Western Filter™

FEATURES

Western Filter suction strainers are constructed with aluminum end-caps and stainless steel screen to protect hydraulic pumps from harmful large contaminants that tend to accumulate on the bottom of hydraulic reservoirs.

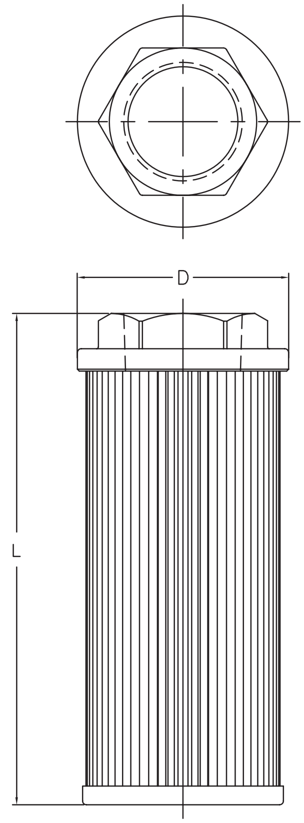
- 5 Sizes of NPTF threads available
- Available with or without bypass
- Replaces competitive products

Sizing Data	Nominal Capacity (GPM*)	(L) Inches	(D) Inches	(L) MM	(D) MM
3/4″ NPT	8	4.1	2.7	105	68
1″ NPT	10	5.5	2.7	139	68
1-1/4″ NPT	20	7.7	3.5	195	88
1-1/2″ NPT	50	10.0	3.5	260	88
3″ NPT	100	10.7	5.7	272	150

*Flows indicated are based on ≤ 1.0 PSID maximum @ 150 SSU

WSS Series

In-Tank Suction Strainers



Model Number	Size	Micron Rating	Bypass
WSS-8-125-	**3/4” NPT**	**125 (standard)**	NON-BYPASS
WSS-8-060-	3/4″ NPT	060 (special order)	ADD - N
WSS-8-250-	3/4″ NPT	250 (special order)	AT END OF MODEL #
WSS-10-125-	**1” NPT**	**125 (standard)**	(i.e. - WSS-8-125-N)
WSS-10-060-	1″ NPT	060 (special order)	
WSS-10-250-	1″ NPT	250 (special order)	
WSS-20-125-	**1-1/4” NPT**	**125 (standard)**	3 PSID BYPASS
WSS-20-060-	1-1/4″ NPT	060 (special order)	ADD - X
WSS-20-250-	1-1/4″ NPT	250 (special order)	AT END OF MODEL #
WSS-50-125-	**1-1/2” NPT**	**125 (standard)**	(i.e. - WSS-8-125-X)
WSS-50-060-	1-1/2″ NPT	060 (special order)	
WSS-50-250-	1-1/2″ NPT	250 (special order)	
WSS-100-125-	**3” NPT**	**125 (standard)**	
WSS-100-060-	3″ NPT	060 (special order)	
WSS-100-250-	3″ NPT	250 (special order)	

FEATURES

Western Filter Filler/Breathers protect your hydraulic system from harmful airborne contaminants during normal "breathing" of the reservoir as fluid levels fluctuate and as cylinders are activated and other factors. Filler/Breathers should be of the same or better micron rating as the main system filtration. To help insure system cleanliness integrity, breather caps should become a part of normal maintenance procedures and be changed whenever the system hydraulic filter element filters are replaced.

Model Number	Micron	Basket
WFB-03-B	03 - 3µ	3″ stainless steel basket with chain included
WFB-10-B	10 - 10µ	

Replacement Cap Only

Model Number	Micron	No Basket
WFC-03-N	03 - 3µ	N
WFC-10-N	10 - 10µ	N

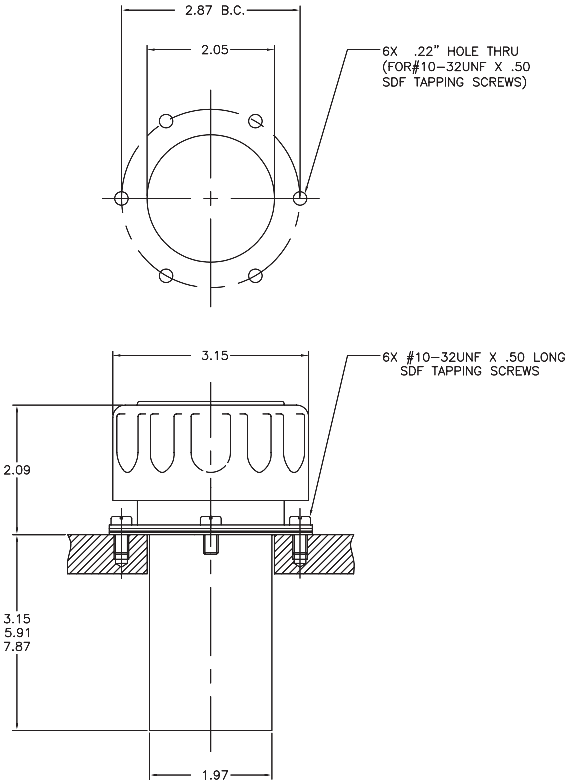
* Replacement breather cap fits competitive filler flanges, eliminating the need to change the entire Filler/Breather

Technical Data:

- Choice of 3µ or 10µ breather
- Chrome plated cap
- Corrosion proof stainless steel filler basket
- Brass chain
- Reservoir self-tapping screws included
- Bayonet mount fits competitive filler baskets
- Standard seal material: cork
- 03 air flow ∆/P = .5 PSI @ 20 SCFM
- 10 air flow ∆/P = .5 PSI @ 80 SCFM

WFB Series

Bayonet Style Filler/Breather



ACCESSORIES
TECHNICAL DATA
REFERENCE DATA & SERVICE PARTS

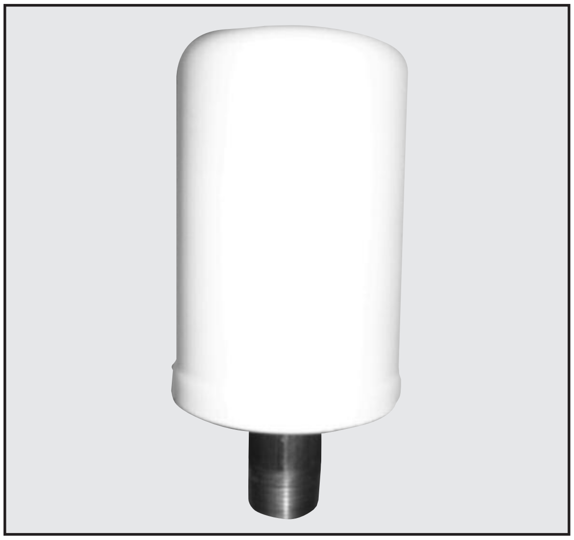
Western Filter

BENEFITS & FEATURES

- Choice of 3 micron ratings
- Choice of two element lengths
- Uses standard Western Filter replacement canisters
- Air Flow to 220 SCFM
- Oil Flow to 485 GPM
  (350 SCFM w/ water removal)

TB Series

Tank Breathers

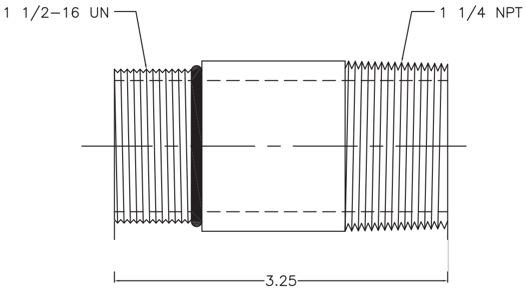


Sizing Information/Replacement Element Part Numbers

7" Canisters	Micron	11" Canisters
1P10/SCFM = 85	10µ	2P10/SCFM = 160
1P20/SCFM = 115	20µ	2P20/SCFM = 220
1W/SCFM = 135	Water Rem.	2W/SCFM = 350

High-Capacity Reservoir Breather Kit

Model Number Selection	Micron	Canister Length	A
WHB-1P10-7-A	10µ	7" CANISTER	1-1/2" NPT Adapter Included
WHB-2P10-11-A	10µ	11" CANISTER	
WHB-1P20-7-A	20µ	7" CANISTER	
WHB-2P10-2-A	20µ	11" CANISTER	
WHB-1W-7-A	25µ Nominal	7" CANISTER	
WHB-2W-11-A	25µ Nominal	11" CANISTER	



Tank Breather Adapter Part Number P-077002

BASIC MODEL FEATURES

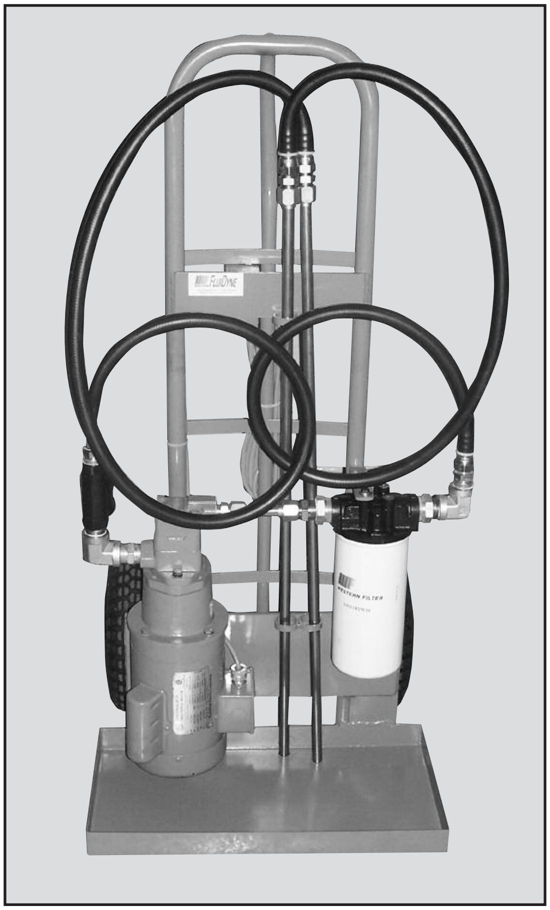
- 1 HP 1800 RPM
- V101P8P pump 10 GPM
- Heavy duty cart w/ pneumatic tires
- Drip pan under hose assembly
- 10 ft. hose wand on suction side
- 5 micron spin on filter element, W023 with visual indicator
- Inlet strainer on inlet of pump
- Wired for 110/60 AC with on/off switch

ADDITIONAL OPTIONS

- Clear inlet hose (not shown)
- Water absorbing filter (not shown)
- Electric cord/wind up reel
- 20 ft. hose reel on outlet of cart
- Other flow rates available: 3 GPM, 5 GPM, 12 GPM
- Cartridge filters available

Filter Carts

Low “Center of Gravity” design



- **Wind up electric cord**
- **Tip back drip tray holds spilled oil while cart rolls**
- **Western Filter carts have a low center of gravity design for easy movement through shop**
- **Outlet hose reel**

CONTAMINATION

The primary function of a filter is to reduce or eliminate undesirable contaminants from fluids prior to their flow through sensitive system components. These contaminants, when allowed to flow freely in a system can cause wear, malfunction, and failure of many expensive components.

Regardless of conditions, contamination is inherent in every fluid system. It is influenced by many factors, generated by mechanical components, and collected by the fluid as it circulates.

There are several factors to consider when determining fluid system needs and selecting filters. These include, but are not limited to: the complexity of the fluid system, the various functions of the system, the type(s) of components used, and the fluid itself. A complex system would require several filters to protect each component adequately.

CONTAMINANT SOURCES

External Contamination, also known as ingressed contamination, may stem from many environmental sources. However, there are four major ways contaminants can enter a system: reservoir vent ports (breathers), power unit or system access plates, components left open during maintenance, and faulty seals or o-rings. Generally ranging in size from 1-500 microns, these contaminants may be dust, dirt, corrosion, adhesives, paint, etc.

Internal Contamination is the most dangerous contamination to a system. Internal contamination is the contamination generated by the system itself. Particles created by such conditions as adhesive wear or galling, abrasive wear, surface fatigue, and erosion are "work hardened" to a greater material hardness than the surface from which they came and are very aggressive in causing further wear to the system. Pumps generate contaminants during normal operation that if not immediately removed, result in elevated contamination levels having an extremely accelerated wear effect, causing more particulate contaminant, causing more wear, and so on until the inevitable failure occurs. Other internal sources of concern include chemical wear, excessive heat, and microbiological growth.

One noteworthy and unique source of internal contamination is filter failure. A common cause of catastrophic failure is improper maintenance and poor quality filtration products. When a filter element fails, it collapses and unloads much or all of the contaminant (both internal and external) previously captured. This extreme concentration of system contamination is suddenly released downstream and whatever is in it's path may be severely damaged or destroyed.

Contaminated New Oil, an often overlooked source, is a major contributor to system contamination. Although hydraulic and lubrication oils are refined and blended under relatively clean conditions, the fluid travels through many hoses and pipes before it is stored in drums or in a bulk tank at the users facility. At this point the fluid is no longer clean. It is almost guaranteed the pumps, the lines, and the drums it has traveled through have contributed metal, rubber, flakes of scale, corrosion, and exposure to dirt and dust.

Storage tanks are severe problems as water condenses on the inner walls, causing rust particles that then enter the fluid. Contamination from the atmosphere also finds its way into the tank when sufficient air breather filtration is not installed.

Built in Contamination from new machinery is most always a cause for concern. Typical incidences are burrs, chips, flash, slag, weld splatter, dirt, dust, fiber, sand, moisture, pipe sealant, paint, flushing solution, and almost anything imaginable.

Damage Caused by Contamination

- Adhesive Wear
- Fatigue Wear
- Abrasive Wear
- Corrosive Wear
- Intermittent Failure
- Degradation Failure
- Catastrophic Failure

Western Filter H-Pak[M] elements offer collapse ratings up to 3000 PSID for extreme protection of critical components.

Western™ Filter

FLUID SYSTEMS

As in any aspect of machine design or maintenance, cost of installation and operation is an important concern. For filters, the length of time an element performs its function and the initial cost of element combine to determine the economics of it's use.

There are several ways to determine when a filter should be replaced. The simplest, not always the best, method is the use of a non-bypass filter housing with a high collapse-resistant filter element. This method has the advantage of continuous full flow filtration. As the filter element becomes clogged with contaminant, the differential pressure (ΔP) increases until the system stops functioning and forces element replacement.

Bypass valves and differential pressure indicators are valuable tools in fluid power systems. A bypass valve will begin to open as differential pressure from a clogged filter element rises, allowing a minimal amount of unfiltered fluid downstream, maintaining system flow. Though undesirable to have fluid circulating unfiltered, unfiltered fluid is less damaging than no fluid at all, and a properly functioning bypass valve will still maintain filtration of as much fluid as the pressure allows.

Differential pressure indicators generate a signal, either visually (button) or electronically (light) to indicate when filter element replacement is recommended.

There are several variations in each, with a multitude ΔP indication ranges and actions, chosen by system requirements or manufacturer recommendations. The most common being a visual, resettable, red button that "pops" up. Other types may include options of automatic reset, or an electrical signal to trigger a safety shutdown, visual light, etc. Periodic maintenance based on projected element life, is always more desirable than a system malfunction.

Maintenance considerations will determine the choice of reusable or disposable filter elements. Reusable filter elements, typically of all metal construction, can be cleaned for three to ten life cycles. More expensive than disposable elements, each successive cleaning cycle achieves only a fraction of the original efficiency and capacity rating as minor damage occurs. However, cleanable elements do offer strength and durability over disposable elements, as well as the advantages of minimal media migration, absolute size rating, and compatibility with most any fluids and temperatures.

Disposable filter elements are less expensive, require no maintenance besides replacement, provide excellent filtration efficiencies, and offer greater contaminant capacity than cleanable elements of the same micron rating. Yet, disposable elements offer greater chance for media migration, limited temperature operating range, increased sensitivity to flow fatigue, and limited fluid compatibility.

Micron is the term for the SI unit, micrometer, and is exactly one millionth of a meter. To gain some perspective, consider the following:

SCALE

INCHES	MICRONS	
	130	– Table Salt
.005	120	
	110	
	100	
.004	90	
	80	– 200 Mesh Screen
.003	70	
	60	– Human Hair
	50	– Pollen
.002	40	
	30	– Lower limit of vision
.001	20	
	10	
.0001	1	– Red blood cells
		– Bacteria

Reliability requirements and operating parameters of a system will dictate the filter medium and the plant engineer must decide filter locations in the overall fluid system to control contaminants.

Selection Criteria

- Critical Location
- Fluid Cleanliness Level
- Fluid Type
- Flow Rate
- Size & Weight
- Maintenance
- Cost

Western Filter E-Pak™ Elements reduce cost and waste. With a coreless design, material quantities are minimized, and are crushable to 40% of operating size.

FILTER PERFORMANCE AND SYSTEM CLEANLINESS

Filtration Efficiency is important because it is a direct measure of how well the filter performs. Filtration efficiency is often stated as a Beta Ratio. This is defined as the ratio of the number of particles greater than a specified size in the incoming fluid (upstream), to the number of those particles in the outgoing fluid (downstream) under specified test conditions. The higher the Beta Ratio, the more particles are retained by the filter and the greater its efficiency. (See Multipass Test Section)

For instance, if a filter is rated at a Beta 10 to 200, ($\beta_{10} = 200$) when tested, there would be 200 times more 10-micron sized particles measured upstream than down-stream. If there were 1000 particles upstream, there would be only 5 particles downstream. The filter is 99.5% efficient in capturing 10-micron sized particles.

Dirt-Holding Capacity (DHC) is important because it can be used to determine the time required between element changes, i.e., how long your filter elements will last. Filters are the only component within a hydraulic system that "fail" in order to do their job. DHC is defined as the weight in grams of an artificial test dust which can be added (at specified intervals and flow rate) to produce a fixed differential pressure across the filter element. This weight can be converted to the useful life, in hours, of a filter element.

Pressure Drop is important because it may affect system performance. Every component between the pump (pressure line) and actuator in a hydraulic system reduces the pressure that reaches that actuator and therefore reduces power at the point of work. Likewise, components added after the actuator (return line) cause back-pressure, which can also affect the system performance. Whether in a pressure line or return line, when adding filters to a system it is important to minimize pressure drop.

The true merit of a hydraulic or lube filter is in its ability to actually clean the system. **System cleanliness** is characterized by a three number code. The International Standards Organization (ISO) has adopted a revised procedure for the use of this code (ISO4406:1999), which corresponds to the concentration of contaminant particles larger than 4, 6, and 14 microns in a one-milliliter sample of fluid. Relative fluid cleanliness can be measured, therefore, using fluid sampling and analysis.

For example, if a fluid sample contains sixty 4-micron particles (range number = 13), fifteen 6-micron particles (range number = 11), and four 14-micron particles (range number = 09), it can be assigned an ISO cleanliness rating of 13/11/09 (See table).

This standard allows you to quantify current particulate cleanliness levels and set targets for cleanup. Notice that each step in the ISO code represents either double or half the particle count relative to an adjacent code.

As a general rule of thumb, initial clean pressure drop should be no more than 30% of **Bypass Valve Setting**. Longer element lengths extend element service service life (time between element changes). Using the longest element length for each housing is often the best design practice.

Target Cleanliness Levels are determined by either the manufacturer of the system, or in system design, the requirements of the most sensitive component.

Different types of systems and the different types of components within systems all require different cleanliness levels for optimum system health. These cleanliness levels coincide generally with the critical clearances within the component or how delicate the mechanism may be. For instance, a system that contains servo valves may be required to maintain a cleanliness level of 16/14/11 while a system controlled by cartridge valves may be recommended to maintain a cleanliness level of 18/16/13. A system with both would need to be maintained to the cleaner of the two.

General system maintenance protocol dictates that a target cleanliness level be set according to the most sensitive component within the system, that fluid analysis be conducted to measure current cleanliness levels, and that filtration devices be placed within the targets are properly selected to achieve the target cleanliness. Under this type of protocol, a normal hydraulic system should last for many years.

Below: BetaPore™ Media codes and related Target Cleanliness Levels. Use the Media Grade Selection Guide on page 6 to assist in determining system requirements.

CODE	TARGET CLEANLINESS LEVEL
03	16/14/12
05	18/16/14
10	20/18/15
20	22/19/16

THE MULTIPASS TEST

Originally outlined in ISO 4572, and now superceded by ISO 16889, the **Multipass test** was developed as a test in which a filter element was subjected to multiple passes of a constant rate of uniformly contaminated fluid. The multipass test consists of two "loops," the test loop, and the injection loop. The test loop is where the element is contained. The element is placed in a closed, recirculating circuit under constant flow and temperature. To this system, the injection loop constantly injects a controlled amount of contaminated fluid. This contaminated fluid injection generates the particulate ingression for a standardized test system. From the test loop, fluid samples are constantly taken from both upstream and downstream of the filter element assembly. This combined sample rate is equivalent to the injection rate, thus maintaining a constant test system volume.

The upstream and downstream fluid samples are analyzed by automatic particle counter, utilizing laser light for more accurate results.

The count data is then interpreted and displayed in counts per ml, by micron size. 2, 3, 4, 5, 7, 10, 20, 30, etc. The sizes monitored vary according to the calibration setting.

The Beta Ratio (β)

From these multipass tests, and the subsequent fluid sample monitoring, filtration performance is evaluated. At a given micron rating, taking the upstream particle counts and dividing into this the downstream particle count, a ratio is generated. This ratio is commonly known as the Beta Ratio (β) or also as the Filtration Ratio.

$$\frac{u_x}{d_x} = \beta_x$$

When: u_x = the upstream particle count and
d_x = the downstream particle count

(at particular micron rating x)

Efficiency

Filtration efficiency can be determined at any micron rating from the known Beta ratio as follows:

$$eff_x = \frac{\beta_x - 1}{\beta_x} \times 100$$ Percent efficiency at micron x

and conversely:

$$\beta_x = \frac{1}{1 - eff_x}$$ when efficiency is expressed in a decimal form (99% = .99)

Using the above formulas it can be shown that for Beta ratio of 200, the efficiency of the particular element is 99.5% in removing particulate contaminant of the monitored size and larger. A Beta of 1000 converts to 99.9% efficiency, and so on.

ISO SOLID CONTAMINATION CODE REVISION, 1999

ACFTD, (AC Fine Test Dust) was the standard for contamination testing since 1940. This dust was produced from Arizona silica under very controlled manufacturing processes. A very constant particle size distribution was maintained, and with this known distribution, the calibration of automatic particle counters was feasible.

In March of 1992 AC announced it would cease production of test dust, and in April of the same year, ISO 12103-1: Road Vehicles – Test Dust for Filter Evaluation was published. In it the size dispersion of four test dusts was defined.

It was decided that ISOMTD (ISO Medium Test) bore the closest resemblance to the ACFTD and a suitable replacement was settled upon.

With the replacement of ACFTD with ISOMTD, the filtration industry continued with development and testing of filter elements. Using this calibration, micron ratings for elements were established and remain in the market today, although most recently, target cleanliness levels have taken precedence with the advance of the portable particle counter.

In 1999 ISO redefined calibration, testing, and classification procedures, and essentially all standards dealing with the AC Fine test dust. This was done to reflect accurately the newly accepted replacement dust, and to give these calibrations traceability back to the National Institute of Standards (NIST).

PREVIOUS ISO STANDARD	Has been superceded and replaced by:	NEW ISO STANDARD (of the same title)
ISO 4402: **Automatic Particle Counter (APC) Calibration**		**ISO 11171**
ISO 4406: **Coding of contaminants by particle size**	Has been superceded and replaced by:	**ISO 4406:1999**
ISO 4572: **The Multipass Test**		**ISO 16889**

Western Filter BetaPore™ filtration media Paks™ have shown consistent Beta ratios for a desired micron rating well above 200 and typically into the 1000 and greater range.

FLUID CLEANLINESS STANDARDS

As it is not very economical for every end user to own a multipass test stand, and/or hire someone to perform and interpret the test, the industry took another look at element efficiencies and began analyzing not the element, but the entire system around the element. Not necessarily "What was the element rated for in Beta and/or Dirt Capacity?" but "How does it perform in the system?" What does the fluid being treated by this filtration device look like? As the end user became wiser to the necessity of proper filtration, the filtration manufacturers had to provide reasonable, easy to understand test data.

Since real-life applications vary, ISO designed a method of class coding the contamination level in a given hydraulic system. This class code chart can be found in ISO 4406:1999 as well as later in this publication.

This "coding" of solid contaminant has become the benchmark of hydraulic filtration. With the calibration changes mentioned before, much concern arose with the effect of the particle classification process.

The original ISO 4406 code classified two orders of contaminant: the 5µ and larger, and the 15µ and larger particle. Represented in the form of: **XX / XX** where the "X's" denote a 2-digit class code number.

This number, defined in a logarithmic scale, represented the number of particles equal to and larger than the **5µ / 15µ** particle size, per mL, in that order. This method was sufficient for many years, however particle counter (APC) manufacturers, filtration engineers and end-users the like all found that the most severe damage to a system can be caused by the smallest of particulate. With this knowledge, the 3-order classification arose in the form of **XX/XX/XX** where the X's denote particulate in the order of 2µ and larger, 5µ and larger, and 15µ and larger, per mL of sample.

2µ / 5µ /15µ

With the new 11171 calibration issues at hand, ISO recognized the significance of this smaller micron class code and addressed it in the new release of 4406:1999. The new classification contained three codes, and represented the scales of 4µ and larger, 6µ and larger, and 14µ and larger, per mL of sample.

$4\mu_{(c)}$ /$6\mu_{(c)}$ /$14\mu_{(c)}$

The (c) denotes the new standard.

The most significant impact of this new ISO calibration, classification and cleanliness coding scheme, is that there is no impact!

Correlation(s) between the old and new standard maintained and preserved the class code definitions, so the end user, and the maintenance department wouldn't have to be

In other words, a system designed for and maintained to a target cleanliness level, still has the same target cleanliness level.

Western Filter developed and tested our new offerings of BetaPore™ Media Paks™ using the new standard ISO 16889 Multipass Test.

Western Filter™

ISO 4406 OLD AND NEW

Below are two tables. One representing the particle count and subsequent ISO class number as previously defined in 4406, the next representing the new table as defined in 4406:1999. Notice the quantity of particulate remains the same yet, 4406:1999 shifts and extends the upper limits of the counting, while the target cleanliness code remains the same. **Whether your fluid analyzing equipment is calibrated to the old standard or the new, your system cleanliness remains the same. Western Filter has associated a target cleanliness level to each of our BetaPore™ media codes.** These target cleanliness tables are on every model code page, as well as earlier in this publication, and associate the cleanliness level to the the media grade for the specific element code application.

ISO 4406
PARTICLE COUNTS/ML

More Than	Up to and Including	Scale Number
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
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0.005	0.01	0
0.0025	0.005	0.9

ISO 4406: 1999
PARTICLE COUNTS/ML

More Than	Up to and Including	Scale Number
1,300,000	2,500,000	28
640,000	1,300,000	27
320,000	640,000	26
160,000	320,000	25
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
3	5	9
1	2.50	8
1	1.3	7
0	0.64	6
0	0.32	5
0	0.16	4
0	0.08	3
0	0.04	2
0	0.02	1
0	0.01	0

ISO CLEANLINESS CODE
16/14/12

16	14	12
320 to 640 counts/ml >2µ	80 to 160 counts/ml >5µ	20 to 40 counts/ml >15µ

ISO CLEANLINESS CODE
16/14/12 (c)

16	14	12
320 to 640 counts/ml >4µ$_{(c)}$	80 to 160 counts/ml >6µ$_{(c)}$	20 to 40 counts/ml >14µ$_{(c)}$