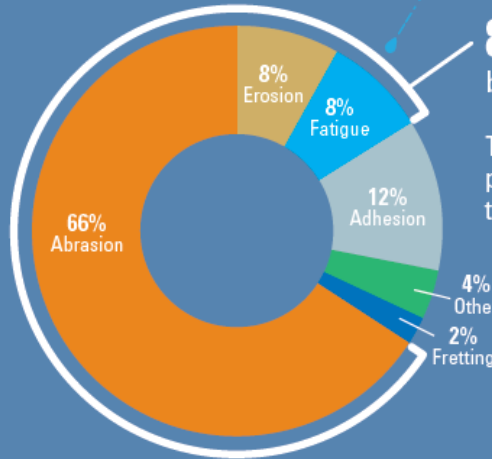


Lubricant Cleanliness Matters



Contamination

- The leading cause of lubricant related equipment failure
- Accounts for 82% of mechanical wear



82% of mechanical wear is caused by particle contamination.¹

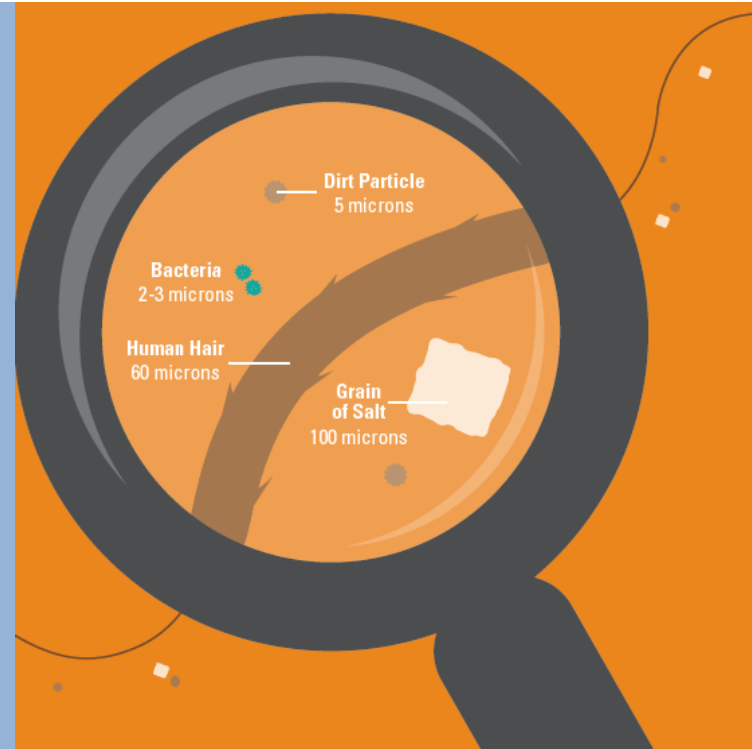
The two leading types of contamination in oil are particulates and water. Dirt and contaminants are the leading causes of hydraulic system failures.

OIL

¹ Source: Noria Corporation

It's what you can't see that's most harmful!

- Particles are typically measured in microns
 - One millionth of a meter
- <40 microns is not visible by the human eye
- Particles that are 1 to 10 microns are the most harmful
 - can enter the lubrication zone between parts
- Enter the system as airborne dirt or water vapor



Measuring Contaminants – ISO Cleanliness Code – XX/YY/ZZ

- XX = total number of particles $\geq 4 \mu\text{m}$
- YY = total number of particles $\geq 6 \mu\text{m}$
- ZZ = total number of particles $\geq 14 \mu\text{m}$

20/17/13

Some programs or equipment guides may report under the old two-number system. In this case, simply drop the first number: */17/13.

	Particles/ml	ISO Cleanliness Code
>4 μ	9,721	20
>6 μ	1,254	17
>10 μ	326	
>14 μ	73	13
>21 μ	12	
>38 μ	5	
>70 μ	0	
>100 μ	0	

More than (p/ml)	Up to and including (p/ml)	ISO Cleanliness Code
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

How much is too much?

As little as one teaspoon of dirt is enough to contaminate a 55 gallon (208L) drum

- Approx. 1 billion particles \geq 4 microns
- ISO code of 19/17/14

Leads to:

- Shorter equipment life – wear
- Shorter oil life - additive depletion
- System pressure inefficiencies



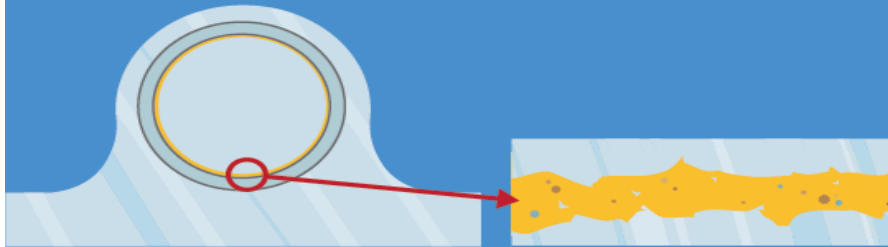
How clean does oil need to be?

Determined by most sensitive component in the system

- Protect the tightest machine tolerance
- Particles that enter lubrication zone are the most damaging

Most equipment and component manufacturers provide ISO cleanliness requirements for oils

Component Type	Typical ISO Cleanliness Level
Hydraulic with Servo Valves	15/13/11
Hydraulic with Proportional Valves	16/14/12
Hydraulic Variable Piston Pump	16/14/12
Hydraulic Fixed Piston Pump	17/15/12
Hydraulic Variable Vane Pump	17/15/12
Hydraulic Fixed Vane Pump	18/16/13
Hydraulic Fixed Gear Pump	18/16/13
Ball Bearings	15/13/11
Roller Bearings	16/14/12
Journal Bearings (>400 RPM)	17/15/13
Journal Bearings (<400 RPM)	18/16/14
Gearboxes	18/16/13
Hydrostatic Transmissions	16/14/11
Pumps	16/14/12



Benefits of using clean oil

Life Extension Chart - Hydraulic Systems

Current Machine Cleanliness	28/26/23	5	7	9	>10	>10	>10	>10	>10	>10	>10	>10
	27/25/22	4	5	7	9	>10	>10	>10	>10	>10	>10	>10
	26/24/21	3	4	6	7	9	>10	>10	>10	>10	>10	>10
	25/23/20	2	3	4	5	7	9	>10	>10	>10	>10	>10
	24/22/19	1.6	2	3	4	5	7	8	>10	>10	>10	>10
	23/21/18	1.3	1.5	2	3	4	5	7	9	>10	>10	>10
	22/20/17		1.3	1.6	2	3	4	5	7	9	>10	>10
	21/19/16			1.3	1.6	2	3	4	5	7	9	>10
	20/18/15				1.3	1.6	2	3	4	5	7	>10
	19/17/14					1.3	1.6	2	3	4	6	8
	18/16/13						1.3	1.6	2	3	4	6
	17/15/12							1.3	1.6	2	3	4
	16/14/11								1.3	1.6	2	3
15/13/10									1.4	1.8	2.5	
	22/20/17	21/19/16	20/18/15	19/17/14	18/16/13	17/15/12	16/14/11	15/13/10	14/12/9	13/11/8	12/10	
	New Cleanliness Level											

**System Components
Last Two Times Longer**

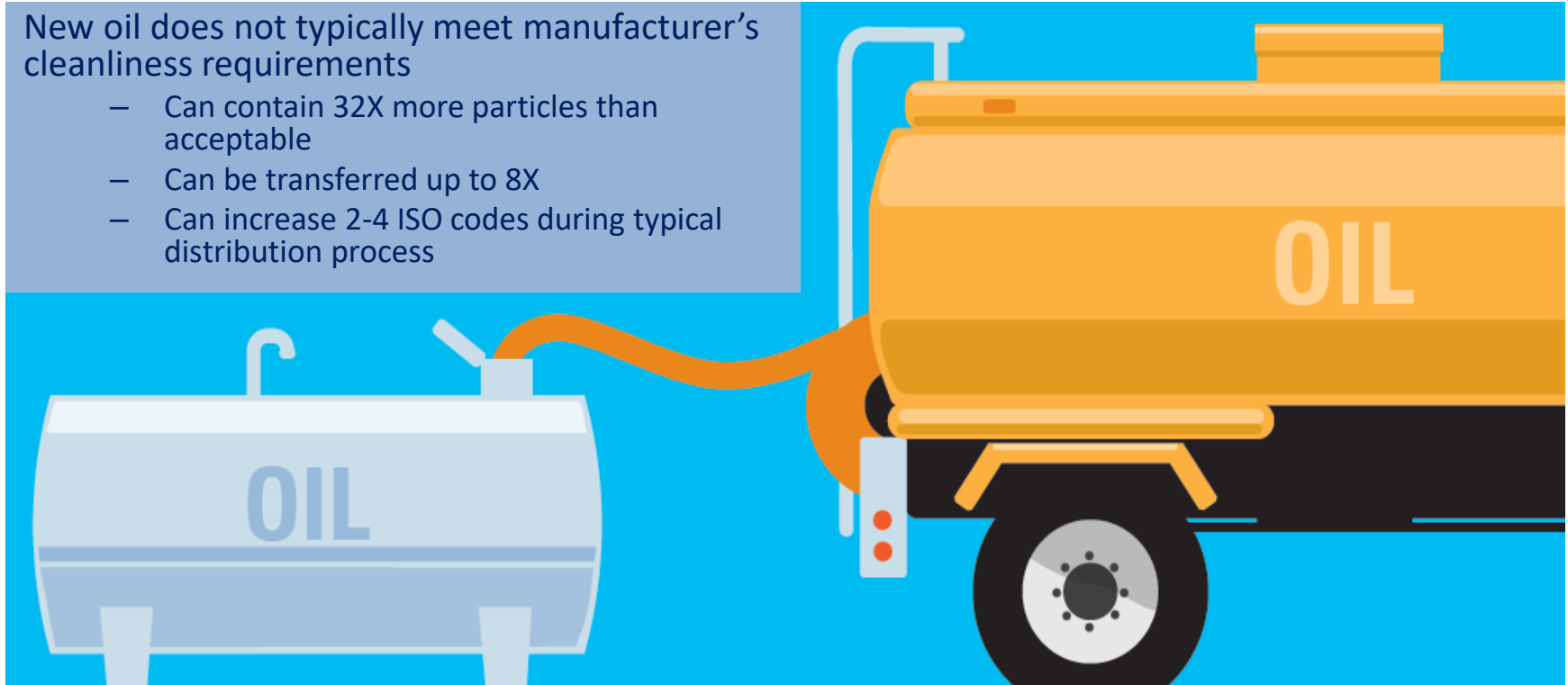
This is an example for demonstration purposes. Actual savings will vary depending on lubricant performance, oil sample frequency, equipment type, equipment condition and previous condition, and the ability to keep the fluid clean.

Source: Noria Corporation, Fundamentals of Machinery Lubrication, Noria Skills Training

Isn't new oil clean enough?

New oil does not typically meet manufacturer's cleanliness requirements

- Can contain 32X more particles than acceptable
- Can be transferred up to 8X
- Can increase 2-4 ISO codes during typical distribution process

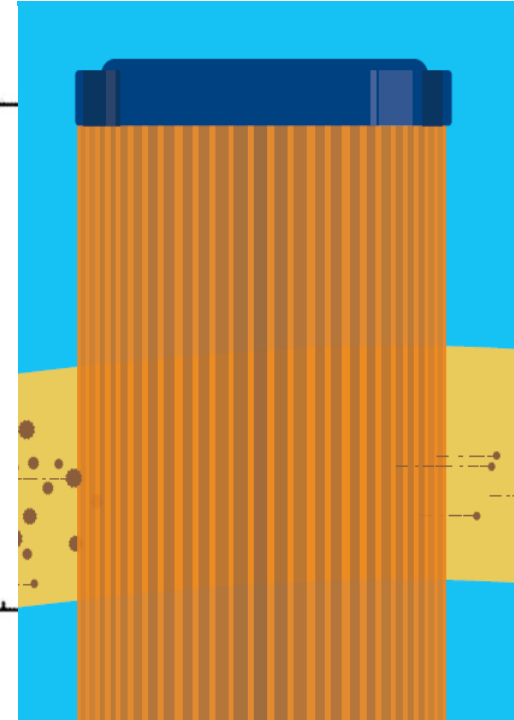
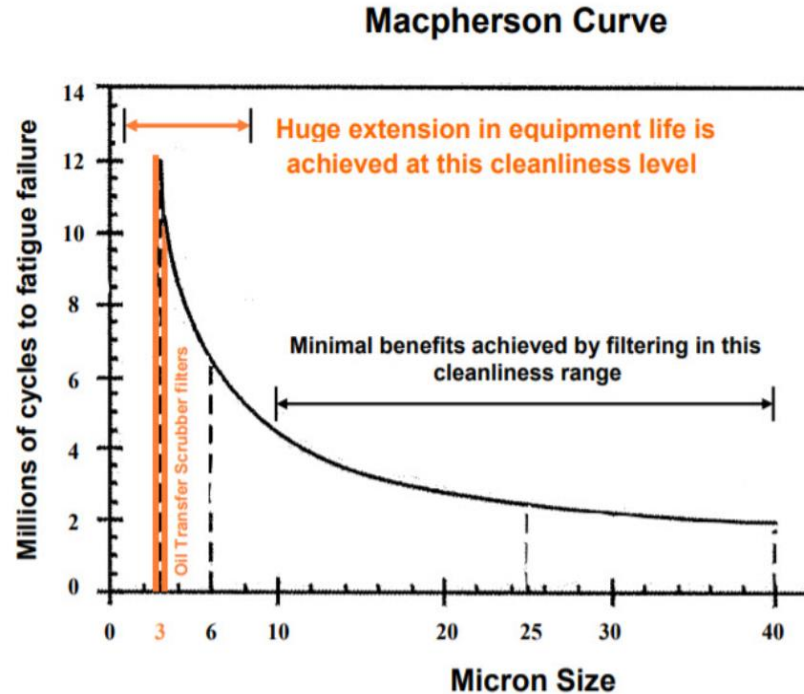


What about the filters on my equipment?

Filters will remove some but not all contaminants

- Wear is possible before the system can remove initial contamination
- Many systems are not properly balanced or sized to remove critical clearance-sized particles

Starting with clean oil will ensure you're not introducing harmful particles and assist on-board filtration





Purpose



Research **damage** progression of hydraulic system components to levels of **lubricant cleanliness**.

Chevron Rando[®] HD 32 - **ISOCLEAN[®] Certified**

VS.

Typical Hydraulic Fluid ISO 32



ASTM D 6973 Test Criteria



	Test Fluid A Chevron Rando HD ISO 32 - ISOCLEAN® Certified	Test Fluid B Typical Hydraulic Fluid ISO 32	Test Fluid C Typical Hydraulic Fluid ISO 32
Target Start ISO 4406 Cleanliness Code	17/15/12	23/21/17	23/21/17
Filter	Standard 25 micron Beta 200	Standard 25 micron Beta 200	In Bypass Mode (Removed)

Operating Parameters: 35-40 GPM, 2400 RPM, 3000 PSI, 93 °C

Test Volume: 50 gallon sump

Test Duration: Single cartridge for 150hrs with pump teardowns at 50hr intervals & fluid change

Two tests performed with Test Fluid B

First test failed @ 128 hours from pressure loss

Second completed full 150 hour test

Test Fluid C (Bypass Filtration) failed in ~1 hour

Catastrophic failure to pump

Not able to maintain full system pressure and flow rate

System Hydraulic Fluid Cleanliness Levels

System filter easily **maintained** cleanliness level when starting with **ISOCLEAN® Certified** product

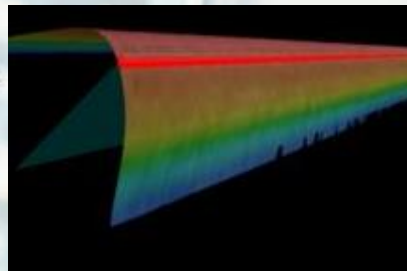
System filter gradually clean fluid however **damage** occurred during the process

		Typical Hydraulic Oil AW 32 with System Filter	Chevron Rando HD 32 - ISOCLEAN® Certified with System Filter	Hydraulic OEM Lubricant Cleanliness Target
Test	Operating Time	ISO 4406 Cleanliness Code	ISO 4406 Cleanliness Code	ISO 4406 Cleanliness Code
Stage 1	0 Hours (Fresh Fluid Fill)	22/21/19	15/14/12	17/15/12
	10 Hours	20/15/8		17/15/12
	25 Hours	18/13/6		17/15/12
	50 Hours (Drain Fluid)	16/14/11	15/14/11	17/15/12
Stage 2	51 Hours (Fresh Fluid Fill)	22/21/16	16/13/9	17/15/12
	100 Hours (Drain Fluid)	17/14/10	16/15/10	17/15/12
Stage 3	101 Hours (Fresh Fluid Fill)	22/20/14		17/15/12
	150 Hours (End of Test)	18/14/11		17/15/12
NOTES		System Filter gradually cleaned fluid over operating time	System Filter easily maintained required system cleanliness	

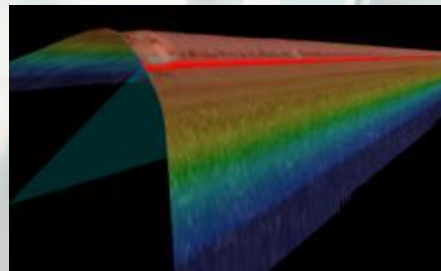
* Particle Counts results from Spectro Laser Net Fines Q200

* System filter rating 25 micron beta 200

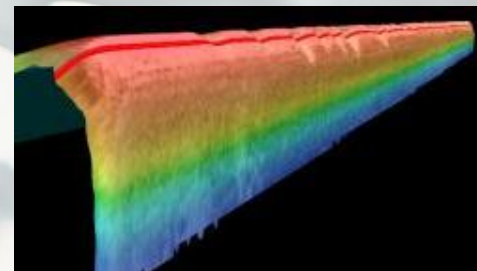
Vane Wear Progression End of Test



New Vane



Chevron Rando HD 32 –
ISOCLEAN[®] Certified
(150 hours)

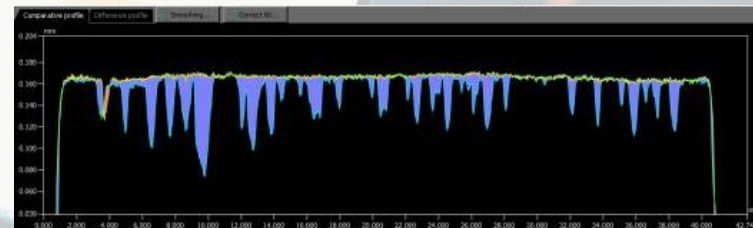


Typical Hydraulic Fluid B
ISO 32
(128 hours)

Major impact on pump performance

Leads to increased internal leakage causing cavitation.

Diminishes proper flow & pressure efficiency.



Pressure Control Valve

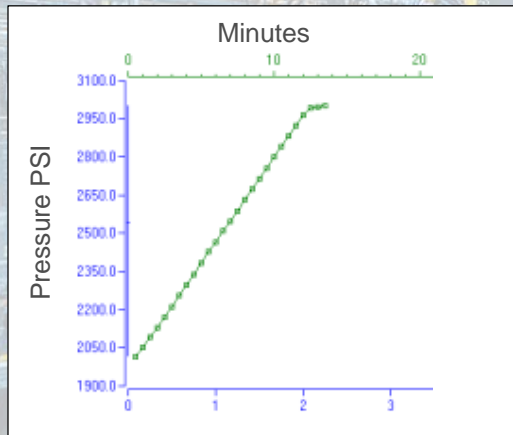
Chevron Rando® HD 32 – ISOCLEAN® Certified (System Filter)

Smooth pressure control curve

No interruptions or signs of valve problems

Valve cylinder shows **no wear rings**

Valve piston **undamaged**



Valve Cylinder Bore



Valve Piston

Pressure Control Valve

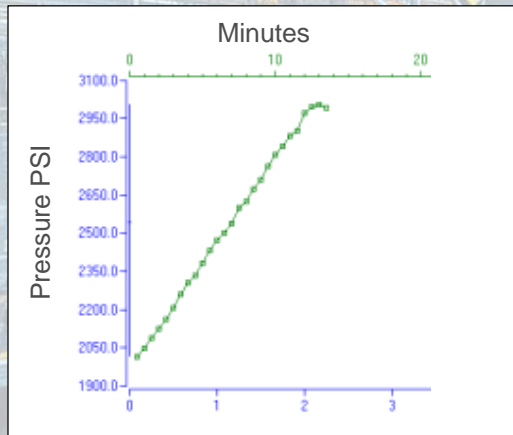
Typical Hydraulic Fluid B ISO 32 (System Filter)

Jumpy/jerky pressure control curve

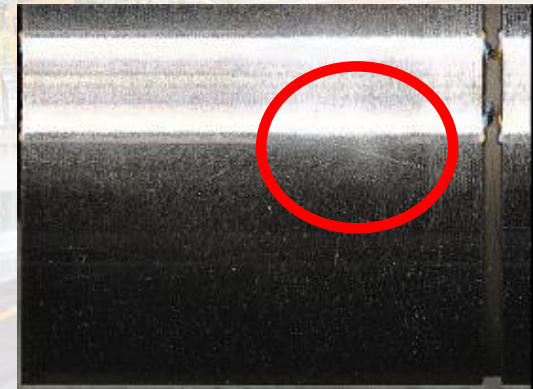
Signs of interruptions in valve caused by dirt or damage

Valve cylinder shows **signs of wear rings**

Valve piston shows **slight sandblasting**



Valve Cylinder Bore



Valve Piston

Pressure Control Valve

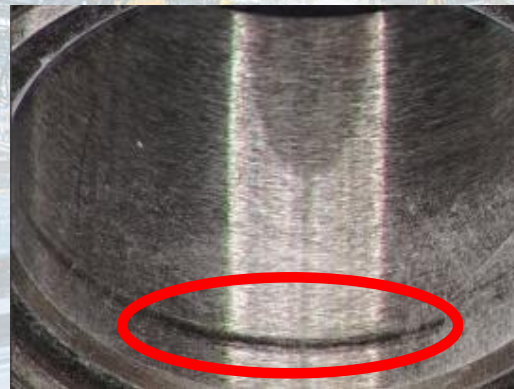
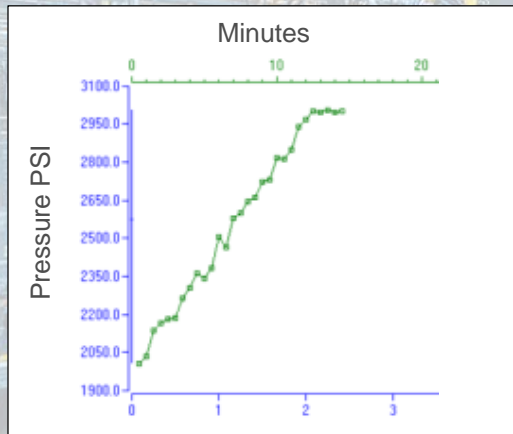
Typical Hydraulic Fluid C ISO 32 (Filter Bypass)

Extremely chaotic pressure control curve

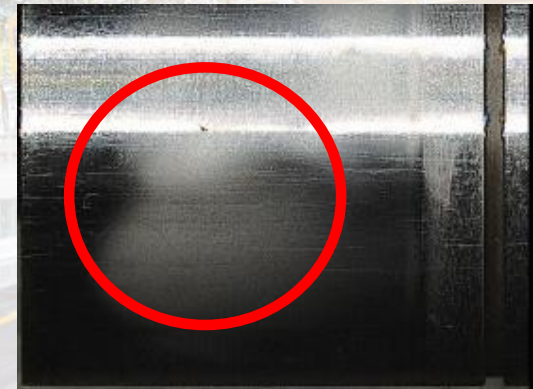
Signs of **interruptions in valve** caused by dirt or damage

Valve cylinder shows clear **wear ring**

Valve piston shows increased **sandblasted area**



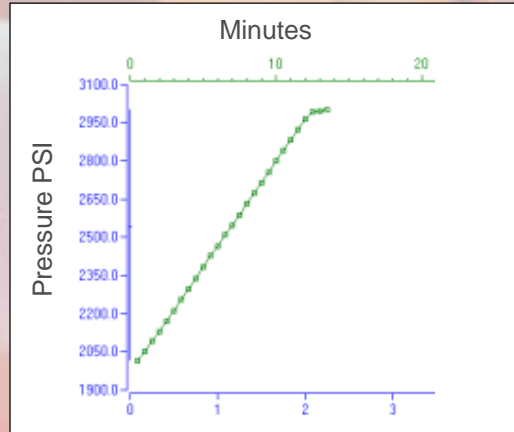
Valve Cylinder Bore



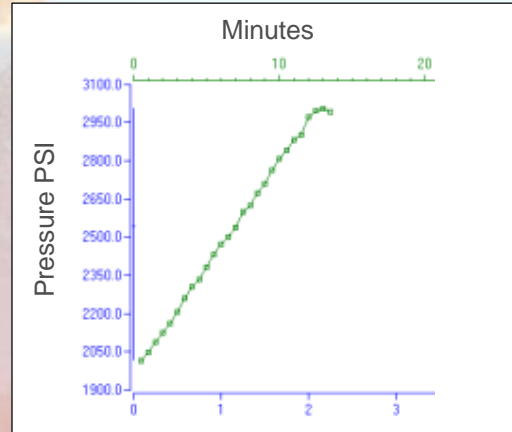
Valve Piston

Hydraulic System Fluid Pressure

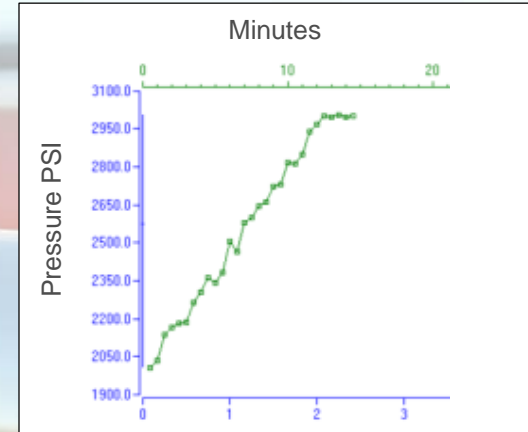
Chevron Rando[®] HD 32
ISOCLEAN[®] Certified



Typical Hydraulic Fluid B
ISO 32



Typical Hydraulic Fluid C
ISO 32 (Filter Bypass)



Pressure control valve **loses ability**
to provide stable, smooth pressure.

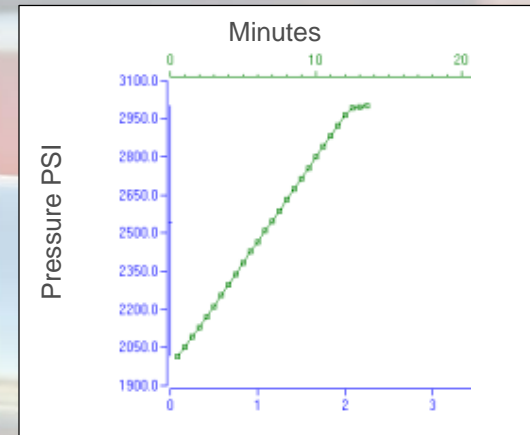
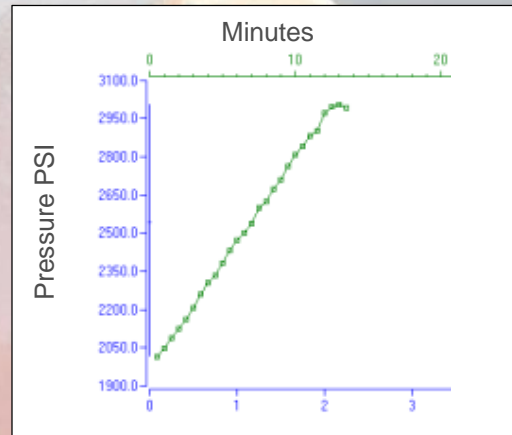
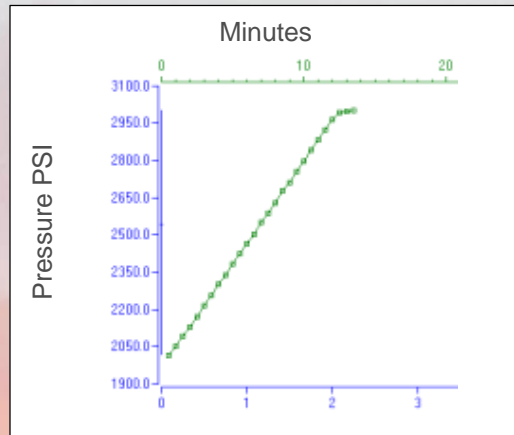
Fluid Pressure Test using End of Test Parts

Chevron Rando[®] HD 32
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Typical Hydraulic Fluid B
ISO 32 (System Filter)

Chevron Rando[®] HD 32
ISOCLEAN[®] Certified

Using End of Test (150 hrs.)
Damaged Parts from
Typical Hydraulic Fluid B ISO 32



Increasing cleanliness of hydraulic fluid can lead to **increase in system efficiency.**

System fluid pressure could stabilized when using
Chevron ISOCLEAN[®] Certified Lubricant in previously damaged valve.

Key Findings

Correlation between **initial hydraulic fluid cleanliness** and **amount of wear** on hydraulic system components.

Hydraulic system filters are effective in maintaining fluid cleanliness. When required to reduce fluid cleanliness level **component wear damage** can occur during the process. (Additional damage can occur during continual drain and fill intervals.)

System fluid pressure and efficiencies can be **negatively impacted** by fluid cleanliness including systems with some damage.

Learn More

Chevronindustrial.com/ISOCLEAN

ChevronLubematters.com

