



# REDLIST



## 5 Steps to Maintaining a Successful Lubrication Program

**Tim Dunton**

Reliability Solutions LP



# WHO ARE WE?



## RELIABILITY SOLUTIONS

- All-Inclusive Reliability Improvement Company
- Training provider for Workforce Skills Enhancement
- Industrial Service and Maintenance Provider

## RELIABILITY SOLUTIONS TRAINING

- Assist in Bridging the Skills Gap within Manufacturing
- Focus on **4 Specific Pillars of Reliability**
- Hands-On Hard Skills with Practical Application
- Live and or remote delivery

## RELIABILITY SOLUTIONS MAINTENANCE

- Field Services
- Condition Monitoring Services
- Quality Assurance/Quality Control





# Overview

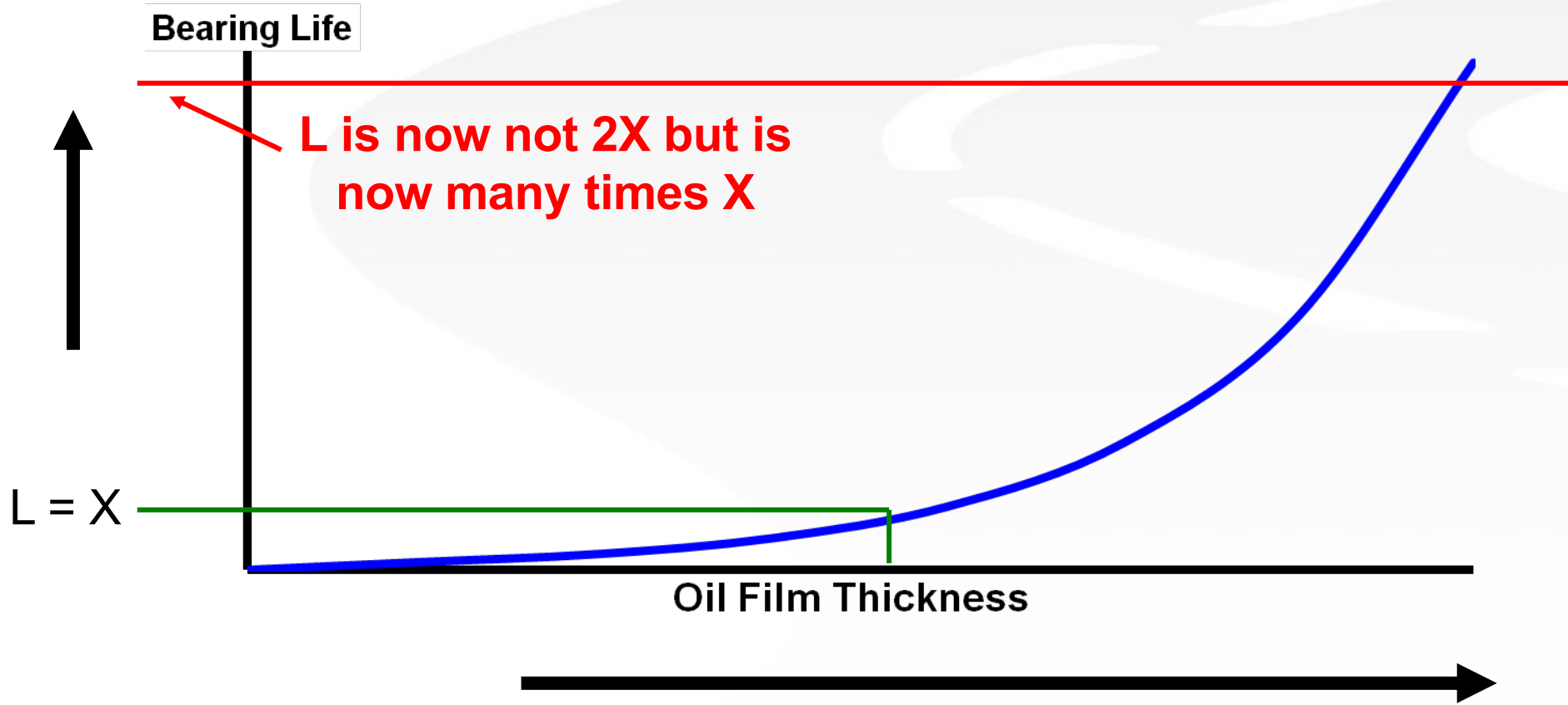
- Selection of Lubricants
- Cleanliness Standards
- Contamination Control
- Applying Lubricants
- Digital Lubrication Management



# PROPERTIES OF LUBRICANTS



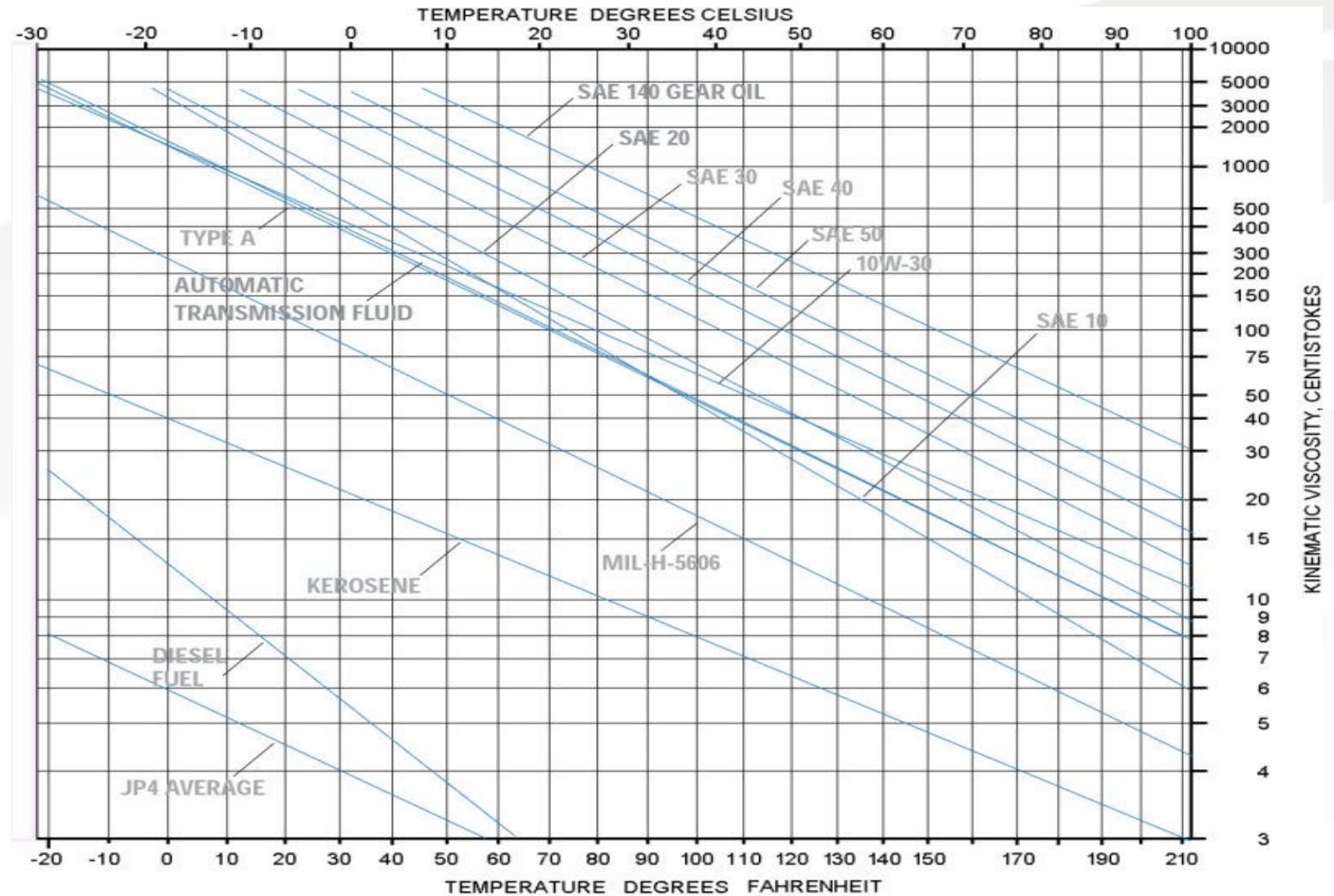
# Bearing Life vs. Oil Film Thickness



# Lubricant Properties



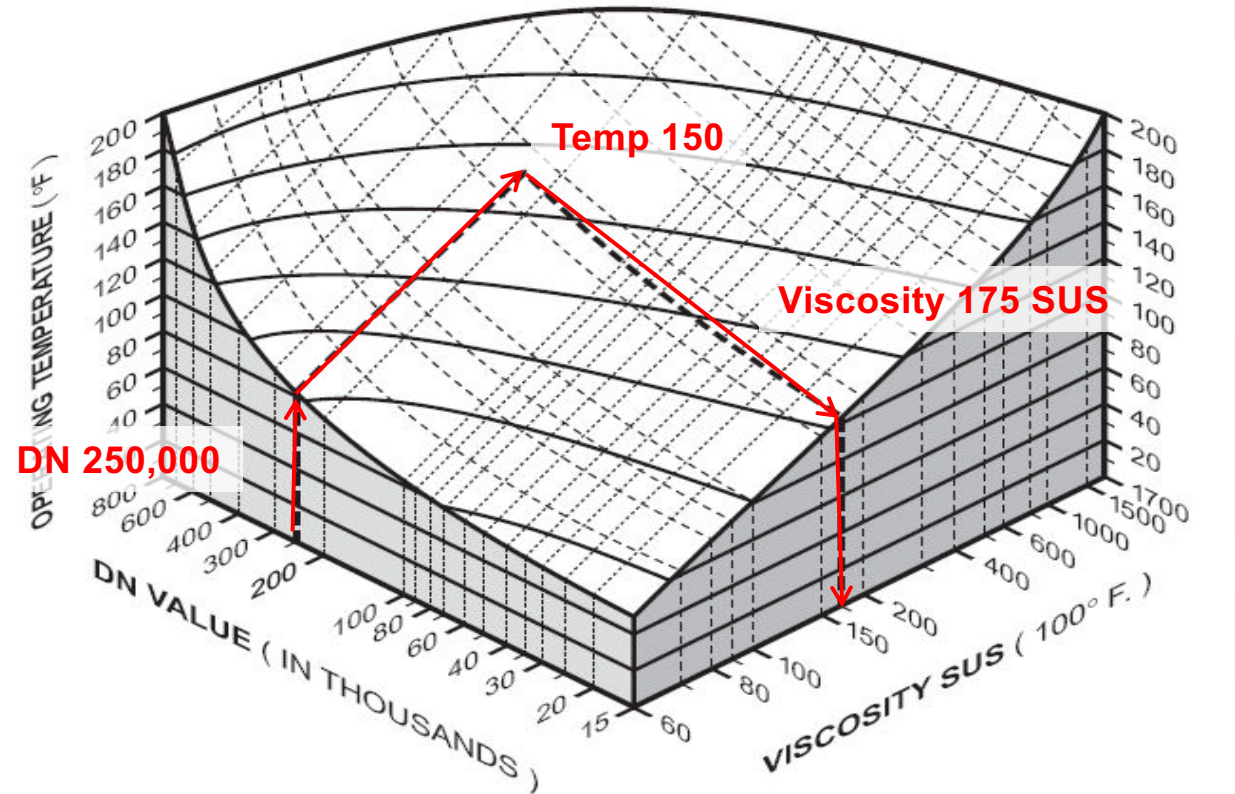
- Viscosity selected by
  - Temperature
  - Speed
  - Load





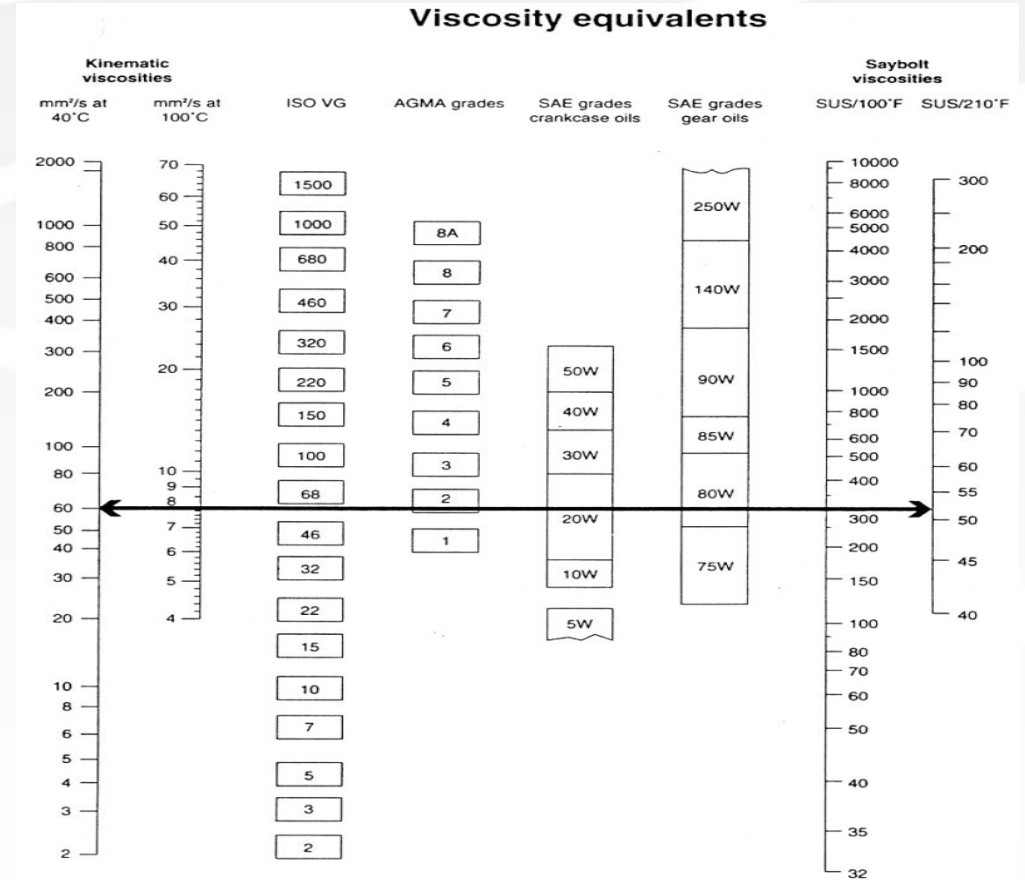
# How Viscosity is Selected

- 6314 Bearing, 3600 RPM
- 150F (65C)
- $DN = 70\text{mm} \times 3600 = 252,000$
- From Chart Viscosity = 175 SUS (+- ISO VG32)





# Viscosity Equivalents



Viscosities based on 95 VI single-grade oils.  
ISO grades are specified at 40°C.  
AGMA grades are specified at 100°F.  
SAE 75W, 80W, 85W, and 5 and 10W specified at low temperature (below -17°F = 0°C).  
Equivalent viscosities for 100°F and 210°F are shown.  
SAE 90 to 250 and 20 to 50 specified at 210°F (100°C).





# Other Properties

- Acidity vs Alkalinity
  - TAN Acid for mineral Oils
  - TBN Alkalinity for Engines
- Oxidation Resistance
  - Becomes darker
  - Becomes acid and corrosive
  - Increases in viscosity
  - Forms harmful deposits (varnishes, gums)
  - Metals accelerate Oxidation (Contaminants)
  - 10C deg above 60 C
- Water Separation
  - 0.1% = 1000ppm
- Pour Point
- Demulsability
  - Water Separation
- Flash Point
- Color



# Additives

- Surface Additives...Protecting lubricated surfaces.
  - Corrosion inhibitors
  - EP/Anti Wear
  - Tackiness... Long chain polymers
  - Detergents/Dispersants
  - Compounded Oils...lubricity improvements...worm gears
- Performance Enhancing... Improving oil performance.
  - Pour Point
  - VI Improvers
  - Emulsifiers...coolants, cutting oils
  - Demulsifiers...normal for industrial applications
- Lubricant Protective... Protecting the lubricant itself.
  - Oxidation Inhibitors
  - Anti Foam



# CLEANLINESS STANDARDS



# What is Practical Cleanliness?

- Machine type and operating context
- Machine component clearances
- Lubricant type
- Lubricating delivery system
- Lubricating system volume and flow rate
- Operating environment
  - Types of potential contaminants
  - Likelihood of contamination
- Machine criticality
- Plant lubricant storage and handling practices
- Mean time between failure (repair history)
- Repair costs
- Lost production costs
- Lubricant purchase costs
- Lubricant change frequencies and volumes
- Lubricant disposal costs
- Contamination control system capital costs and operating expenses
- Health, safety, and environmental considerations
- Initial lubricant particle counts, water concentration, and ingress rates



# ISO Cleanliness

- 16/15/12
- 4 $\mu$ m/6 $\mu$ m/14 $\mu$ m

## Range of number of particles per milliliter:

<i>Code</i>	<i>More Than</i>	<i>Up to &amp; Including</i>
<b>24</b>	80,000	160,000
<b>23</b>	40,000	80,000
<b>22</b>	20,000	40,000
<b>21</b>	10,000	20,000
<b>20</b>	5,000	10,000
<b>19</b>	2,500	5,000
<b>18</b>	1,300	2,500
<b>17</b>	640	1,300
<b>16</b>	320	640
<b>15</b>	160	320

<i>Code</i>	<i>More Than</i>	<i>Up to &amp; Including</i>
<b>14</b>	80	160
<b>13</b>	40	80
<b>12</b>	20	40
<b>11</b>	10	20
<b>10</b>	5	10
<b>9</b>	2.5	5
<b>8</b>	1.3	2.5
<b>7</b>	.64	1.3
<b>6</b>	.32	.64

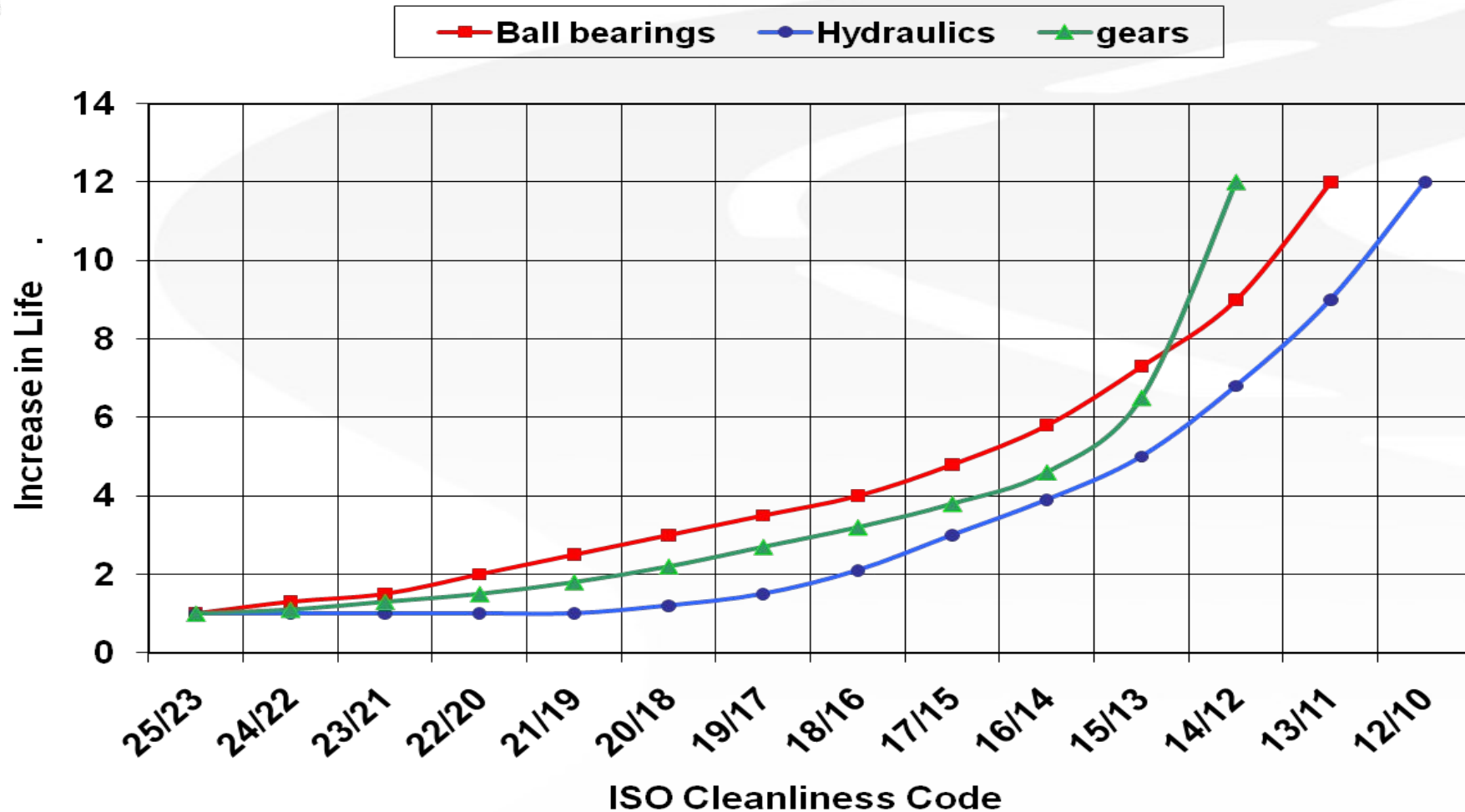


# Target ISO Cleanliness (General Machinery)

<b>Machine/Component</b>	<b>Typical Target ISO Cleanliness Code (ISO 4406:1999)</b>
Servo valve	13/12/10
Proportional valve	14/13/11
Variable volume pump	15/14/12
Fixed piston pump	16/15/12
Vane pump	16/15/12
Gear pump	16/15/12
Ball bearing	14/13/11
Roller bearing	15/14/12
Journal bearing	16/15/12
Industrial gearbox	16/15/12
Turbine	17/15/12
Diesel engine	17/16/14
Paper machine	18/16/13



# Effects of Improving Cleanliness on Machine Life



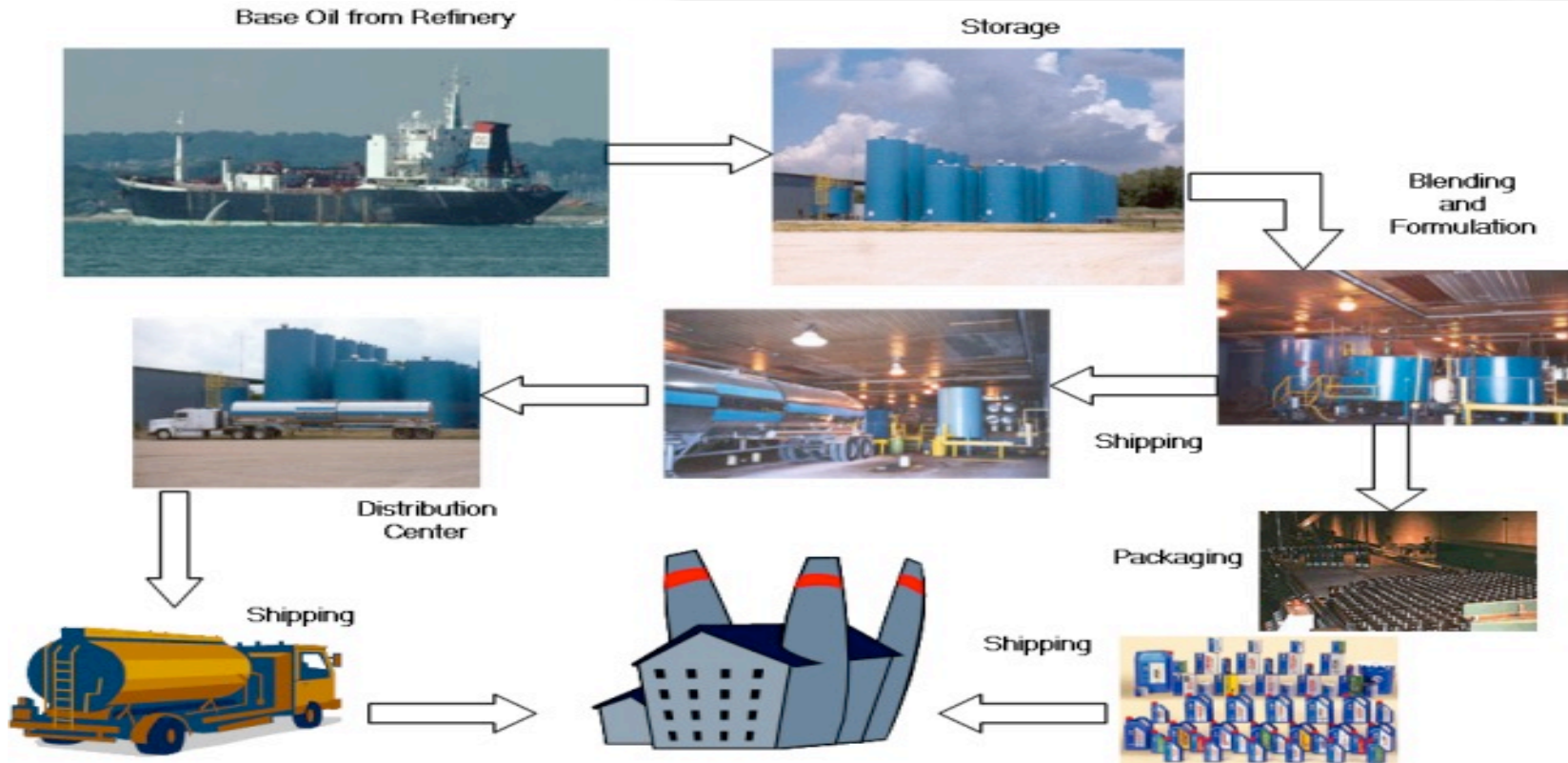


# SOURCES OF CONTAMINATION

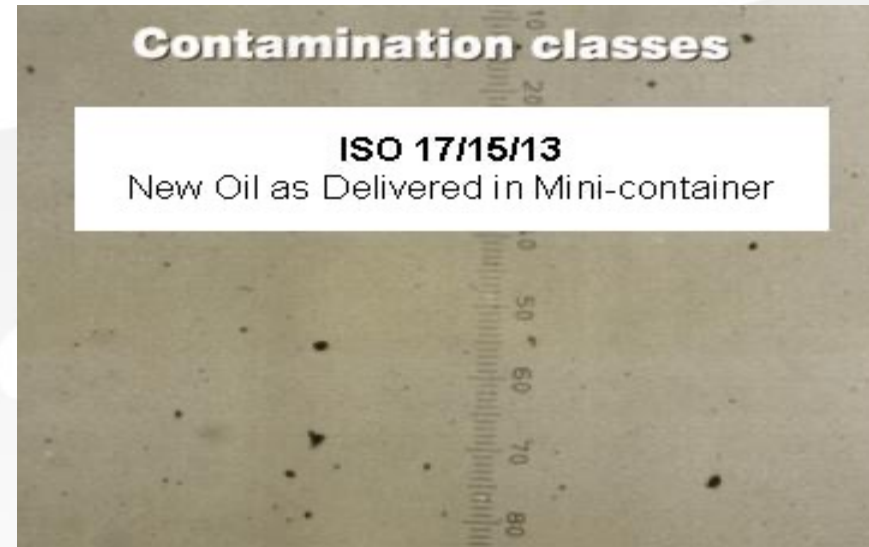
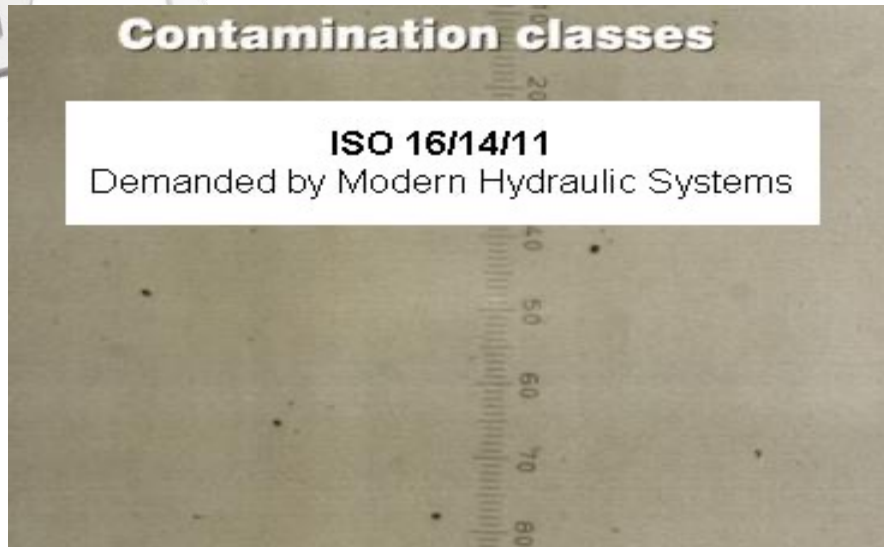




# New Oil Contamination



# New Oil Sample Patches





# How do we get clean oil?

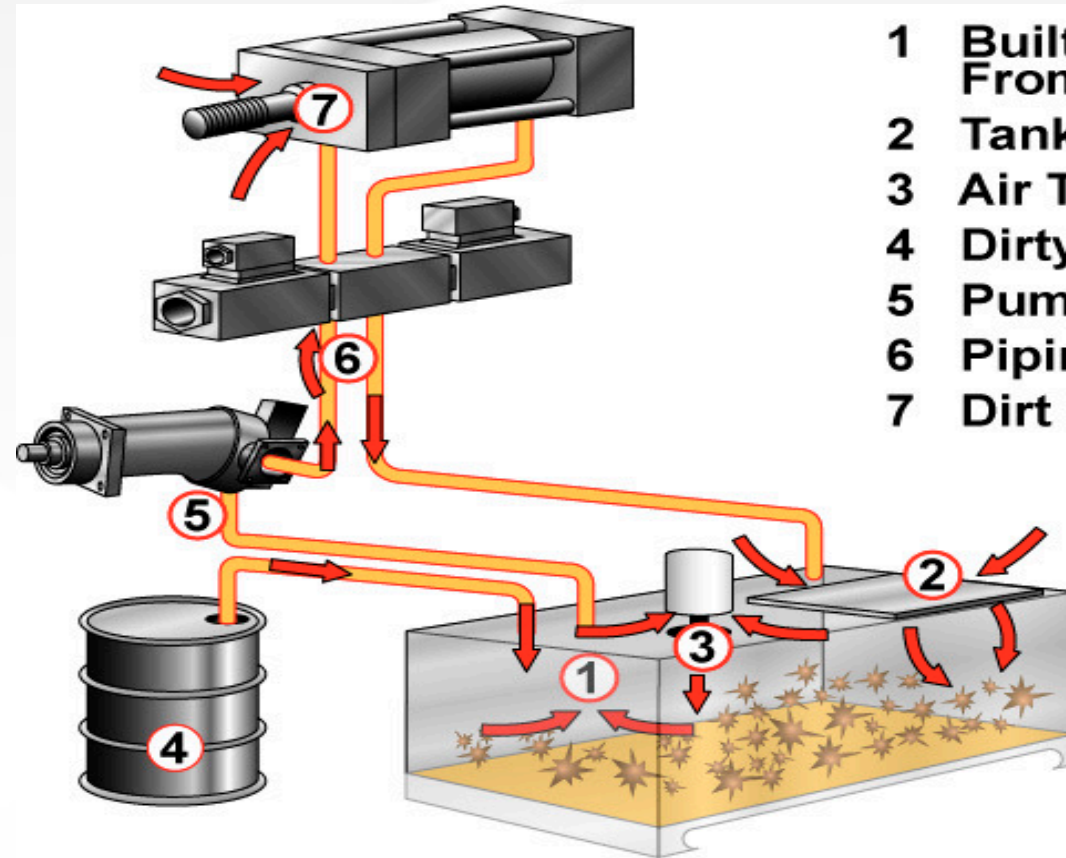
- Incoming Sampling regimen
- Inbound Filtration
- Do not use reconditioned Drums unless drum liners are used





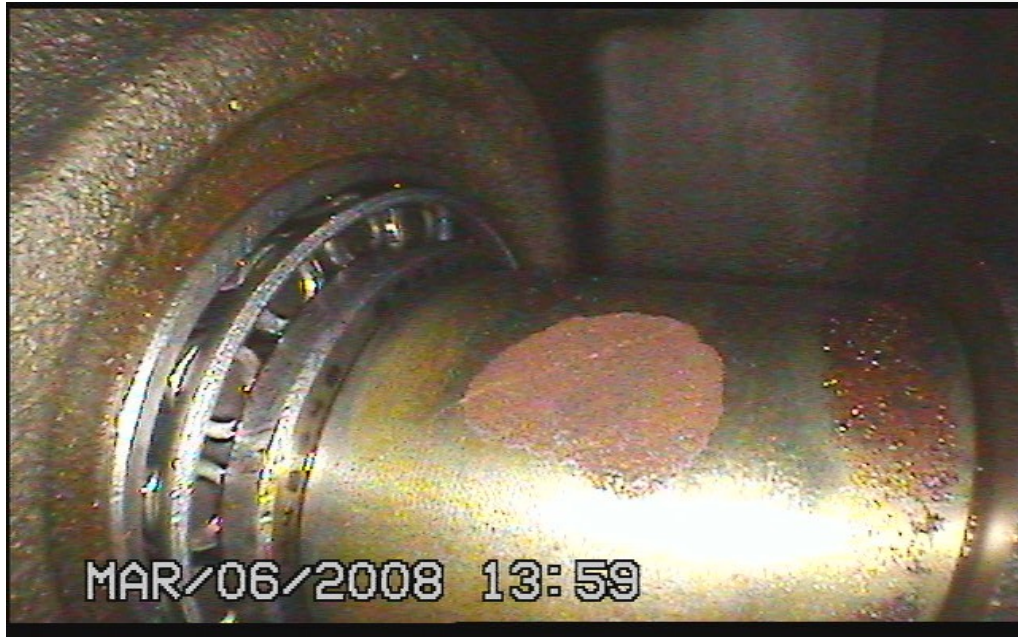
# Machine Contamination

- Built-in
- System Generated
- Externally Introduced



- 1 Built-In or From Maintenance
- 2 Tank Leakage
- 3 Air Through Breather
- 4 Dirty New Oil
- 5 Pump Wear
- 6 Piping Scale
- 7 Dirt On Rods

# Built In





# Machine Contamination

- Externally Introduced

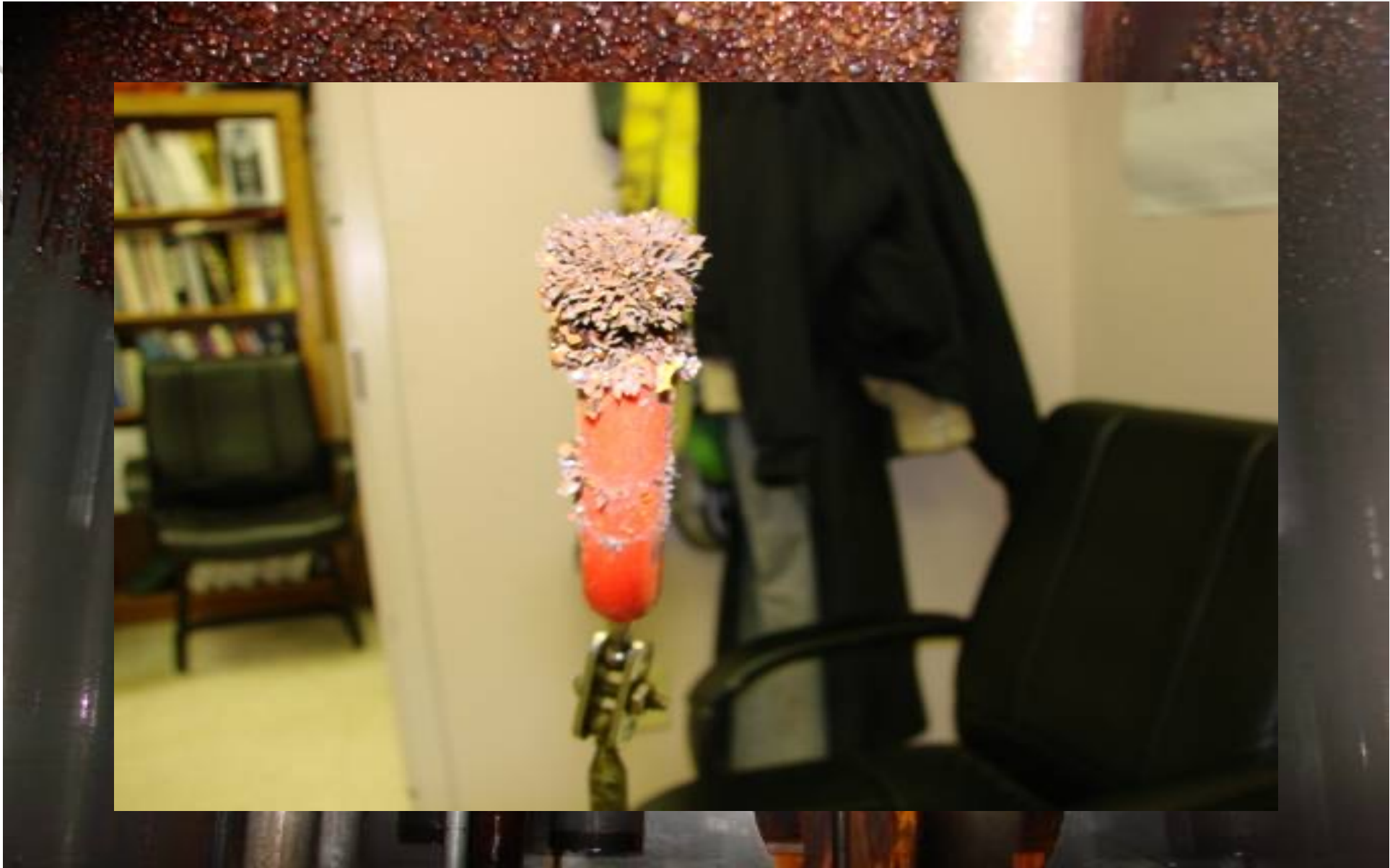




# Water Contamination

- Absorption
  - Solubility
- Condensation
  - Temperature Change
- Heat Exchangers
- Free Water



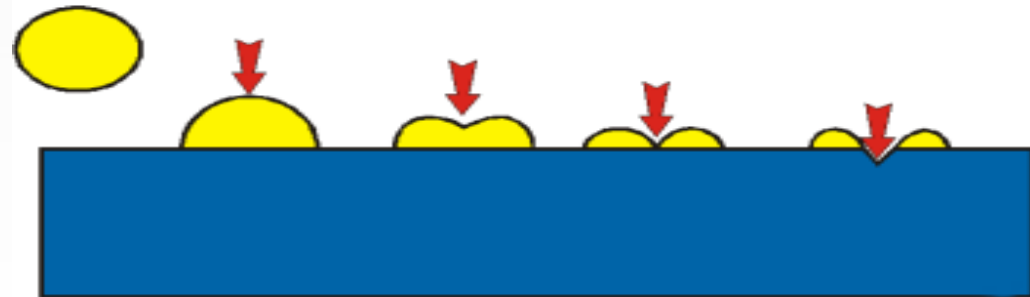






# Effects of Water In Oil

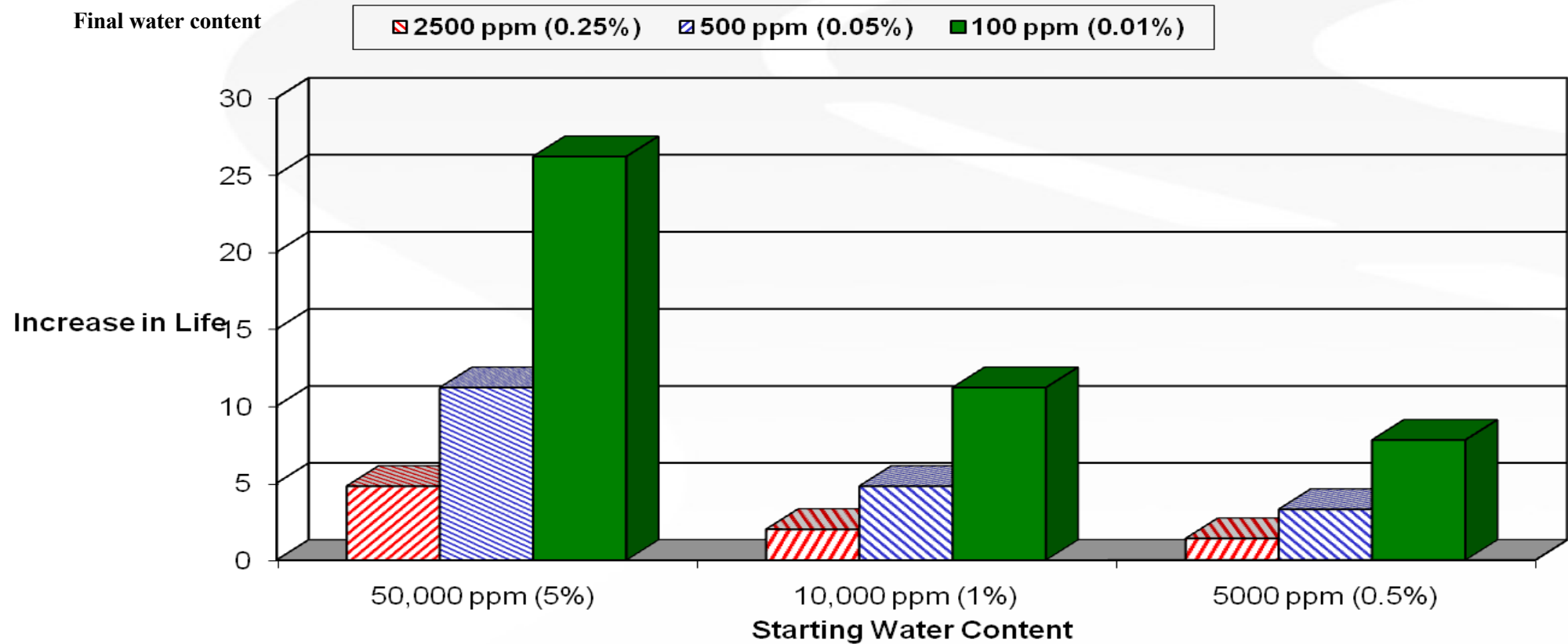
- Viscosity
- Fluid Film Strength
- Cavitation
- Oxidation
- Corrosion





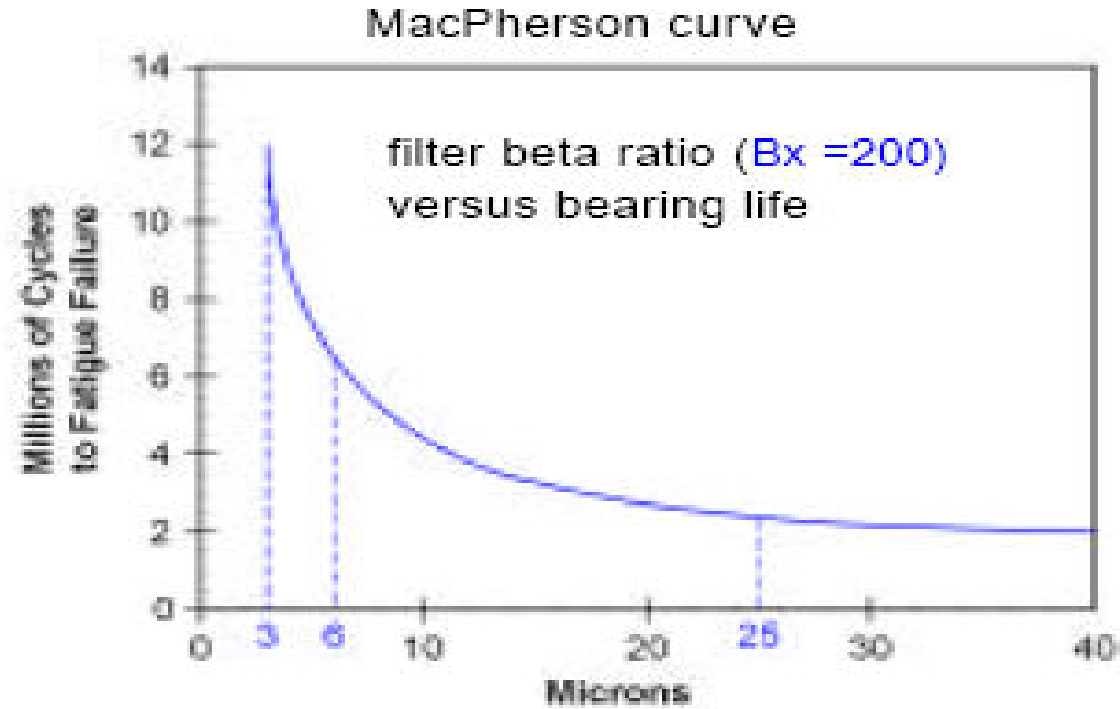
# Water and Bearings

Effect of Reducing Water Contamination on Rolling Element Bearing Life



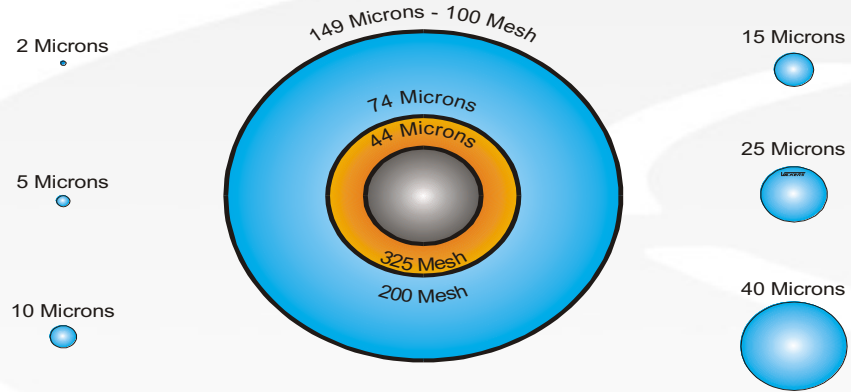


# Solid Contaminants





# Solid Contaminants Sizes



Grain of salt .....	100 Microns
Average human hair .....	74 Microns
Limit of visibility to unaided human eye .....	40 Microns
White blood cells .....	25 Microns
Red blood cells .....	8 Microns
Bacteria (COCCI) .....	2 Microns

1 Inch .....	25.4 Millimeters	25,400 Microns
1 Millimeter .....	0.0394 Inches	1,000 Microns
1 Micron .....		0.001 Millimeters
1 Micron .....		0.000039 Inches

Mesher per linear inch	U.S. Sieve number	Opening in inches	Opening in microns
52.36 .....	50 .....	0.0117 .....	297
72.45 .....	70 .....	0.0083 .....	210
101.10 .....	100 .....	0.0059 .....	149
142.86 .....	140 .....	0.0041 .....	105
200.00 .....	200 .....	0.0029 .....	74
270.26 .....	270 .....	0.0021 .....	53
323.00 .....	325 .....	0.0017 .....	44
		0.00039 .....	10
		0.000019 .....	5

Figure 6-13 Particle size relationships  
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# Applying Lubricants



# Initial Lubrication Quantity

- How Much Depends upon
  - Application
  - Bearing and Retainer Design
  - Housing Design
  - Type of Grease Used
- Can be as Little as 20 %
  - High speed high precision
- As Much as 80%
  - Low Speed Application
- Oscillating Service 100%
  
- Rule of Thumb
  - $\frac{1}{3}$ <sup>rd</sup> to  $\frac{1}{2}$  Cavity



# Re-lubrication Quantity

## Imperial Units

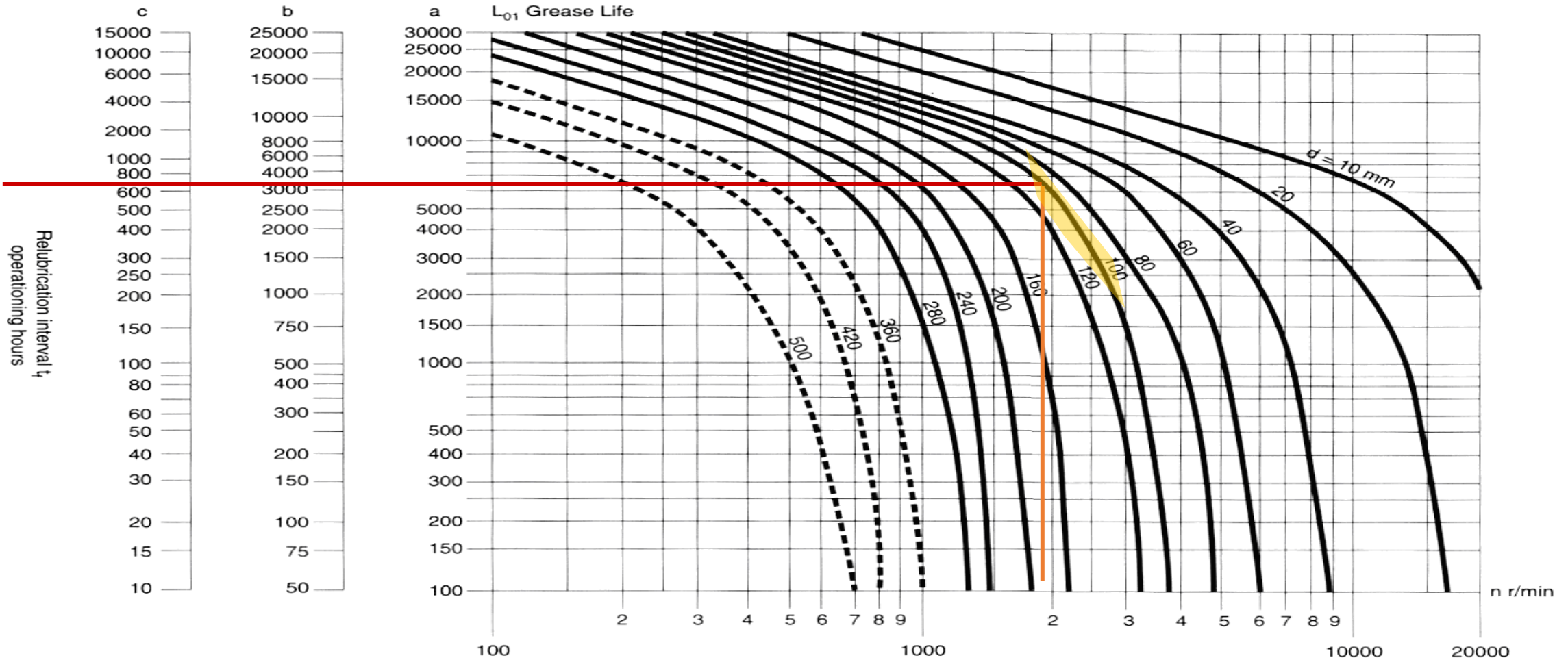
- Grease Quantity (oz.)
- =  $0.1 \times B \times D$ 
  - B = Width of Bearing (in)
  - D = OD of Bearing (in)

## Metric Units

- Grease Quantity (g)
- =  $0.005 \times B \times D$ 
  - B = Width of Bearing (mm)
  - D = OD of Bearing (mm)

- Grease Gun Calibration

# Relubrication Intervals



**Scale a:** radial ball bearings

**Scale b:** cylindrical roller bearings, needle roller bearings

**Scale c:** spherical roller bearings, CARB™ toroidal roller bearings, taper roller bearings, thrust ball bearings; cylindrical roller thrust bearings, needle roller thrust bearings, spherical roller thrust bearings (0.5 $t_r$ ); crossed cylindrical roller bearings with cage (0.3 $t_r$ ); full complement cylindrical roller bearings (0.2 $t_r$ )

**d:** bearing bore diameter (mm)





# Modifiers

Environmental Factors	Description	Multiply Interval by
Temperature	Housing below 150°F (65°C)	1.0
	Housing 150-175°F (65-80°C)	0.5
	Housing 175-200°F (80-95°C)	0.2
	Housing above 200°F	0.1
Contamination	Light non-abrasive dust	1.0
	Heavy non-abrasive dust	0.7
	Light abrasive dust	0.4
	Heavy abrasive dust	0.2
Moisture	Humidity less than 80%	1.0
	Humidity between 80% and 90%	0.7
	Occasional condensation	0.4
	Occasional water on housing (wash down)	0.1
Orientation	Horizontal	1.0
	Inclined (45 deg)	0.5
	Vertical	0.3



# Digital Lubrication Management

# QUESTIONS?

Contact Us!



Tim Dunton, Director | [timdunton@ReliabilitySolutions.net](mailto:timdunton@ReliabilitySolutions.net) | +1 (251)-599-7828