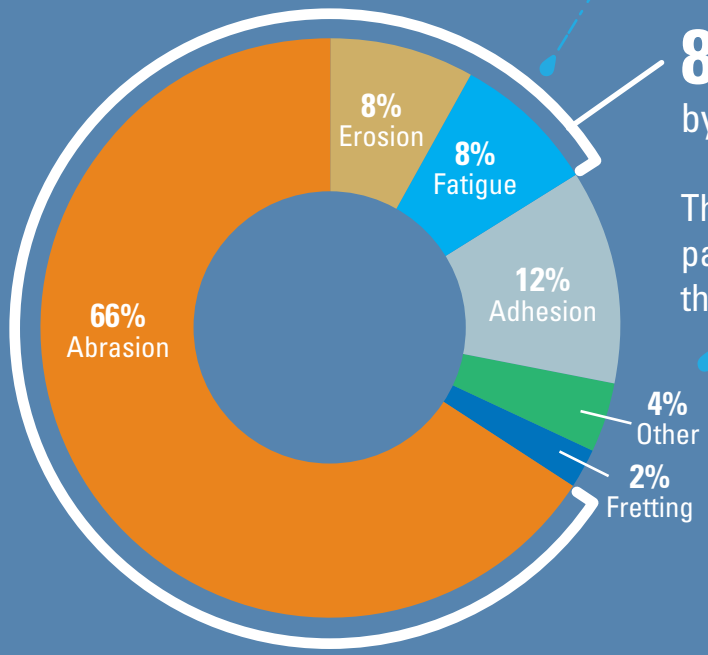
WHAT YOU CAN'T SEE CAN HURT YOU

THE IMPACT OF OIL CLEANLINESS ON YOUR EQUIPMENT

CONTAMINATION
IS THE LEADING CAUSE OF LUBRICANT-RELATED
EQUIPMENT FAILURE



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

Your equipment is being damaged by contaminants in the oil that you probably can't even see.

Particles are typically measured in microns. A micron is one millionth of a meter, which is equal to 0.000039 inches or 9.906e – 5 centimeters. Most people cannot see something that is smaller than 40 microns.

The particles that do the most damage are in the 1 to 10 micron range. These clearance-size particles enter the lubrication zone between machine parts and generate wear. The particles typically enter the oil after floating in the air or from water vapor.

MEASURING CONTAMINANTS

To understand how many contaminants are in oil and what size those contaminants are, the International Organization for Standardization (ISO) developed a standard known as the ISO Cleanliness Code.

The ISO Cleanliness Code groups the number of particles in a range and measures the contamination levels per milliliter of fluid at three sizes: 4 microns, 6 microns and 14 microns. Each number represents a contaminant level code for the correlating particle size including all particles of the specified size and larger. It is written as XX/YY/ZZ where:

- XX = total number of particles ≥ 4 µm
- YY = total number of particles ≥ 6 µm
- ZZ = total number of particles ≥ 14 µm

20/17/13

	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	

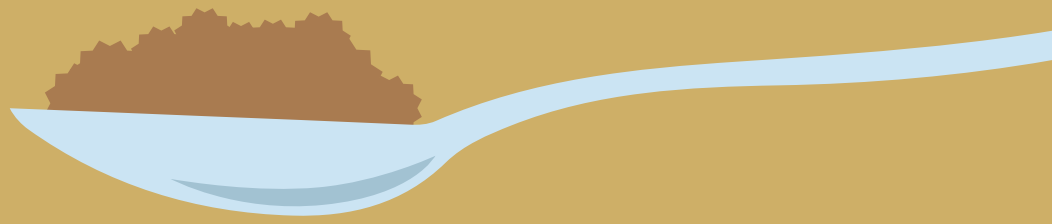
Some programs or equipment guides may report under the old two-number system. In this case, simply drop the first number: */17/13.

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

A SMALL AMOUNT OF CONTAMINANTS CAN SHORTEN EQUIPMENT LIFE

It doesn't take much to contaminate clean oil. As little as one teaspoon of dirt in 55 gallons/208 liters of oil could equate to about a billion particles 4 microns and larger. This level would be equal to an ISO Cleanliness Code of 19/17/14.

This level of contamination can be a double negative. It generates wear and can restrict the oil from protecting the component parts. Additives in the oil can be consumed trying to manage the level of contaminants and that can lead to shortened oil life and shortened equipment life.



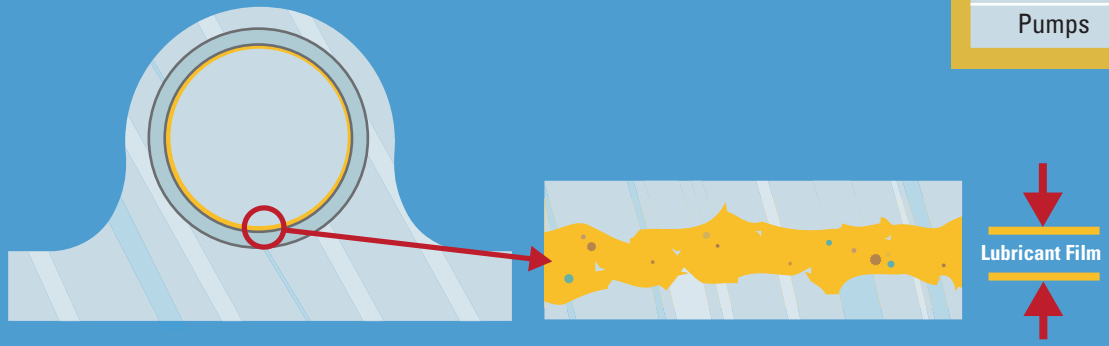
HOW CLEAN DOES OIL NEED TO BE?

To maximize productivity and component life, equipment manufacturers machine component parts to precision levels. A component's sensitivity to contamination determines how clean the oil needs to be.

Here's a good rule of thumb: Oil needs a cleanliness level to protect the tightest machine clearance on your equipment. So, if a proportional control valve on a hydraulic system is the tightest clearance on a piece of equipment and the control valve component manufacturer requires an ISO Cleanliness Code of 16/14/12, then an ISO Cleanliness Code of 16/14/12 would be the target level for new oil.

Most equipment manufacturers and individual component manufacturers set 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



Clearance-size particles that can enter the lubrication zone are the most damaging.

THE BENEFITS OF USING CLEAN OIL

Using clean oil that meets your equipment manufacturers' requirements has multiple benefits to the component and the lubricant. The top benefit is **increased component life**.

The Noria Life Extension Chart below demonstrates the relative life of a hydraulic system component based on its cleanliness. As an example, we'll go from a current ISO Cleanliness Code of 20/18/15 to a new ISO Cleanliness Code of 17/15/12. To do that, locate the current code of 20/18/15 on the "Y" Axis and then move horizontally to the new target cleanliness level of 17/15/12. With this change in cleanliness, the life extension factor for hydraulic system components equals 2. That means that if we can obtain and maintain the target cleanliness level of 17/15/12, we can expect the system components to **last two times longer** than currently being experienced with the 20/18/15 level.

Life Extension Chart - Hydraulic Systems

Current Machine Cleanliness	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
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

New Cleanliness Level

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

System Components Last Two Times Longer

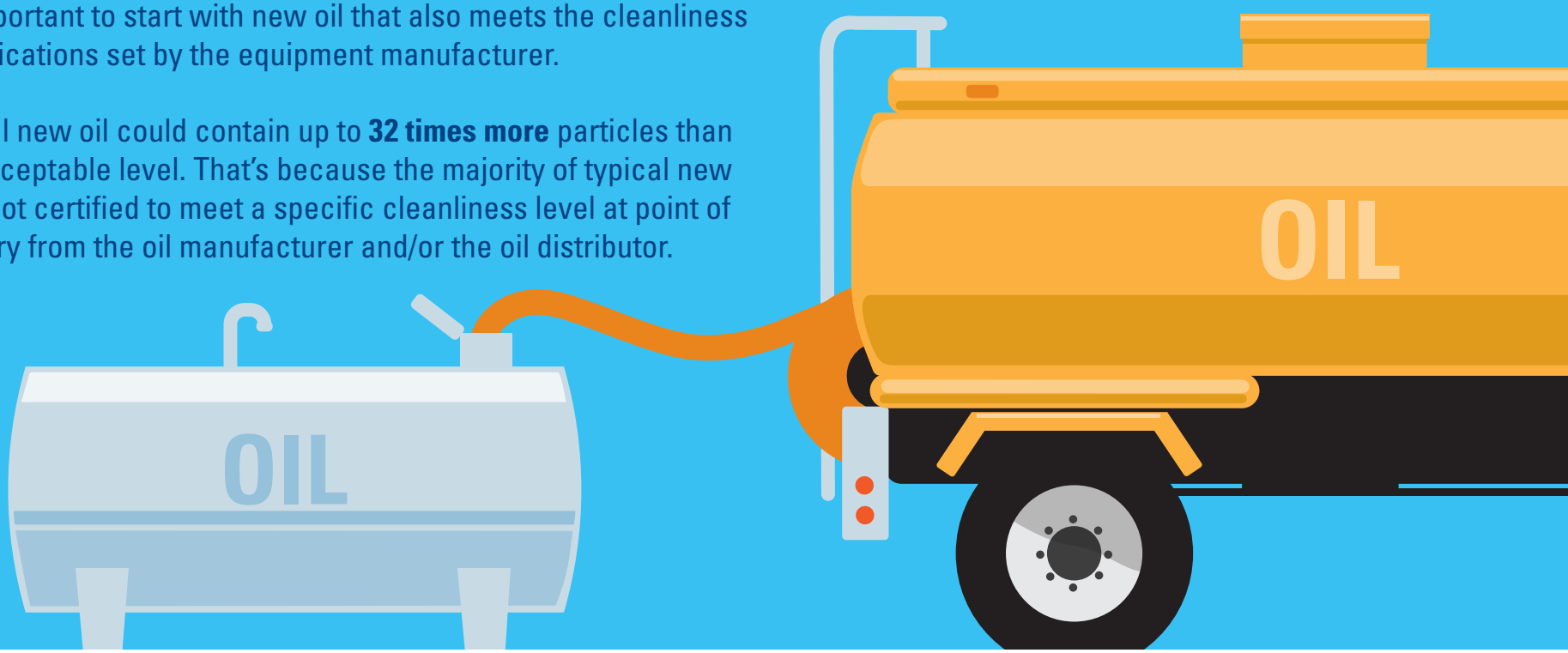
This is an example for demonstration purposes. Actual savings will vary depending on lubricant performance, oil sample frequency, equipment type, equipment condition and previous condition, and the ability to keep the fluid clean.

TYPICAL NEW OIL IS PROBABLY NOT SUITABLE FOR YOUR EQUIPMENT

Many people assume typical new oil meets both the performance and cleanliness requirements set by their equipment's manufacturer. **That's usually not true**.

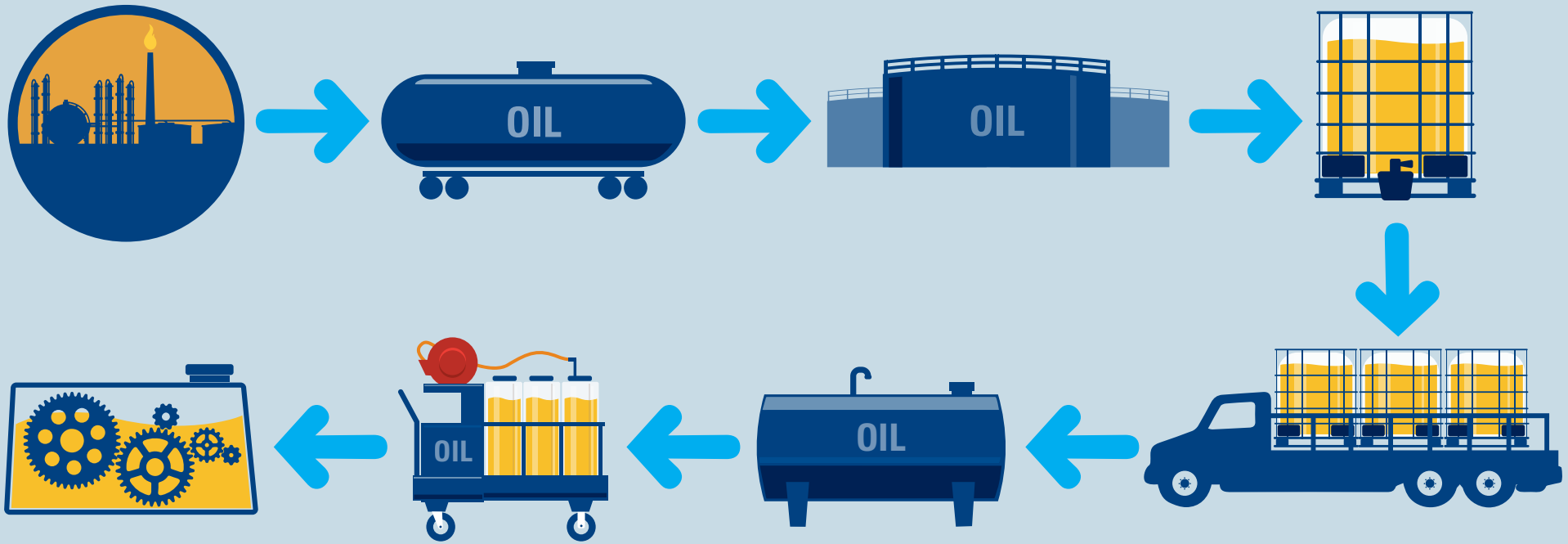
End users and oil suppliers often focus only on the performance specifications of new oil. To achieve maximum component life, it's important to start with new oil that also meets the cleanliness specifications set by the equipment manufacturer.

Typical new oil could contain up to **32 times more** particles than the acceptable level. That's because the majority of typical new oil is not certified to meet a specific cleanliness level at point of delivery from the oil manufacturer and/or the oil distributor.



HOW NEW OIL GETS
CONTAMINATED

Typical bulk oil can be transferred up to **eight times** before it reaches your equipment. Each time it's transferred, the oil can pick up more contaminants. In fact, it's common for a lubricant to increase **two to four ISO Cleanliness Codes** during the typical distribution process.



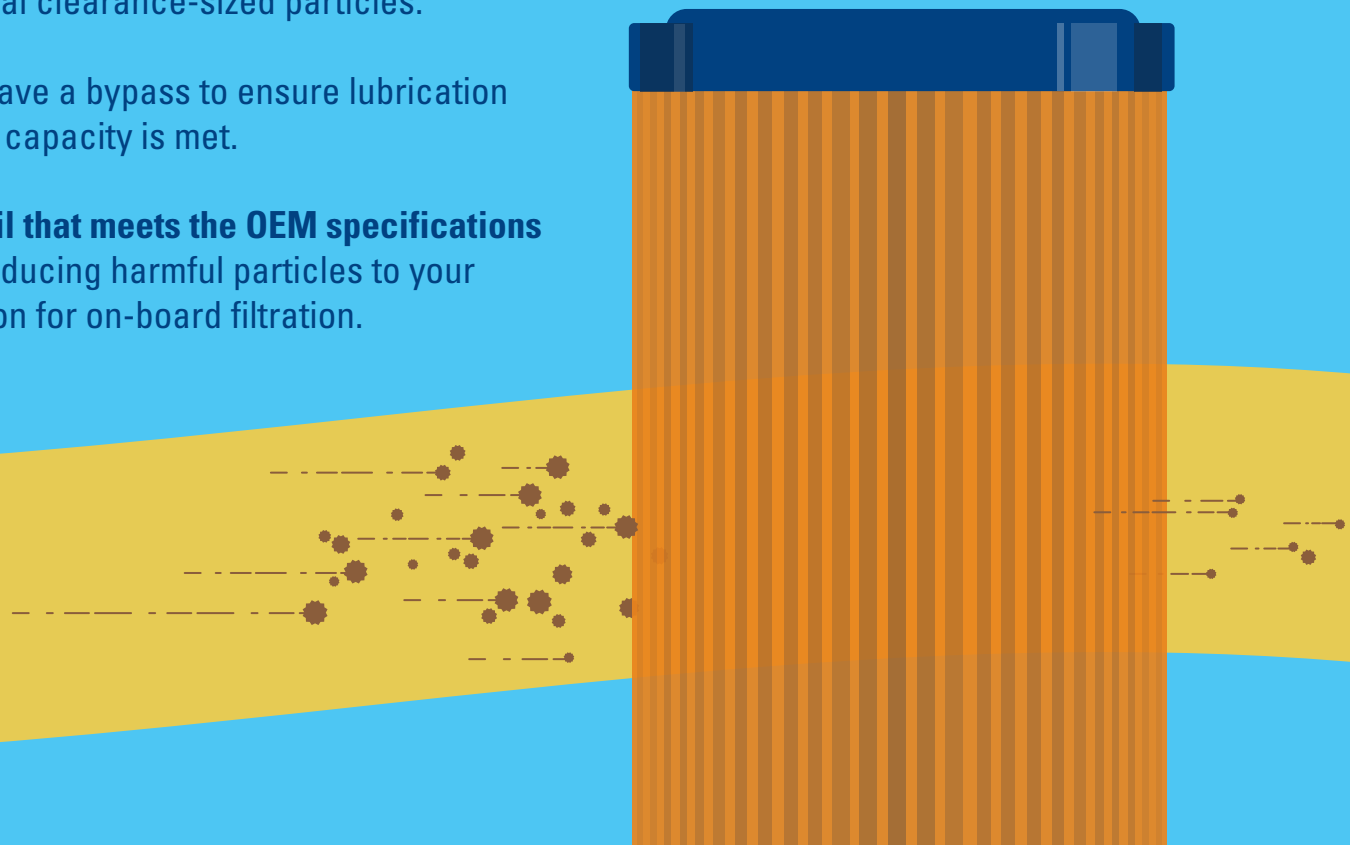
WON'T THE OIL FILTERS ON MY EQUIPMENT REMOVE THE CONTAMINANTS?

Filters on equipment will remove some but not all contaminants – and not before those contaminants have already caused damaging wear.

Many systems are not properly balanced or sized to exclude and remove the most critical clearance-sized particles.

On-board filters typically have a bypass to ensure lubrication is not cut off once a filter's capacity is met.

Starting with clean new oil that meets the OEM specifications will ensure you're not introducing harmful particles to your system and ease the tension for on-board filtration.



DO YOU PRE-FILTER NEW OIL ON SITE?

4 REASONS NOT TO DO IT YOURSELF

Pre-filtering new oil can be expensive and a risk to your equipment:

1. Increased Capital Investment.

What is your initial and ongoing capital cost to purchase and operate filtration equipment?

2. Increased Manpower Cost.

What do you want your personnel to be doing — pre-filtering new oil or focusing on maintaining your equipment?

3. Technical Expertise Required.

Do your maintenance personnel have the technical expertise to ensure each type of oil is not over-filtered? Over-filtering oil can remove additives and cause further harm to your equipment.

4. Doesn't Always Work.

Are you sure pre-filtering new oil on site will work? Often, companies purchase filtration equipment that is not designed correctly or their systems are not properly maintained. Results are not measured. Also, oil filtration targets are rarely met and equipment suffers.