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Bearing and Equipment Lubrication Strategies - Getting it Right.

What is it and Why Do It?

Today we talk about
Lubrication Reliability

1. What is it & Why Do It?
2. Proactive Maintenance.
3. Assessments - Getting Started.
4. Management.
5. Implementation .
6. Lubrication Root Cause Failure Analysis

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What is it and Why Do It?

The Impact.

➢ Direct effect on reliability!
➢ Reduces failures!
➢ Reduces wear!
➢ Uses less bearings!
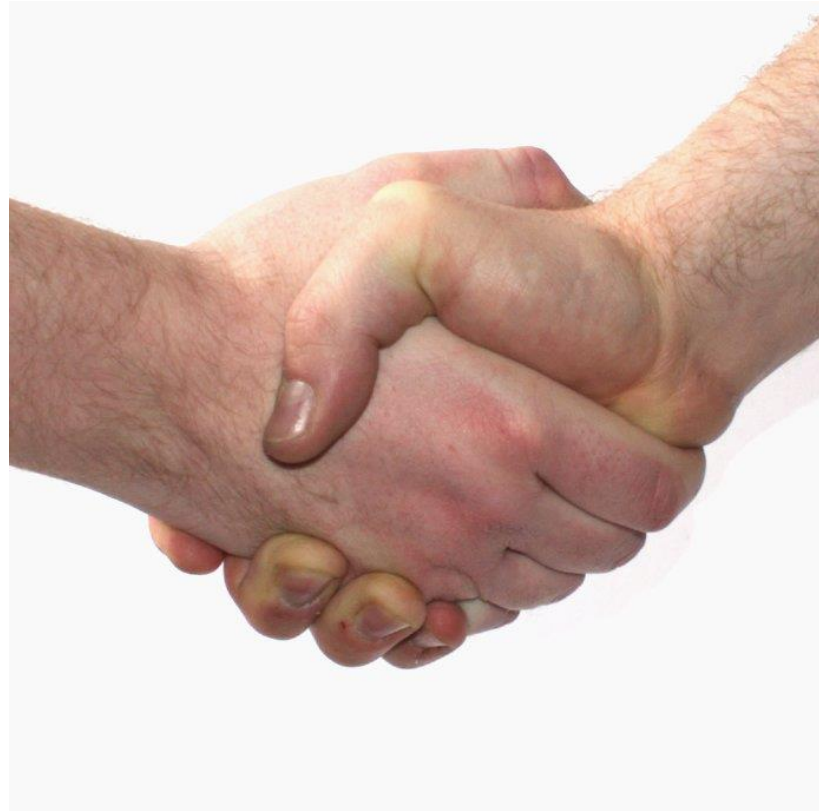➢ Reduces lube consumption!
➢ Increases business results!

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It's Not Easy!

The 6 Lubrication R's

- ➤ The *right* Lube.
- ➤ The *right* Time.
- ➤ The *right* Amount.
- ➤ The *right* Way.
- ➤ In the *right* Condition.
- ➤ Kept in the *right* Condition.
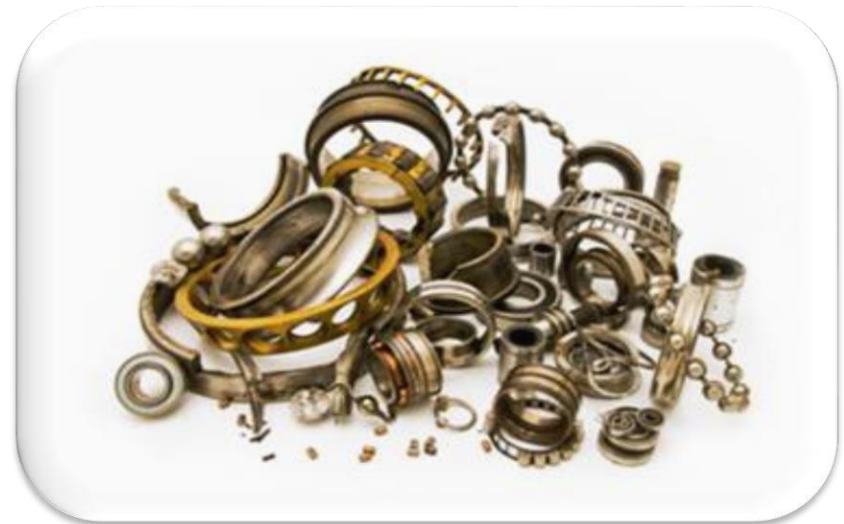
What is it and Why Do It?

The Evidence!

Over 60% of bearing failures are lubrication related.

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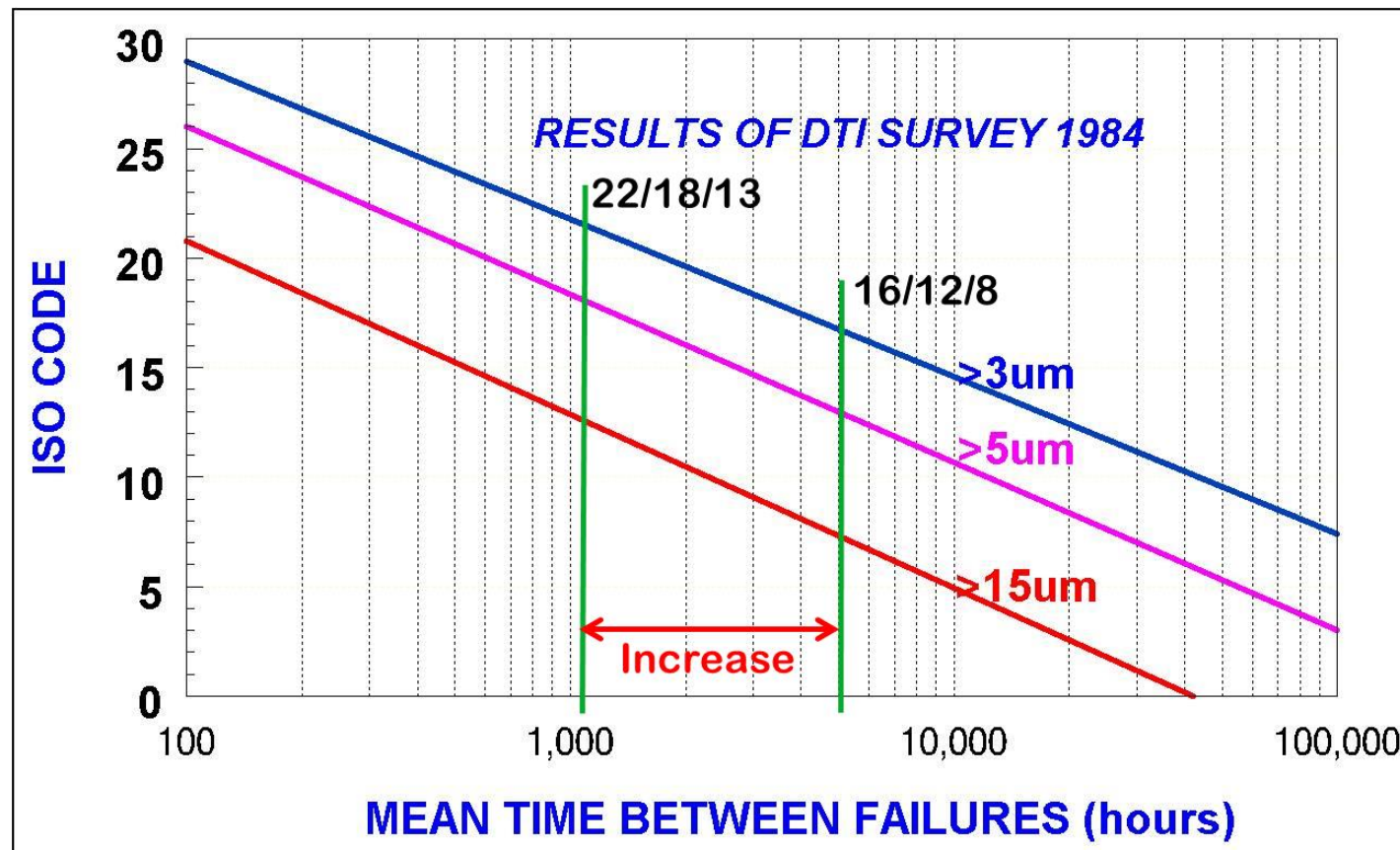
What is it and Why Do It?

Our own Evidence!

➤ **Over 60% of bearing failures are lubrication related.**

➤ **15%** were due to poor **maintenance issues.**

➤ **5%** were due to **ignorance issues.**
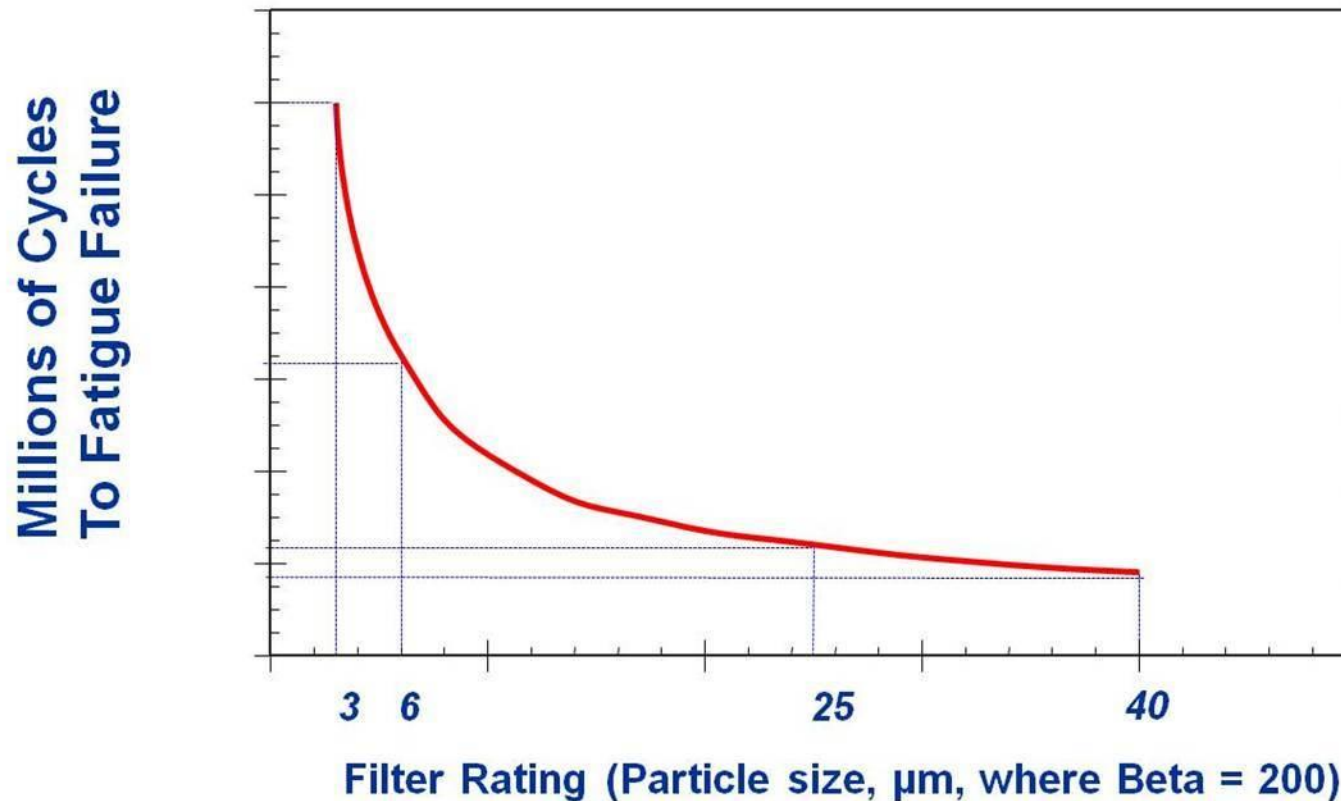
➤ **15%** The balance (approx) **in good condition**

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Important Consideration

RESULTS OF DTI SURVEY 1984

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BEARING RELIABILITY CONFERENCE & EXPO

Important Considerations

Ref Dr. D.P. MacPhearson of Westland Helicopters Ltd.

Millions of Cycles To Fatigue Failure (y-axis)

Filter Rating (Particle size, µm, where Beta = 200)

3 6   25   40

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What is it and Why Do It?

Important Considerations

Important Considerations

Approx. 20 μm

Lubrication Film Thickness.
➢ 1/20th of a strand of hair.
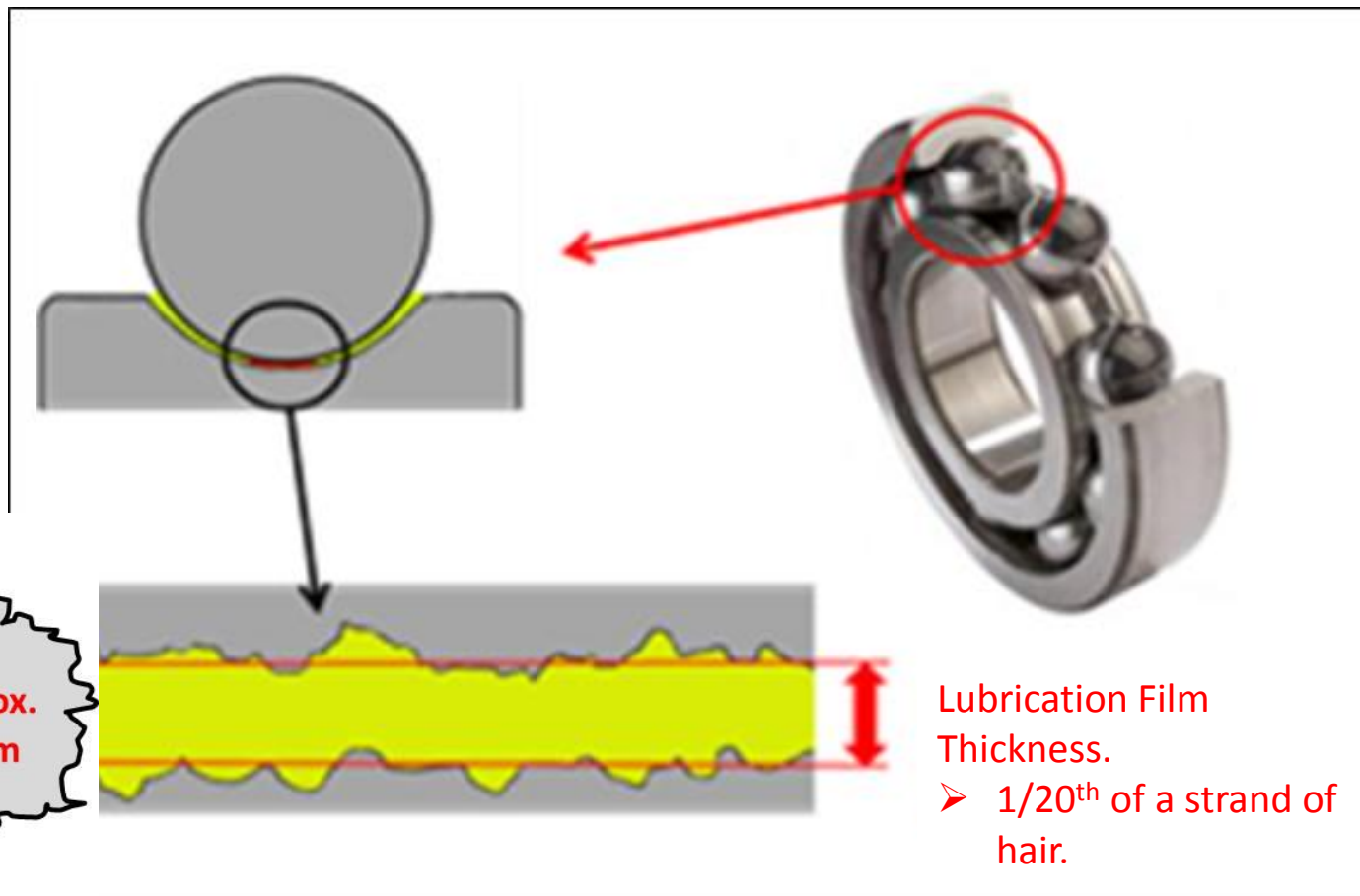
What is it and Why Do It?

Lubrication Reliability Summary

1. Lubrication causes bearing damage

2. Bearings are the machine center

3. Lubrication must work reliably

4. Machine reliability will improve

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Lubrication Reliability
Part 2. ProActive Maintenance

ProActive Maintenance

We Start with The 6 Lubrication Rights.

- Right Lube
- Right Time
- Right Qty
- Right Way
- Right Condition
- Maintained Right

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ProActive Maintenance

The Right Lube

Many different lubes to select from.

- Different viscosities
- Different additives
- Different brands
- Not all are compatible

Don't allow mixing!

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ProActive Maintenance

The Right Time

Oil and grease needs to be replenished.

- We might forget
- Outages can interfere
- We may over or under lube
- Frequency is application driven

Don't miss a schedule!

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ProActive Maintenance

The Right Quantity

Speed, load & temperature defines the quantities needed.

- Don't over lube - heat!
- Don't under lube - starvation!
- Do we measure?
- Grease gun quantities!

Keep the machines fed!

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ProActive Maintenance

The Right Way

Oil and grease needs to be dispensed correctly.

- No spillage!
- No contamination!
- Quantities measured
- Environmental protection

Satisfy the environment & the machines!

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The Right Condition

Dirty or contaminated lube causes wear and damage.

- Use only clean oil
- Clean it in the storeroom
- Unclean containers pass on dirt
- It is a clinical process!

Use only clean lubricants!

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ProActive Maintenance

Kept in the Right Condition

Oil in machines can become contaminated.

- Poor quality air breathers
- Operational contamination
- Oxidation can occur
- Are we filtering the dirty oil?

Keep operating lube clean!

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ProActive Maintenance

Important Considerations!

Prediction?   Strategy?   Data Base?

6th R – Maintained in the Right Condition.

- ➢ Kept Clean
- ➢ Chemically Sound

…. Working Reliably!

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ProActive Maintenance

Explaining ProActive Maintenance

A process of eliminating failures or problems that could be repetitive.

Based on the Deming Model of Plan, Do, Check and Act

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ProActive Maintenance

Plan, Do, Check and Act.

ProActive Maintenance

Must start with defined standards.

	Oil Analysis					
Line #1	Oilcirculation system	256348	28-feb-05	15/12		19/15
Line #2	Oilcirculation system	256349	14-feb-05	15/12		17/12
Line #3	Oilcirculation system	256350	14-feb-05	15/12		16/13
Line #4	Oilcirculation system	256351	23-feb-05	15/12		na
Line #5	Oilcirculation system	256352	14-feb-05	15/12		15/12
Line #6	Oilcirculation system	256353	14-feb-05	15/12		19/14
Line #7	Oilcirculation system	256354	17-mrt-05	15/12		16/12
Line #8	Oilcirculation system	256355	14-feb-05	15/12		15/11
Line #9	Oilcirculation system	256356	14-feb-05	15/12		17/13
Line #10	Oilcirculation system	256357	14-feb-05	15/12		19/16
Line #11	Oilcirculation system	256358	29-nov-04	11/9		16/12
Line #12	Oilcirculation system	256359	14-feb-05	15/12		14/10
Line #13	Oilcirculation system	256360	15-jul-04	11/9		16/13
Line #14	Oilcirculation system	256361	14-feb-05	15/12		16/12
Line #15	Oilcirculation system	256362	19-nov-04	11/9		17/13
Line #16	Oilcirculation system	256363	14-feb-05	15/12		16/13
Line #17	Oilcirculation system	256364	14-feb-05	15/12		na
Line #18	Oilcirculation system	256365	14-feb-05	15/12		16/12
Line #19	Oilcirculation system	256366	14-feb-05	15/12		15/12
Line #20	Oilcirculation system	256367	14-feb-05	15/12		15/12
Line #21	Oilcirculation system	256368	16-nov-04	11/9		16/13
Line #22	Oilcirculation system	256369	12-aug-04	11/9		16/13
Line #23	Oilcirculation system	256370		11/9		

Lubrication Reliability
Part 3. Assessments – Getting Started

Assessments – Getting Started
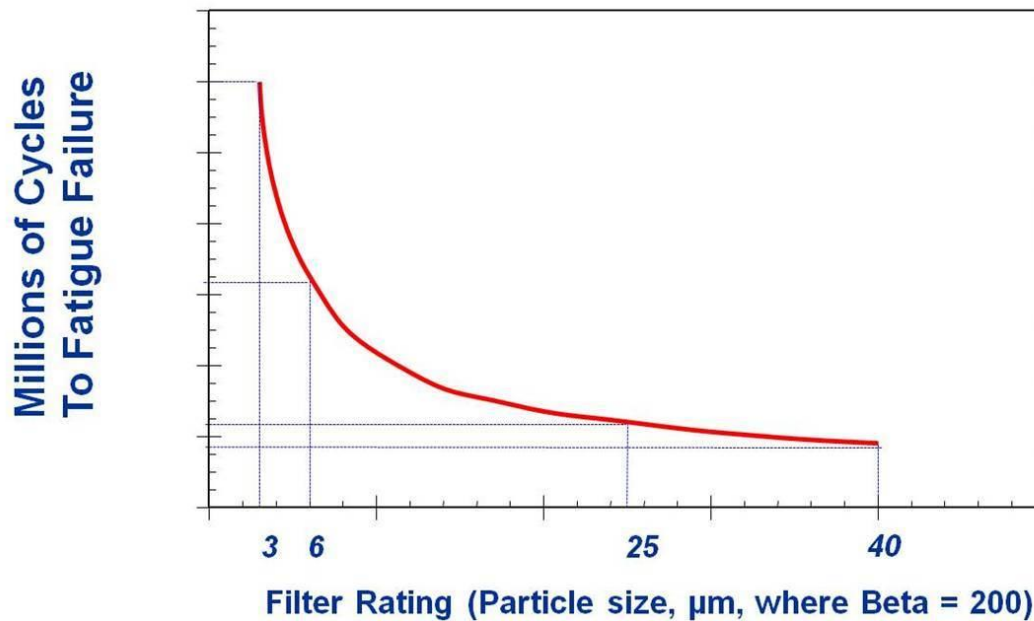
Fundementals!

Questions to answer

➢ Will a better strategy help us with our Reliability?

➢ Where are we compared to Best Practices?

➢ What are we doing Right?

➢ What are we doing Wrong?

➢ How much will it cost?

➢ Who will do it - Our self or via a Contractor.

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Will a better strategy help us with our Reliability?

Ref Dr. D.P. MacPhearson of Westland Helicopters Ltd.

Millions of Cycles To Fatigue Failure vs. Filter Rating (Particle size, μm, where Beta = 200)

3   6   25   40

Assessments – Getting Started

Where are we compared to Best Practices?

➢ **Do you have an oil cleanliness standard?**

➢ **Do you have KPI's for bearing and Lube consumption?**

➢ **Do you apply the 6R's concept to each point?**

➢ **Are you doing RCFA on all damaged parts?**

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Assessments – Getting Started

What are we doing Right?

Assessments – Getting Started

What are we doing Wrong?

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How much will it cost?

Consider it as an Investment.

And

Show the potential R.O.I.

Assessments – Getting Started

Strategic Parts!

All activities to improve reliability

Processes & tools to reduce equipment wear and damage

The people and their commitment to the work

Administration of the work to be done

Lubrication Strategy

Contamination Control

Lubrication Knowledge and Application

Data Base Management and Reporting

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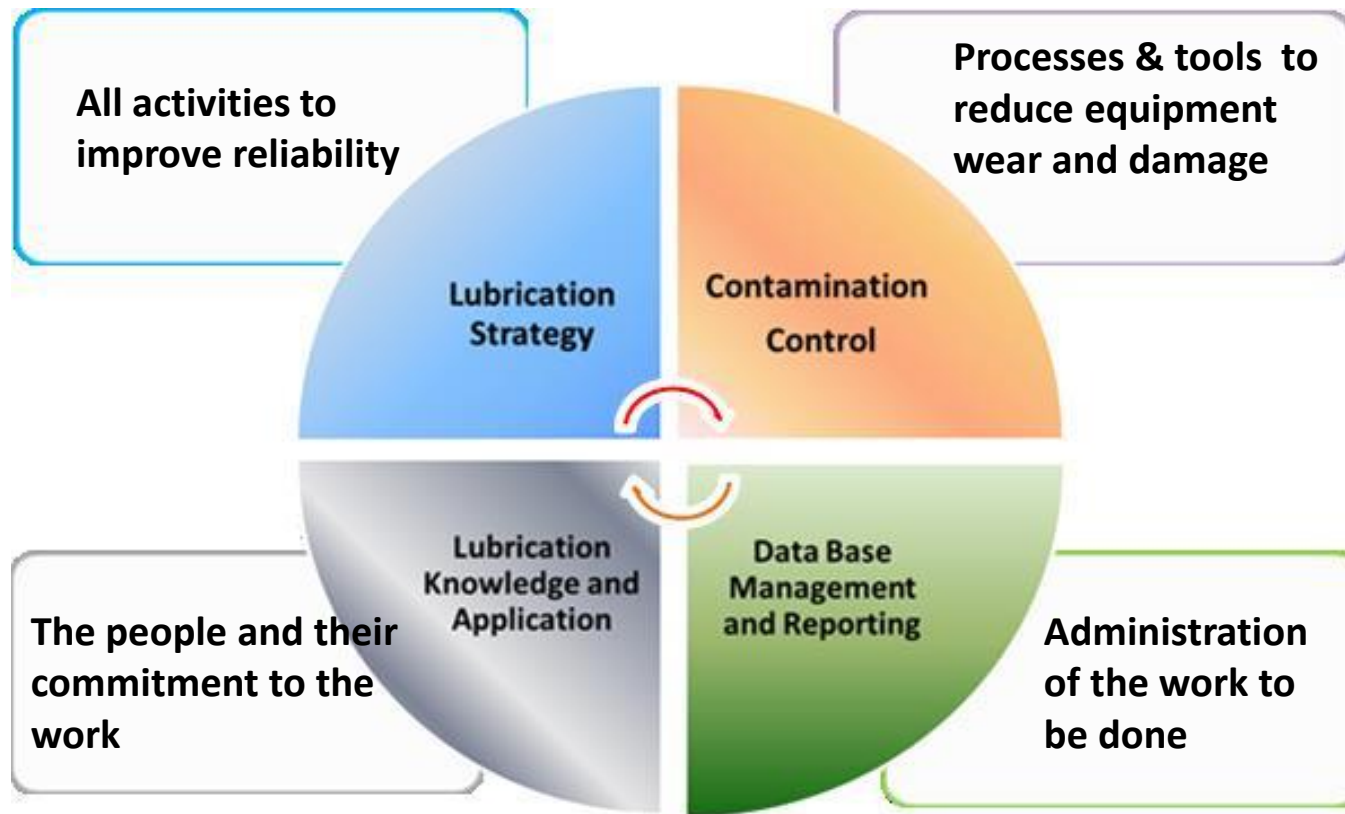
Assessments – Getting Started

Maturity / Development Levels

Activity

- Lubrication Strategy
- Cleanliness and Contamination Control
- Data Base Management and Reporting
- Lubrication Knowledge and Application
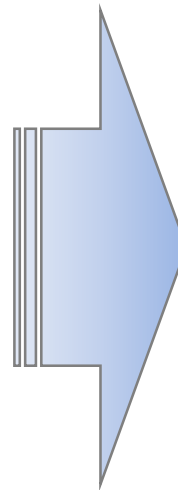
Maturity Level

- Asset Efficiency Culture
- Proactive Lubrication Management
- Lubrication Processes
- Basic Requirement

Assessments – Getting Started

Targets

	Lubrication Strategy	Cleanliness & Contamination Control	Data Base Management and Reporting	Lubrication Knowledge & Application
Asset Efficiency Culture	KPI's on Lube Effect to Reliability	Overall Plant Cleanliness Measurements	Integrated and Seamless to CMMS	Measurement of Activity Effectiveness
Proactive Lubrication Management	RCFA on all failed Parts	Oil Analysis and Evaluation	Dedicated Lube Software	Integrated in Reliability Program
Lubrication Processes	Instructions for the Work	Procedures for Reducing Contamination	Maintenance Planning Controls	Trained Staff on Lubrication
Basic Requirement	Dedicated Resources	Lube Room Standards in Place	Data Base Existence	Cost verses Investment in Uptime

Assessments – Getting Started

Document your Plan

Lubrication Reliability
Part 4. Management

Management

Overview

Prediction.
Oil Analysis and
Contamination Control.

Data Base.
How we control the activity.

ROI.
Return on Investment

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Management

**Prediction.
Oil Analysis and
Contamination Control.**
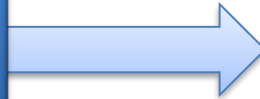
Determining when the lubrication is not working reliably.

Contamination
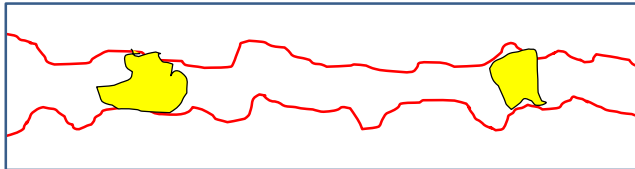
Loss of Lube Film Thickness
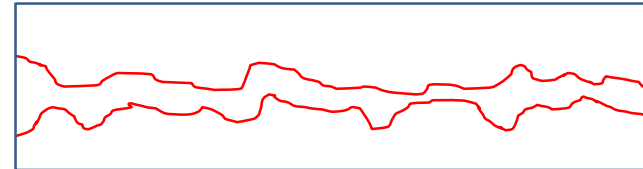
Oil Analysis

Oil Analysis

Vibration

Thermography

Ultra Sonics

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Management

Prediction.
Oil Analysis and
Contamination Control.

→

Determining when the lubrication is not working reliably.

Oil Analysis

Testing for:-
- ➤ Viscosity
- ➤ Oxidation
- ➤ Water
- ➤ Solid contaminants
- ➤ Loss of additives

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Management

Number 1 cause of damage is 3 Body Abrasive Wear

Management
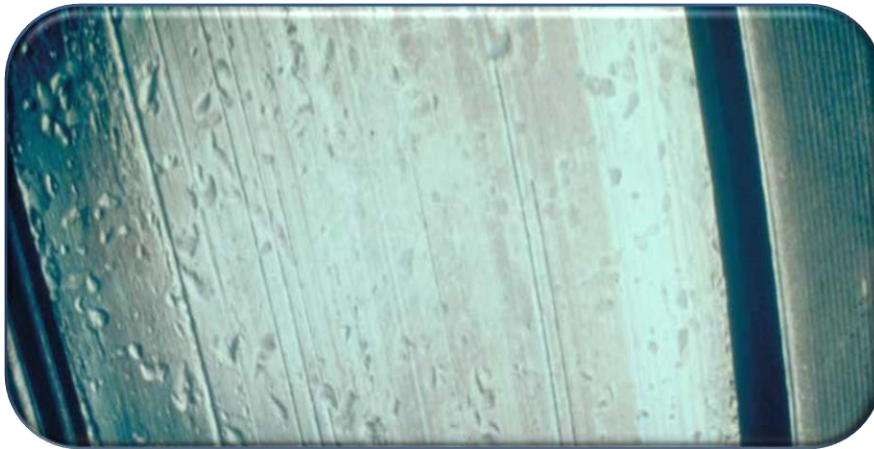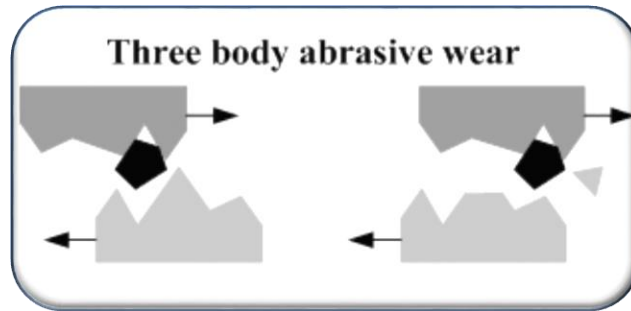
KPI for Oil Cleanliness = ISO 4406

➢ **Shown by 3 numbers (22/18/13)**
➢ **Number of particles of 4, 6, and 14 μm, in 1 ml of oil.**

Example = ISO Code 22/18/13

Larger than 4 μm = 22,340

Larger than 6 μm =   1,950

Larger than 14 μm =   43

Allocation of Particle Count Scale Numbers

ISO Scale Number	Particles per milliliter	
	More than	**Less than**
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.25	2.5

Table 2: ISO 4406 Allocation of particle count scale number

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Management

The Effects Of Filtration

Ref Dr. D.P. MacPhearson of Westland Helicopters Ltd.
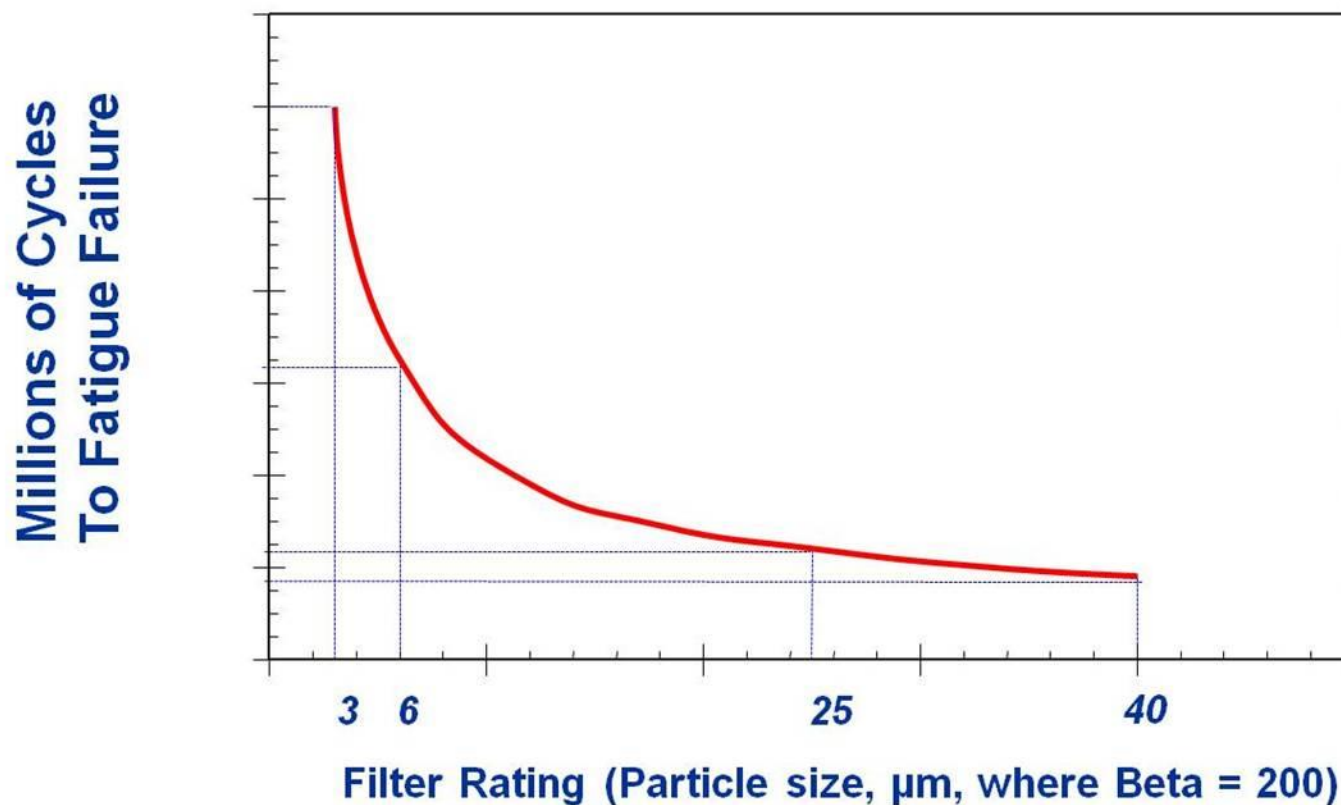
The Dirty Path of Contamination

Oil arrives on site
ISO 18/16/13

Oil barrel left open
ISO 20/18/15 (4x)

Dirty stick used to check level
21/19/16 (8x)

Oil dispensed in dirty container
ISO 22/20/17 (16x)

Dirty hoses and funnels used
ISO 23/21/18 (32x)

Machine run without protection
ISO 24/22/19 (64x)

WEAR AND FAILURE

Management

How Do Contaminants Accumulate?

ISO Code	4 µm More than	Up to & incl.	6 µm More than	Up to & incl.	14 µm More than	up to & incl.
24/22/19	80,000	160,000	20,000	40,000	2,500	5,000
18/16/13	1,300	2,500	320	640	80	160
16/14/11	320	640	80	160	10	20

250 times less contaminants from 24/22/19 to 16/14/11

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Management

Prevention Mechanisms

Prediction.
Oil Analysis and
Contamination Control.

Start with Clean Oil

Clean & Safe Dispensing

Ongoing Filtration

Data Base Management

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Management

Data Base.
How we control the activity.

Fact!

Most CMMS do not go down into enough details to manage the lubrication activity effectively.

1. **Plant structure**
   - Plant down to specific point.
2. **Activity / point**
   - Lube, Qty, Process, Freq.
3. **Time based Schedules**
   - Paper copies or Handheld PC's
4. **Closing out completed schedules**
5. **Enabling / Disabling points**
6. **Catering for shut down activities**
7. **Managing Routes**
   - Changing points / responsibilities
8. **Reporting activities and consumption**

Ease of use

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Management

Data Base.
How we control the activity.

Stand Alone
Vender Specific

Stand Alone
Vender Neutral

Internet Based
Vender Specific

Internet Based
Vender Neutral

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Management

ROI.
Return on Investment

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Management

ROI.
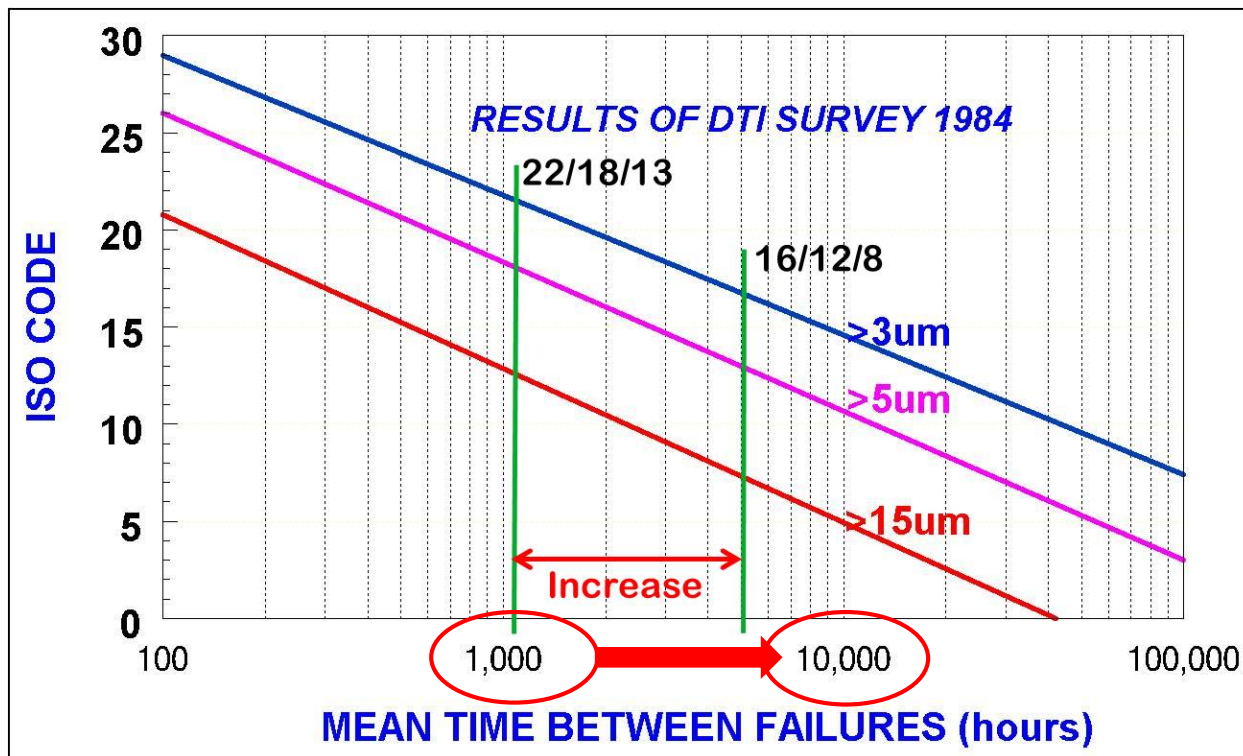
Return on Investment

Port of Tacoma Case Study
Improvements in Cleanliness of Diesel Engines

- ❑ **From 19/16 ISO code to 15/12 gave a 3 X Life Extension.**

- ❑ **Mean Time Between Engine Rebuilds, from 7,200 hours to 21,000 Hours.**

- ➢ **5 Year Net Gain = $ 702,391.00**
- ➢ **Rate of Return = 662%**
- ➢ **Payback Period = 2.04 m**

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Lubrication Reliability
Part 5. Implementation

Implementation Plan

Key Activities

1. Define the lubes and create a colour coded system.
2. Establish and fill a Data Base.
3. Set KPI's for the lubrication activity.
4. Create a clean and dry Lube storage facility.
5. Create a labelling system for storage, dispensing and the machines.
6. Initiate an Oil Analysis program to control the KPI's.
7. Train the key lubrication staff on all facets of lubrication.
8. Fit desiccant breathers to all key oil systems.
9. Establish a filtering system to keep the oil clean.

Implementation Plan

The Continual Check List!

We ask ourselves In all planning activities. *"Will this action ensure that we will always….."*

1. Add the *right* Lube in the right machine?
2. Add it at the *right* time.
3. Add the *right* amount of lube.
4. Done in the *right* way.
5. With it in the *right* condition.
6. And kept in the *right* condition.

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Implementation Plan

Define the lubes and create a colour coded system.

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The Lubrication Reliability Specialists

Oil LUBRICANT LABELING CONVENTION

COLOUR	SHAPE	TYPE OF LUBRICANT	NAME OF PRODUCT	VISCOSITY
RED	#1	Gear Box Oil	(Company & product name)	ISO ?
BLUE	#2	Gear Box Oil	(Company & product name)	ISO ?
MID GREEN	#3	Hydraulic Oil	(Company & product name)	ISO ?
BLACK	#4	Hydraulic Oil	(Company & product name)	ISO ?
GREY	#5	Transmission Oil	(Company & product name)	ISO ?
PURPLE	#6	Transmission Oil	(Company & product name)	SAE ?
BEIGE	#7	Compressor Oil	(Company & product name)	ISO ?
DARK GREEN	#8	General Lube Oil	(Company & product name)	ISO ?
YELLOW	#9	Turbine Oil	(Company & product name)	ISO ?
ORANGE	#10	Motor Oil	(Company & product name)	SAE ?

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Implementation Plan

Establish and fill a Data Base.
  Start with Key component standards

Implementation Plan

Establish and fill a Data Base.
Key Information.

Building ID
Route ID
Point ID
Lube ID and colour
Frequency Of lubrication
Quantity of lube to be added
Lubrication Schedule

Special Instruction
How to lube
Cleaning
Oil Analysis
Inspection
Filtering

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Implementation Plan

Create a clean and dry Lube storage facility.

Implementation Plan

Set KPI's for the lubrication activity.

- ➢ Oil Cleanliness levels per application.
- ➢ Lubrication Consumption
- ➢ Bearing Consumption.
- ➢ 100% of achieved schedule.
- ➢ 100% of RCFA on damages.

Implementation Plan

Create a labelling system for storage, dispensing and the machines.

Initiate an Oil Analysis program to control the KPI's.

Implementation Plan

Train the key lubrication staff on all facets of lubrication.

Fit desiccant breathers to all key oil systems. .
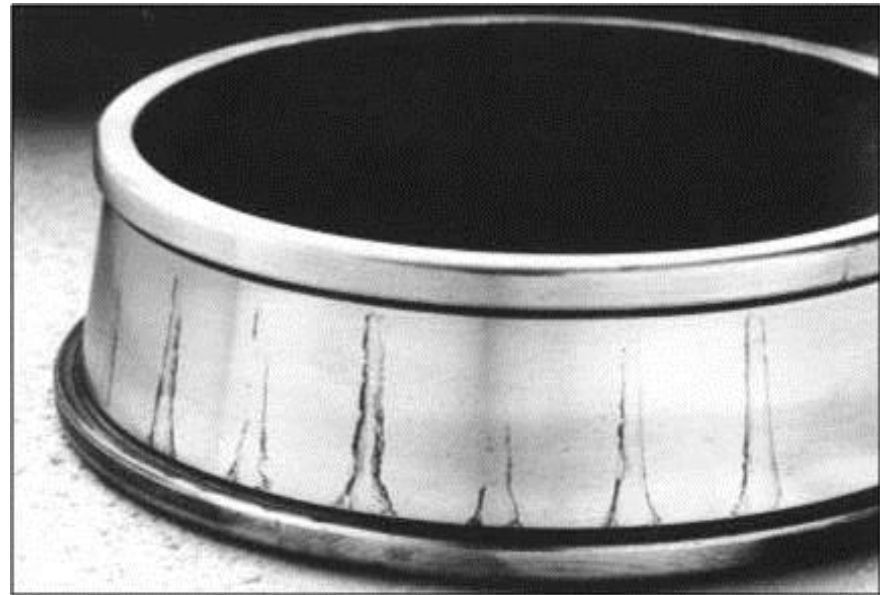
Establish a filtering system to keep the oil clean.

Implementation Plan

Train the staff on bearing Failure analysis.

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And finally to be innovative