MAKE YOUR WORLD RUN SMOOTHER WITH BEST LUBRICATION PRACTICES

INDUSTRY TRENDS

- Best Lubrication cleanliness practices
- Storage of products
- Manufactures requirements and changes
- Solutions
- How lubrication can improve your T.C.O
- Optimized Drain intervals
- Product consolidation

But First .....Safety

“SAFETY BY CHOICE, NOT BY CHANCE”

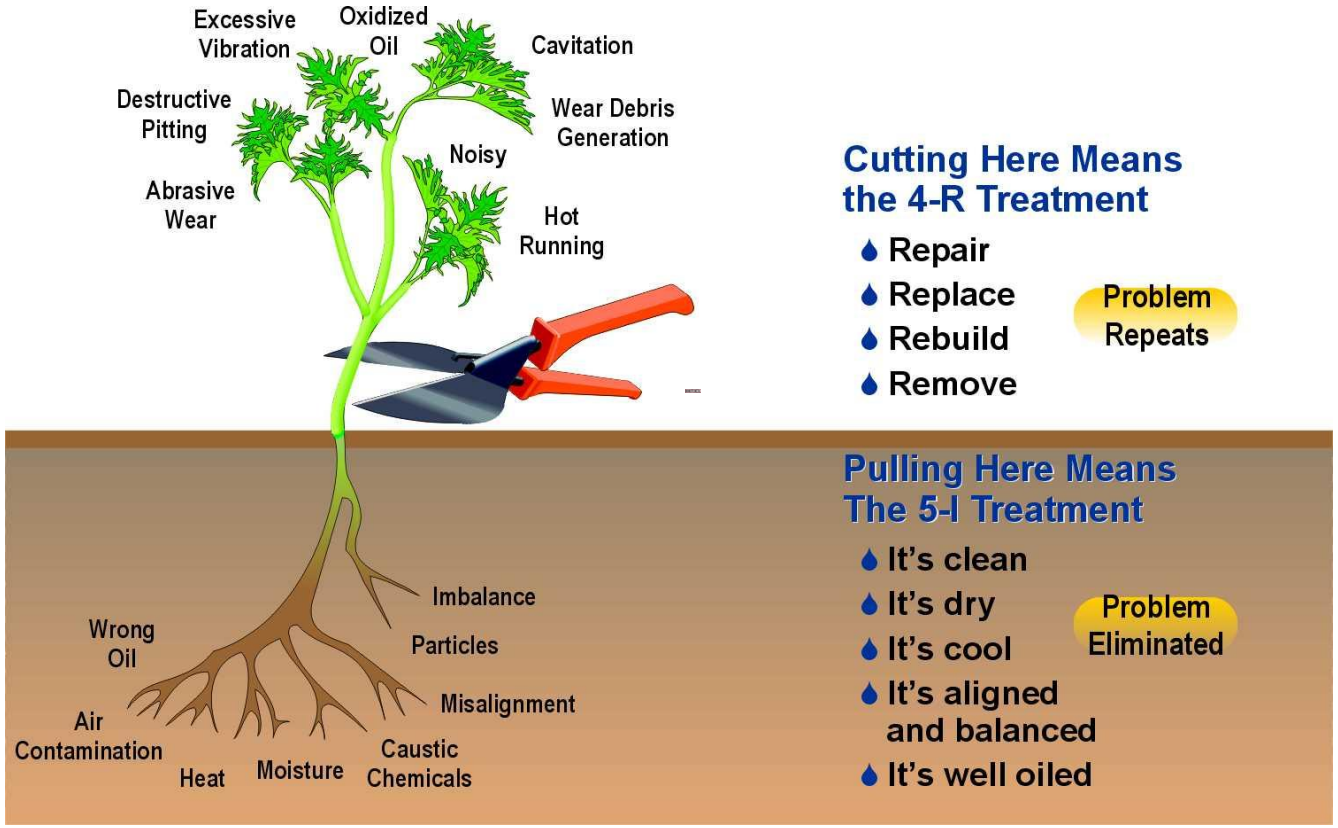
10 Life Saving Rules

SAFE START

Personal safety awareness

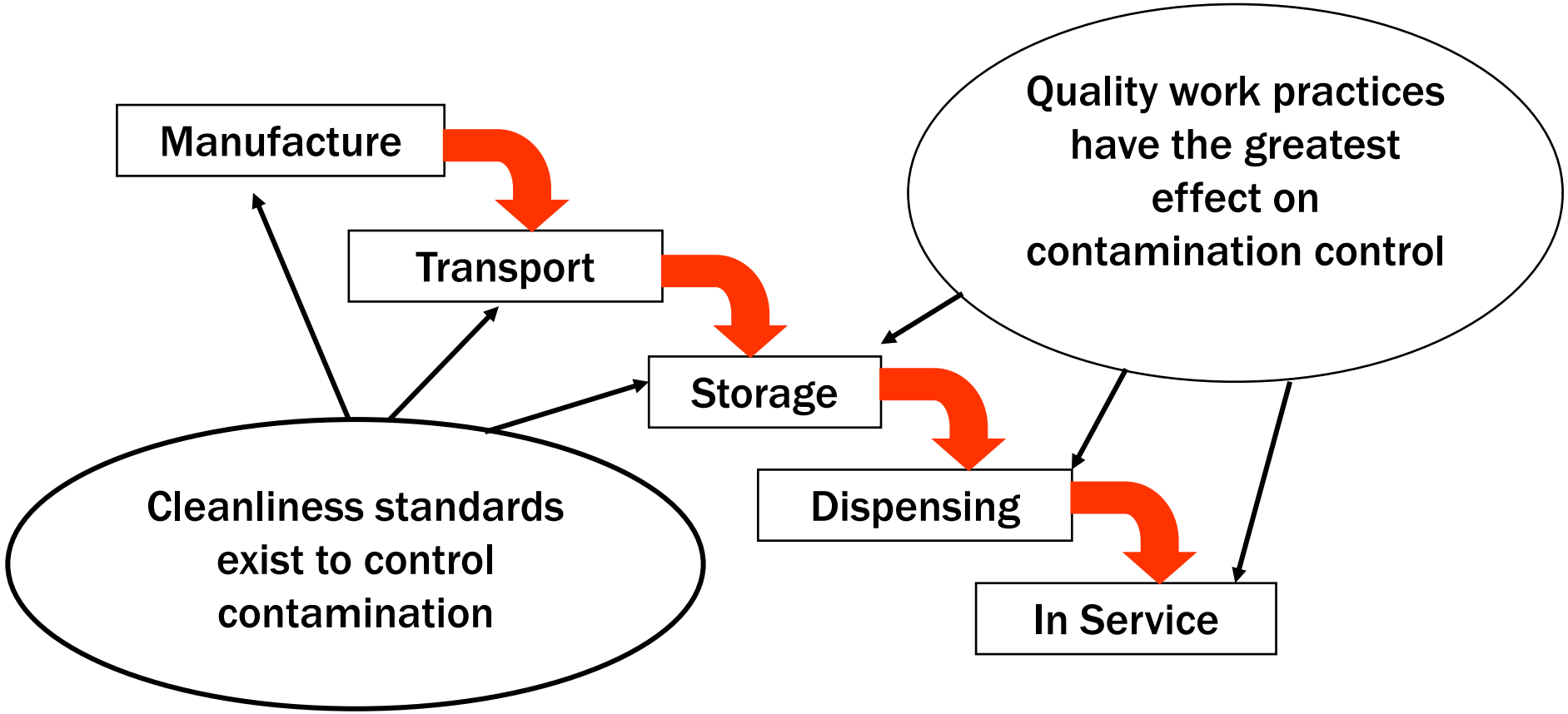
Corporate safety success

ARE YOU PULLING YOUR WEEDS OUT BY THE ROOTS?



Noria slide

Introduced contamination can occur at any stage along the life line of lubricants and fuels



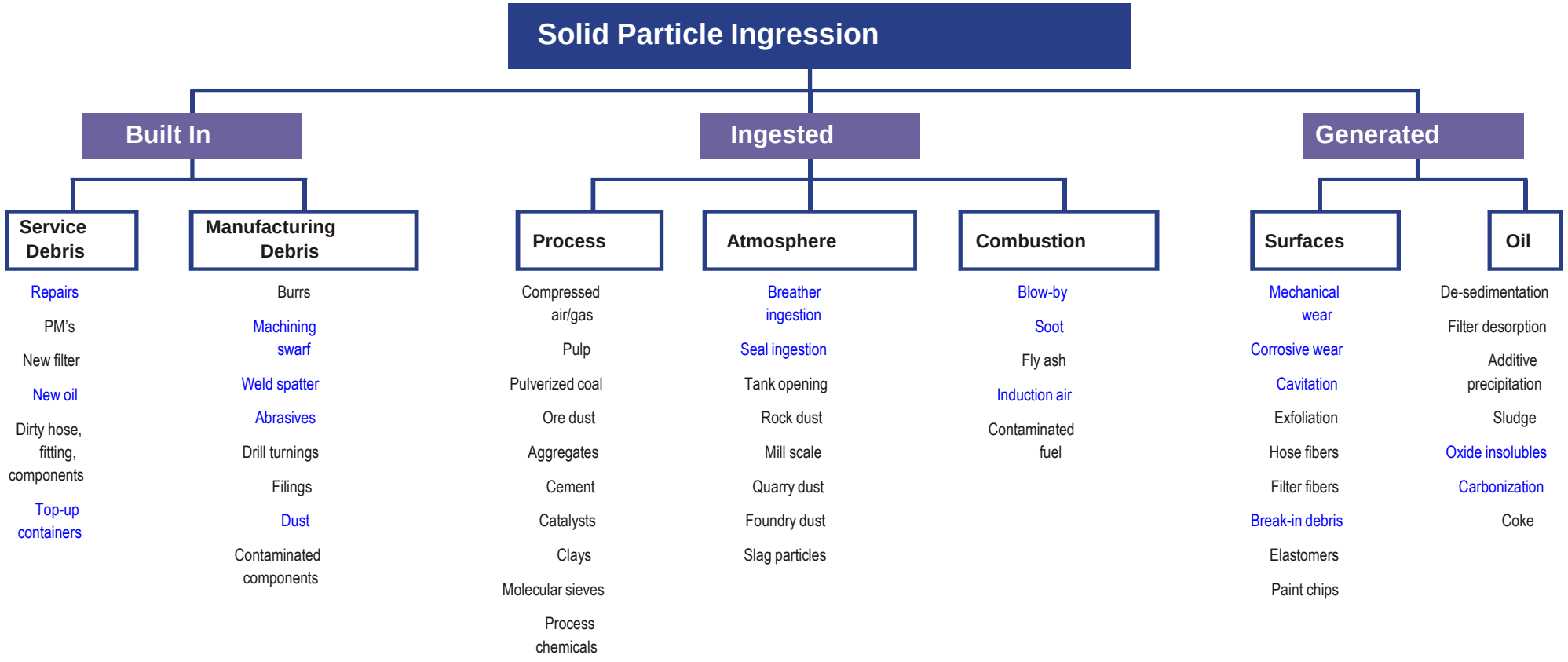
PARTICLE OR SOLID CONTAMINATION

CONTAMINATION EFFECTS AND CONTROL

Damage Caused by Oil Contamination

Contaminant	Oil Chemistry Changes	Physical Property Changes	Chemical Effects to Machine Surfaces	Mechanical Effects to Machine Surfaces
Solids	· Oxidation · Additive Depletion	Viscosity Effects	Adherent Varnish	· Abrasion · Surface Fatigue
Water	· Oxidation · Additive Depletion	Viscosity Effects	· Acidity Destruction · Rust	· Cavitation · Scuffing
Fuel	· Additive Depletion · Aromatics	· Lowers Flash · Lowers Viscosity · Increase Vapor Pressure	Sulfuric Acid *Less prominent with ULSD	Loss of Film Strength
Glycol	· Oxidation · Sludge	Viscosity Increase	Acidity Increase	Loss of Film Strength
Air	Oxidation	Oxidation	Rust & Corrosion	· Cavitation · Loss of Film Strength
Heat	· Thermal Degradation · Oxidation	Viscosity Increase	· Varnish · Acidity	Loss of Film Strength

WHERE DOES PARTICLE CONTAMINATION COME FROM?



Ingression → **All new particles entering a lubricant, regardless of source.**

NATIONAL RESEARCH COUNCIL OF CANADA – WHAT CAUSES WEAR/FAILURE?

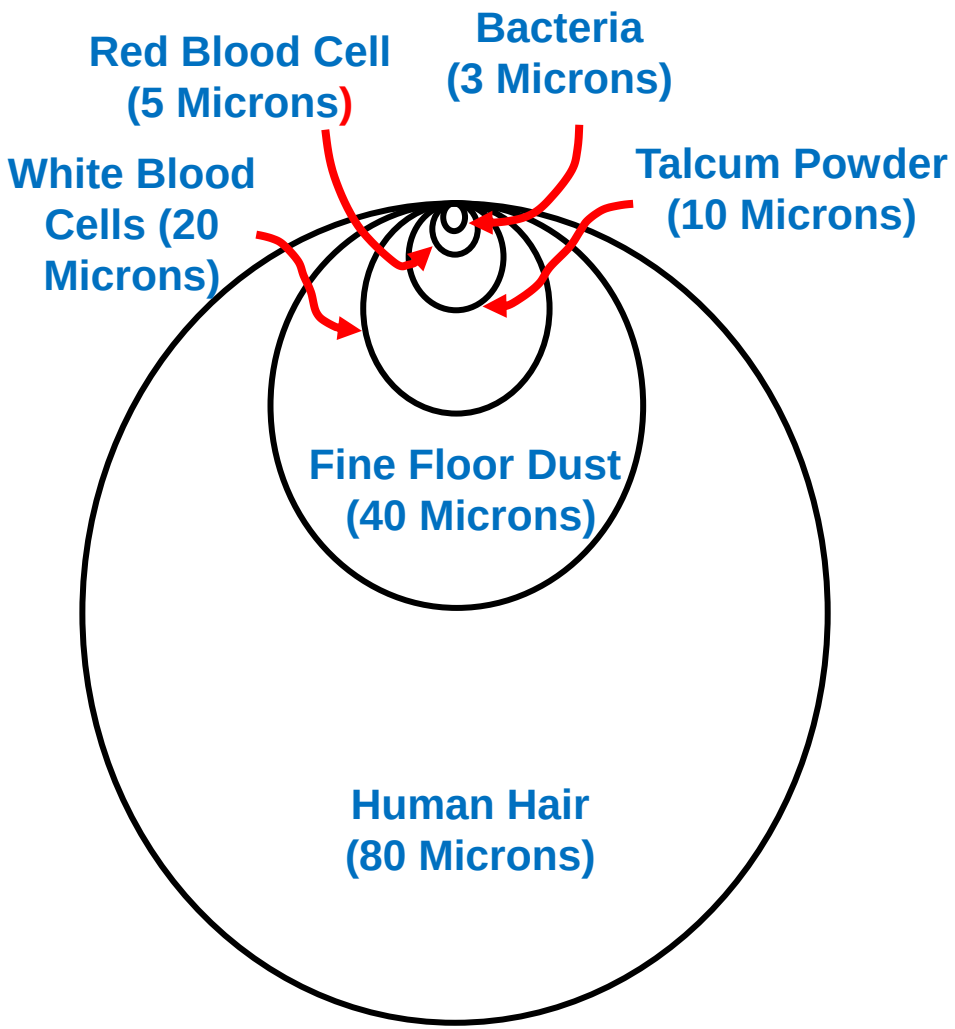
Sector	Particle Induced			Non-Particle Induced			Total
	Abrasion	Erosion	Fatigue	Adhesion	Fretting	Other	
Pulp & Paper	217	93	13	36	4	19	382
Forestry	101	-	14	25	12	6	158
Mining	551	117	25	15	1	17	726
Agriculture	735	54	45	104	2	-	940
Transportation	799	-	202	240	17	68	1326
Power Generation	69	30	-	31	26	34	190
Total	2472	294	299	451	62	144	3722
Percentage by Category	82%			18%			

Oil Film Thicknesses in Machine Dynamic Clearances

Component	Clearance
Roller Element Bearings	0.1-3 Microns*
Journal Bearings	0.5-100
Gears	0.1-1
Engines	
- Ring/Cylinder	0.3-7
- Rod Bearing	0.5-20
- Main Bearings	0.8-50
- Piston Pin Bushing	0.5-15
- Valve Train	0.0-1.0
- Gearing	0.0-1.5
Pump, Gear	
- Tooth to Side Plate	0.5-5
- Tooth Tip to Case	0.5-5
Pump, Vane	
- Vane Sides	5-13
- Vane Tip	0.5-1
Pump, Piston	
- Piston to Bore	5-40
- Valve Plate to Cylinder	0.5-5
Servo Valves	
- Orifice	130-450
- Flapper Wall	18-63
- Spool to Sleeve	1-4
Actuators	50-250

*0.001 Inches=25.4 Microns

Understanding Particle Size and Particle Count



Size Microns	Size Inches	Typical Number of Particles in 1 PPM
3	0.00012	1036
5	0.0002	584
10	0.0004	183
20	0.0008	36
40	0.0016	5
80	0.0032	1

As Size gets Larger...

...Number Becomes Smaller

25,400 Microns = 1 Inch

* Fuel HPCR >2um

ISO Cleanliness Standards

- ISO Standard 4406-1999
- 29 levels
- Contamination particle count in 1 ml of fluid
- Particle count doubles for each increase in level

ISO Cleanliness Code ISO 4406:99

Expressed as 2 (or some times a 3) index code */R_6/R_{14} (or R_4/R_6/R_{14}) where:

R_4 relates to the number of particles > 4 μm in size

R_6 relates to the number of particles > 6 μm in size

R_{14} relates to the number of particles > 14 μm in size

Example: ISO 18/15 (still used)

Example: ISO 18/16/13

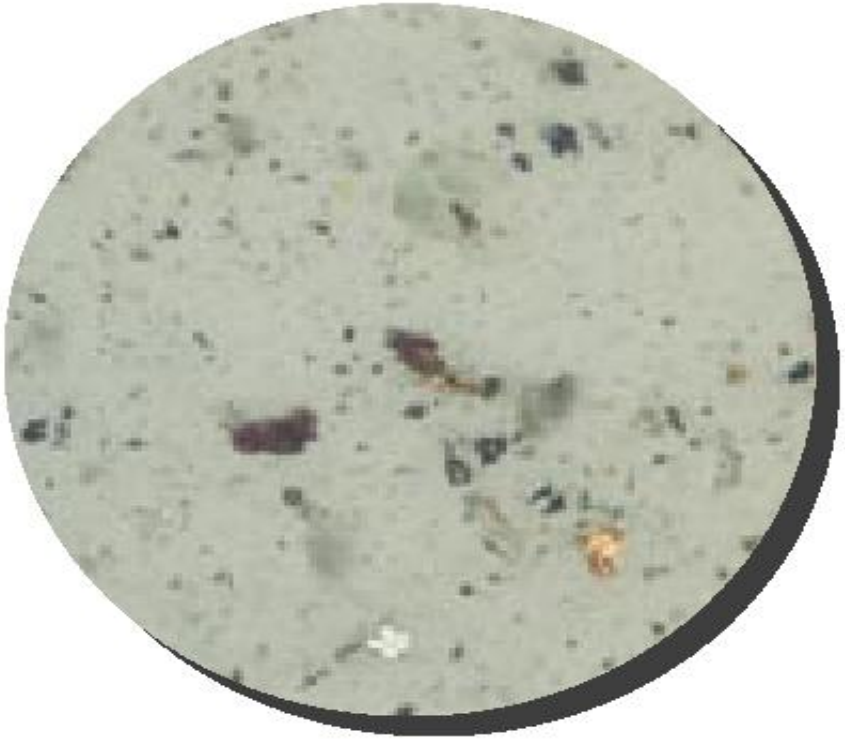
In this example, you can see how the particles measured at the given micron levels are assigned the specific code based on where that value falls in the table. For this example, the ISO code would be 20/17/13.

Table 1

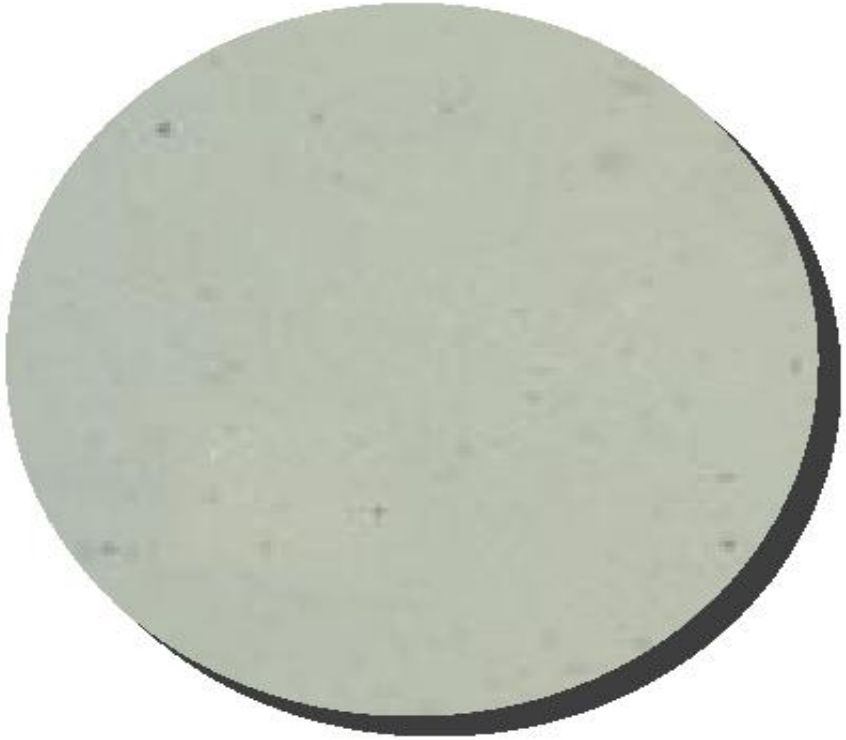
	PARTICLES/ML	ISO CODE
>4 microns	9,721	20
>6 microns	1,254	17
>10 microns	326	
>14 microns	73	13
>21 microns	12	
>38 microns	5	
>70 microns	0	
>100 microns	0	

MORE THAN	UP TO AND INCLUDING	ISO CODE
(p/ml)	(p/ml)	
80,000	160,000	24
40,000	80,000	23
20,000	40,000	22
10,000	20,000	21
5,000	10,000	20
2,500	5,000	19
1,300	2,500	18
640	1,300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5	9
1.3	2.5	8

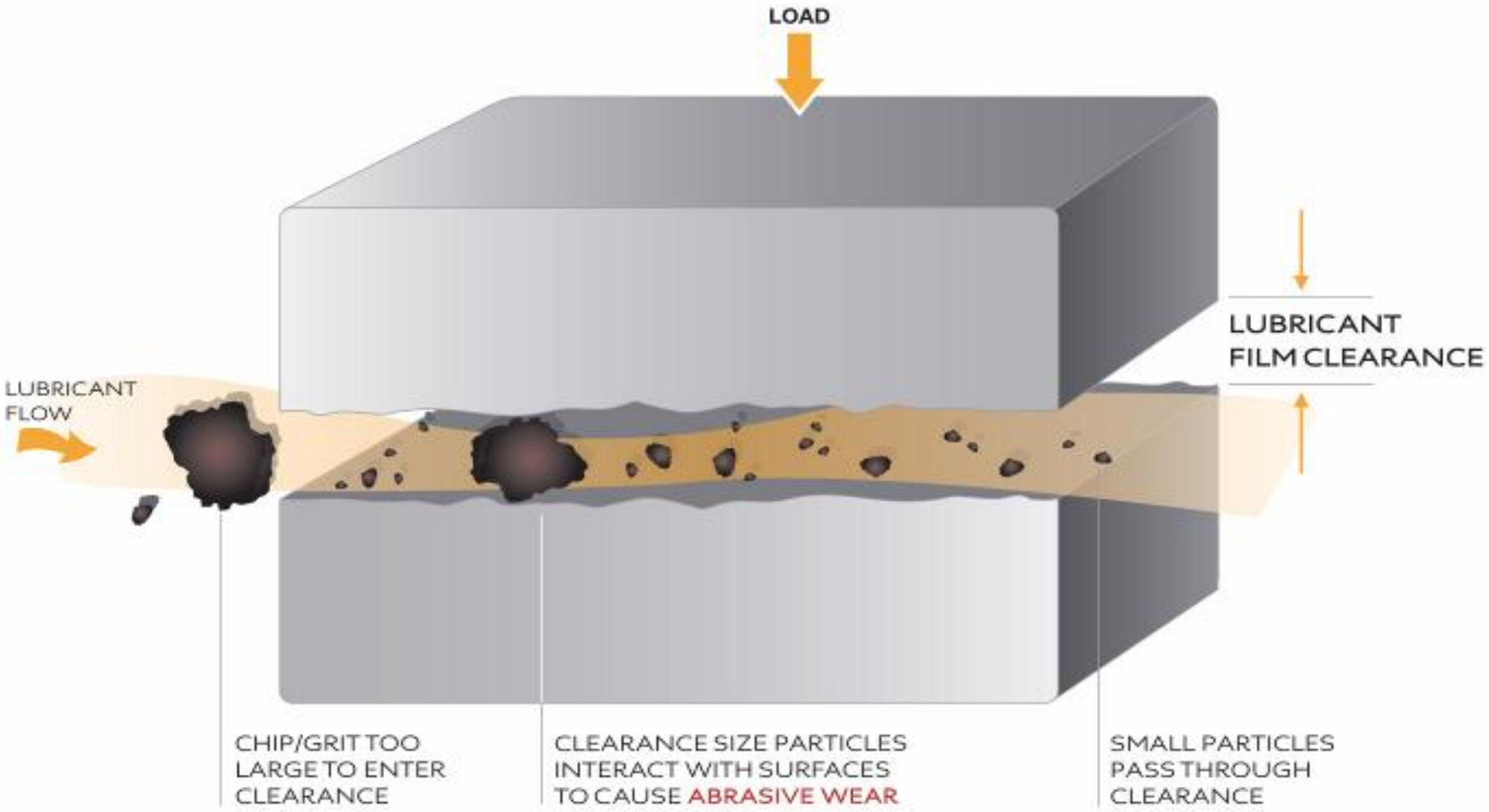
Contamination ISO 19/17 Vs ISO 14/11



ISO 21/19/17 fluid (magnification 100x)



ISO 16/14/11 fluid (magnification 100x).


LOAD
LUBRICANT FLOW
LUBRICANT FILM CLEARANCE
CHIP/GRIT TOO LARGE TO ENTER CLEARANCE
CLEARANCE SIZE PARTICLES INTERACT WITH SURFACES TO CAUSE ABRASIVE WEAR
SMALL PARTICLES PASS THROUGH CLEARANCE

GUIDELINE CLEANLINESS LEVELS

Machine	ISO Code
Ball Bearing	16/13/11
Roller Bearing	17/14/12
Journal Bearing	18/15/12
Industrial Gearbox	18/15/12
Mobile Gearbox	18/16/13
Diesel Engine	18/16/13
Steam Turbine Oils	18/14/11

FLUID CLEANLINESS REQUIRED FOR TYPICAL HYDRAULIC COMPONENTS

Operating Pressure	< 1500 psi	1500-2500 psi	> 2500 psi
Servo Valves	16/14/12	15/13/11	14/12/10
Proportional Valve	17/15/12	16/14/12	15/13/11
Variable Volume Pump	17/16/13	17/15/12	16/14/12
Cartridge Valve	18/16/14	16/16/13	17/15/12
Fixed Piston Pump	18/16/14	17/16/13	17/15/12
Vane Pump	19/17/14	18/16/14	17/16/13
Pressure/Flow Control Valve	19/17/14	18/16/14	17/16/13
Solenoid Valve	19/17/14	18/16/14	18/16/14
Gear Pump	19/17/14	18/16/14	18/16/14

Life Extension Table - Particles

New Cleanliness Level (ISO Code)

Current Machine Cleanliness (ISO Code)

	20/17		19/16		18/15		17/14		16/13		15/12		14/11		13/10		12/9		11/8		10/7	
26/23	5	3	7	3.5	9	4	>10	5	>10	6	>10	7.5	>10	9	>10	>10	>10	>10	>10	>10	>10	>10
	4	2.5	4.5	3	6	3.5	6.5	4	7.5	5	8.5	6.5	10	7	>10	9	>10	10	>10	>10	>10	>10
25/22	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	7	>10	9	>10	>10	>10	>10	>10	>10
	3	2	3.5	2.5	4.5	3	5	3.5	6.5	4	8	5	9	6	10	7.5	>10	9	>10	>10	>10	>10
24/21	3	2	4	2.5	6	3	7	4	9	5	>10	6	>10	7	>10	8	>10	10	>10	>10	>10	>10
	2.5	1.5	3	2	4	2.5	5	3	6.5	4	7.5	5	8.5	6	9.5	7	>10	8	>10	10	>10	>10
23/20	2	1.5	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	8	>10	9	>10	>10
	1.7	1.3	2.3	1.5	3	2	3.7	2.5	5	3	6	3.5	7	4	8	5	10	6.5	>10	8.5	>10	10
22/19	1.6	1.3	2	1.6	3	2	4	2.5	5	3	7	3.5	8	4	>10	5	>10	6	>10	7	>10	>10
	1.4	1.1	1.8	1.3	2.3	1.7	3	2	3.5	2.5	4.5	3	5.5	3.5	7	4	8	5	10	5.5	>10	8.5
21/18	1.3	1.2	1.5	1.5	2	1.7	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	7	>10	10
	1.2	1.1	1.5	1.3	1.8	1.4	2.2	1.6	3	2	3.5	2.5	4.5	3	5	3.5	7	4	9	5.5	10	8
20/17			1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	5	>10	7	>10	9
			1.2	1.05	1.5	1.3	1.8	1.4	2.3	1.7	3	2	3.5	2.5	5	3	6	4	8	5.5	10	7
19/16					1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	6	>10	8
					1.2	1.1	1.5	1.3	1.8	1.5	2.2	1.7	3	2	3.5	2.5	5	3.5	7	4.5	9	6
18/15							1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4.5	>10	6
							1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	3.5	2.5	5.5	3.7	8	5
17/14									1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	6	3	8	5
									1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	4	2.5	6	3.5
16/13											1.3	1.2	1.6	1.5	2	1.7	3	2	4	3.5	6	4
											1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.8	3.7	3	4.5	3.5
15/12													1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5
													1.2	1.1	1.5	1.4	1.8	1.5	2.3	1.8	3	2.2
14/11															1.3	1.3	1.6	1.6	2	1.8	3	2
															1.3	1.2	1.6	1.4	1.9	1.5	2.3	1.8
13/10																	1.4	1.2	1.8	1.5	2.5	1.8
																	1.2	1.1	1.6	1.3	2	1.6

Hydraulics and Diesel Engines	Rolling Element Bearings
Journal Bearings and Turbo Machinery	Gear Boxes and Other

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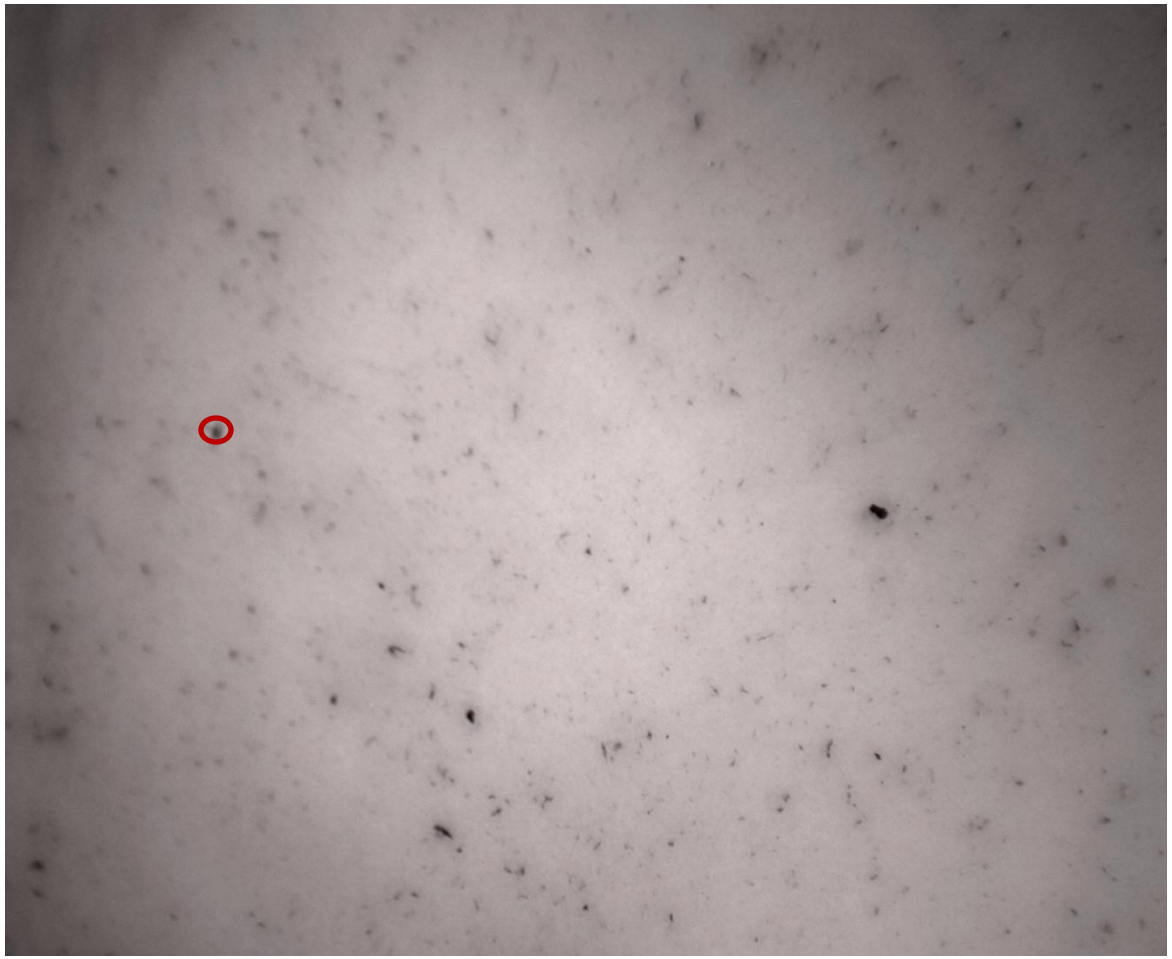
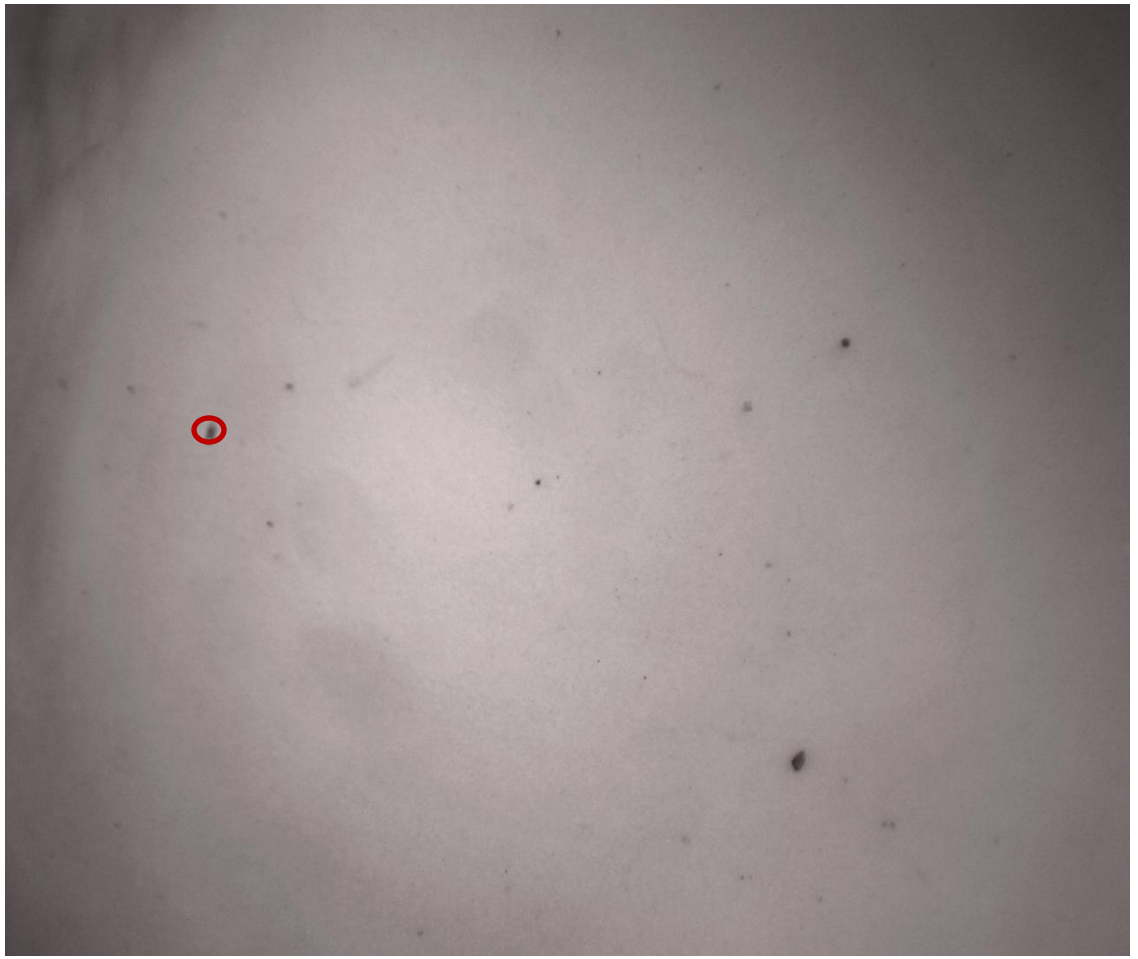
Filtered New Lubricants Using 7um Beta 1000 Filters .08um Micro Patch 100X Magnification

Pre - Filter

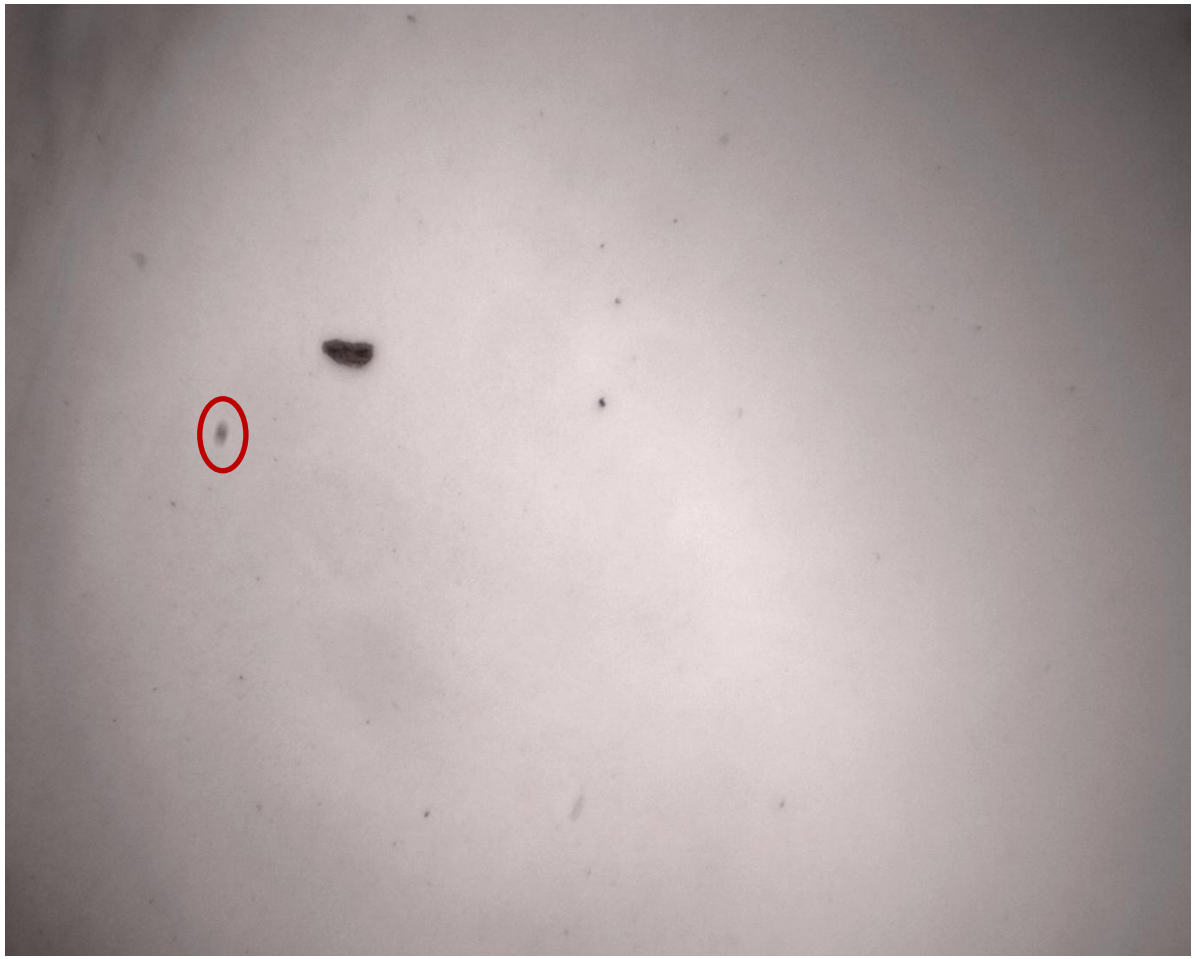


Post Filter



Power Drive 6000

Pre - Filter

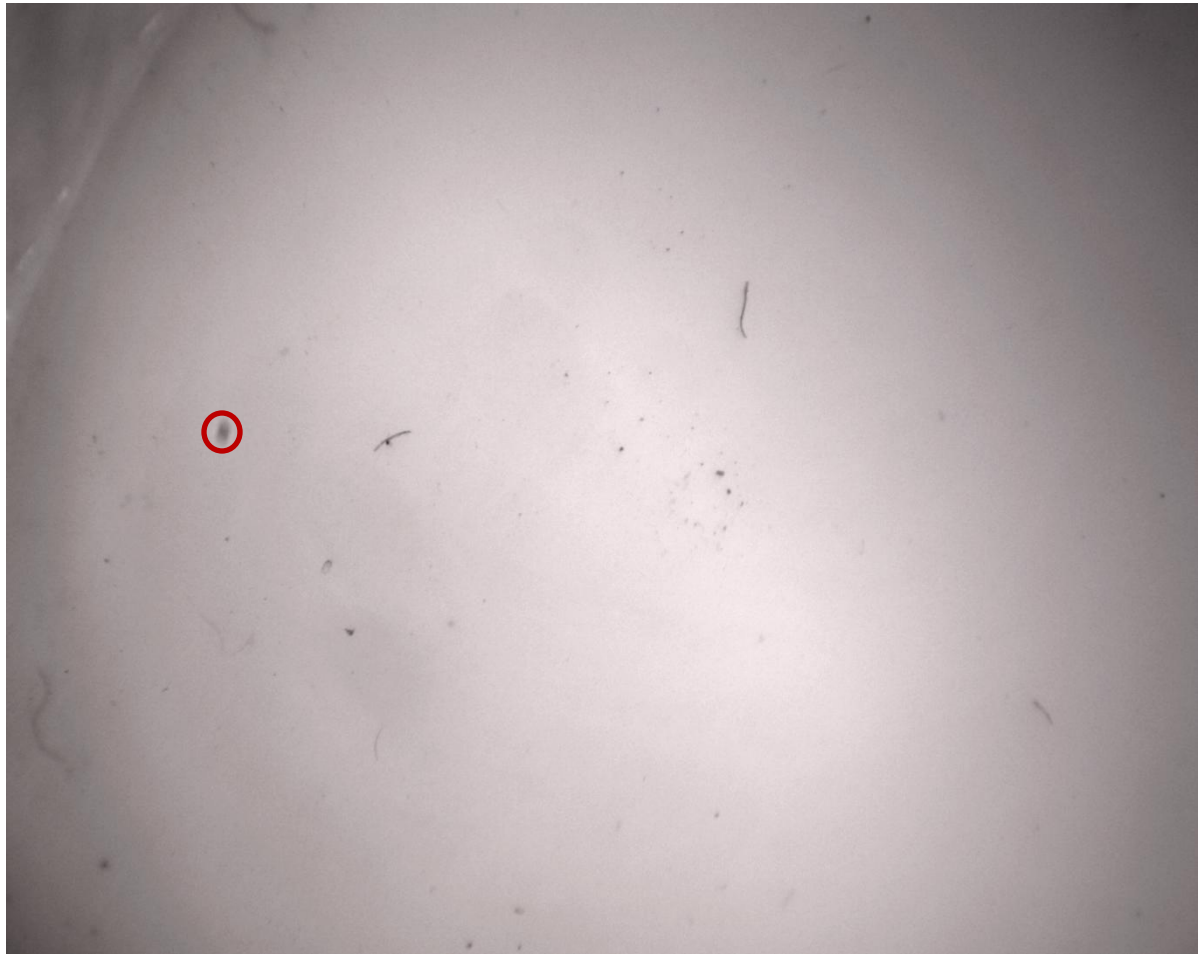


Post Filter

Guardol ECT 15/40

Pre - Filter

Post Filter



Power Drive 10wt

In Service Contamination

KEEP IT DRY, KEEP IT COOL ,KEEP IT CLEAN

Water Contamination

Dissolved individual water molecules dispersed in oil, can't be seen
Emulsified as dissolved water content increases water becomes suspended as the internal phase of a water in oil emulsion, leads to cloudy or milky appearance, most damaging of the three forms
Free water phase separation of water producing a layer of water

Since it is desirable to maintain the moisture level below the saturation point, water content data alone not as useful as knowledge of the saturation point.
Saturation point is influenced by base oil [Group I retains more dissolved water than Group II], age, [aged oils retain more dissolved water], polar additives [detergents, dispersants] raise saturation point.
For most mineral oils saturation point is about 200-300 PPM for a hydraulic oil and about 500-600 PPM for a lubricating oil, some synthetics are 1000 PPM
Oil is cloudy when it is above its saturation level.

Heat = Oxidation or Thermal Break Down

Overheating equipment has an adverse effect on lubricants

- Film strength breakdown
- Formation of sludge and varnish
- Depletion of additives
- Oxidation of oil
- Formation of acids
- Cracking & coking of oil
- Every 10° C increase in temperature = doubled oxidation = oil life reduced by half

Maintaining correct operating temperatures helps reduce the amount of internally created contaminants

Air Entrainment Effects

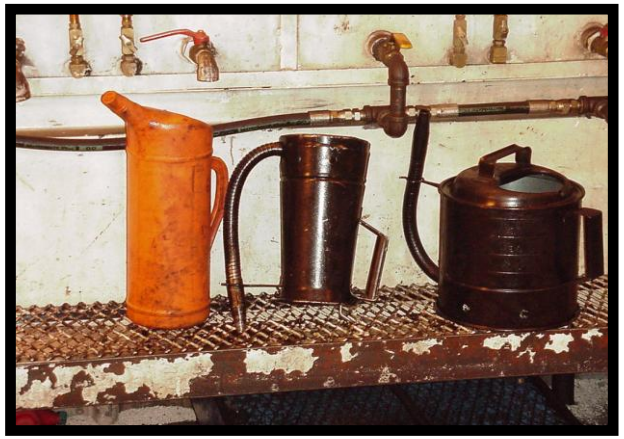
- Cavitation
- Foaming
- Film strength breakdown
- Oxidation of oil
- Hot operation
- Varnish
- Spongy actuators
- Erratic system controls (hydraulics)

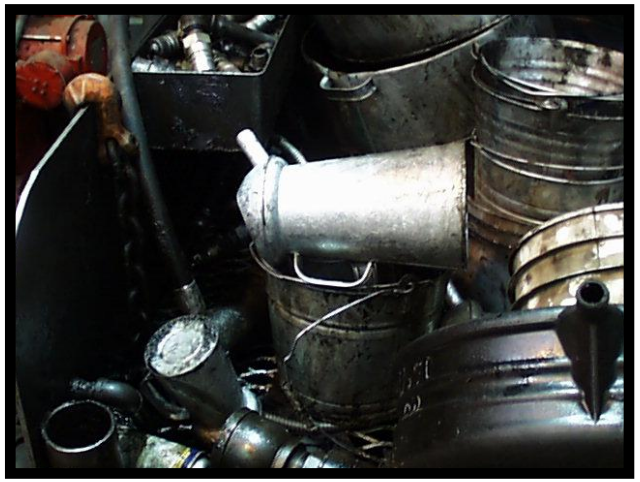
START CLEAN


OIL FILTRATION SYSTEMS
Boerne, TX 78006
800-449-0262
oilfiltrationsystems.com


OIL FILTRATION SYSTEMS
Boerne, TX 78006
800-449-0262
oilfiltrationsystems.com

START CLEAN KEEP IT CLEAN





LID TYPE	PICTURE	OUTLET OPENING DIAMETER	ADDITIONAL	1.5 L/ US QUART	2 L/ US QUART	3 L/ US QUART	5 L/ US QUART	10 L/ US QUART	PUMP ACC.	EXT. HOSE
Oil Safe® Mini Spout Lid Kit		1/4″	Good for equipment where filler holes are small	X	X	X	X	X		
Oil Safe® Stretch Spout Lid Kit		1/2″	Good when precise pouring is needed, including hard to reach areas. Good for low viscosity oil (<ISO 220)	X	X	X	X	X		
Oil Safe® Stumpy Spout Lid Kit		1″	Good for applications that require a high flow of lubricants	X	X	X	X	X		X
Oil Safe® Utility Lid Kit		2″	Multi-purpose lid. Match this lid to an accessory pump			X	X	X	X	
Oil Safe® Storage Lid Kit		none	For storage and prefilling for easier no-spill contamination free transportation	X	X	X	X	X		

Breather micron rating should match filtration micron rating


CAUTION

Best In Class Assessments

- Experienced field service and support
- Comprehensive in depth audits of equipment & facilities
- Lubricant surveys - Right Oil ,Right Place, Right Time
- Cost saving initiatives – extended oil life, extended component life, product consolidation

SUPPLIER SERVICES: ROLES AND RESPONSIBILITIES

- Communication of Product Knowledge
- Product Approvals & Registrations
- Product & Technical Training
- Customer Inquiries /Hotline
- Field support, one-off troubleshooting

TEAM ON SITE TRAINING

Basic Course

- Available through Lubestream
- 40+ hours of online training
- Have ideas for ongoing Improvement

Advanced Lubrication Course

- 3 ½ days instructor facilitated
- Sponsored by Sales Regions
- Covers a little bit of everything
- Our flagship fundamentals course
- Updated annually

THANK YOU!

QUESTIONS?