Bearing and Equipment Lubrication Strategies - Getting it Right.
Today we talk about

Lubrication Reliability

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

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.
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
What is it and Why Do It?

Important Consideration

RESULTS OF DTI SURVEY 1984

ISO CODE

MEAN TIME BETWEEN FAILURES (hours)

>3um

>5um

>15um

Increase
What is it and Why Do It?

Important Considerations

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

![Graph showing correlation between Filter Rating (Particle size, μm, where Beta = 200) and Millions of Cycles to Fatigue Failure.](image-url)
What is it and Why Do It?

Important Considerations

- Silent Phase
- Prediction Phase
- Breakdown Phase

Risk of Failure

Service Life

The Bearing Silent Killer

0
100%
Important Considerations

Lubrication Film Thickness.
- 1/20th of a strand of hair.
Lubrication Reliability Summary

1. Lubrication causes bearing damage
2. Bearings are the machine center
3. Lubrication must work reliably
4. Machine reliability will improve
Lubrication Reliability
Part 2. ProActive Maintenance
We Start with The 6 Lubrication Rights.

1. Right Lube
2. Right Time
3. Right Qty
4. Right Way
5. Right Condition
6. Maintained Right
The Right Lube

Many different lubes to select from.

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

Don't allow mixing!
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!
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!
The Right Way

Oil and grease needs to be dispensed correctly.

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

Satisfy the environment & the machines!
ProActive Maintenance

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!
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!
ProActive Maintenance

Important Considerations!

- Prediction?
- Strategy?
- Data Base?

6th R – Maintained in the Right Condition.

- Kept Clean
- Chemically Sound

.... Working Reliably!
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
ProActive Maintenance

Plan, Do, Check and Act.
**ProActive Maintenance**

Must start with defined standards.

<table>
<thead>
<tr>
<th>Line #</th>
<th>Oilcirculation system</th>
<th>Date</th>
<th>Value 1</th>
<th>Value 2</th>
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<tbody>
<tr>
<td>#1</td>
<td>Oilcirculation system</td>
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<td>15/12</td>
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<td>16/nov-04</td>
<td>11/9</td>
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<td>12/aug-04</td>
<td>11/9</td>
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<td>256370</td>
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<td>16/13</td>
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</table>
Lubrication Reliability
Part 3. Assessments – Getting Started
Assessments – Getting Started

Fundamentals!

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.
Assessments – Getting Started

Will a better strategy help us with our Reliability?

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

![Chart](chart.png)

- Millions of Cycles To Fatigue Failure
- Filter Rating (Particle size, μm, where Beta = 200)
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?
Assessments – Getting Started

What are we doing Right?

<table>
<thead>
<tr>
<th>SHAFT</th>
<th>TYPE OF LUBRICANT</th>
<th>NAME OF PRODUCT</th>
<th>GRADE</th>
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<tbody>
<tr>
<td>RED</td>
<td>Bearing Grease</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>BLUE</td>
<td>Bearing Grease EP</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>MID GREEN</td>
<td>Ball Mill Trunions</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>BLACK</td>
<td>Spindle Grease</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>GREY</td>
<td>Mobile Equipment</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>PURPLE</td>
<td>Food Grade Grease</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>BEIGE</td>
<td>Wire Ropes Grease</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>DARK GREEN</td>
<td>Gearbox Grease</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>YELLOW</td>
<td>Corrugator Rolls</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
<tr>
<td>ORANGE</td>
<td>High Temperature</td>
<td>(Company &amp; product name)</td>
<td></td>
</tr>
</tbody>
</table>
Assessments – Getting Started

What are we doing Wrong?

[Images of various industrial equipment and containers.]
Assessments – Getting Started

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
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

<table>
<thead>
<tr>
<th>Asset Efficiency Culture</th>
<th>Lubrication Processes</th>
<th>Basic Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPI’s on Lube Effect to Reliability</td>
<td>Instructions for the Work</td>
<td>Dedicated Resources</td>
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<tr>
<td>Overall Plant Cleanliness Measurements</td>
<td>Procedures for Reducing Contamination</td>
<td>Lube Room Standards in Place</td>
</tr>
<tr>
<td>Integrated and Seamless to CMMS</td>
<td>Maintenance Planning Controls</td>
<td>Data Base Existence</td>
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<tr>
<td>Measurement of Activity Effectiveness</td>
<td>Trained Staff on Lubrication</td>
<td>Cost verses Investment in Uptime</td>
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</tbody>
</table>

### Proactive Lubrication Management

- RCFA on all failed Parts
- Oil Analysis and Evaluation
- Dedicated Lube Software
- Integrated in Reliability Program
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
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
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
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 $\mu$m, in 1 ml of oil.

Example = ISO Code 22/18/13

<table>
<thead>
<tr>
<th>ISO Scale Number</th>
<th>More than</th>
<th>Less than</th>
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<tbody>
<tr>
<td>22</td>
<td>20,000</td>
<td>40,000</td>
</tr>
<tr>
<td>21</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td>20</td>
<td>5,000</td>
<td>10,000</td>
</tr>
<tr>
<td>19</td>
<td>2,500</td>
<td>5,000</td>
</tr>
<tr>
<td>18</td>
<td>1,300</td>
<td>2,500</td>
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<tr>
<td>17</td>
<td>640</td>
<td>1,300</td>
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<tr>
<td>16</td>
<td>320</td>
<td>640</td>
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<tr>
<td>15</td>
<td>160</td>
<td>320</td>
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<td>14</td>
<td>80</td>
<td>160</td>
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<td>13</td>
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<td>80</td>
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<tr>
<td>12</td>
<td>20</td>
<td>40</td>
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<tr>
<td>11</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>1.25</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 2: ISO 4406 Allocation of particle count scale number
The Effects Of Filtration

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

Millions of Cycles To Fatigue Failure

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

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
How Do You Store Your Lubricants Now?

- Oil arrives on site. (possible ISO 18/16/13)
- If a drum is left open.
- Dirty stick to check the drum level.
- Oil dispensed with dirty containers.
- Dirt hoses and funnels used.
- Machine running without air breathers.
  - Wear debris is being generated in the machine and oil is not filtered. (possible ISO 24/22/11)

<table>
<thead>
<tr>
<th>ISO Code</th>
<th>$4 \mu m$ More than</th>
<th>Up to &amp; incl.</th>
<th>$6 \mu m$ More than</th>
<th>Up to &amp; incl.</th>
<th>$14 \mu m$ More than</th>
<th>up to &amp; incl.</th>
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</thead>
<tbody>
<tr>
<td>24/22/19</td>
<td>80,000</td>
<td>160,000</td>
<td>20,000</td>
<td>40,000</td>
<td>2,500</td>
<td>5,000</td>
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<tr>
<td>18/16/13</td>
<td>1,300</td>
<td>2,500</td>
<td>320</td>
<td>640</td>
<td>80</td>
<td>160</td>
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<tr>
<td>16/14/11</td>
<td>320</td>
<td>640</td>
<td>80</td>
<td>160</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

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

Prevention Mechanisms

- Prediction. Oil Analysis and Contamination Control.
- Start with Clean Oil
- Clean & Safe Dispensing
- Ongoing Filtration
- Data Base Management
Management

Data Base. How we control the activity.

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

Fact!

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

Ease of use
Management

Data Base.
How we control the activity.
Management

ROI.
Return on Investment

RESULTS OF DTI SURVEY 1984
22/18/13
16/12/8
>3um
>5um
>15um

Increase

1,000 → 10,000

MEAN TIME BETWEEN FAILURES (hours)
ROI.
Return on Investment

- 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
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.
Implementation Plan

Define the lubes and create a colour coded system.

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>SHAPE</th>
<th>TYPE OF LUBRICANT</th>
<th>NAME OF PRODUCT</th>
<th>VISCOSITY</th>
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<tr>
<td>RED</td>
<td>#1</td>
<td>Gear Box Oil</td>
<td>(Company &amp; product name)</td>
<td>ISO ?</td>
</tr>
<tr>
<td>BLUE</td>
<td>#2</td>
<td>Gear Box Oil</td>
<td>(Company &amp; product name)</td>
<td>ISO ?</td>
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<tr>
<td>MID GREEN</td>
<td>#3</td>
<td>Hydraulic Oil</td>
<td>(Company &amp; product name)</td>
<td>ISO ?</td>
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<tr>
<td>BLACK</td>
<td>#4</td>
<td>Hydraulic Oil</td>
<td>(Company &amp; product name)</td>
<td>ISO ?</td>
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<td>GREY</td>
<td>#5</td>
<td>Transmission Oil</td>
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<td>Transmission Oil</td>
<td>(Company &amp; product name)</td>
<td>SAE ?</td>
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<td>#7</td>
<td>Compressor Oil</td>
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<td>General Lube Oil</td>
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<td>(Company &amp; product name)</td>
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<td>ORANGE</td>
<td>#10</td>
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<td>(Company &amp; product name)</td>
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### Implementation Plan

Establish and fill a Data Base.

*Start with Key component standards*

<table>
<thead>
<tr>
<th>Process</th>
<th>Safety</th>
<th>Equipment</th>
<th>Quality</th>
<th>Cost/Profit</th>
<th>Risk</th>
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<td>Bottom level process: Line #1 press</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location: 256348</td>
<td>Line #1 press</td>
<td>Equipment nr.:</td>
<td>F 6749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintainable unit:</td>
<td>Oil circulation system</td>
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<td></td>
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<tr>
<td>Process &amp; design information</td>
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<td></td>
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<td></td>
<td></td>
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<td>Medium:</td>
<td>Fuchs DS16 AYT</td>
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<td>15/12</td>
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<td>Flow:</td>
<td>1/min</td>
<td>Water:</td>
<td>100 ppm</td>
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<tr>
<td>Viscosity:</td>
<td>68cSt @ 40°C</td>
<td>System pressure:</td>
<td>60 bar</td>
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<td>Temperature:</td>
<td>50°C</td>
<td>Tank:</td>
<td>800 liter</td>
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<td>Failure modes:</td>
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<td>Maintenance concepts</td>
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<td>Cleanliness &gt; 15/12</td>
<td>Risk</td>
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<td></td>
<td>1 Monthly oilsampling</td>
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<tr>
<td>Oil pressure &lt; 60 bar</td>
<td>Risk</td>
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<td></td>
<td>2 Yearly calibration pr. switch</td>
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</tr>
<tr>
<td>Oil pressure &gt; 60 bar</td>
<td>Risk</td>
<td></td>
<td></td>
<td>3 Yearly calibration pr. switch</td>
<td></td>
</tr>
<tr>
<td>Water &gt; 100 ppm</td>
<td>Risk</td>
<td></td>
<td></td>
<td>4 Monthly oilsampling</td>
<td></td>
</tr>
</tbody>
</table>

Analyse results: [http://www.fuchs.isl/customer/256348](http://www.fuchs.isl/customer/256348)

Fuchs Analysis number: 951085

Analyse Freq: 1 mnd

Filter sparepartnumber: CMMS256348
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
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.

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

Note: any shape can be any colour.

Optional Info Box

*Text boxes can be added as required.*
Implementation Plan

Initiate an Oil Analysis program to control the KPI’s.
Implementation Plan

Train the key lubrication staff on all facets of lubrication.
Implementation Plan

Fit desiccant breathers to all key oil systems.
Implementation Plan

Establish a filtering system to keep the oil clean.
Implementation Plan

Train the staff on bearing Failure analysis.
Implementation Plan

And finally to be innovative