SAF Pillow Block seal as of Oct. 1998, combines features of LER and A-9508, but includes O-Ring, and provides the option to field retrofit Positrac Plus (LORC)

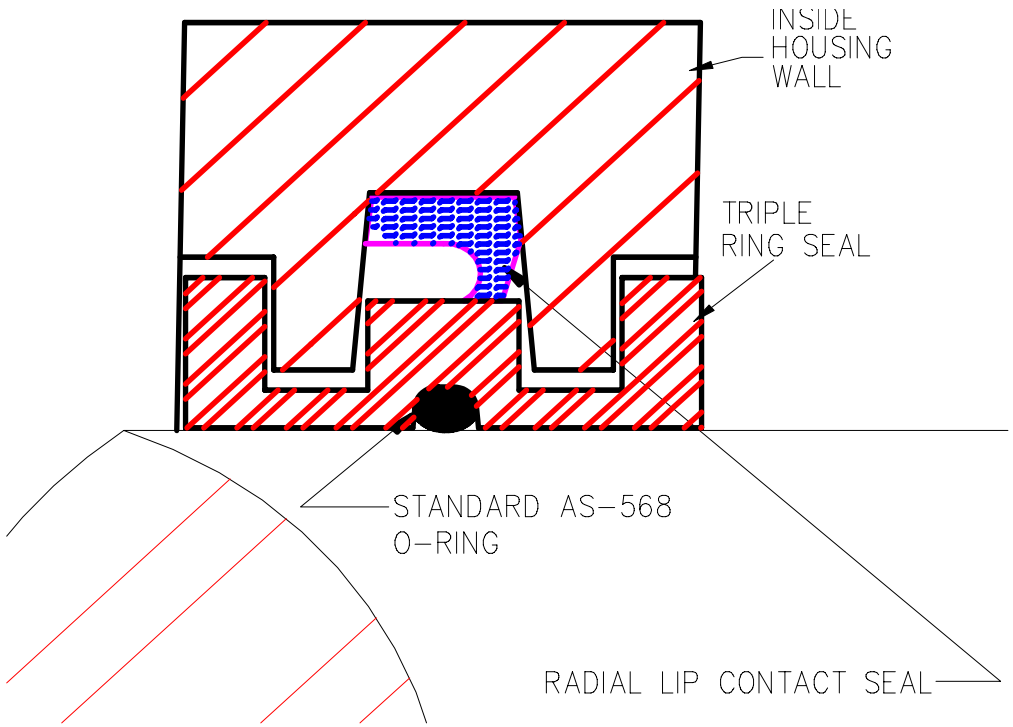


•LER – Standard SAF pillow block seal until Oct 1998, provides grease and oil retention. Also provides protection from contaminants.



• A-9508 – O-ring for oil applications to prevent oil leakage between shaft and seal (wider overall width), O-ring not included.

Positrac Plus Sealing



Not usually recommended for fans because at high speeds the lip friction generates heat.

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Lubrication

Lubrication Selection Guidelines

Ambient gas fans:

- Mineral oil based grease up to 180°F bearing temp.
- Synthetic oil based grease up to 220°F bearing temp.
- Mobilith SHC 220 or equivalent is very common for SRBs operating at 180°F to 220°F

For above 220°F (Bearing Temp.) circulating oil is recommended

Hot gas fans (air/gas temp > 300°F) typically require circulating oil lubrication

Oil Viscosity “Rules of Thumb”

Same rules apply for fans when selecting oil viscosity

- SRBs & CARB™ require minimum 100 SUS (21 cSt) @ bearing operating temp
- Ball bearings require minimum 70 SUS (13 cSt) @ bearing operating temp

For most ambient temperature air/gas fans ISO VG 150 to 220 base oils are best.

Grease Lubrication

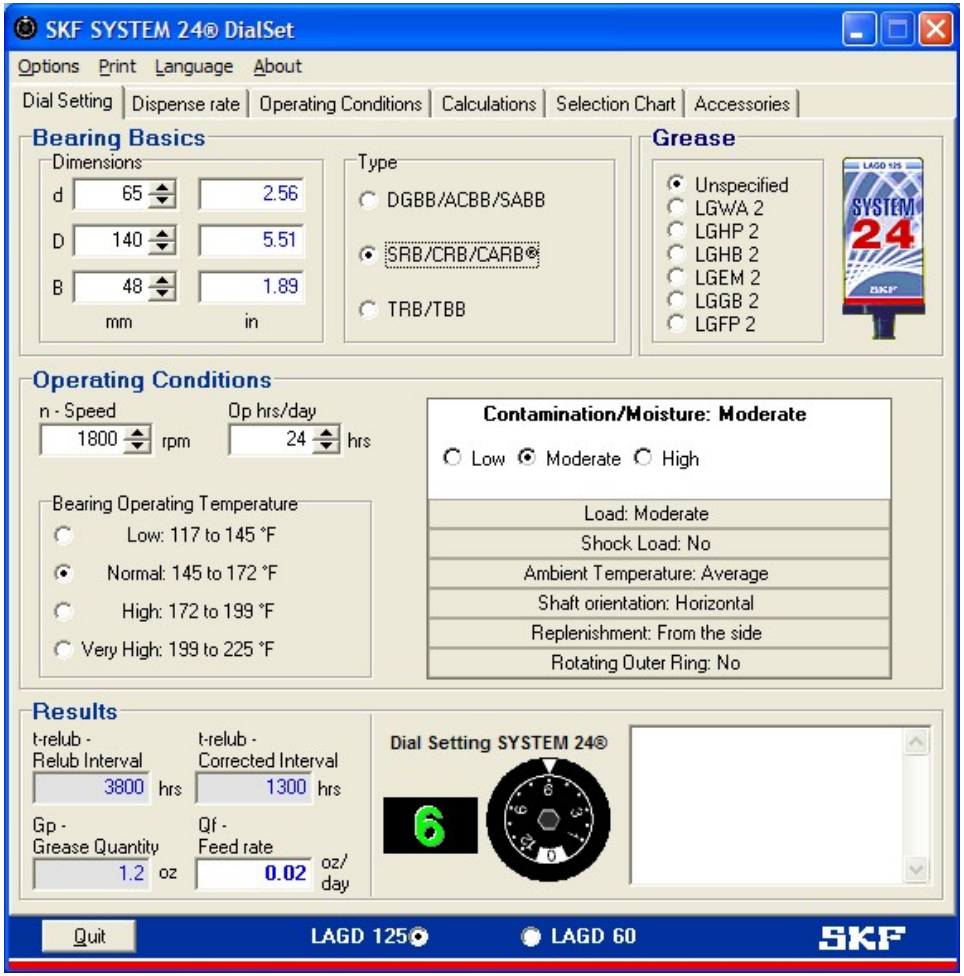
Generally, when greasing split pillow blocks containing SRBs and SABBs fill the bearing 100% full (CARB fill bearing ½ full), housing 1/3 full, and labyrinth seals grooves 100%

Recommended grease

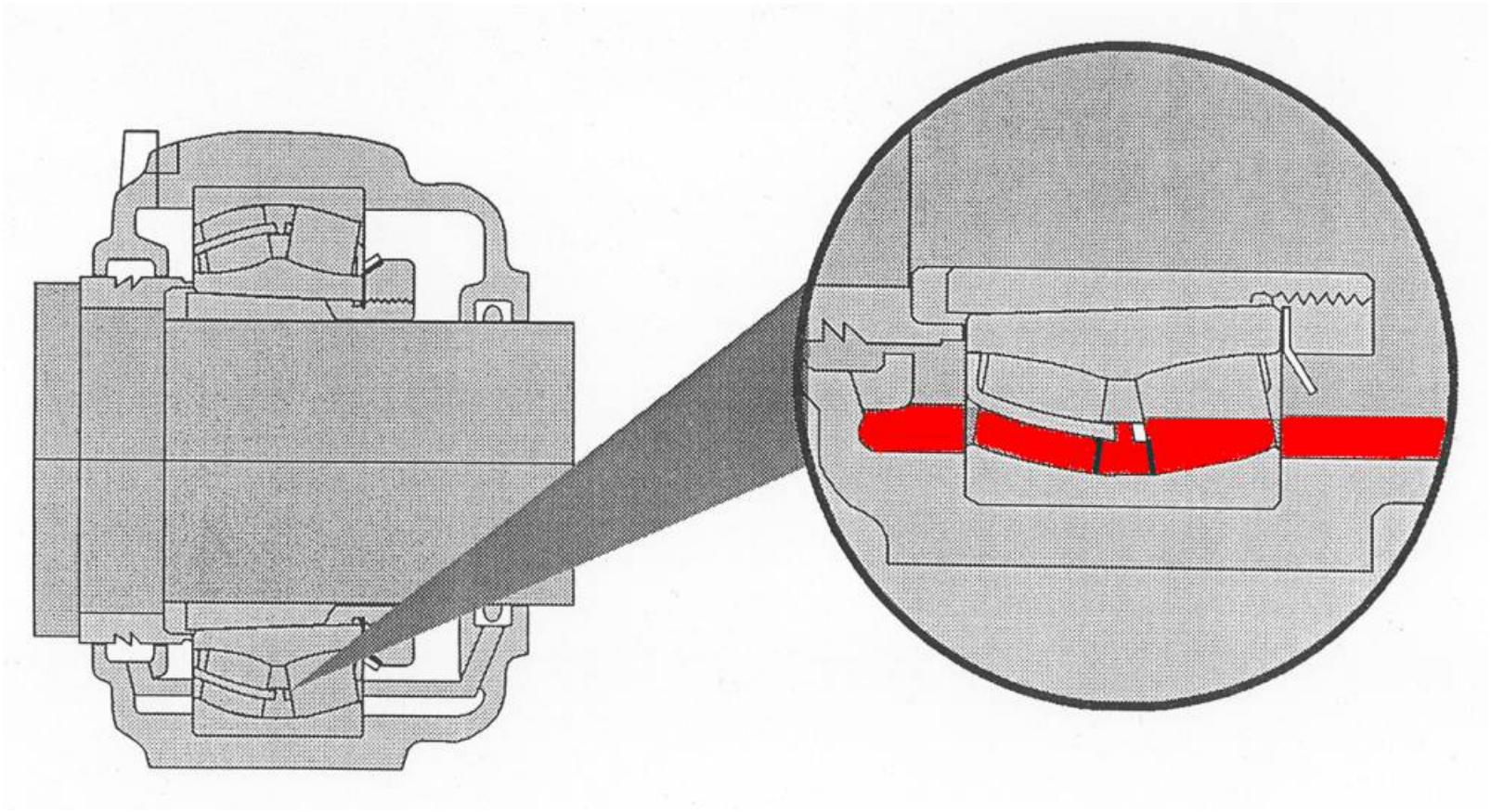
- Lithium or Lithium complex thickener
- NLGI Grade 2
- Oil in grease typically an ISO VG 150 to 220 (depending on bearing operating temperature)
- Generally rust and oxidation inhibitors are desirable

Relubrication mainly depends on the contamination levels and purging action of the seals

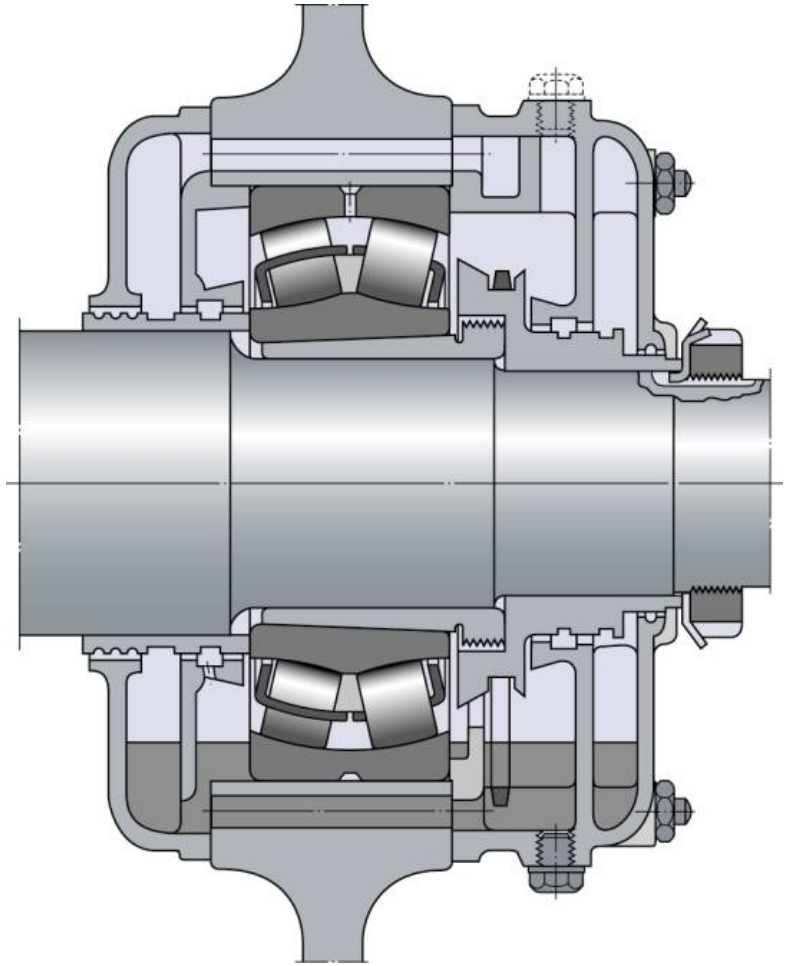
Grease Re-Lubrication



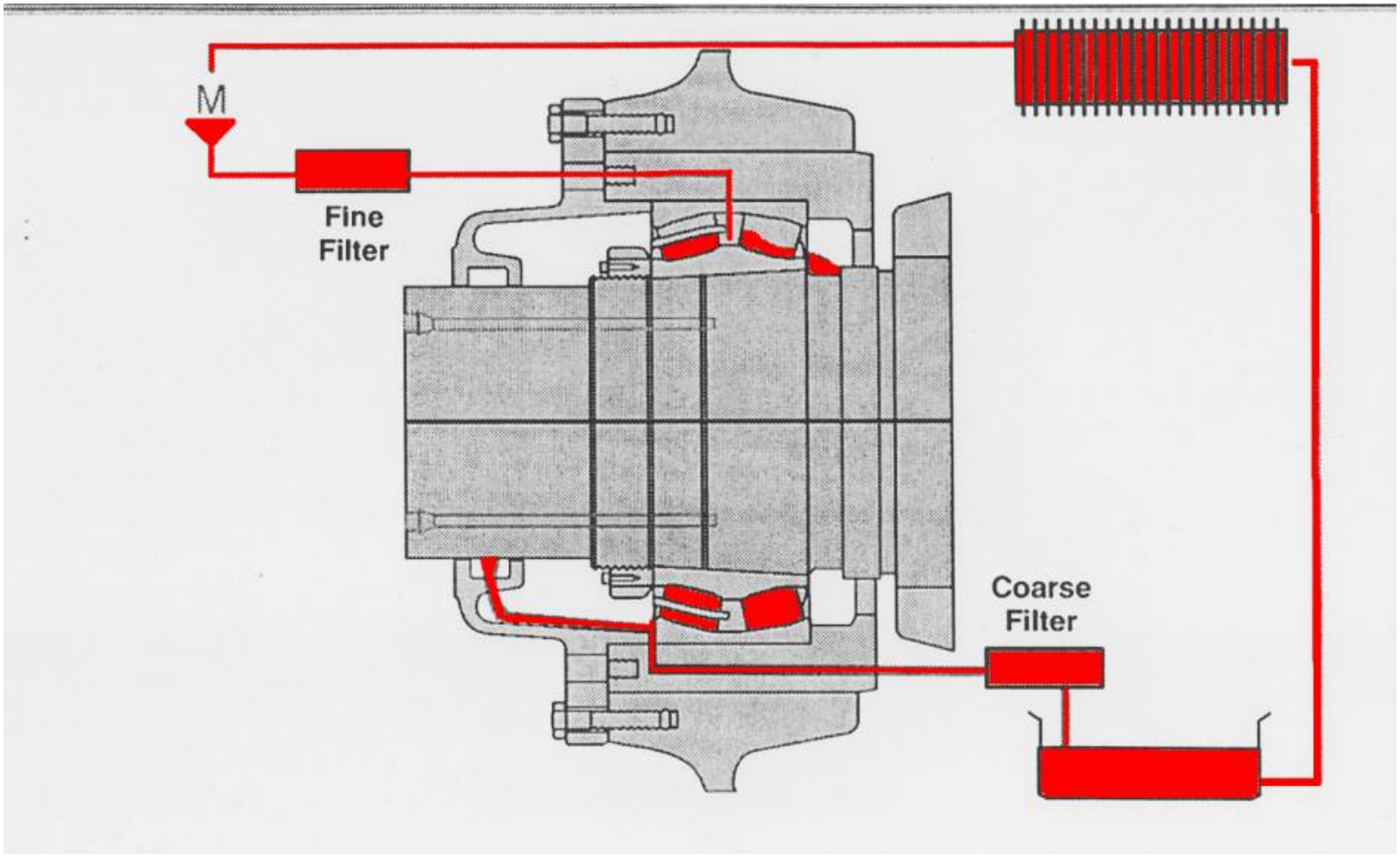
Static Oil Lubrication



Static Oil Lubrication (Oil Lifting Ring)



Circulating Oil Lubrication



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Common Fan Problems

Common Fan Problems

Bearing over heating

- “Free” bearing not moving axially
- Lubrication
- Mounted bearing clearance
- Seal friction

High vibrations

- Misalignment
- Unbalance
- Bolt torque

Bearing Running Hot

First, define hot - What is the bearing operating temperature and is it stable?

What has changed?

Check the basics – proper bearing selection, mounted internal clearance (C3?), lubrication; type and quantity (over greasing)

Selection of “held” and “free” bearing position

Make sure the floating bearing is free to expand axially in the housing – flat base, poor shimming, fretting corrosion (CARB)

Excessive axial or radial load

High Vibration

90 % of vibrations are caused by unbalance

- Unbalance is easily detected in spectral analysis and shows up as a multiple of run speed (usually 1 times)

Bearing damage will also show up in vibration analysis

- Bearing faults have defined frequencies associated with the four main components of the bearing; Inner ring, outer ring, rolling elements & cage. These faults can be detected with spectral analysis.

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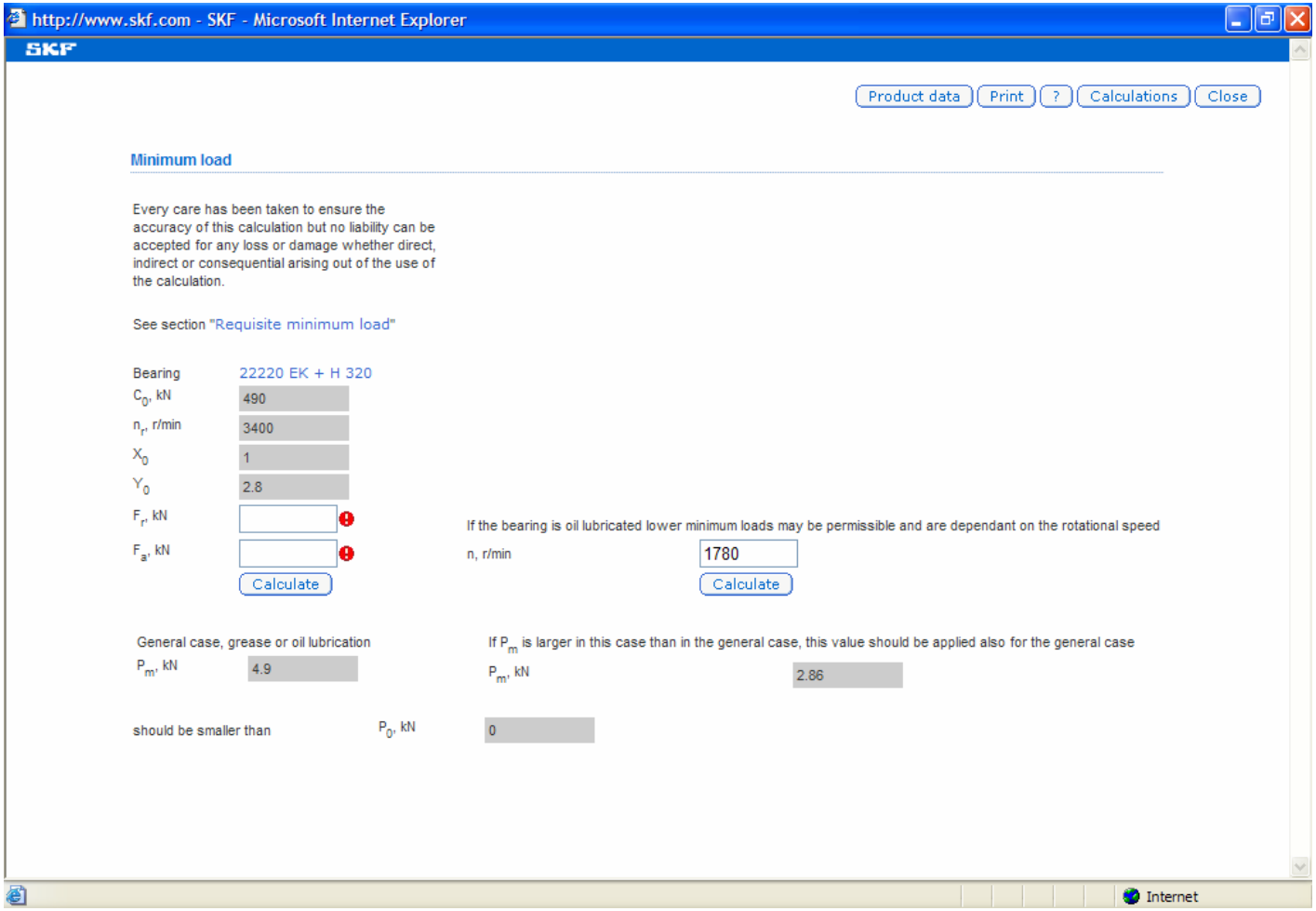
Minimum Loading

Minimum Load Calculation



Low Bearing Load – Smearing [“Skidding”]

Light loads

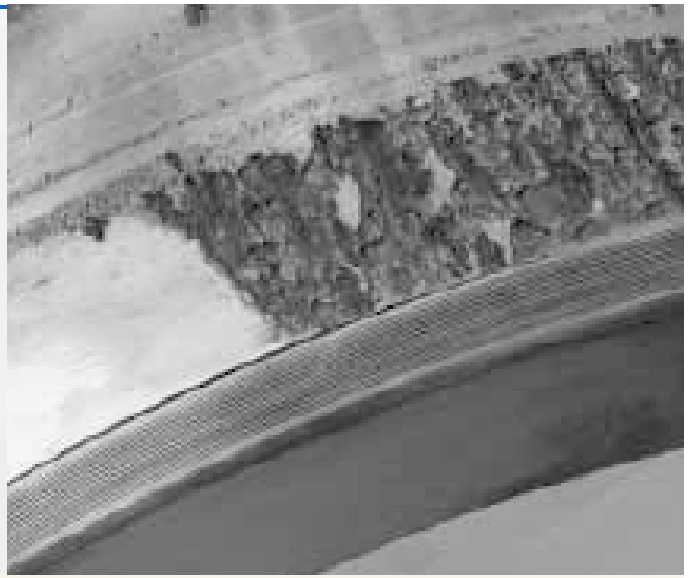
- Load zone [de-]acceleration

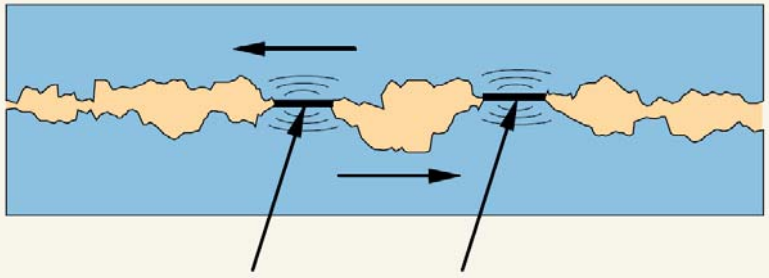
Normal loads

- Poor lubricant film

Most dangerous

- Progressive
- In older bearing designs





Welded material

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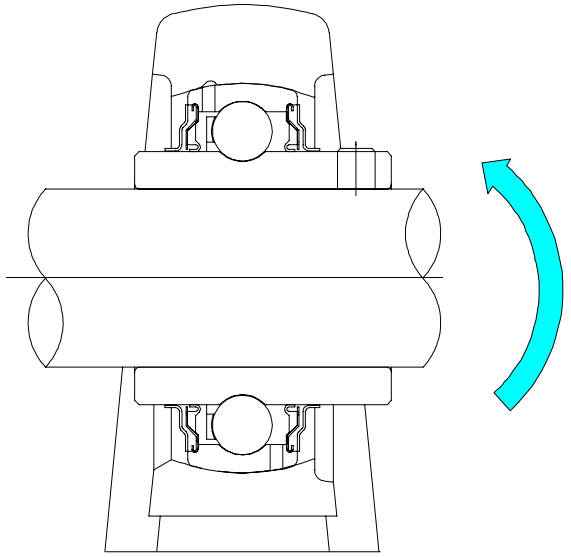
Special Air Handling (AH) Products

SY _ TF/AH - Alignment Torque

SKF AH Units:

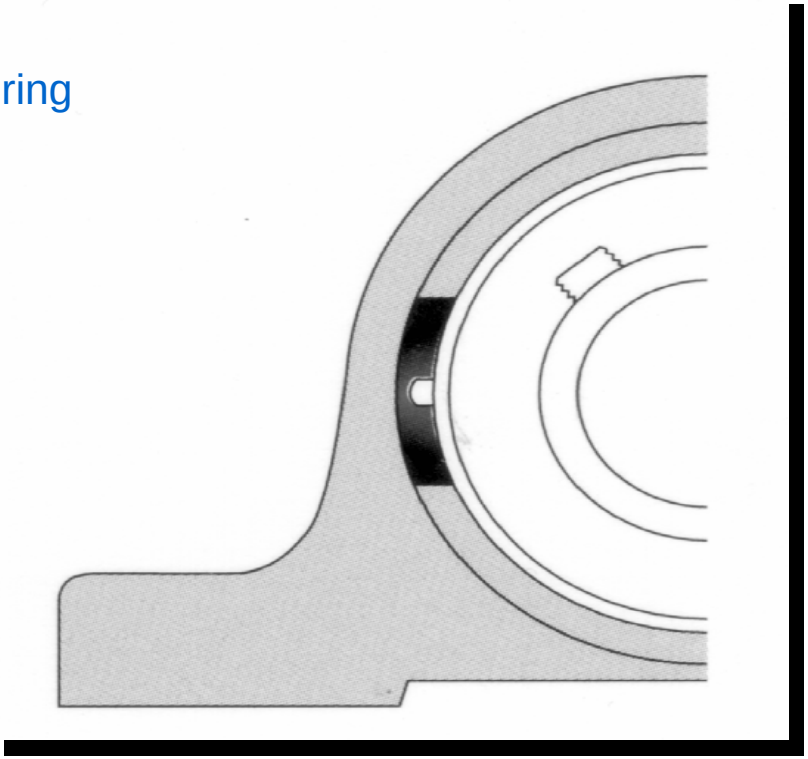
Low Alignment Torque

- Ensures bearings are properly aligned at setup
- reduces vibration
- Prevents distortion of base

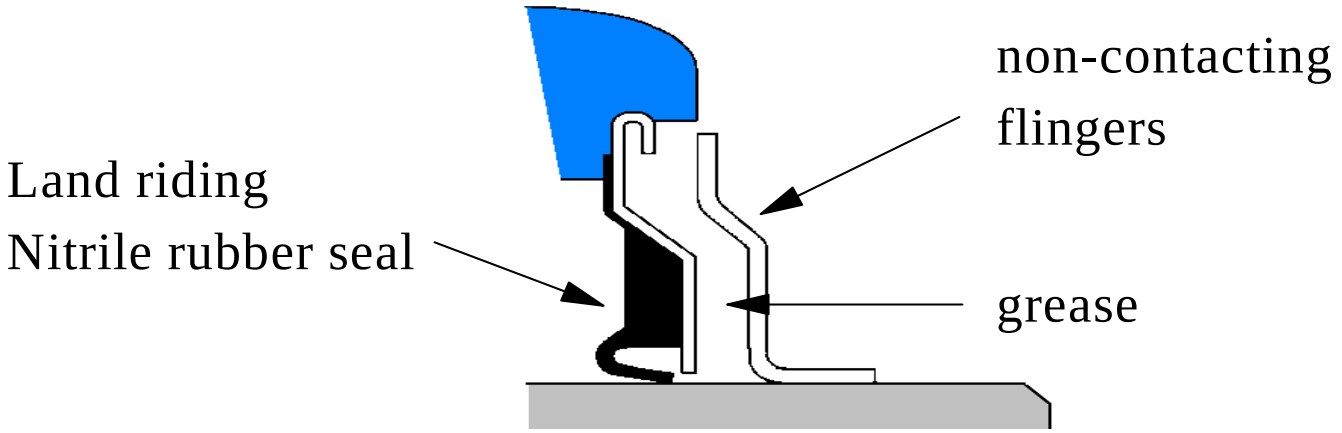


Anti-Rotation Mechanisms

- Used in SKF AH Units
- Anti-Rotation pin prevents outer ring rotation

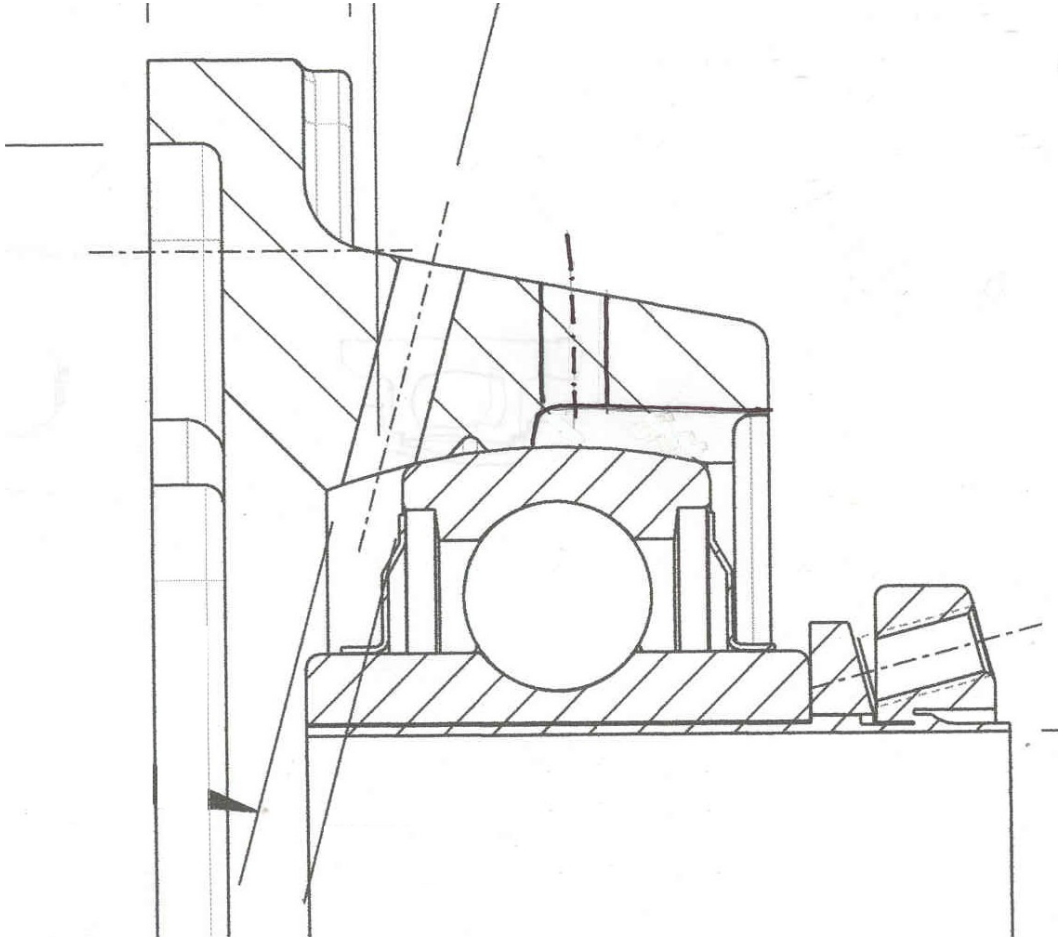


SY _ TF/AH - Grease and Sealing

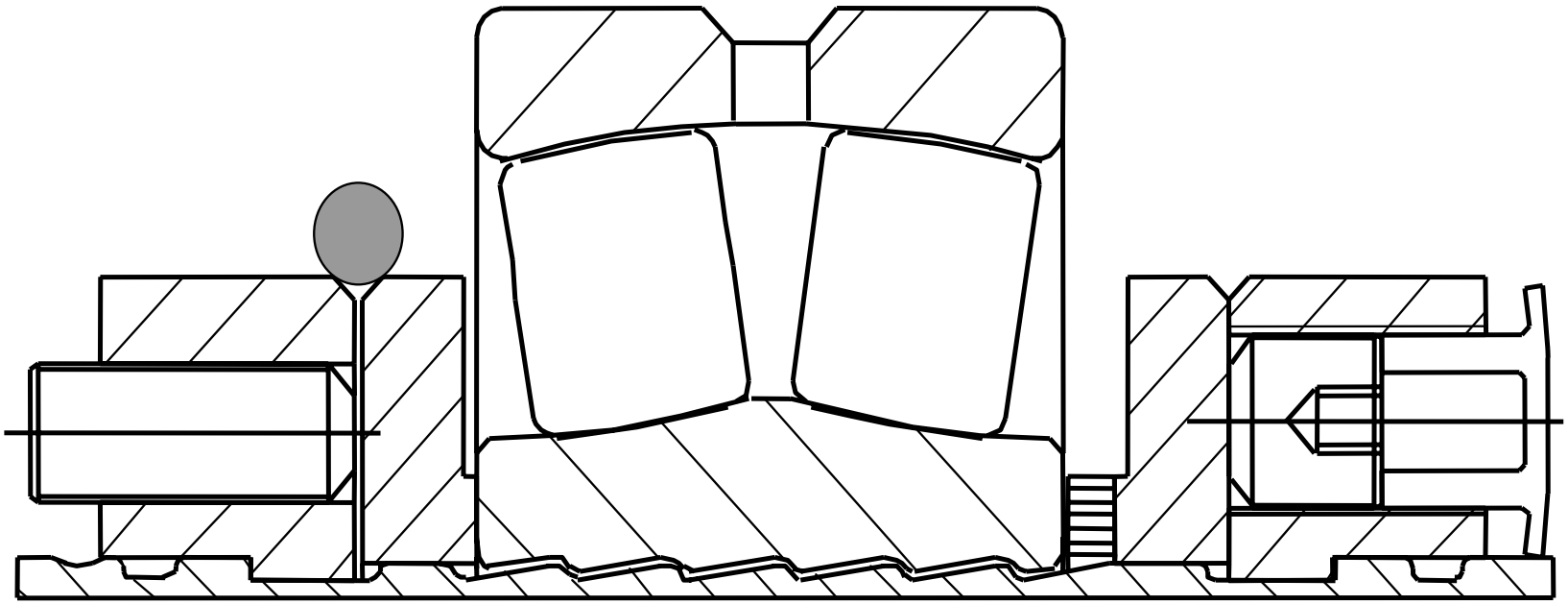


- Triple Protection Seal (TF suffix)
  - ✓ Low friction
  - ✓ High speed operation
  - ✓ Protection from contamination
- Special air handling quality grease:
  - ✓ Start-up capability of -34°C (-30°F)
  - ✓ Operating range: -17°C (0°F) to +100°C (212°F)
  - ✓ Good water resistance and rust protection

ConCentra Unit Ball

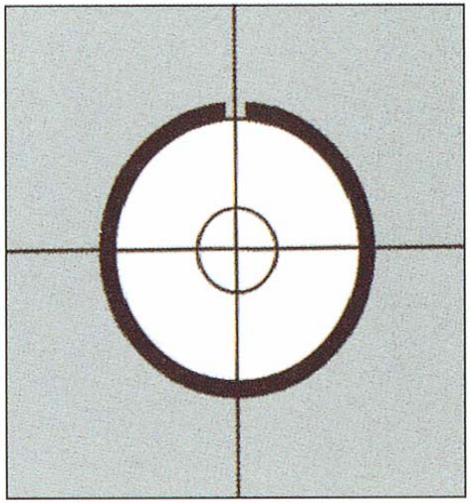


ConCentra Unit Roller

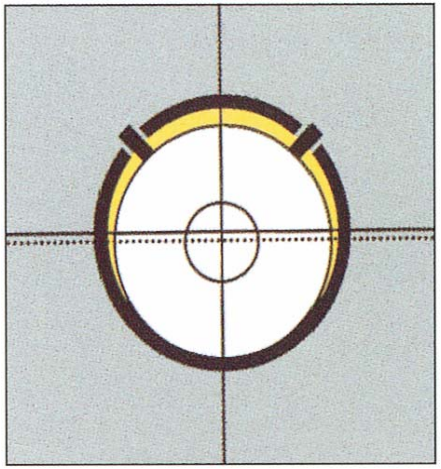


ConCentra vs. Eccentric Locking Collar

- ConCentra Mounting



- Eccentric Locking Collar

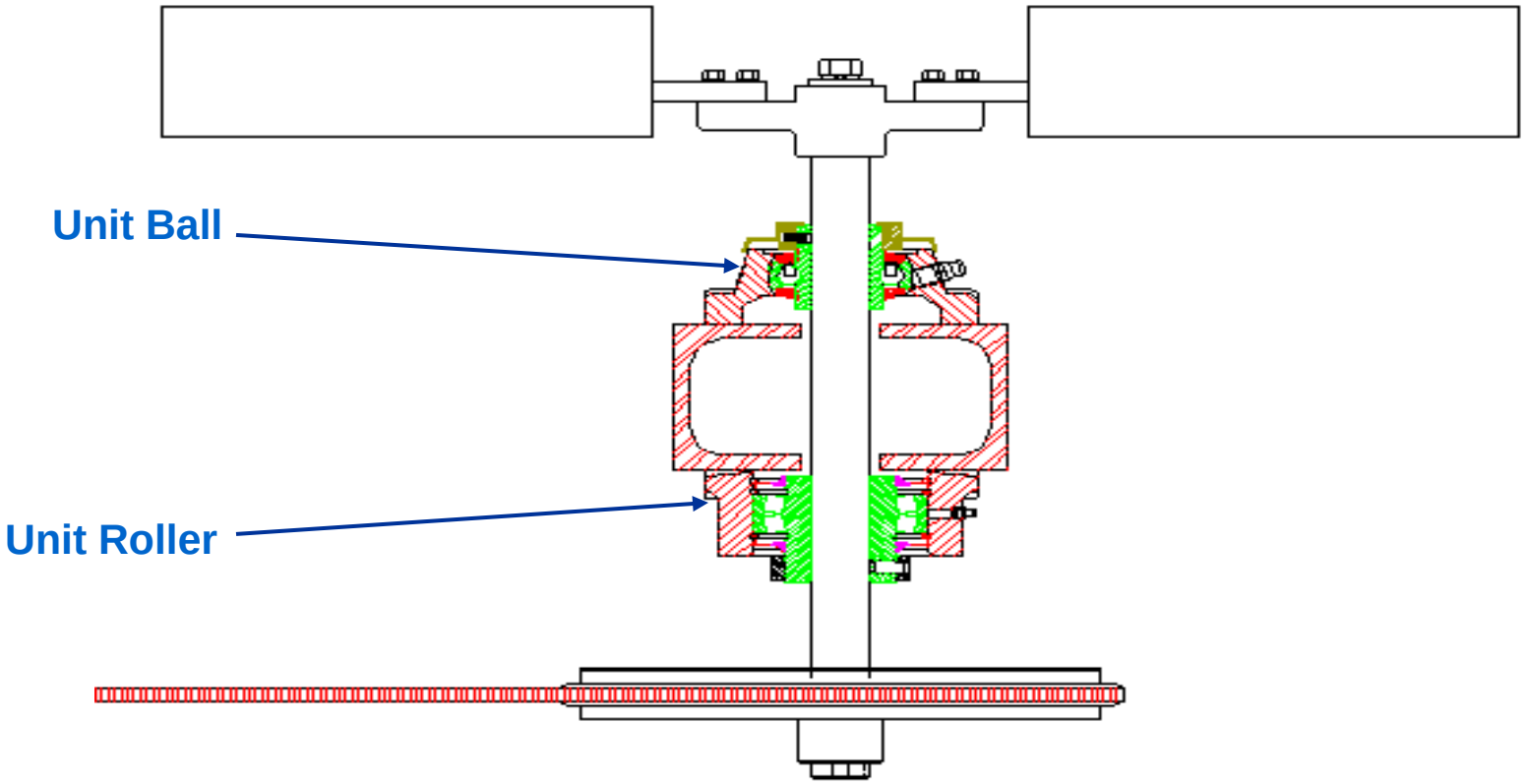


ConCentric Units

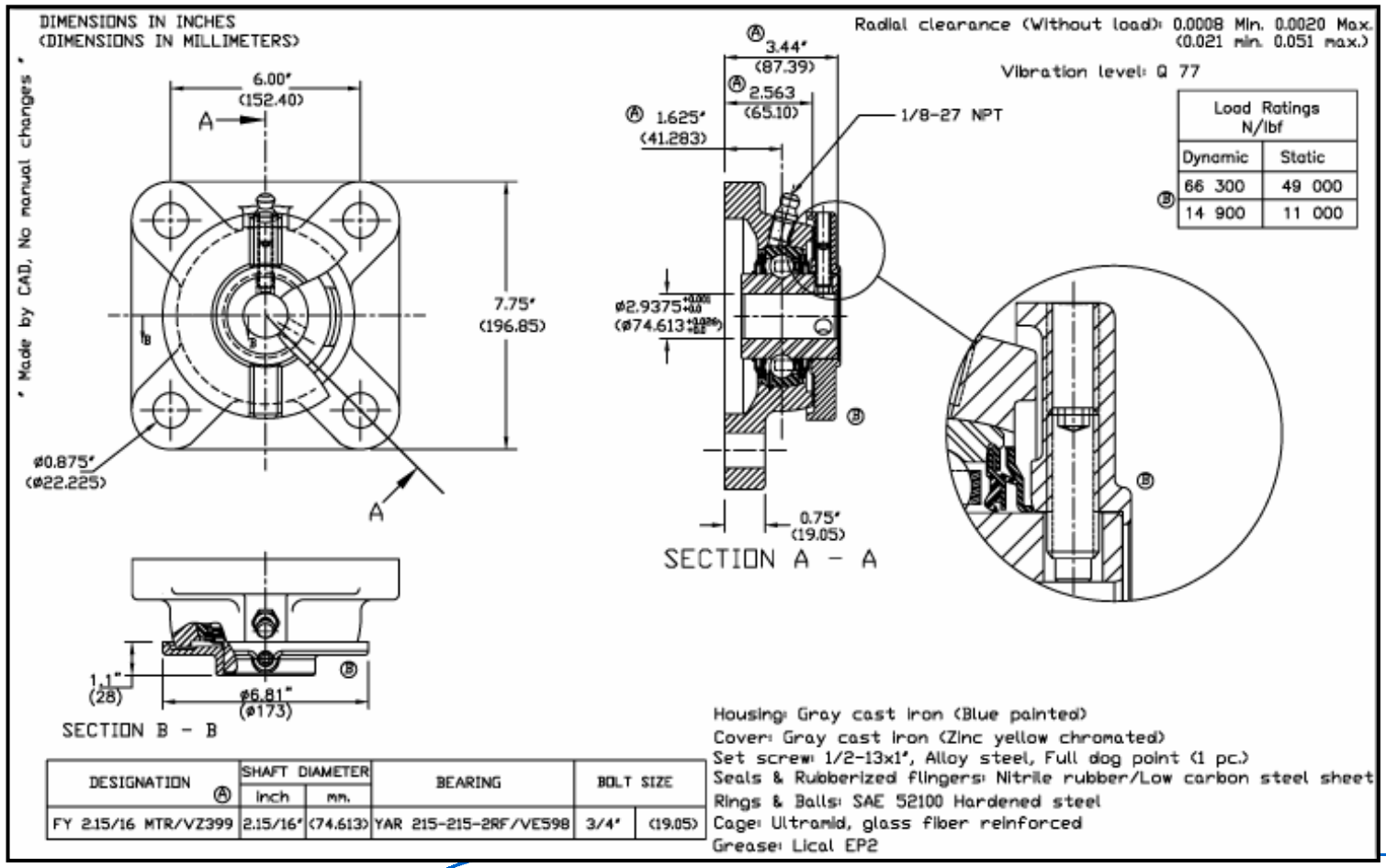
ConCentra combines many of the benefits of an adapter sleeve assembly with the convenience of unit roller products.

- Concentric, interference shaft fit mounting
- Ease of mounting and dismounting
- Pre-assembled and pre-lubricated
- Uses commercial grade shafting for lower total costs
- Directly interchangeable with competitive units

SKF Vertical Heat Exchange Fan Bearings Units



SKF Vertical Heat Exchange Fan Bearings Units



DESIGNATION Ⓐ	SHAFT DIAMETER		BEARING	BOLT SIZE	
	Inch	mm.			
FY 2.15/16 MTR/VZ399	2.15/16"	(74.613)	YAR 215-215-2RF/VE598	3/4"	(19.05)

Under Development

Features

Vertical shaft

- Two flange bearing (Unit Ball on top, Unit Roller below)
- Fan above the bearing arrangement with belt drive below

Two designs

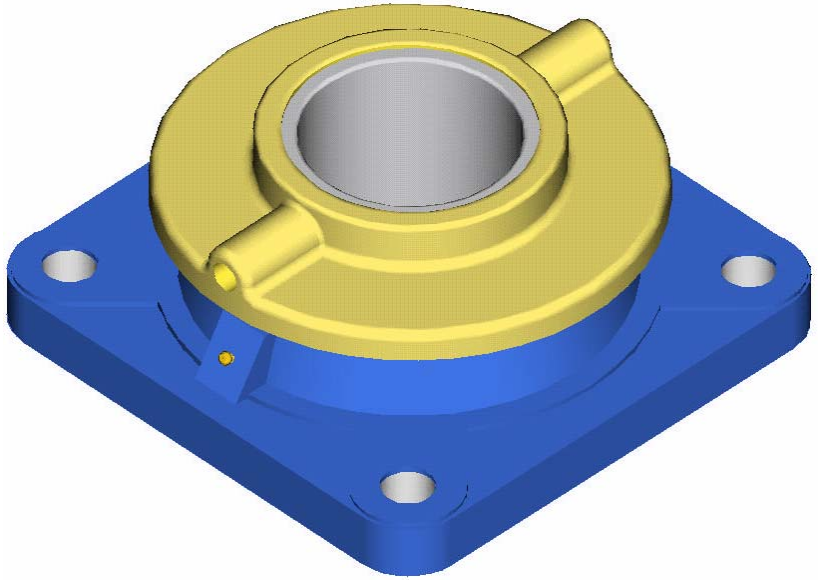
- Induced draft (fan above heat exchanger)
- Forced draft (fan below heat exchanger)

Low speed, typically 300-500 rpm

Low load

- Majority is belt load
- Light thrust load

High Temperature (200 F +)



Under Development

Competitors

Hudson Products Corporation

Trademarked product as the Fin-Fan bearing

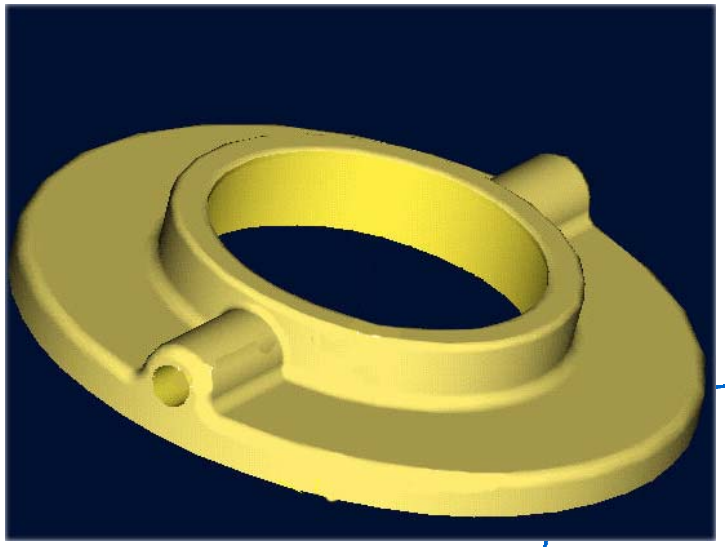
Nomenclature:

- unit roller - item 50080
- unit ball - item 50081

Link-Belt

Nomenclature:

- unit ball - BS226971
- unit roller - BS226857



Dodge

Nomenclature:

- unit ball - SC and SCM series
- unit roller - Type E series

SKF

Nomenclature:

- unit ball –
  - FY 2-7/16 TR/VZ752
  - FY 2-15/16 TR/VZ399
- unit roller –
  - FYE 2-7/16 -3H
  - FYE 2-15/16 -3H

Features

- Unit Ball:
  - multifunction seal, SKF LGEP2 grease (lithium-calcium complex) and zinc-coated cover plate for a longer service life
  - special grub screws allow the bearing to move axially on the shaft - serves as the floating bearing in the arrangement

- Unit Roller:
  - a high quality SKF CC design spherical roller bearing in a 'Held' design to allow support of axial loads
  - SKF LGEP2 (lithium-calcium complex) grease and an optimized garter spring seal design for a longer service life
  - drain holes designed into the housing face to prevent the accumulation of water and debris against the insert bearing.

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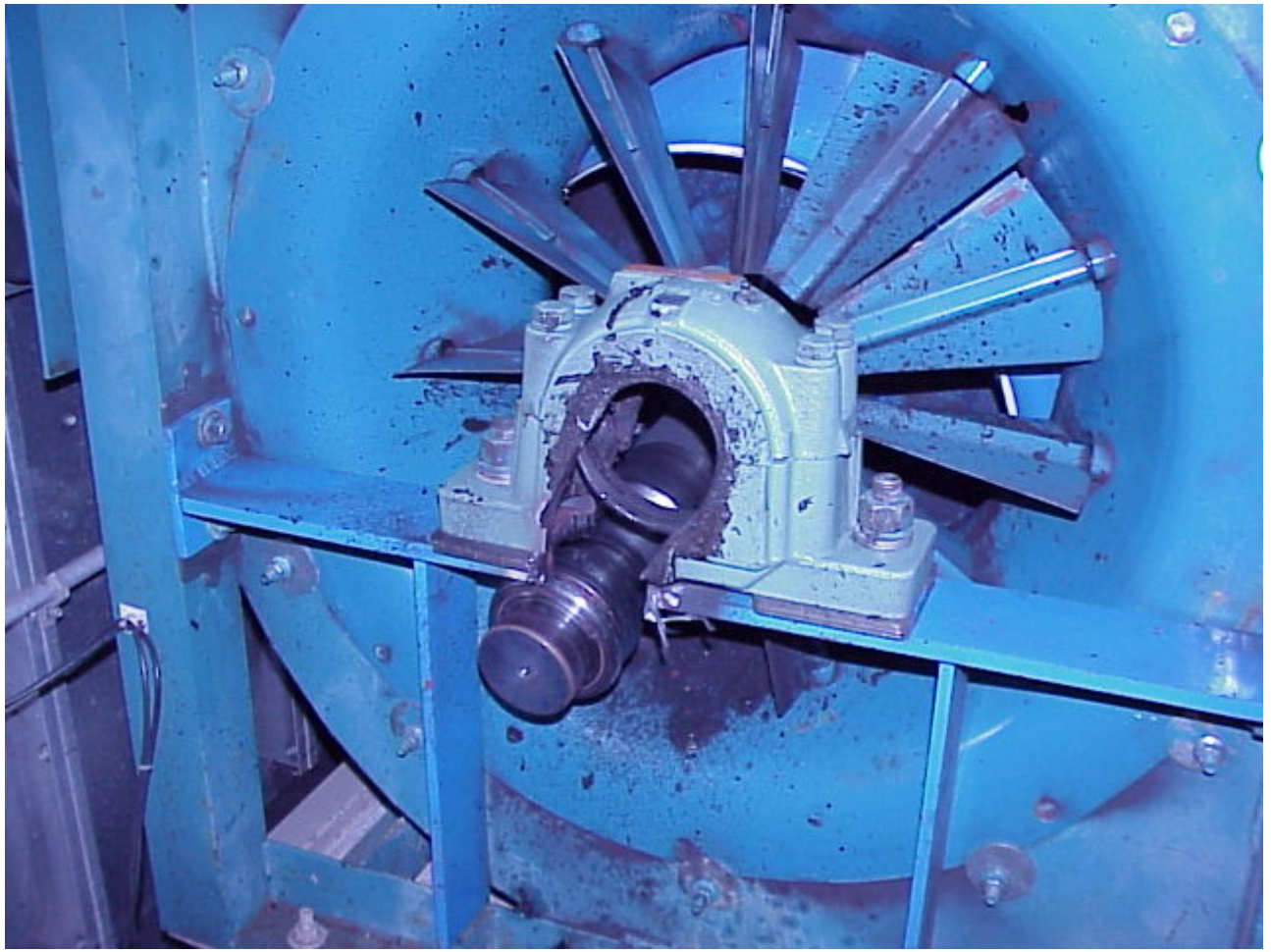
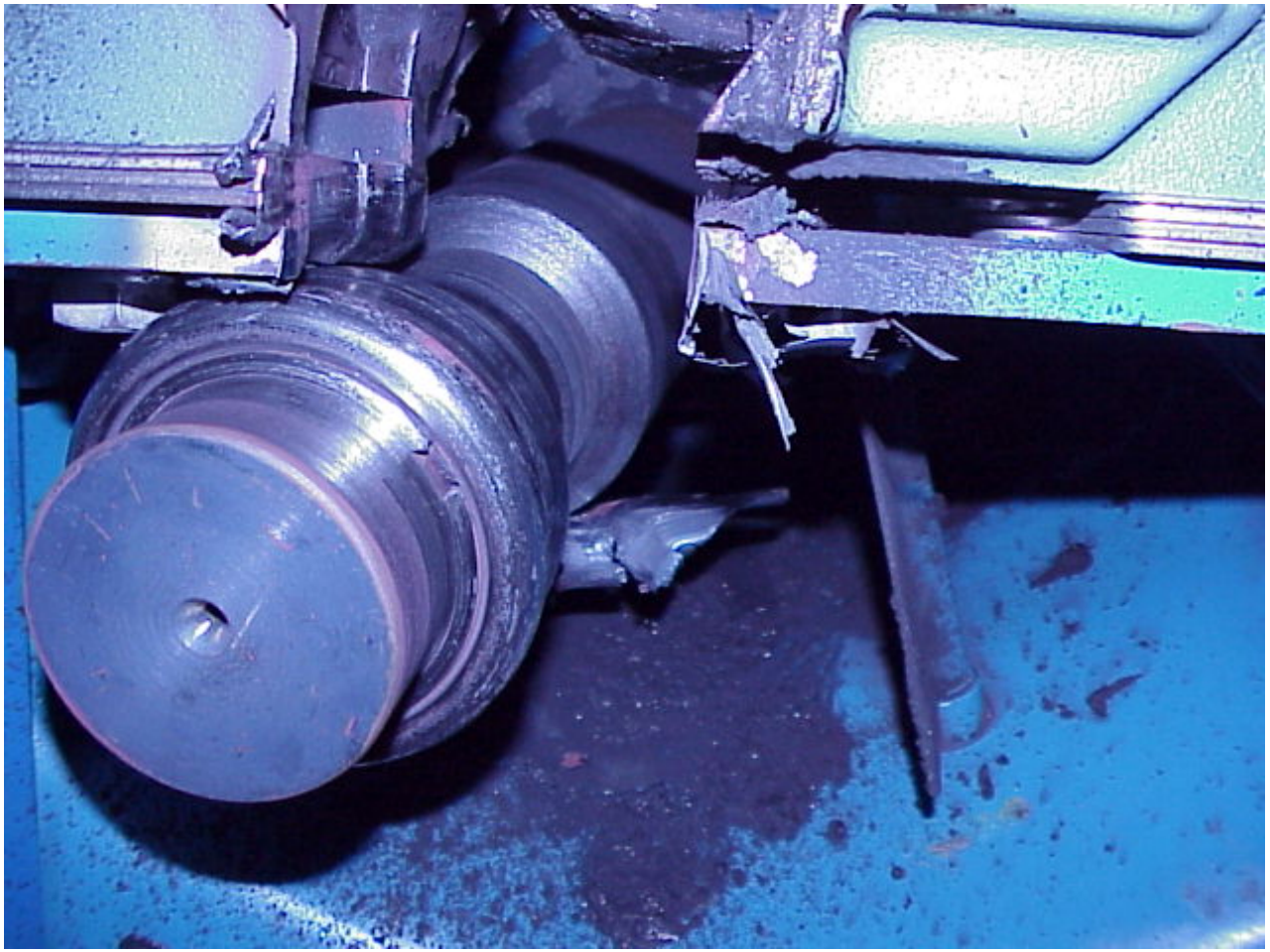
What We Are Trying to Avoid!!!

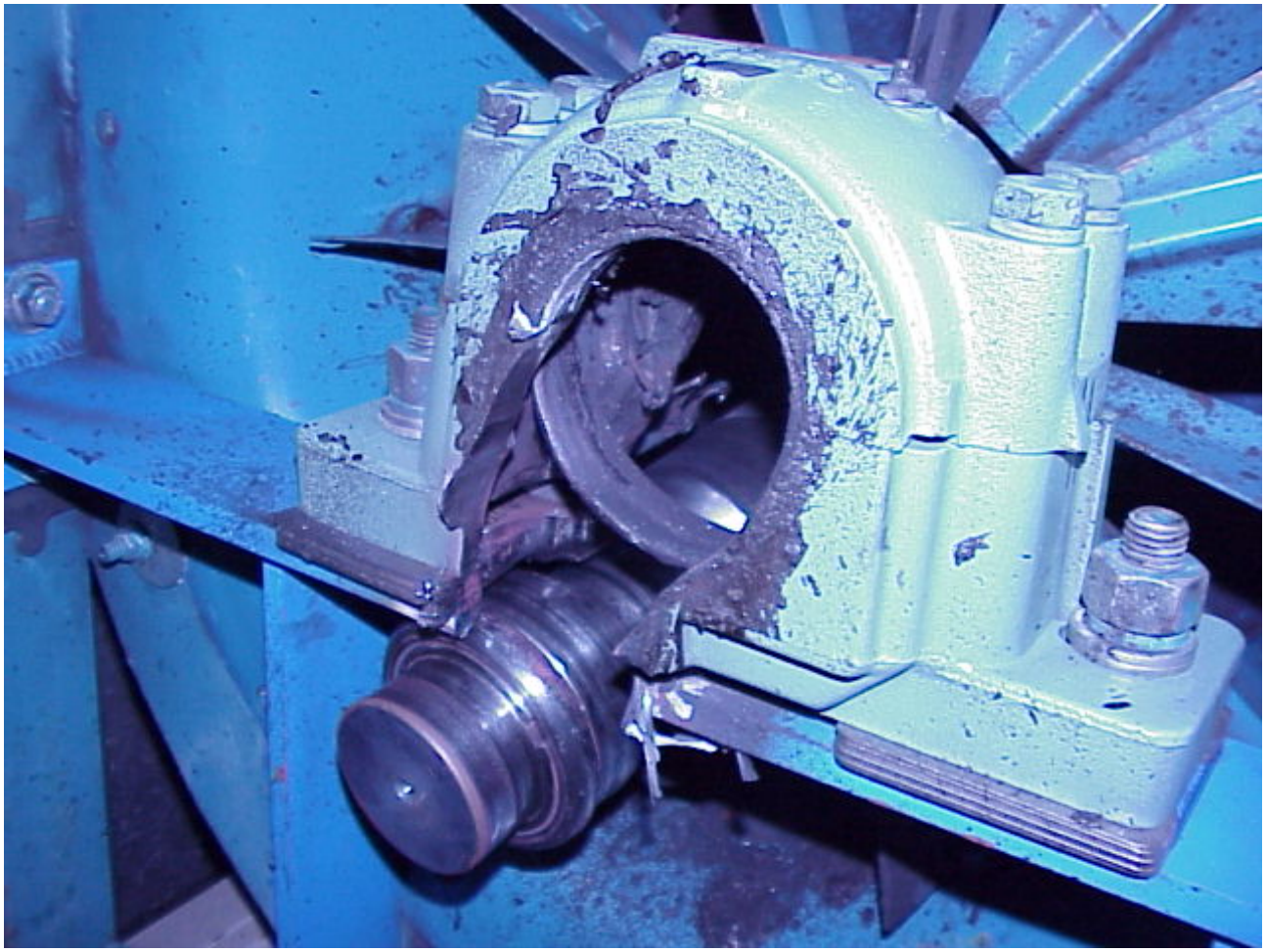
Catastrophic Failure



Catastrophic Failure



Catastrophic Failure



Questions???