

# **Enhanced Bearing Reliability**



**David Keech**  
**Industry Engineer - Mining**  
**Baldor Electric**

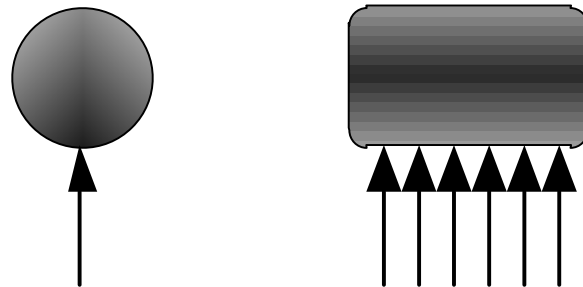
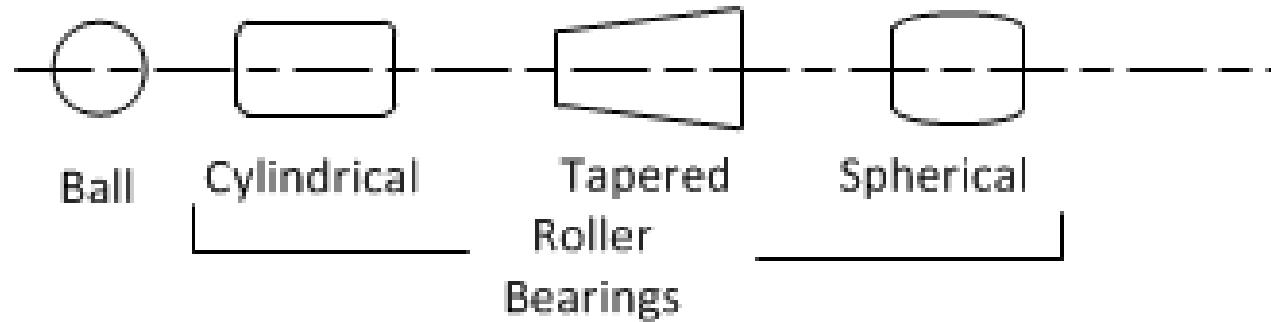
# Overview

- Types of Mounted Anti-Friction Bearings
- Housings
- Shaft Attachment
- Sealing
- Bearing Selection
- Lubrication
- Failures



**BALDOR**  
A MEMBER OF THE ABB GROUP

# Rolling Elements



**Contact Area**

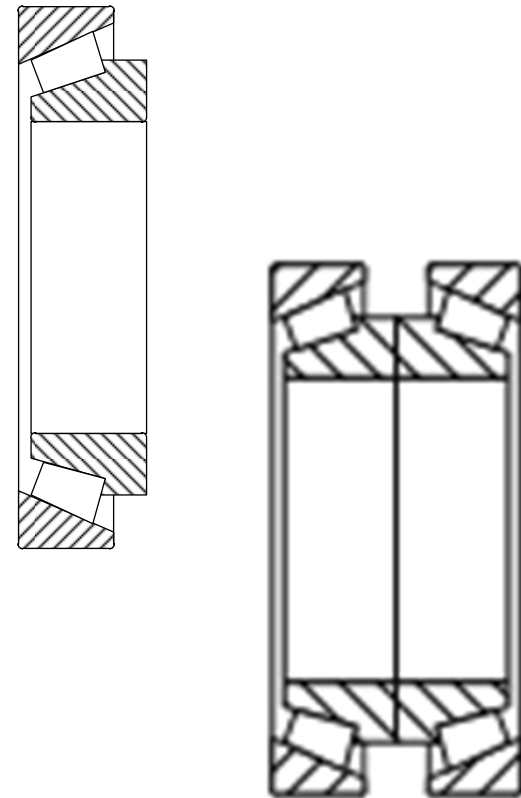
# Ball Bearings

- Single contact point
- High speed and quiet running
- Relatively good radial and axial loading
- Low minimum radial loading required
- Economical
- Maximum bore is about 3-15/16 inches



# Tapered Roller Bearings

- Designed for Heavy Radial and Axial Loads
- Higher friction
- Higher Minimum loads
- Used in pairs to handle axial loads in two directions
- Maximum bore is normally 7 inches can go up to 12 inches



# Spherical Roller Bearings

- Very High Radial and Axial Load Capability
- Fair Speed capability
- Excellent Under Misalignment
  - Up to 1 ½ degrees
- Higher Minimum Loads required
- Friction higher than ball bearings
- Maximum bore is 22 inches and greater



# Housings

- Connection of bearing to machine/structure
- Protect internal components from damage
- Transmit loads from rotating shaft to machine structure
- Helps dissipate heat
- Provide lubrication
- Allows for shaft misalignment

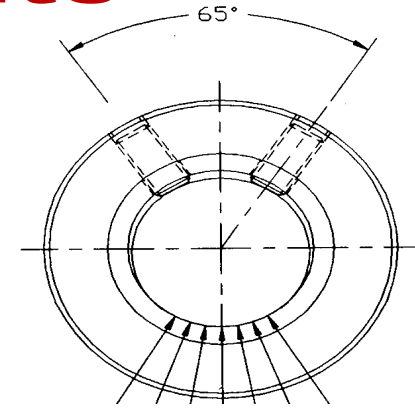


**BALDOR**  
A MEMBER OF THE ABB GROUP

# Shaft Attachments

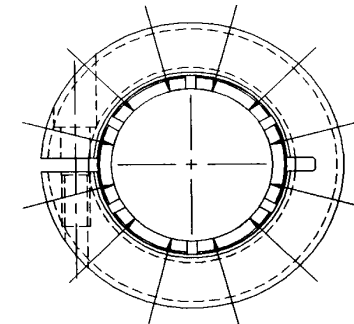
## Set Screw

- 65 Degree Set Screw Angle
- Improved Holding Power
  - Cup point set screws
  - Easy Installation



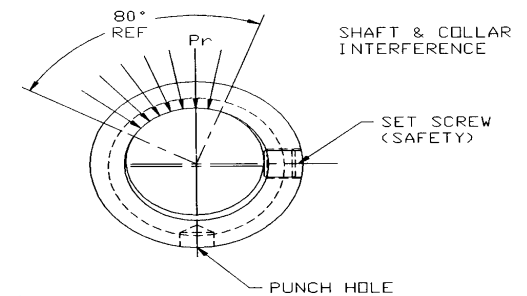
## Locking Collar

- 360 Concentric fit to shaft
- Less Vibration at Higher Speeds
- No Marring of shaft during installation



## Eccentric Locking Collar

- Self Locking 1/4 turn Eccentric Collar
- Secured in Position with single turn and setscrew



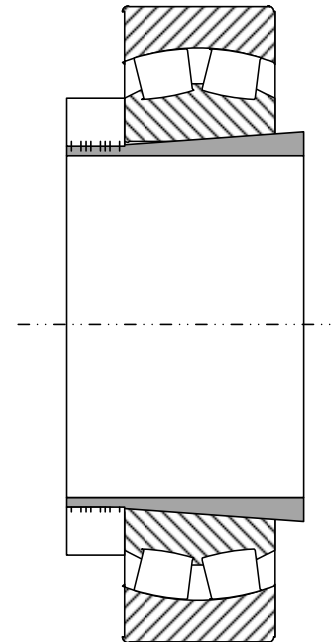
**BALDOR**  
A MEMBER OF THE ABB GROUP



# Shaft Attachments

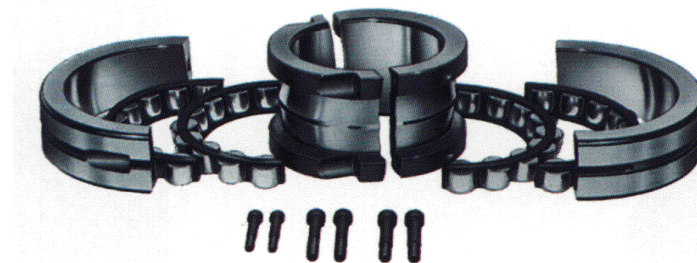
## Taper Adapter Mounting

- Tapered inner bore of bearing
- Split Tapered Adapter Sleeve
- During mounting Bearing is pushed or pulled up adapter
- Concentric 360 degree clamping
- Shaft is centered in bearing bore
- Reduced fretting corrosion

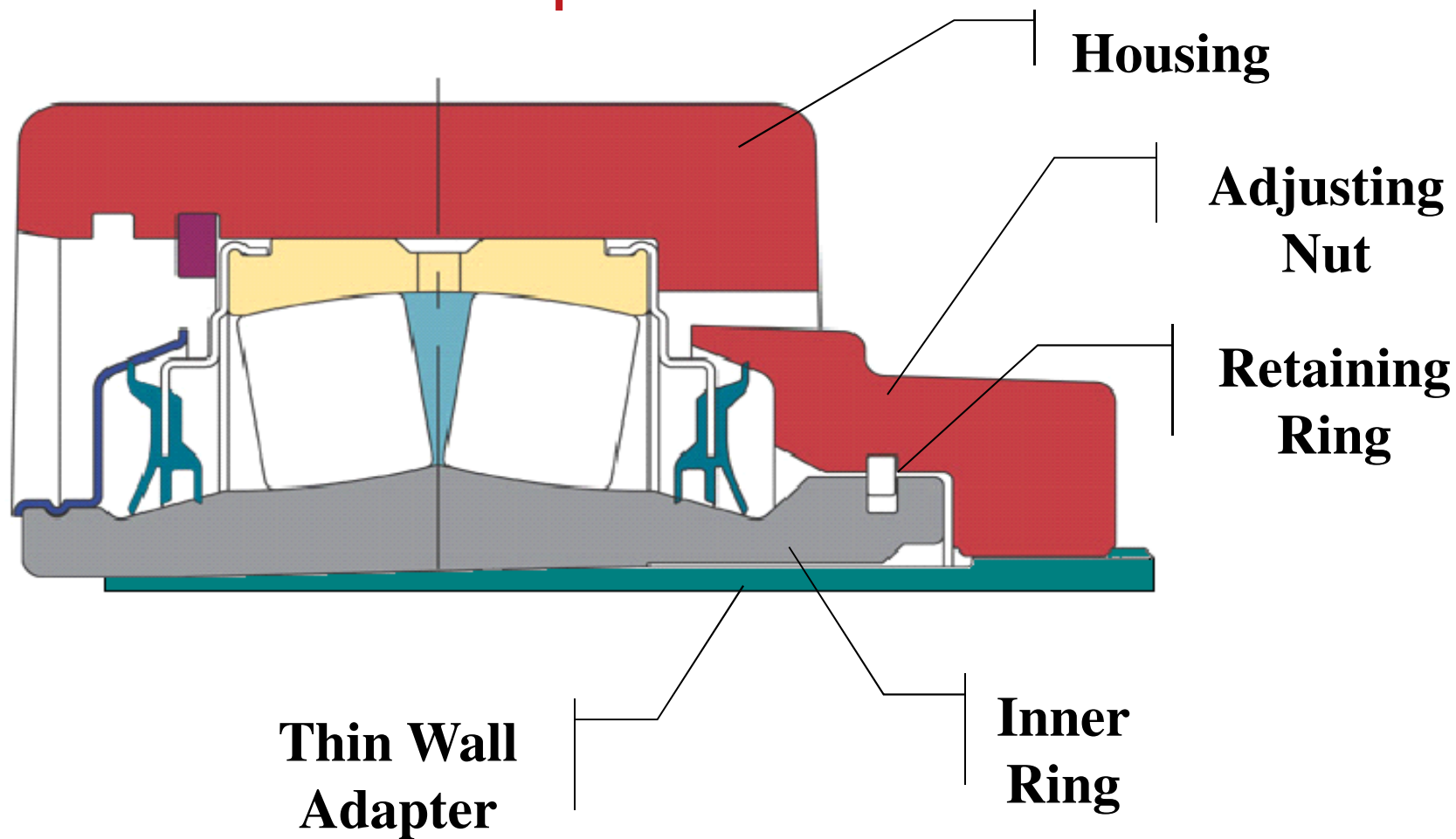


## Split Mounting (spherical)

- Split bearing clamps to shaft
- Fits in standard housing
- Simplifies emergency repairs



# Thin Wall Adapter



# Improved Bearings

## DODGE ISAF



- One part number in one box
- Assembled, lubed, shaft ready
- Easy to install, reposition or remove



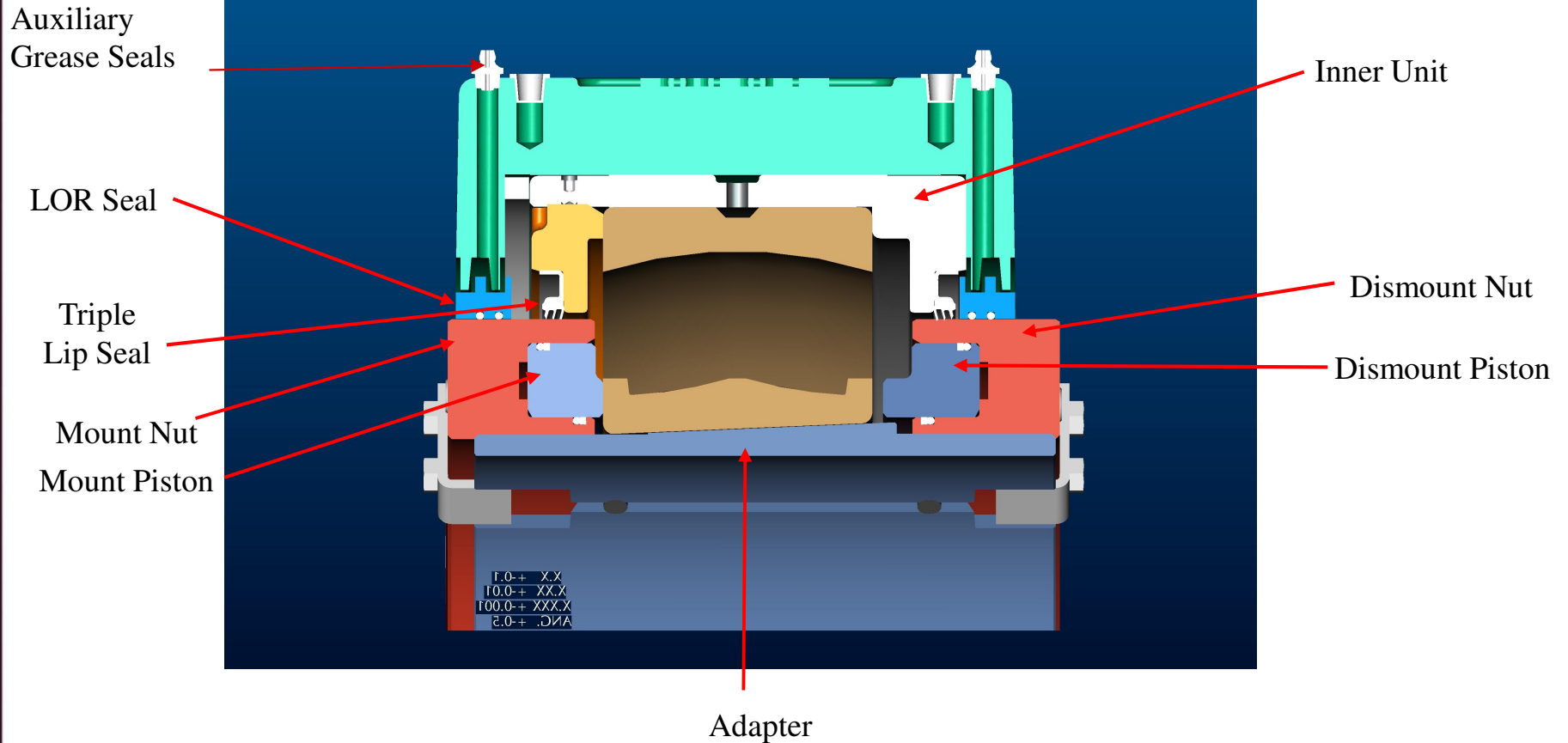
## TRADITIONAL SAF



- Four part numbers in four boxes
- Customer assembles and lubes
- Feeler gauges to install
- Pull or burn to remove

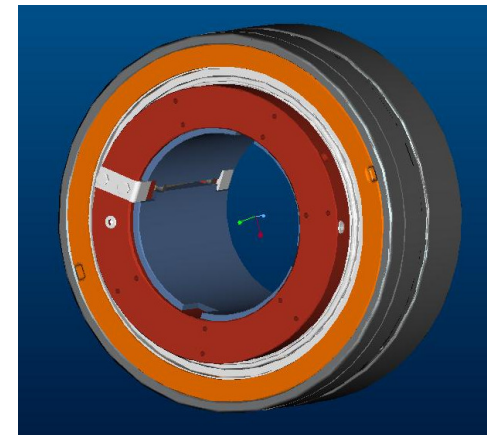
**BALDOR**  
A MEMBER OF THE ABB GROUP

# Hydraulic ISAF



# Dodge Hydraulic ISAF

- Dimensionally Interchangeable with all SAF housings
- Easily Mounts & Dismounts (15 Minutes or Less)
- Automatically Sets Bearing Clearance
- Replaceable Drop-In Inserts
- Sealing system superior to SAF

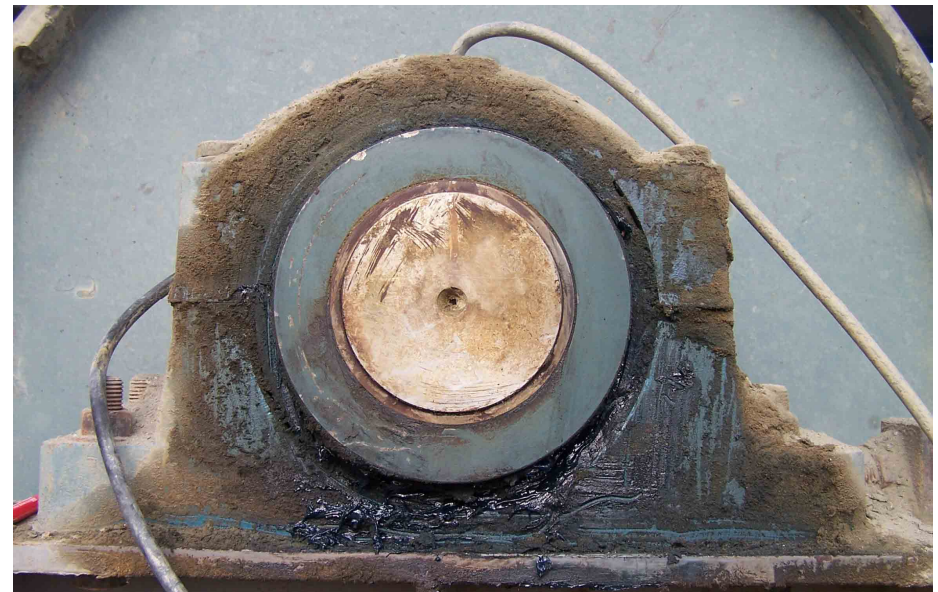




# **Bearing Seals**

## **Protection and Sealing Systems**

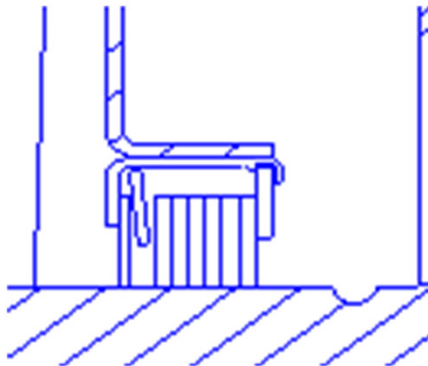
- **Over 25% mounted bearing failures due to contamination**
- **Seals keep contamination out**
- **Seals keep lubrication in**



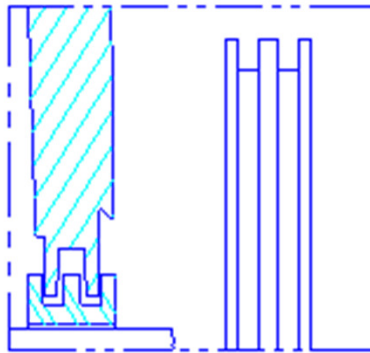
**BALDOR**  
A MEMBER OF THE ABB GROUP

# Bearing Seals

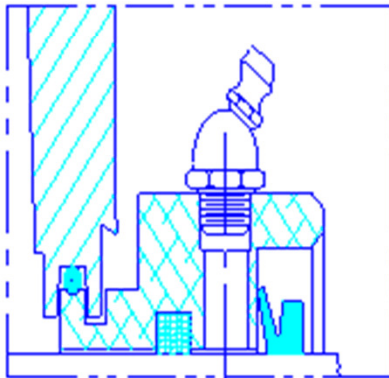
## Protection and Sealing Systems



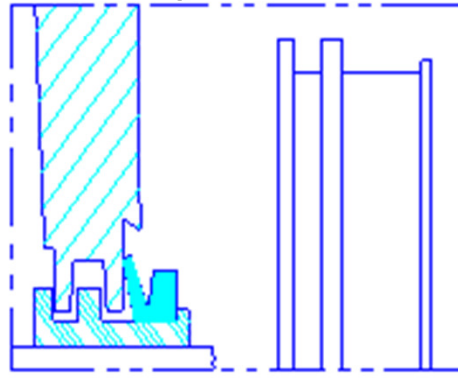
Clearance Seal



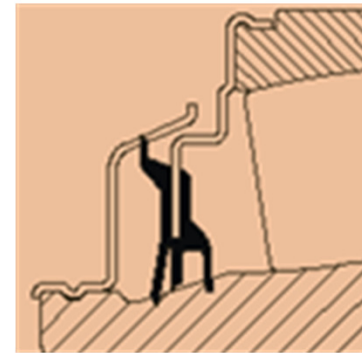
Labyrinth Seal



Taconite Seal



Combination Seal  
Labrynth/Lip



Lip Seal



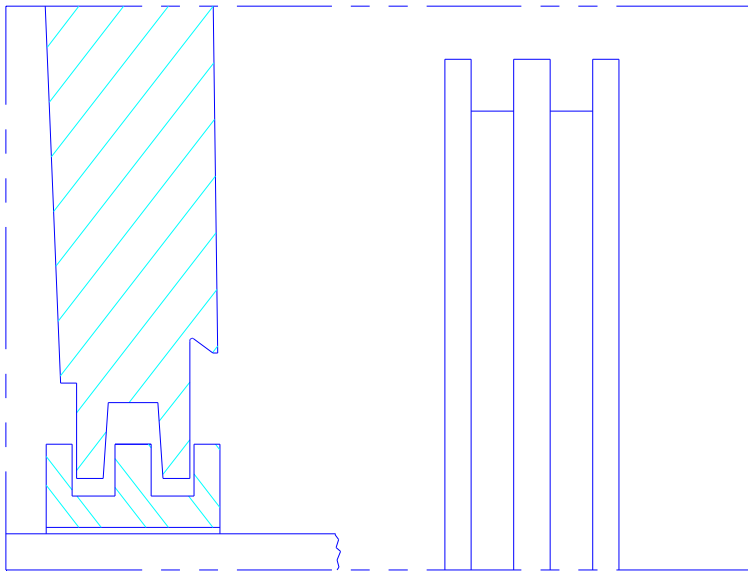
Flinger

**BALDOR**  
A MEMBER OF THE ABB GROUP

# **Bearing Seals**

## **Protection and Sealing Systems**

- **Labyrinth Type Seal**



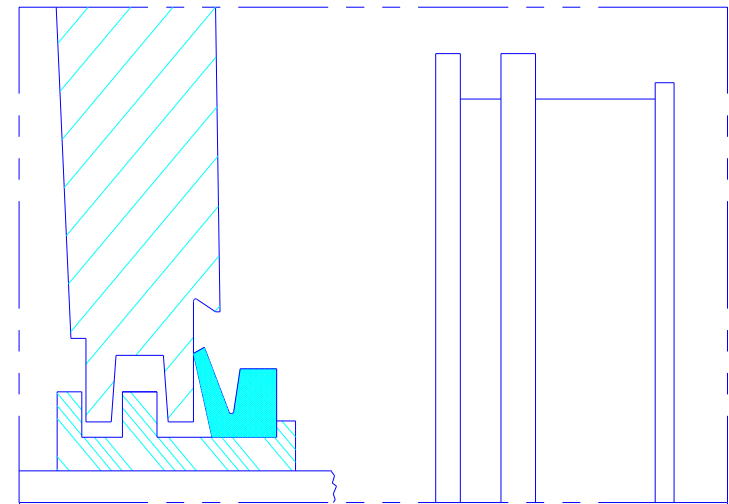
- Protects bearing without completely closing path to bearing
- Grease purges out through passages and forms barrier for contamination
- Non-contact seal
- Suitable for higher speeds



# Bearing Seals

## Protection and Sealing Systems

- **Combination Seal**
  - Combination system
    - Labyrinth & V-ring
  - Full contacting on shaft
  - V-ring as a face seal - sealing contact on housing
  - V-ring protects labyrinth - acts as flinger
  - Grease purges thru labyrinth / V-ring

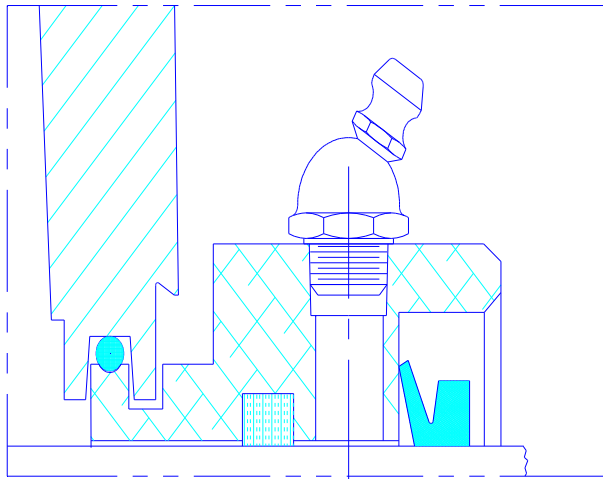


*Triple-Tect Seal*

# Bearing Seals

## Protection and Sealing Systems

- **Auxiliary Taconite Seal**
  - Example of combination style seal
  - Industry standard

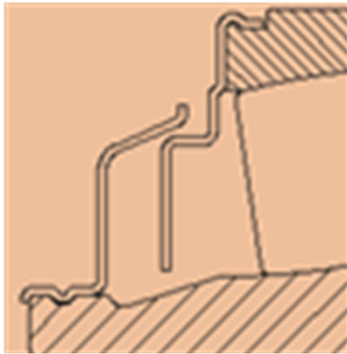


- Excellent sealing action
- Labyrinth w/ O-ring
- Felt ring
- Grease cavity between seal & shaft
- Can require frequent regreasing
- Higher Cost
- Longer length thru bore
- Reduced miss-alignment capability
- Limited speed capability

# Bearing Seals

## Protection and Sealing Systems

- **Shield/Flinger**



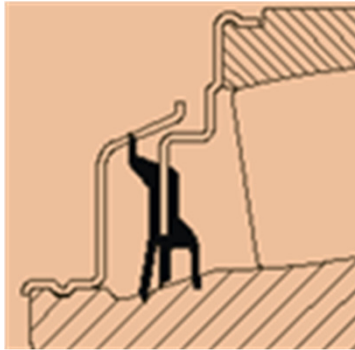
Flinger

- Used as deflector
- Protects primary seal from damage
- Attached to rotating component to fling material away from bearing

# Bearing Seals

## Protection and Sealing Systems

- **Contact Seal**



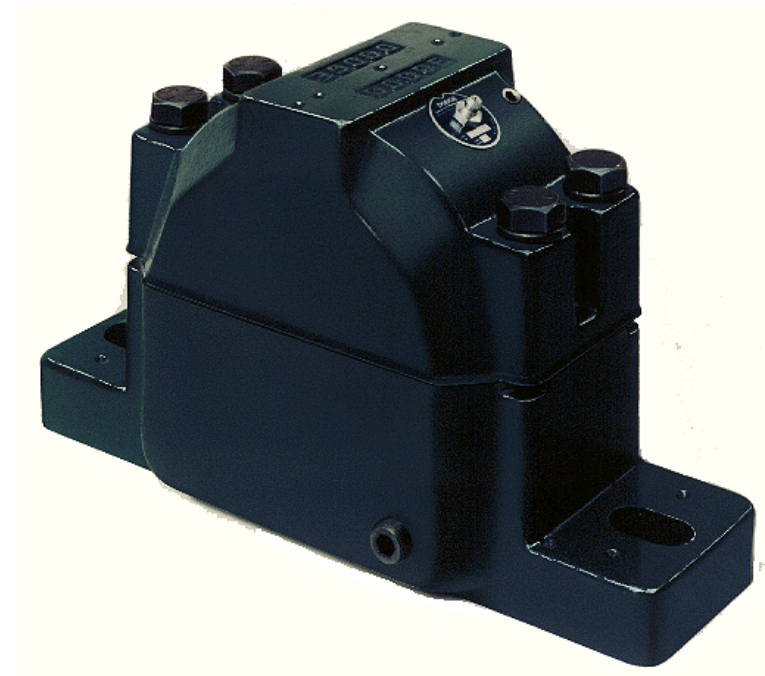
Lip Seal

- Flexible component that closes paths for contamination
- Seal contacts rotating components
- Rubbing contact lips
- Suitable for slow to moderate speeds

# **Bearing Seals**

## **Protection and Sealing Systems**

- **Best Seal = No Seal**
  - Cast closed one end
  - Seal required one side only
  - RTV or other gasketing compound can be used at joint for ultimate in sealing capability



*Unified USAF Spherical  
Bearing*

**BALDOR**  
A MEMBER OF THE ABB GROUP

# Bearing Selection

- What are the loads?
  - Axial
  - Radial
  - Shock / Vibration
- Speed
- L10 Life
- Shaft diameter
- Environment
- Previous experience

## **Equivalent Radial Load (P)**

- When the load on a bearing is solely a radial load, the equivalent radial load (P) is equal to the actual load.
- When a thrust load is applied along with a radial load they must both be converted into an equivalent radial load:

$$P = XF_R + YF_A$$

- Where:
  - P = Equivalent radial load
  - $F_R$  = Radial load
  - $F_A$  = Thrust load
  - X = Radial load factor
  - Y = Thrust load factor

# Bearing $L_{10}$ Life

- $L_{10}$  life is the life attained by 90 % of a statistically similar group of bearings operating under similar load and speed conditions.

---

- For Ball Bearings:  $L_{10} = (C/P)^3 * 16,667/\text{rpm}$

- For Spherical Roller Bearings:  $L_{10} = (C/P)^{(10/3)} * 16,667/\text{rpm}$

- For Tapered Roller Bearings:  $L_{10} = (C_{90}/P)^{(10/3)} * 1,500,000/\text{rpm}$

---

Where:

$C$  = dynamic capacity

$C_{90}$  = dynamic capacity for tapered roller bearings

$P$  = equivalent radial load

rpm = speed of the rotating ring.



# Grease Lubrication

**(90% of all mounted bearings are grease lubricated)**

*The main advantages of grease lubrication are:*

- **Simple design**
- **Action of the grease as a sealing agent**
- **Simple lubricating equipment**
- **Long service life**
  - Grease lubrication used under less strenuous operating and environmental conditions gives you a long grease life.
  - If high stresses are involved (speed, temperature, loads), relubrication at shorter intervals must be planned.

# GREASE PROPERTIES

*During Lubrication selection, the following areas need to be considered.*

- **Consistency of the grease (NLGI)**
- **Viscosity of oil within grease (cst)**
- **Soap Base (Lithium, Barium, Polyurea, etc.)**
- **Load carrying properties (EP additives)**
- **Operating temperature range**

# Bearing Selection Program (BEST)

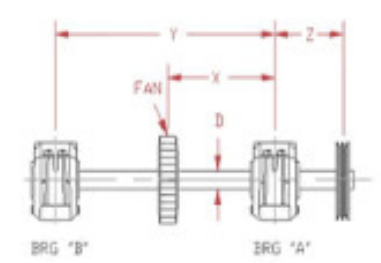
**\* Shaft Orientation**

☒ Horizontal ☐ Vertical

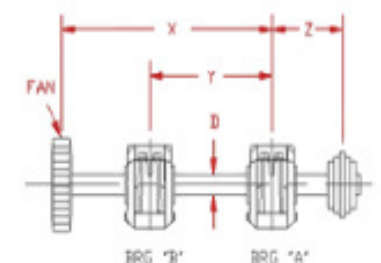
**\* Input/Output**

☒ English ☐ Metric

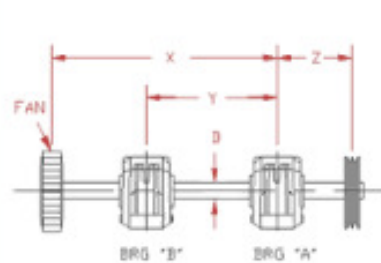
**\* Application**



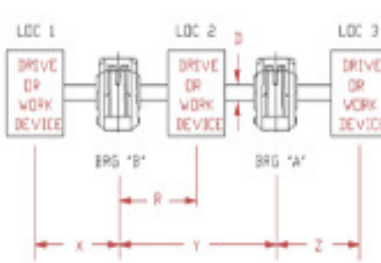
Application #1



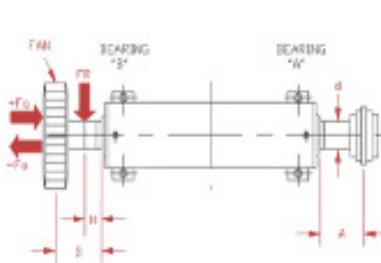
Application #2



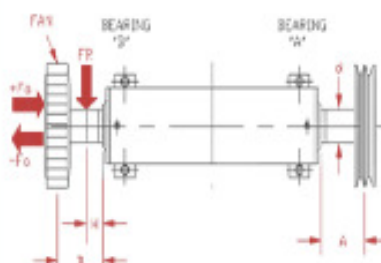
Application #3



General Case



Application PDF#1



Application PDF#2

[www.prodsel.ptwizard.com/best/doc.best.home.do](http://www.prodsel.ptwizard.com/best/doc.best.home.do)

**BALDOR**  
A MEMBER OF THE ABB GROUP

# Bearing Selection Program (BEST)



Baldor Electric Company  
P.O. Box 499  
Greenville, SC 29602-0499  
(864) 297-4800  
General Case Application

## Drive Data

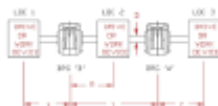
Application:	General Case	Orientation:	HORIZONTAL
Analysis Type:	Load/Life Calculations		
Bearing A Type:	USAF 500 (222K), SAF-XT,SAFS,SDAF230K	Bearing B Type:	USAF 500 (222K), SAF-XT,SAFS,SDAF230K
Application Type:	Belt conveyor pulley	Reliability:	90.00 %
Shaft Speed (RPM):	100.00		
Weights (Lbs.)		Lengths (In.)	
Shaft:	10.00	X	5.00
Fan:	0.00	Y	100.00
Shw/coupling:	0.00	Z	0.00
		R	50.00

## Bearings Loads (Lbs.)

	Bearing A	Bearing B
Input Radial Load	0.00	0.00
Input Thrust Load	0.00	0.00
Vertical	53499.75	53610.25
Horizontal	0.00	0.00
Resultant	53499.75	53610.25
Total Thrust Load	0.00	0.00

## Drives

	Drive Type	HP.	Weight (Lbs.)	Diameter (In.)	Angle (Deg)	Force (Lbs.)	SF
Drive One	Coupling	0.00	100.00	0.00	0.00	0.00	0.00
Drive Two	Pulley	200.00	7000.00	8.00	0.00	100000.00	1.40
Drive Three	Nothing	0.00	0.00	0.00	0.00	0.00	0.00



## Analysis

Bearing A 8.0 In. USAF 500 (222K), SAF-XT,SAFS,SDAF230K

Nominal Viscosity 100.00 @ 40 DEG C

EP Additives Yes

Bearing B 8.0 In. USAF 500 (222K), SAF-XT,SAFS,SDAF230K

Nominal Viscosity 100.00 @ 40 DEG C

EP Additives Yes

	Bearing A	Bearing B
Catalog Capacity (Lbs.)	365000.00	365000.00
Equivalent Load (Lbs.)	53499.75	53610.25
ABMA Life	99840.42 Hrs.	99156.79 Hrs.

## Warnings

Brg A - Upward force on pillow block (Capload) exceeds safe working load for SAF-XT bearings.

	8 hrs/day	16 hrs/day	24 hrs/day
<b>Bearing A</b>			
Min lube interval	323.07 Hrs	5.77 wks.	2.88 wks.
Max lube interval	452.30 Hrs	8.08 wks.	4.04 wks.
Weekly relube qty.	3.05 Oz.		
Monthly relube qty.	4.57 Oz.		
yearly relube qty.	6.10 Oz.		
<b>Bearing B</b>			
Min lube interval	323.07 Hrs	5.77 wks.	2.88 wks.
Max lube interval	452.30 Hrs	8.08 wks.	4.04 wks.
Weekly relube qty.	3.05 Oz.		
Monthly relube qty.	4.57 Oz.		
yearly relube qty.	6.10 Oz.		

If the relube interval is less than a month use the weekly relube quantity at each relube cycle. If it is less than a year use the monthly relube quantity and if it is greater than a year use the yearly relube quantity

**BALDOR**  
A MEMBER OF THE ABB GROUP

# **Bearing Failures**

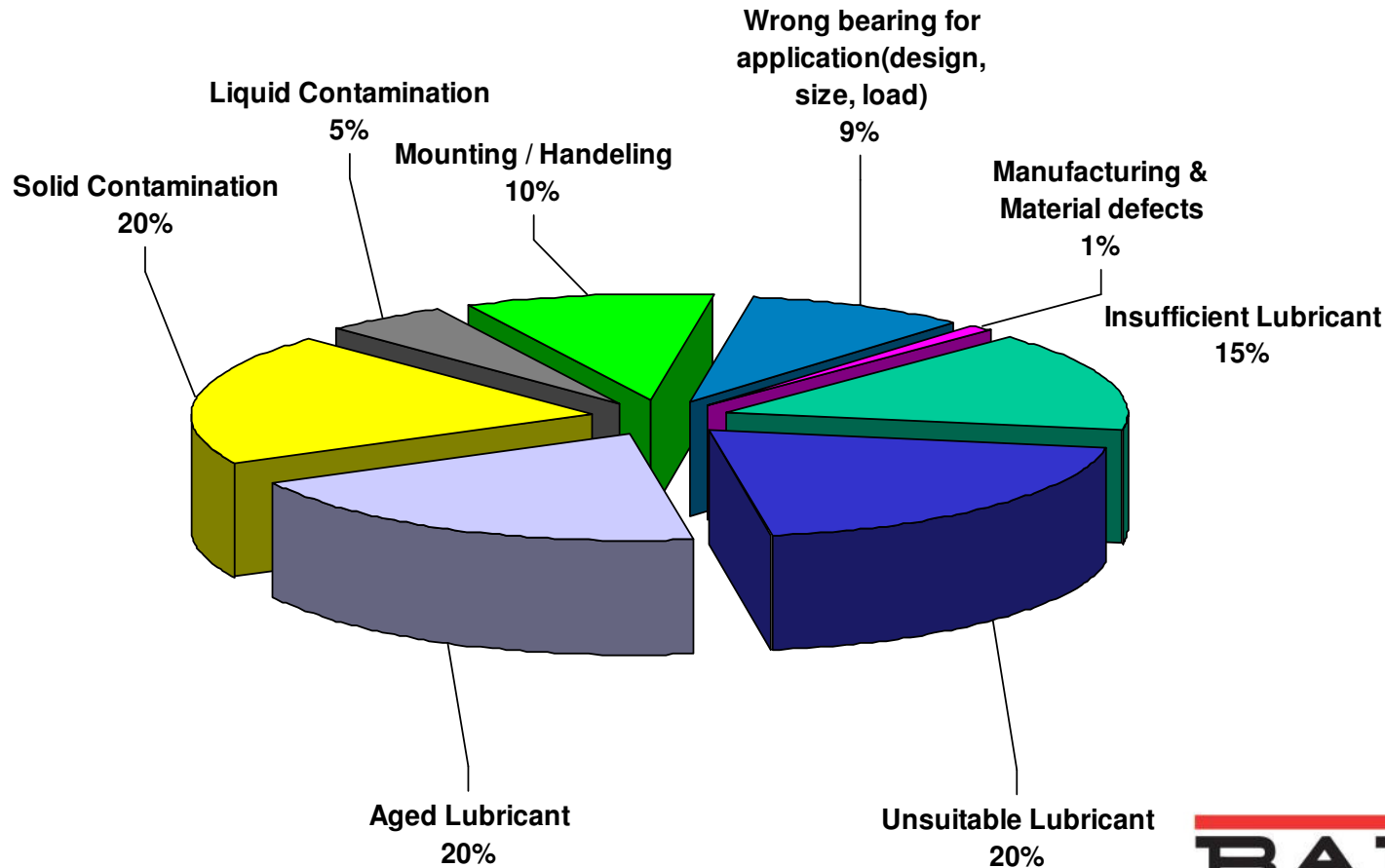
Customer's most common complaints

- **Bearing running Hot**
- **Bearing running Noisy**
- **Excessive Vibration**
- **Bearing Damaging shafting (spinning)**
- **Shaft difficult to turn**
- **Lubrication leakage**
- **Bearing Life too short**

# Causes of Bearing Failures

*(55% of all premature bearing failures are lubricant related)*

*(additional 25% are contamination related and could be minimized under good maintenance guide lines)*

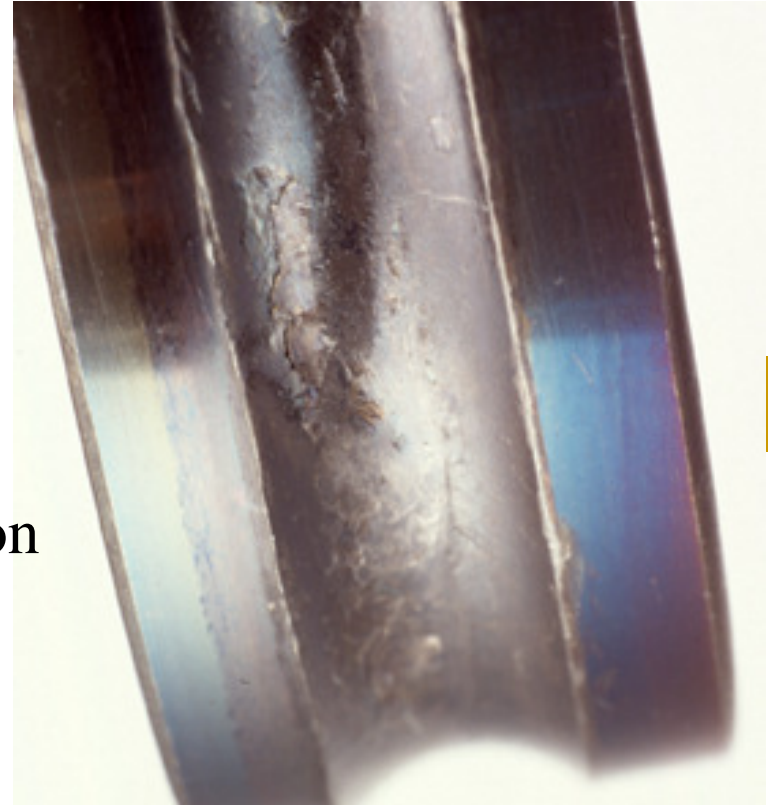


# Ineffective Lubrication

- Excessive Wear of components
- Discoloration of components
- Increase in operating temperature
- Increase in vibration

## Remedies

- Use the correct grease for application
- Use correct amount of grease for the application
- Follow maintenance relubrication intervals

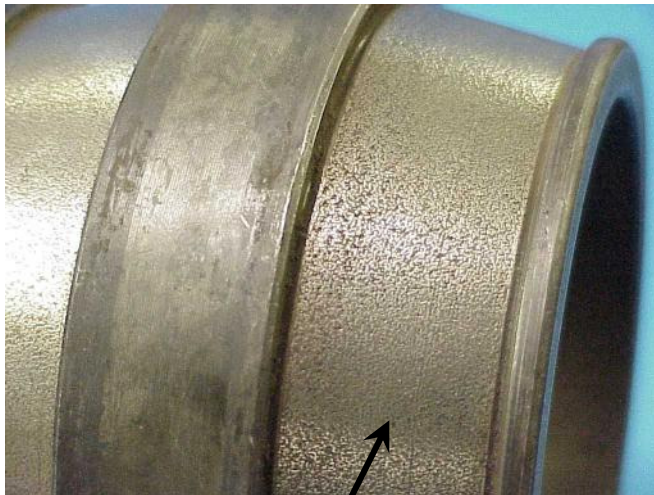




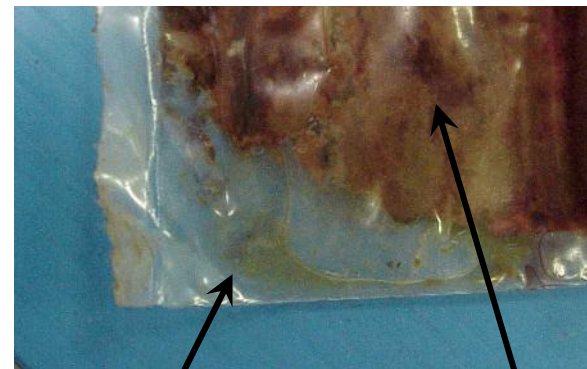
# **Water Contamination Failure**

## **2 7/16" Special Duty Hinged Cap Bearing**

After 9 months of operation bearing was removed  
due to high level of vibration



Corrosion streaks caused by water  
in lubricant while bearing rotated



Water

Grease

Application : Paper Mill felt roll  
Speed = 100 rpm's

Water separation from Grease sample

**BALDOR**  
A MEMBER OF THE ABB GROUP



# Excessive Bearing Wear due to Contamination

( *contaminate acted as Lapping Compound* )



Contamination deteriorates / breaks down the lubricant  
which accelerates the wear due to contamination

# Heavy Vibration Failure Mode

## Raceway with a Washboard wear pattern



Inner ring of a  
22236K.C3 Spherical  
Roller Bearing.

Taken out of service due to noise.  
Estimated service : 2 years  
Application : Large Overland Gold  
Mining Conveyor.

Wear pattern similar to wear pattern seen with the passage of electric current. The difference is electric current damage is more defined and spaced closer together. The above type of damage is commonly found on Shaker Screen Bearing when contamination is present.

**BALDOR**  
A MEMBER OF THE ABB GROUP

# Takeaways

- **Proper selection of mounted Anti Friction Bearings**
  - Application (speed, loads, environment, machine)
  - Sealing
  - Lubrication critical
- **Use expertise of bearing manufacturer**
  - Application selection tools
  - Lubrication decisions
  - Failure analysis on trouble applications

Two vertical lines, one blue and one red, are positioned on the left side of the slide, extending from the top to the bottom.

# Thank you