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The word "DODGE" is written in a bold, white, sans-serif font. The letter "O" is replaced by a white diamond shape with a vertical gradient, transitioning from light to dark. The background of the slide is a dark blue with a repeating pattern of light blue gear teeth.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings



Brad Droegmiller

Dodge Industrial

Senior Territory Manager



The word "DODGE" is written in a bold, white, sans-serif font. The letter "O" is replaced by a white diamond shape with a vertical gradient, transitioning from light to dark. The background of the slide is a dark blue with a repeating pattern of light blue gear teeth.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Agenda

How to Select a Bearing

- Bearing Types
- Shaft Attachments
- Sealing Systems

How to Maintain Bearings

- Lubrication
- Best Practices
- Troubleshooting
- Monitoring

How to Guard Bearings & Shafts

- At Risk Areas
- Guard Designs

Conclusion

- Questions



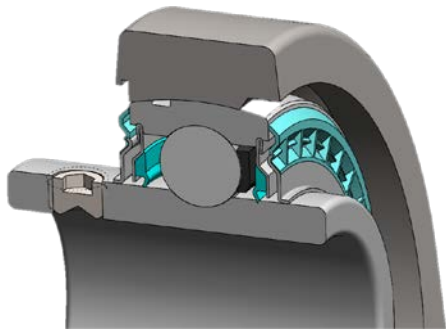
Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

How to select the proper bearing.

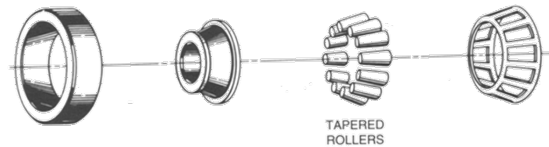
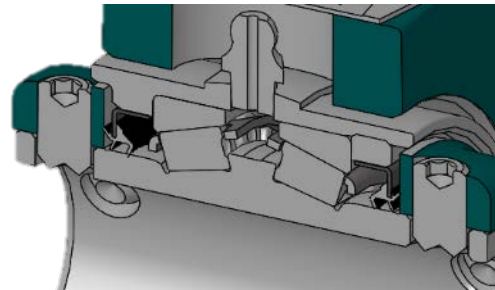
Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Typical bearing classifications used in the grain industry

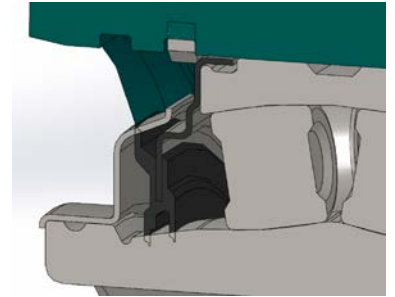
Bearings classified by their rolling element



Ball Bearings



Tapered Roller Bearings



Spherical Roller Bearings

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Selection Factors



Load & Speed

- Operating Speed
- L10 Life (Equivalent Radial Load)
- Minimum Load
- Axial Load Limits
- Shaft Size

Environment

- Wet/Dry Contamination
- Chemical Exposure
- High/Low Temperature
- Seal Options/End Covers

System Mechanics

- Static/Dynamic Misalignment
- Shaft Expansion
- Vibration
- Eccentric Loading

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Load Types

Radial

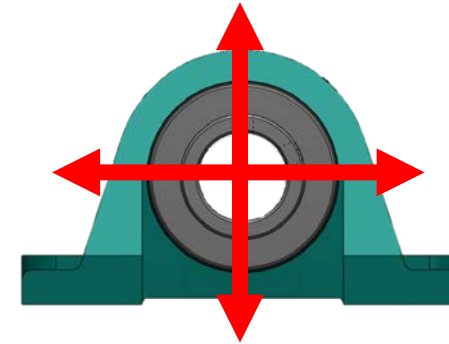
- Applies force perpendicular to the shaft

Axial (Thrust)

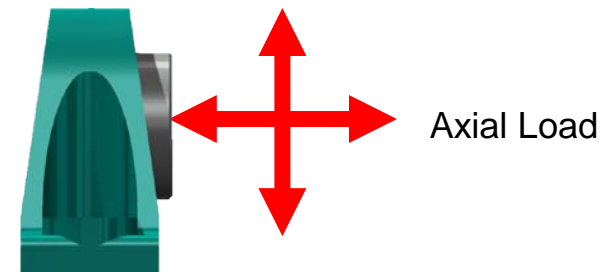
- Applies force parallel to the shaft

Bearing Loads can be created by:

- Weight
- Belt Tension
- Fan Pressure
- Any linear or rotational load on the shaft



Radial Load



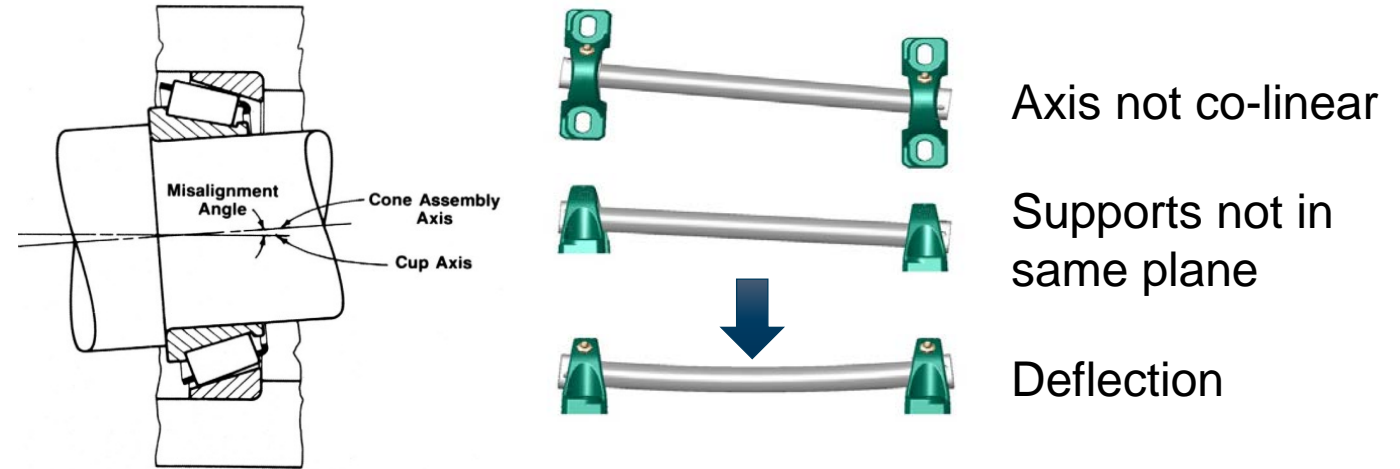
Radial Load

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Types of Misalignment

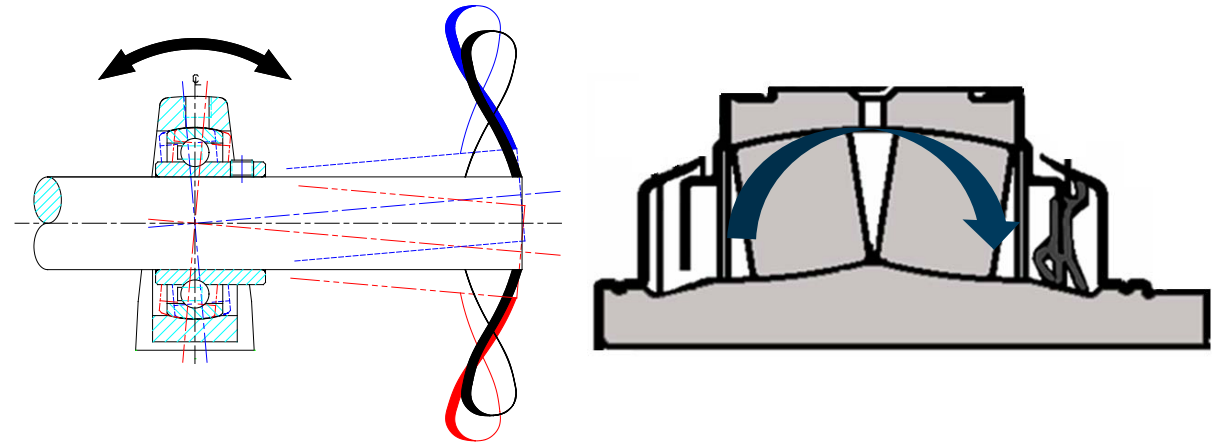
Static Misalignment

- Direction of Misalignment stays constant



Dynamic Misalignment

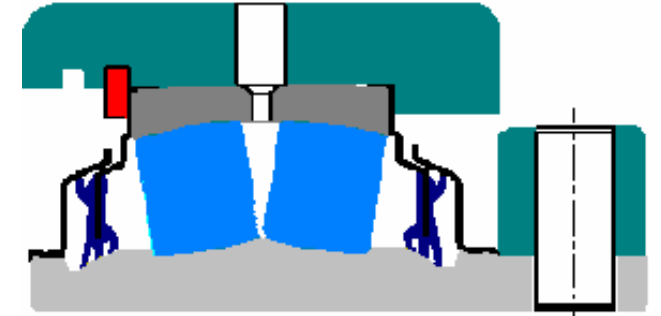
- Direction of Misalignment changes as shaft spins



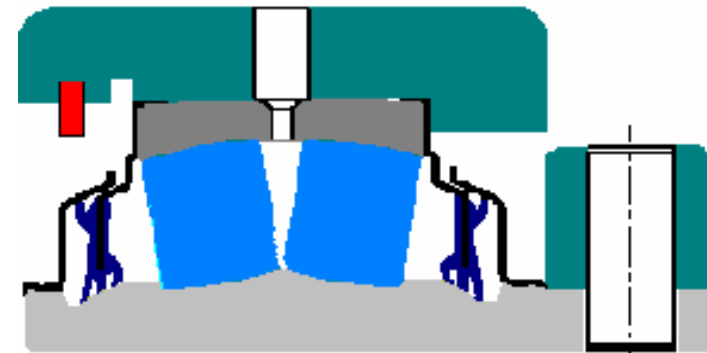
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Expansion of Shafting

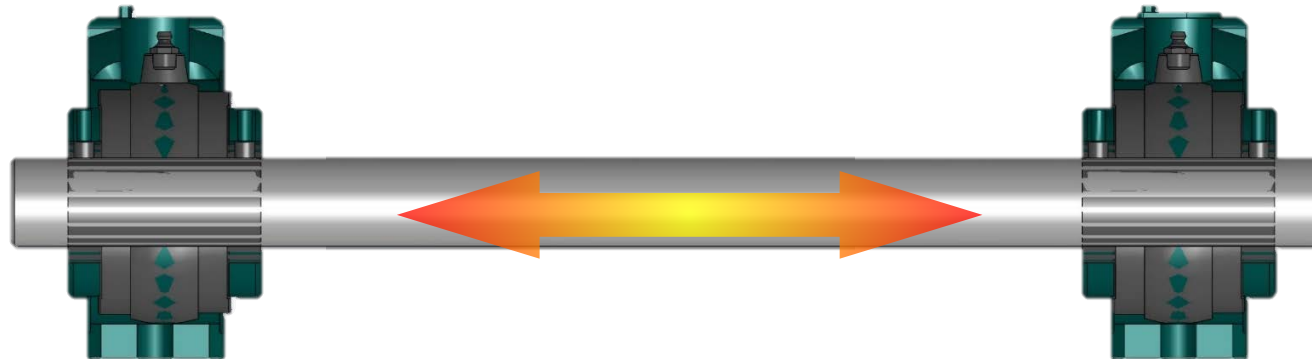
- Expansion bearing moves with shaft and prevents axial load
- Must always have fixed bearing
- Typically, fixed bearing on drive end
- Steel mounting surface will expand with shaft



Non-expansion (fixed)



Expansion (float)









Float/Exp.

Fixed/Non-Exp.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

General Bearing Comparisons

| | <u>Ball</u> | <u>Tapered</u> | <u>Spherical</u> |
|-----------------------|---|---|--|
| Speeds | High | Med (~70% of B.B. Speeds) | Med – High |
| Typical Load Capacity | 1X | 3X | 3.5X |
| Radial Loads | Low | Med – High | High |
| Thrust Loads | Low - Med | Med | Low – Med ($F_r > F_a$) |
| Static Misalignment | +/- 2° (Insert Relative to Housing) | Insert Relative to Housing | +/- 2° (Less with Seal Considerations) |
| Dynamic Misalignment | None | None | +/- 2° |
| Temperature Range | -40°F to 220°F (High temp available to 400°C) | | |
| Expansion Capability | Select PB Only | Yes, Except Type E | Yes |
| Mounting Methods | Setscrew, Eccentric, D-Lok, Adapter | Setscrew, Clamp Collar, Adapter | Setscrew, Adapter, Direct |
| Shaft Size Range | 17mm – 85mm | 35mm – 180mm (up to 300mm special) | 35mm – 140mm (up to 630mm special) |
| Roller Shape | Ball  | Tapered (Conical)  | Spherical (Crowned Barrel)  |
| Raceway Contact Shape | Point  | Line  | Elliptical  |

Comparison Radial Load 2 15/16”

Ball 3,325 LB

Tapered 11,120 LB

Spherical 10,759 LB

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Ball Bearing

Characteristics:

- Light-Medium Loads
- Low-High Speeds
- Pure Radial Load
- Pure Thrust Load
- Combination Loads
- No Minimum Load
- Static Misalignment



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Tapered Roller Bearing

Characteristics:

- Medium-Heavy Loads
- Low-High Speeds
- Pure Radial Load
- Pure Thrust Load
- Combination Loads
- No Minimum Load
- Static Misalignment



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Spherical Roller Bearing

Characteristics:

- Medium-Heavy Loads
- Low-High Speeds
- Radial \geq Axial
- Static/Dynamic Misalignment



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

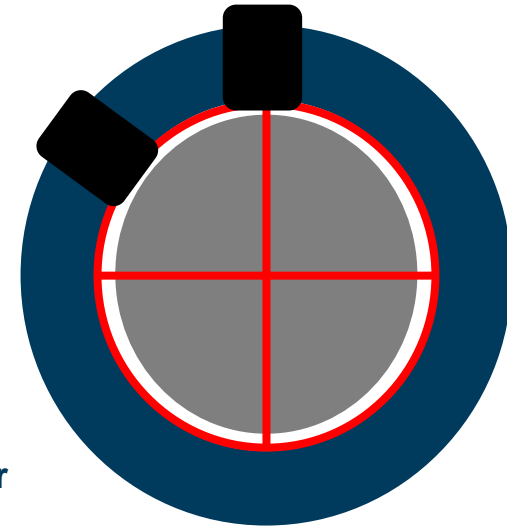
Set Screws

Advantages

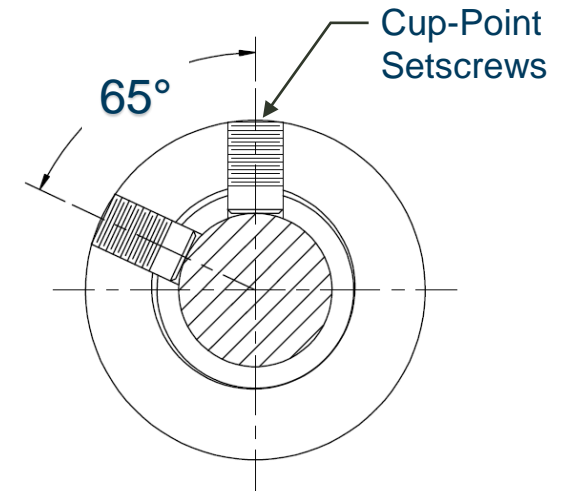
- Highest Holding Power
- Simple Installation

Disadvantages

- Lower Speed Capacity
- Damages Shaft Surface
- Eccentric Hold (Creates Vibration)
- Tight Shaft Tolerances
- Difficult to Remove (Fretting)



Bore
Collar
Shaft
Setscrews



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

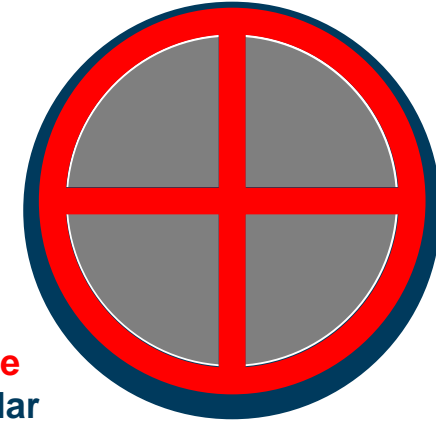
Eccentric Collar

Advantages

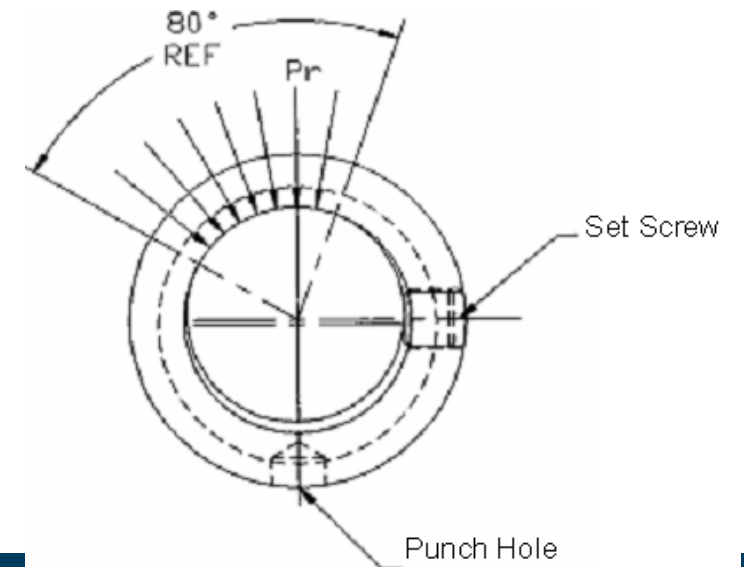
- Simple Installation

Disadvantages

- Lowest Holding Power
- Lower Speed Capacity
- Unidirectional rotation only
- Eccentric Hold (Creates Vibration)
- Tight Shaft Tolerances
- Difficult to Remove (Fretting)



Bore
Collar
Shaft



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

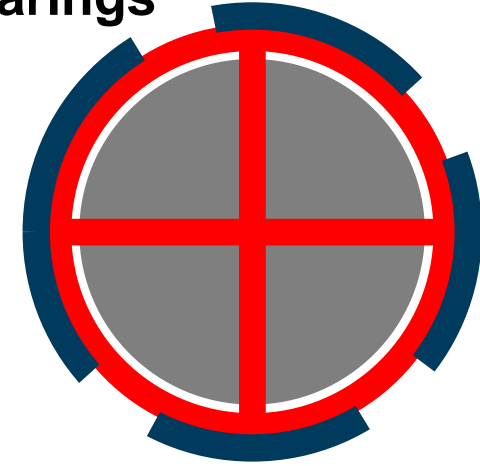
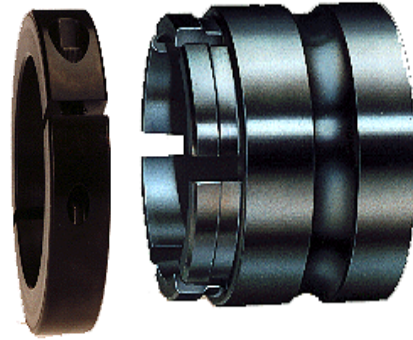
Concentric Collar

Advantages

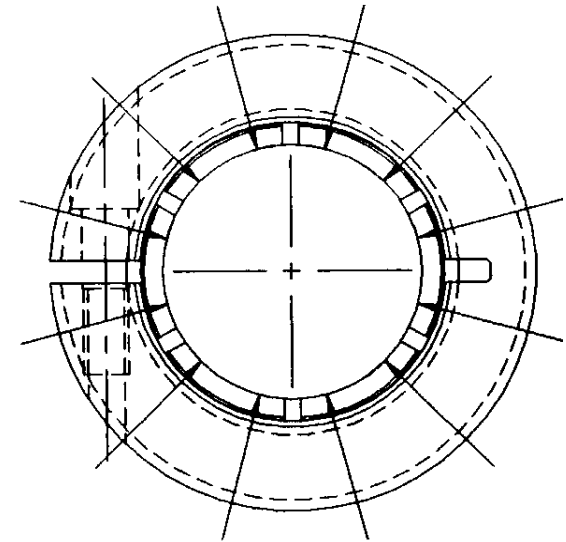
- Simple Installation
- Minimal Shaft Damage
- Concentric Hold (Less Vibration)
- Higher Speed Capacity
- Moderate Holding Power

Disadvantages

- Difficult to Remove (Fretting)
- Tight Shaft Tolerances



Bore
Tabs
Shaft



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

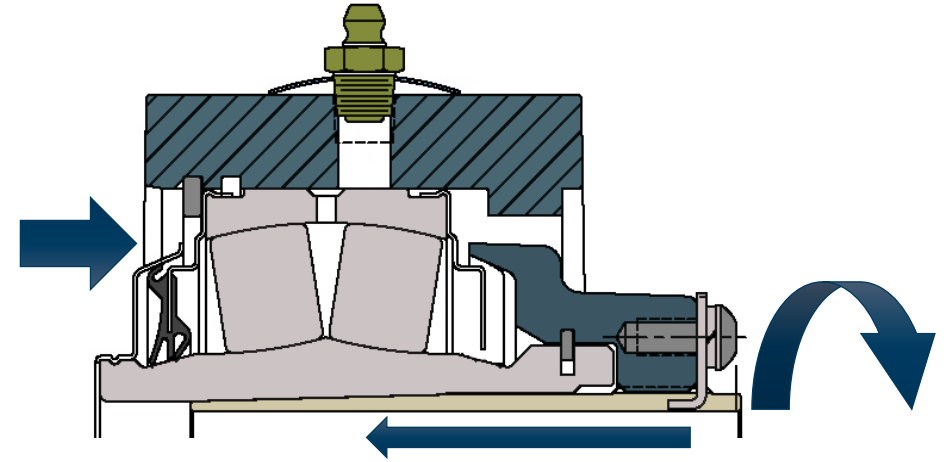
Adapter Sleeve

Advantages

- Moderate Holding Power
- Highest Speed Capacity
- No Shaft Damage
- Concentric Hold (Least Vibration)
- Stock Shafting Tolerances
- Easily Removed

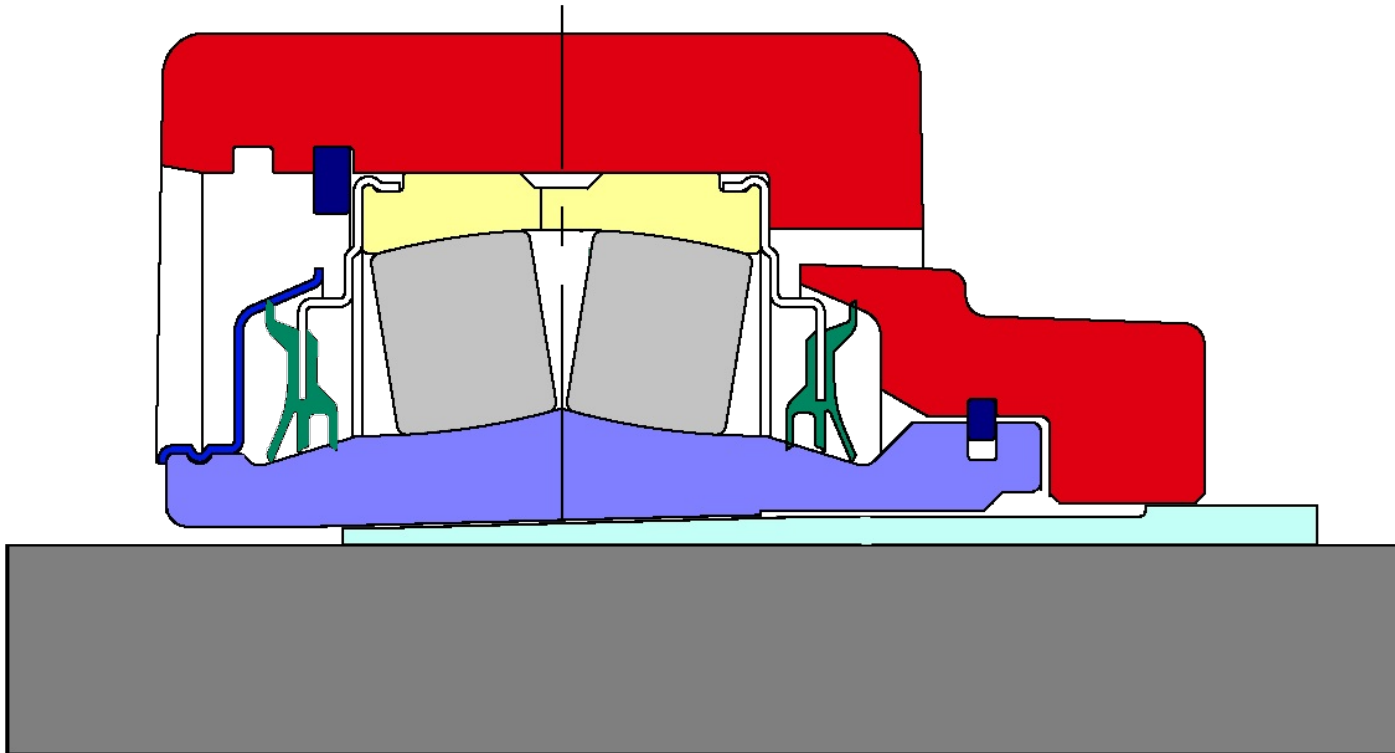
Disadvantages

- More Complex Installation
- Weight must be removed from shaft during installation



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

How the Imperial Adapter Works





- Weight must be removed from shaft to avoid preloading
- Use spanner wrench or drift and hammer to apply final rotations from instruction manual
- Locknut is tightened by hand to zero reference point – no clearance is left between shaft, sleeve, and tapered bore inner ring


Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Shaft Attachment Comparison

| Category | Setscrew | Eccentric Collar | Concentric Collar | Adapter |
|----------------------|----------|------------------|-------------------|----------|
| Holding Power | Best | Worst | Moderate | Moderate |
| Speed Capacity | Worst | Worst | Moderate | Best |
| Vibration | Worst | Worst | Moderate | Best |
| Ease of Installation | Moderate | Best | Moderate | Worst |
| Ease of Removal | Worst | Moderate | Moderate | Best |
| Damage to Shaft | Worst | Moderate | Moderate | Best |
| Shaft Tolerances | Worst | Worst | Worst | Best |

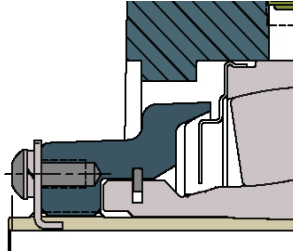
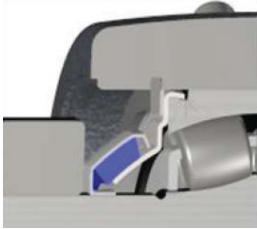
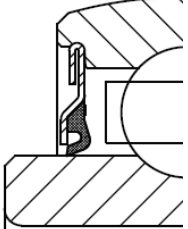
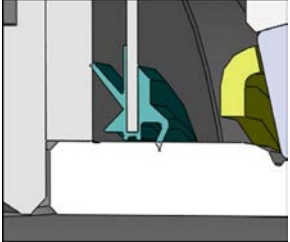
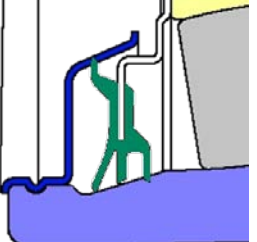
 = Best

 = Moderate

 = Worst

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Sealing Systems

| | Labyrinth | Single Lip Felt | Single Lip | Triple Lip | Combination |
|---------------------|---|--|---|---|---|
| |  |  |  |  |  |
| High speed | **** | ** | *** | ** | ** |
| Water resistance | * | * | ** | *** | *** |
| Solid contamination | * | **** | ** | *** | **** |

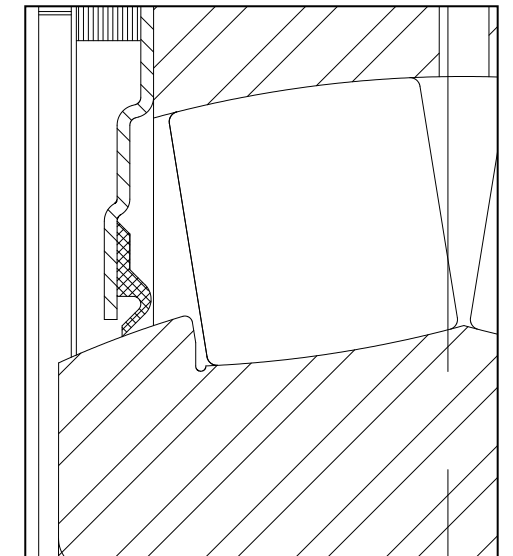
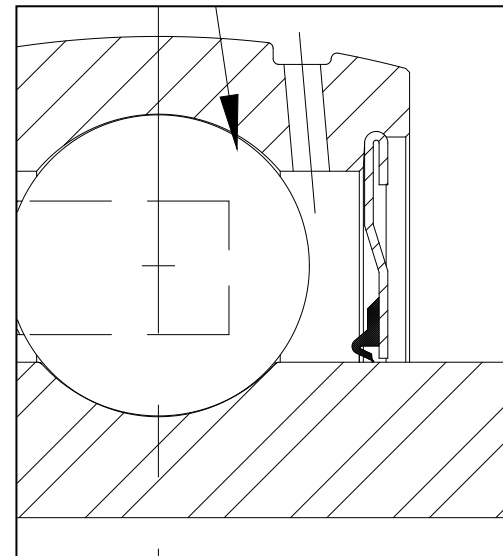
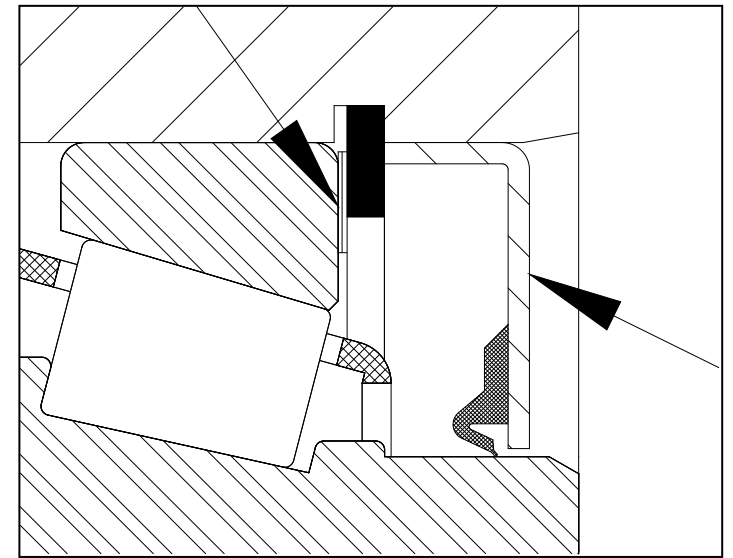
Guide: **** = best * = worst

Best Practice: Seal material and quantity of lips can impact performance. Combination seals provide best protection.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Contact Seals

- Makes direct contact
- Most common type
- Rubber Lip forms one-way valve
- Moderate Speeds
- Moderate Temperatures
- Harsh Environments



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Clearance Seals

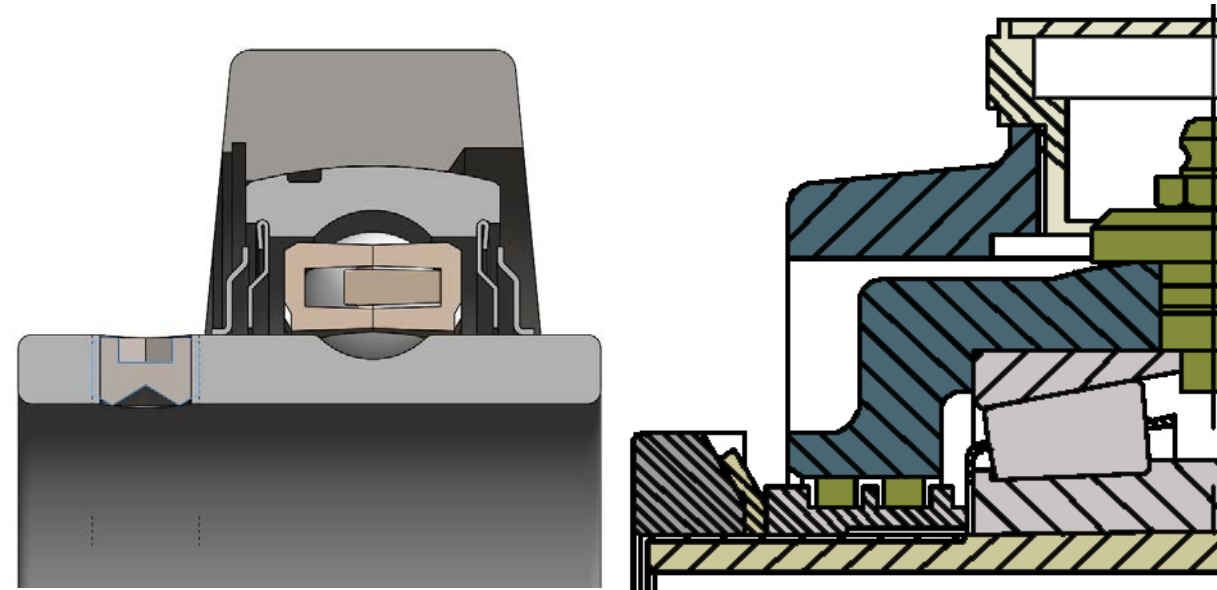
Obstructs particle entry with

- Labyrinth maze
- Grease dam

Higher Speeds

Higher Temperature

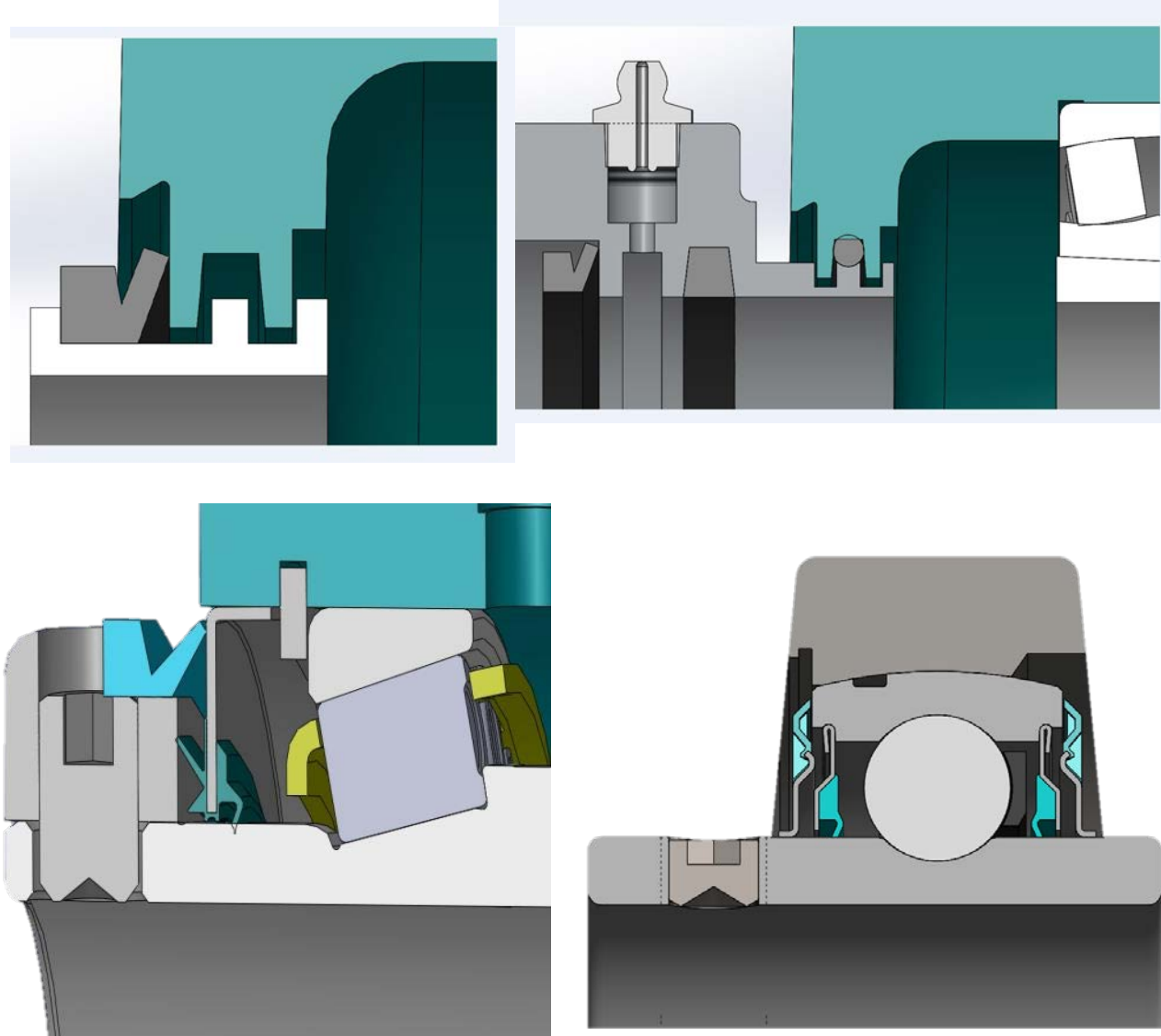
Low Drag



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Combination Seals

- Combines Contact Seals with Labyrinth and Grease Dam
- Most effective sealing
- Moderate Speeds
- Moderate Temperatures
- Washdown and Dusty Environments



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

How to maintain bearings.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Purpose of Lubrication

1. Reduces Friction

- Separates mating surfaces
- Prevents metal-on-metal contact
- Reduces wear and heat

2. Protects Against Contamination

- Grease “dam” forms in seals
- Circulating oil continuously cleans

3. *Removes Excess Heat

- Circulating oil with heat exchanger
- *For SAF and Sleeveoil bearings



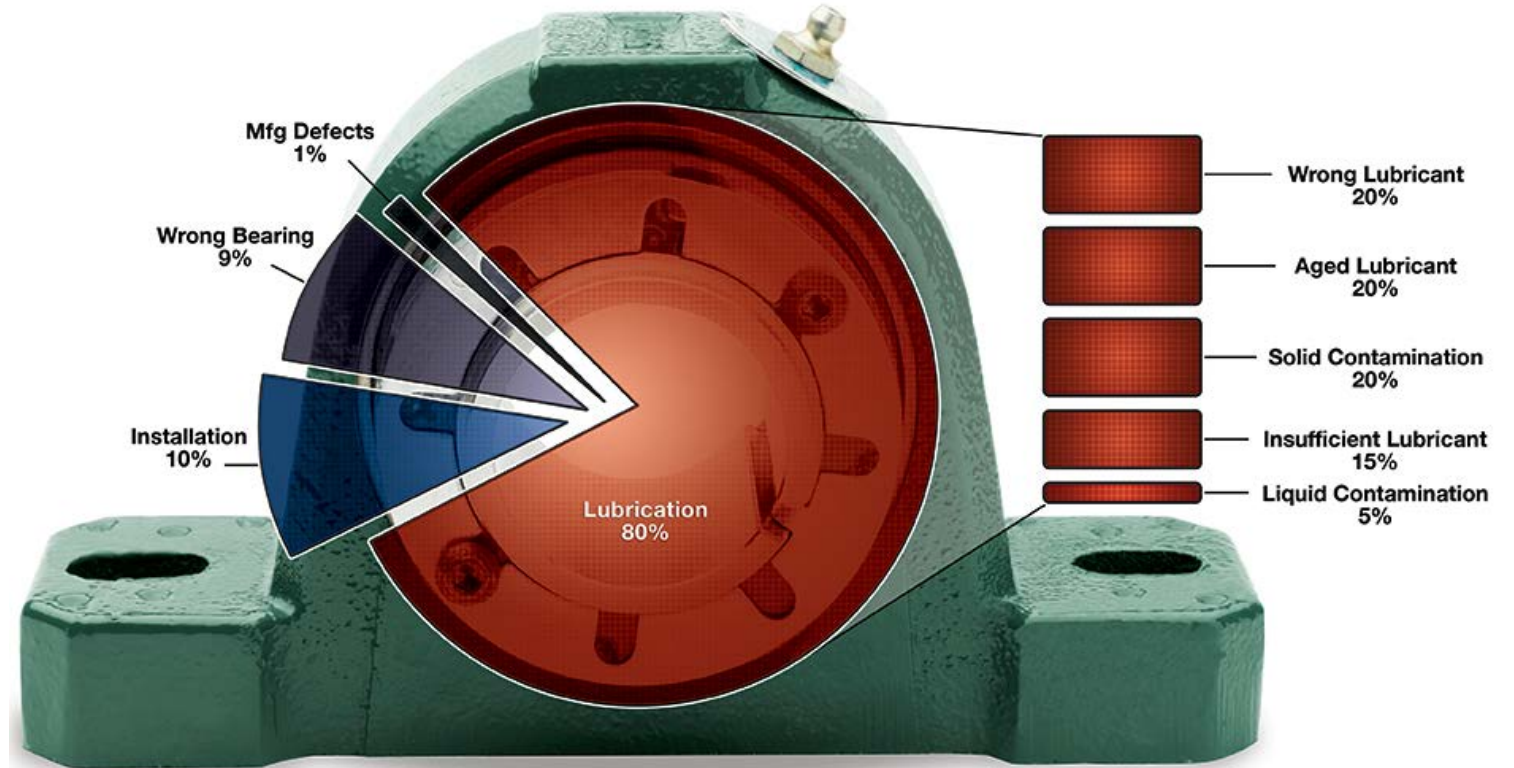
Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Why is Lubrication Important?

About 80% of all bearing failures are due to lubrication

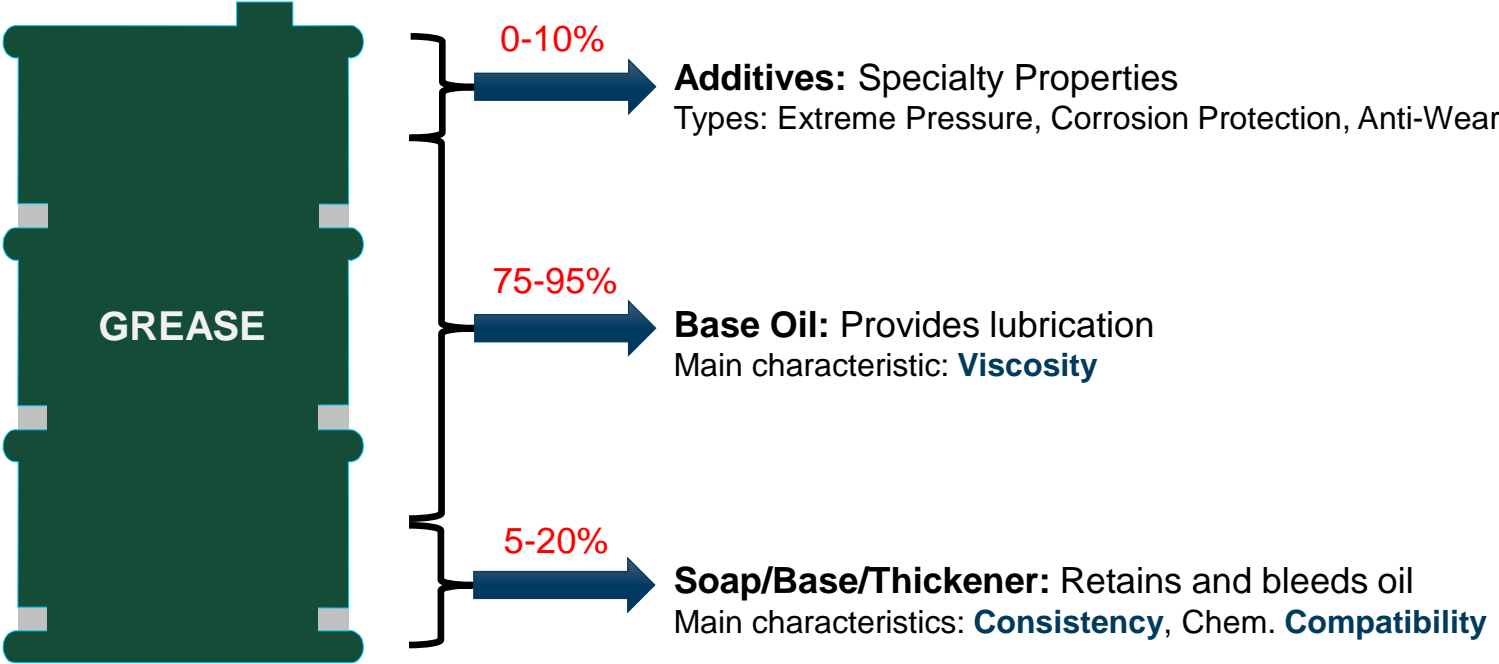
Main contributors:

- Wrong Lubricant (20%)
- Aged Lubricant (20%)
- Insufficient Lubrication (15%)
- Solid Contamination (20%)
- Liquid Contamination (5%)



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

What is Grease?



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Grease Consistency

Consistency – Hardness of soap

Specified by NLGI number
(National Lubrication Grease Institute)

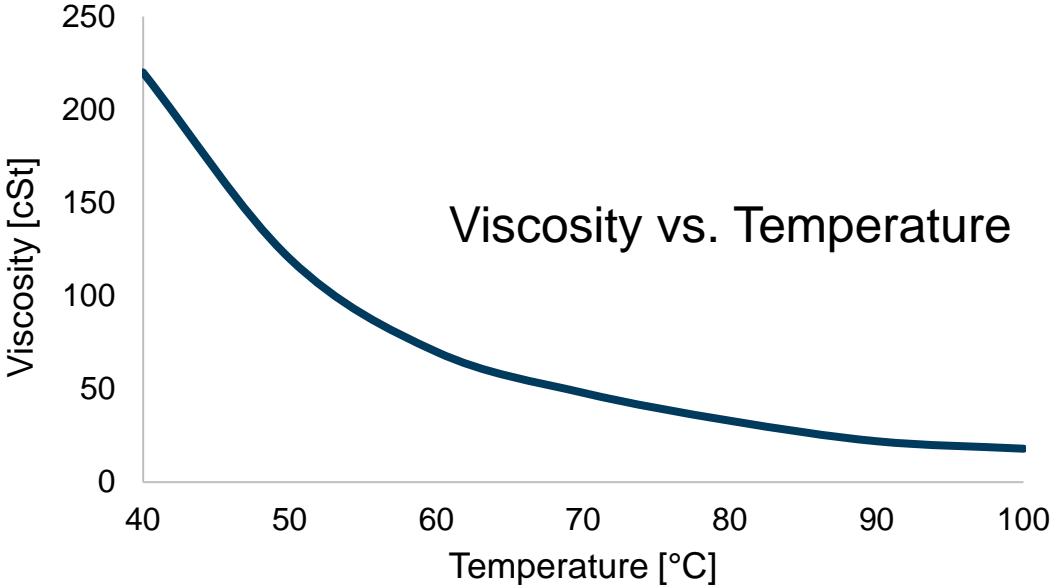
| NLGI # | Comparison | Structure | Applications |
|----------|----------------------|---------------|---|
| 000 | Ketchup | Fluid Greases | Central Lubrication Systems Gear Lubrication |
| 00 | Applesauce | | |
| 0 | Brown Mustard | | |
| 1 | Tomato Paste | Soft Greases | Bearings Pumps |
| 2 | Peanut Butter | | |
| 3 | Vegetable Shortening | | |
| 4 | Frozen Yogurt | Hard Greases | Sealing greases Block greases |
| 5 | Canned Meat | | |
| 6 | Cheese | | |

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Oil Viscosity Selection

Viscosity – Resistance to flow

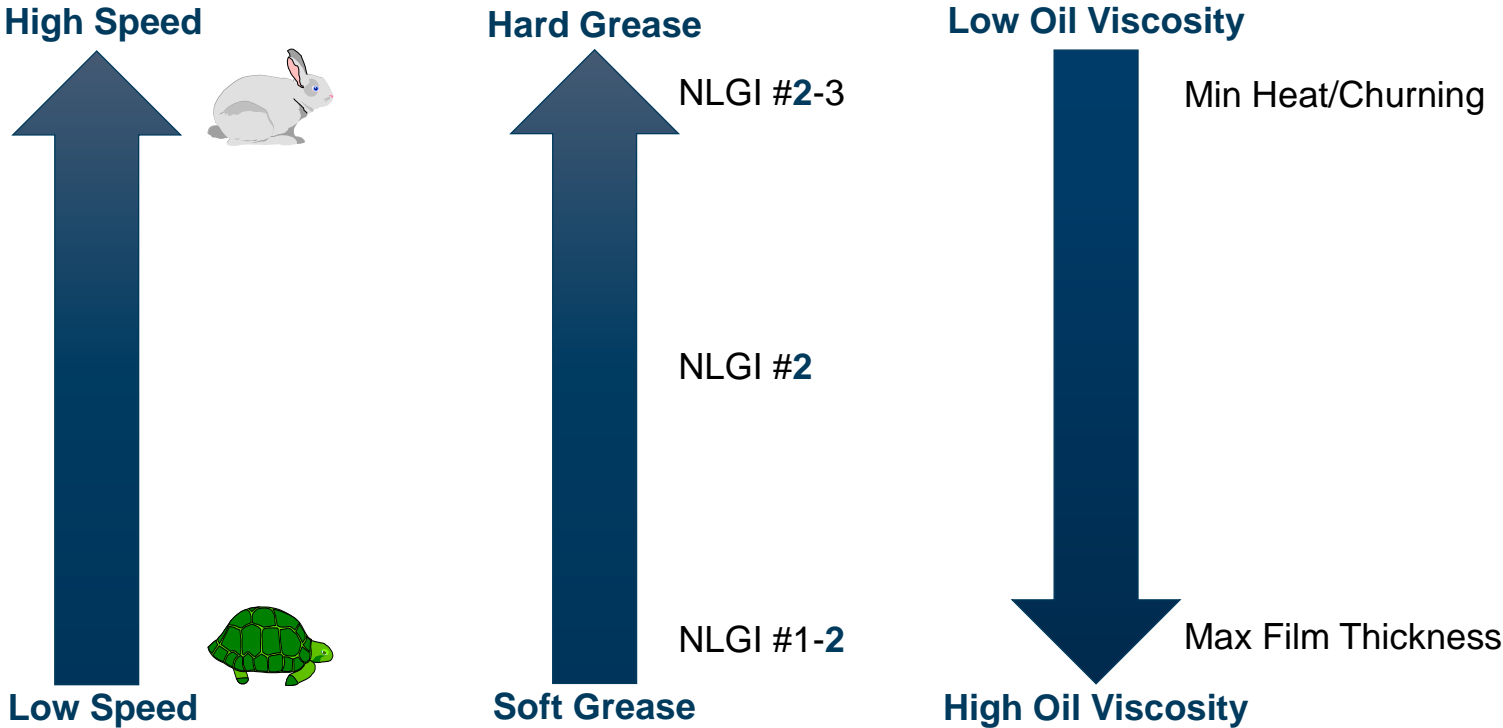
Viscosity usually rated at 40 °C and 100 °C



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Speed Consideration

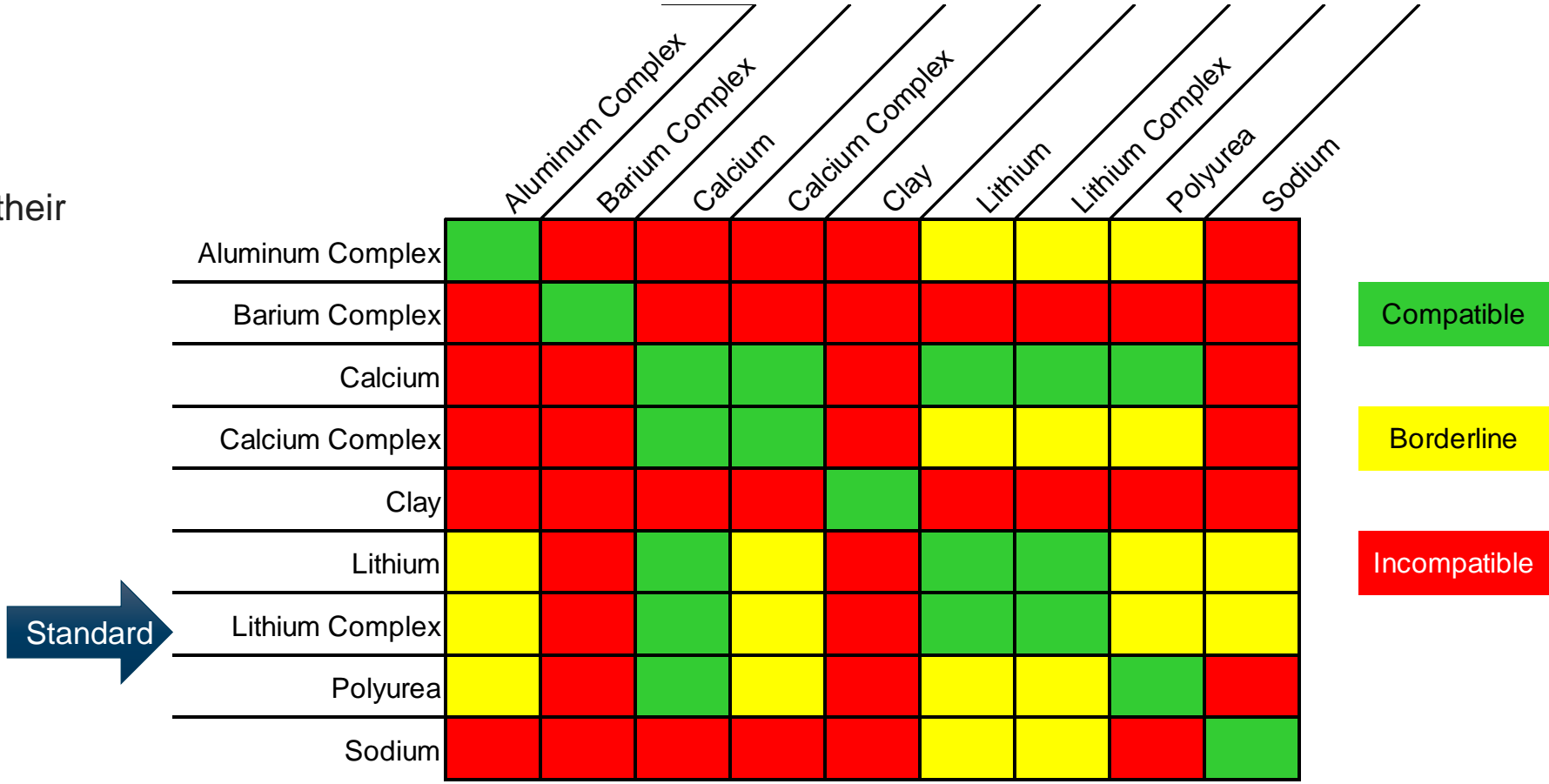
Bearing speed is primary factor for lubricant selection



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Grease Compatibility

- Wrong lubrication causes incompatible greases to lose their effectiveness
- NLGI = 2

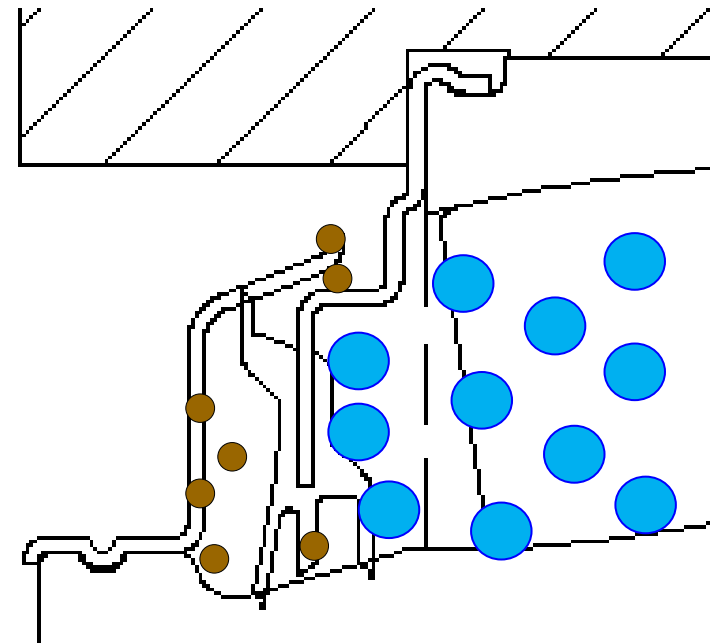


Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Purging Grease

Why purge grease?

- Replaces and pushes old grease out
- Pushes contaminants out and/or away from the bearing
- Provides fresh grease to rollers and raceways
- Recharges grease dams
- If you're not purging, you're only diluting the contaminants



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Build-up of Material

- Keep parts clear of build-up material
- Purgeable seals create a grease dam
- Dust, dirt, conveyed material acts as an insulator
- Bearing housings are designed to dissipate heat



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

- Grease Lubrication Frequency

| Lubrication Guide | | | | | | | | |
|---------------------------------------|--------------|----------------|----------------|-----------------|------------------|------------------|------------------|------------------|
| Suggested Lubrication Period in Weeks | | | | | | | | |
| Hours Run Per Day | 1 to 250 RPM | 251 to 500 RPM | 501 to 750 RPM | 751 to 1000 RPM | 1001 to 1500 RPM | 1501 to 2000 RPM | 2001 to 2500 RPM | 2501 to 3000 RPM |
| 8 | 12 | 12 | 10 | 7 | 5 | 4 | 3 | 2 |
| 16 | 12 | 7 | 5 | 4 | 2 | 2 | 2 | 1 |
| 24 | 10 | 5 | 3 | 2 | 1 | 1 | 1 | 1 |

Rule of Thumb: Amount = 3 shots per inch of shaft diameter

Times to lubricate:

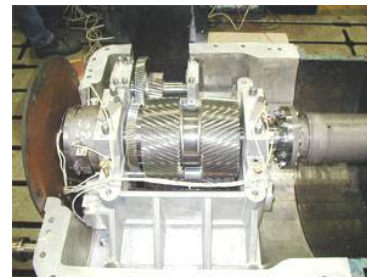
- Before shutdown
- After washdown
- If safe, lubricate with bearing spinning
- If seasonal, purge at shut down and prior to start up
- “Bench Purge” new bearings prior to installation

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Recognize a problem before it comes an emergency

Sensor technology-hands off monitoring of equipment

- Sensors have been around for years
- Variety of manufactures
- Wide range of costs
- Connectivity ranges from wired to wireless
- Features and abilities typically include temperature monitoring

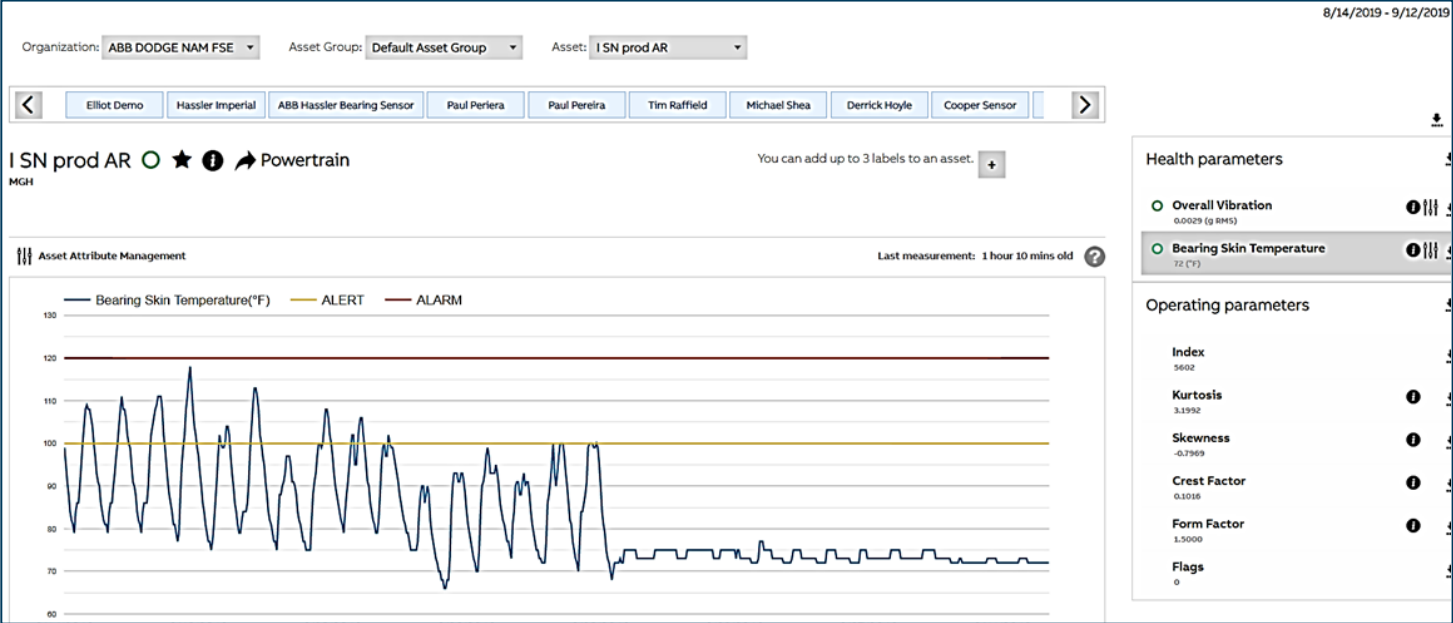
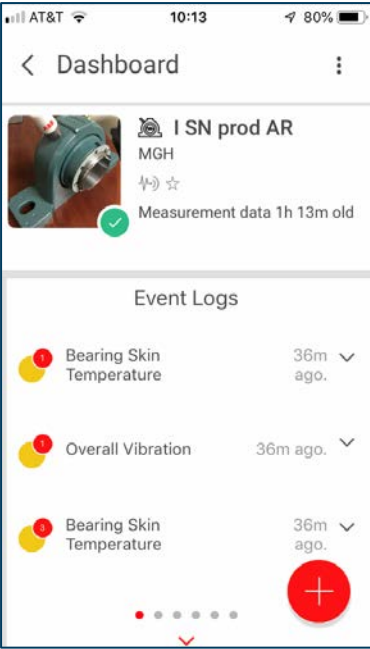
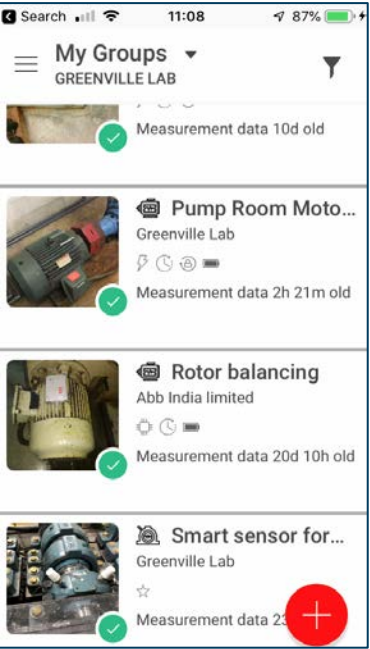
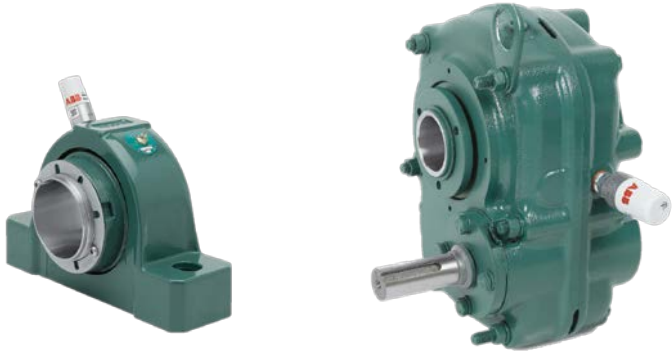


Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Wireless sensor for mechanical products

Condition monitoring, **mobile app or web portal**

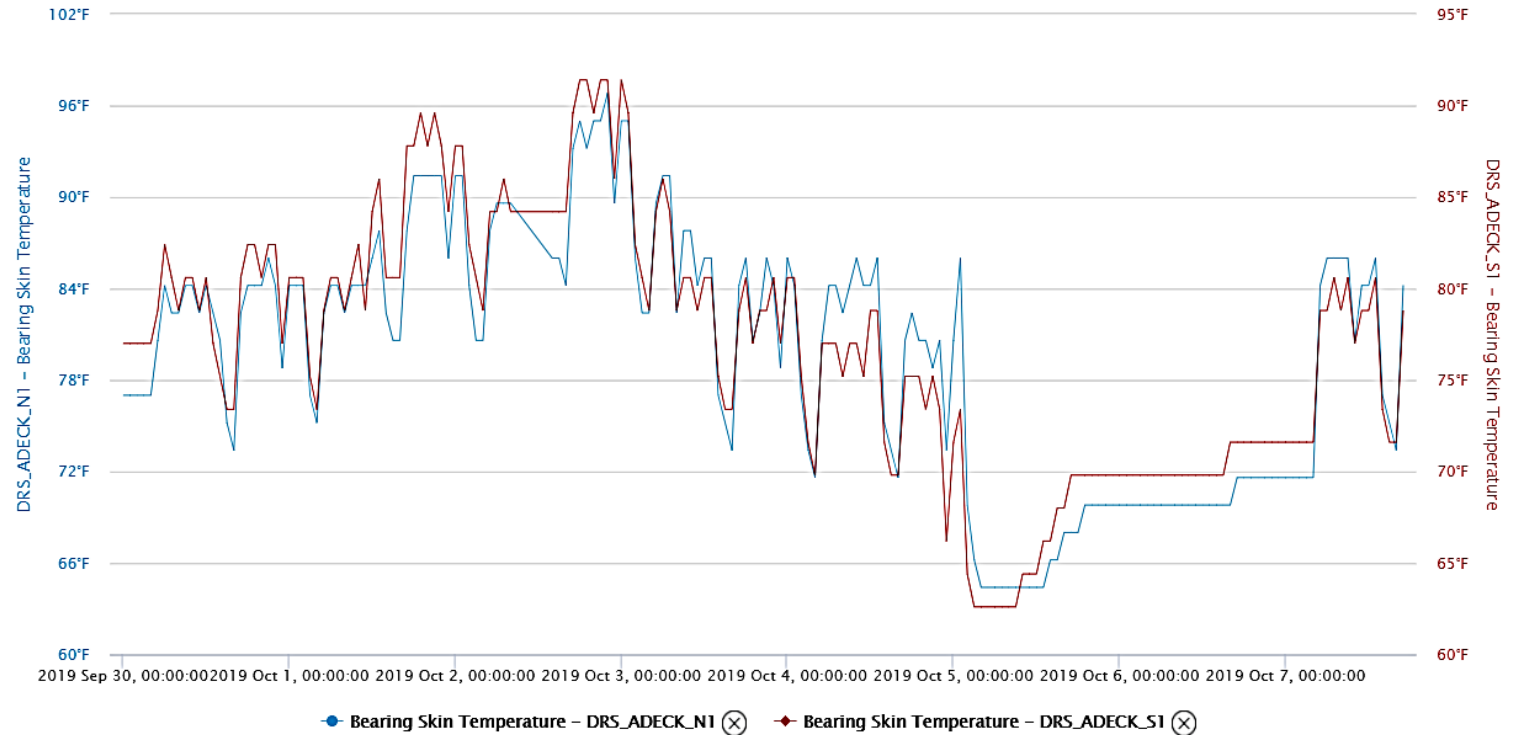
- Provides an easy overview of the status of the assets and organization
- Easy access for users on the move
- Specific asset, “Trend at a Glance”



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Wireless sensor for mechanical products

- Condition monitoring, **powertrain portal**
- Monitor multiple products at once
- Powertrain portal
- Allows to visibility of multiple assets at once.
- Example to the right shows temperature data from two bearings over a selected time period

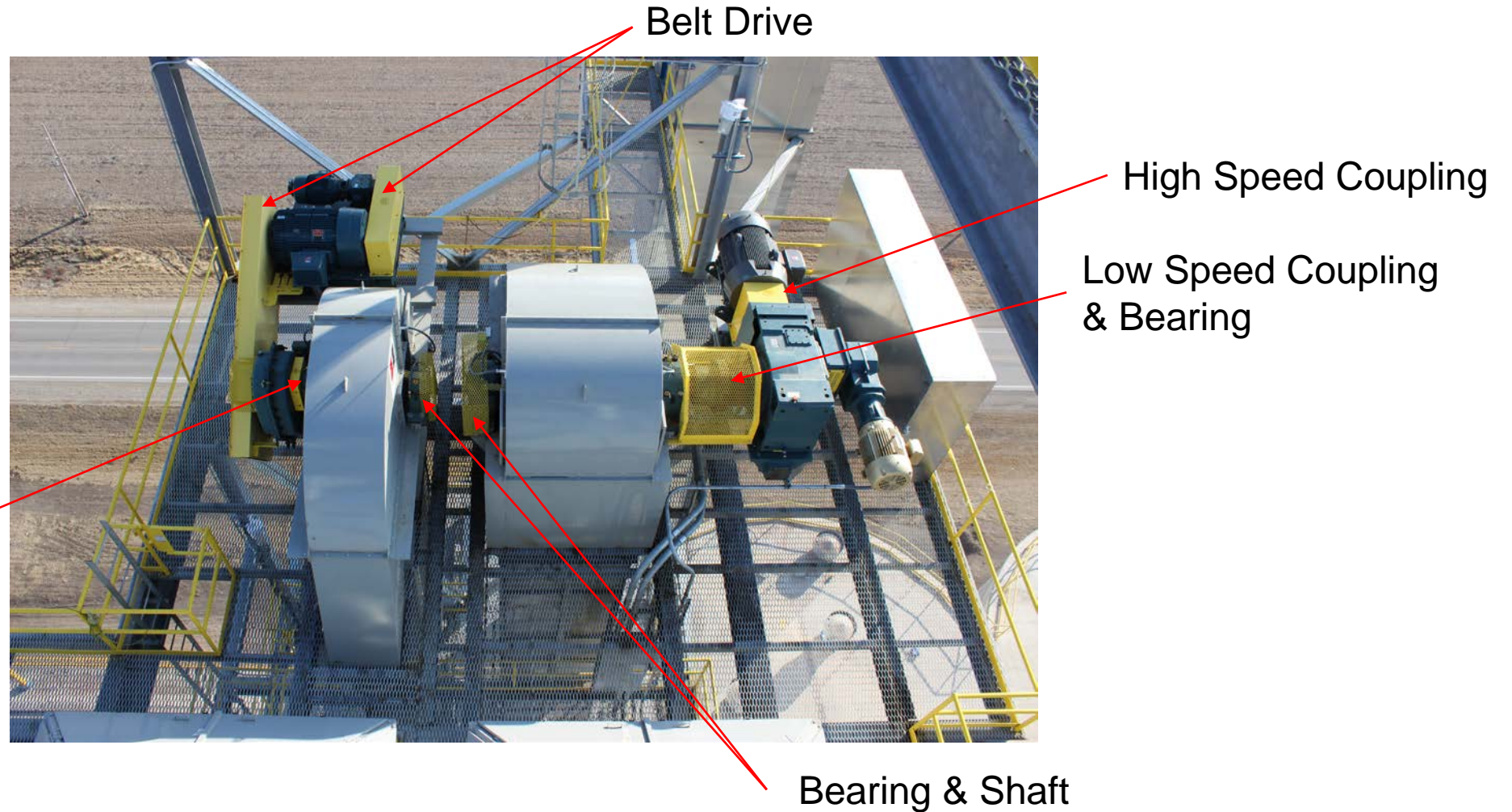


Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

How to guard bearings.

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

At Risk Areas to Guard



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

At Risk Areas to Guard



Exposed Bearing Collar

Exposed Shaft

Exposed Bushing

Typical Shaft/Bearing Installation at Drive Pulley

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Guarding Solutions

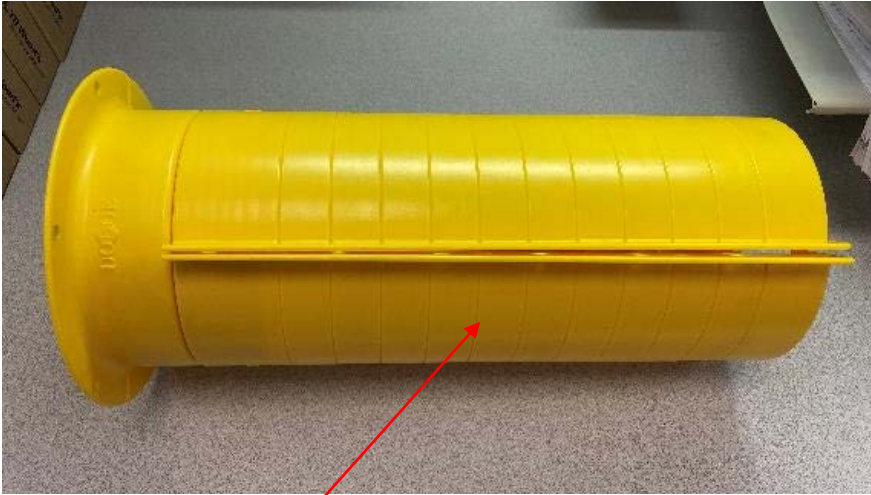
Both Bushings Guarded



Exposed Shaft & Bearing Collar Guarded



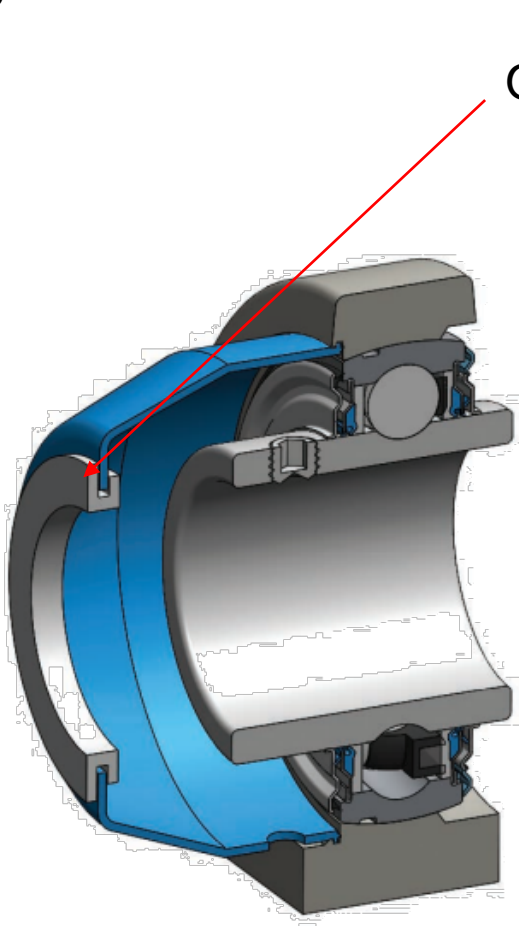
Fine Length Adjustment



Segmented for Cut-To-Size Adjustment

Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

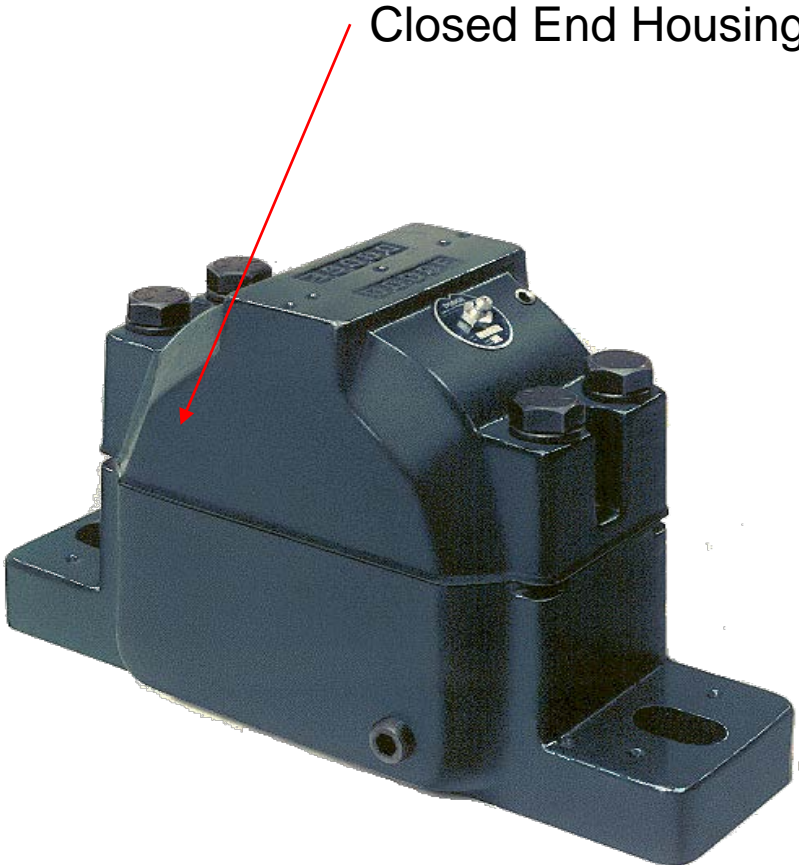
Bearing Covers



Open End Cover



Closed End Cover



Closed End Housing

Thank You!

For more information visit me at Booth 832



Why Bearings Fail – How to Select, Maintain & Properly Guard Bearings

Uptime Calculation

Proper Selection

+

Proper Installation

+

Proper Maintenance

+

Proper Safety

= More Uptime





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