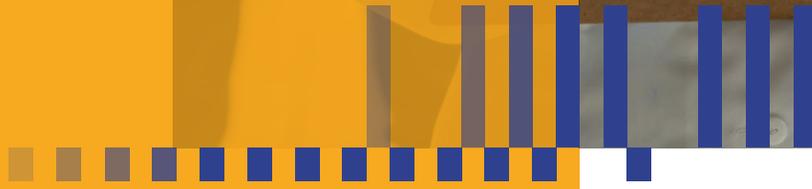




® Knowledge
Beyond
Measure.



Filter Testing for Air Filters and Filter Media



Trusted by Filter Manufacturers Around the Globe

The World Health Organization (WHO) stated "In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met.**" At the same time, there is increasing awareness about the health effects of inhaling higher concentrations of particles and viruses, especially in the recent pandemic. This has caused an increased use of respiratory masks for protection in daily life, at workplaces, in healthcare, by firefighters, etc.

In order to ensure the quality of these protective respiratory masks and filters, worldwide standards are in place to ensure reproducible test results, such as US 42 CFR 84, GB 2626, JMOL, ISO 16900-3, EN 143/149, ISO 23328-1 and more.

*Source: <http://www.who.int/mediacentre/factsheets/fs313/en/>



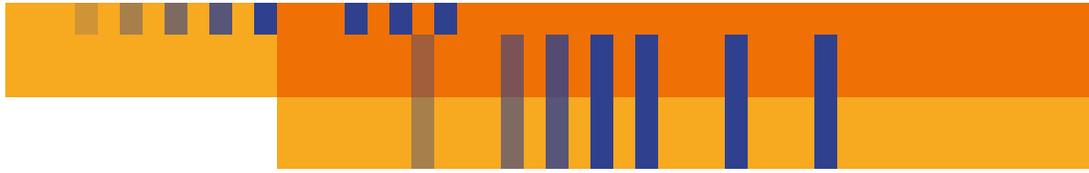
TSI® provides filter testing solutions to manufacturers and certification agencies for performance and compliance testing to many standards and regulations such as:

- Respiratory filter testing: US 42 CFR 84, GB 2626, EN 143/149, ISO 16900-3
- Air cleaner testing: AHAM AC-1-2013, GB/T 18801-2015
- HEPA and ULPA filter and filter media testing: EN 1822 parts 3 and 5, ISO 29463 parts 3 and 5, MIL STD
- Ventilation filter testing: ASHRAE 52.2, ISO 16890-2
- Others (cabin air filter testing, engine intake filter testing)

TSI® also offers various high end components for cost effective customized systems or specific application requirements (e.g. very high efficiency filters, protective garments) for:

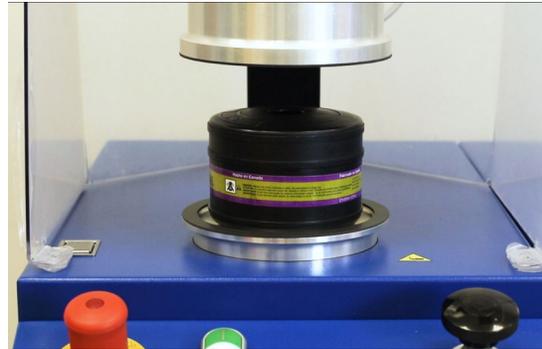
- Aerosol Generation (salt, oil, and powder/dust generators, polydisperse and monodisperse)
- Isokinetic Sampling
- Aerosol Particle Counting and Sizing: (Optical Particle Sizer 3330, Condensation Particle Counters)



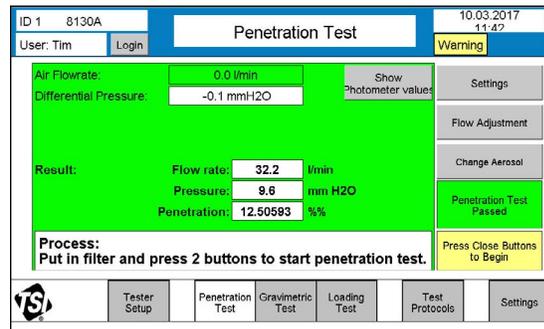


The Automated Filter Testers (AFTs) that are offered for respiratory filter testing and fractional efficiency testing are designed to increase throughput, to reduce the cost of ownership and to result in more profitable filter testing. These AFTs measure the filter or filter media resistance with highly accurate electronic pressure transducers. Simultaneous upstream and downstream detector readings provide the most accurate penetration or filter efficiency measurement results.

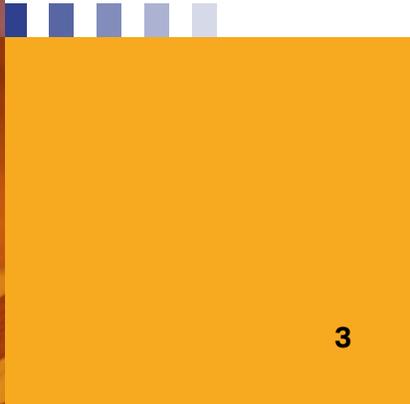
Several hundred Automated Filter Testers are being used worldwide. They have a proven track record of durability, reliability, and minimal maintenance. Additionally, all filter testers are backed by TSI's commitment to provide superior customer support and service.



Respiratory filter cartridge placed into the Automated Filter Tester 8130A



Screen capture of the 8130A graphical user interface. A respiratory filter was tested for penetration and pressure drop and passed the target requirements



Respiratory Filter Testing

Quality Control Filter Testing in the Lab

Meet your standards and achieve your goals with the Automated Filter Tester 8130A

The 8130A enables the testing of respirator filters, disposable filtering face pieces, and a wide assortment of filter media to meet the requirements of many different standards.

Benefits:

- Provides salt and oil testing in one unit
- Ergonomic design improvements for reduced operator fatigue
- Reduced cost of ownership with the new user-serviceable photometers

These improvements not only enable proactive scheduling of maintenance, with minimal impact to production schedules, but also increase uptime. The completely redesigned hardware and electronics coupled with a new intuitive interface, will optimize your testing process.

The model 8130A is based on the model 8130, which for more than 20 years has been well known and used worldwide in quality control and manufacturing testing. Improvements made in signal processing led to increase in sensitivity in the 8130A. It is now able to measure up to six 9's of efficiency with oil. Overall, the data gathered with the new system, compares well with the original 8130.

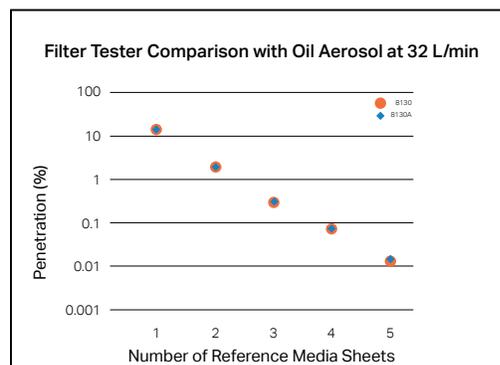


Maintenance and time saving benefits of the 8130A

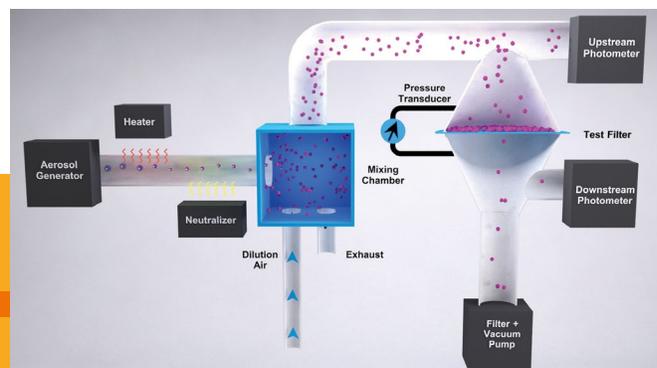
Our customers told us that saving time and costs were their top priorities. They asked us to reduce tester downtime and slowdowns. We listened, and improved the 8130A to make maintenance not only quicker, but also easier. Here are a few examples:

- The photometers can now be cleaned onsite by the user. No tools are necessary to remove the box containing the photometers and filters
- The aerosol generator now swivels out to help ease refilling
- We installed controls and gauges on the door for quick access
- Operators can now change the main filter in significantly less time
- Swapping out filter holders is fast and easy. The bottom chuck is held in place by six strong magnets rather than screws (Which require tools for removal)

Your time is important. The 8130A lets you spend less time on routine maintenance and more time on profitable filter testing.



Comparison of penetration test results between model 8130A and model 8130



Operational schematic of the 8130A

Filter Quality Assurance in the Production Line

Taking high performance from the lab to the production line

The Automated Filter Tester 8150 is designed for 100% quality assurance testing of P100, FFP3/P3 and similar respiratory filters and cartridges directly in the production line to detect defects from the manufacturing process such as cracks in filter media pleats, gaps in the adhesive or assembly defects. While optimized for high-volume throughput and round-the-clock remote operation, the model 8150 also provides penetration measurement results matching those provided by the well-established 8130A used in the quality control lab. The 8150 is a highly compact automated filter tester that can easily be retrofitted into any existing production line.

Innovations that give you the edge

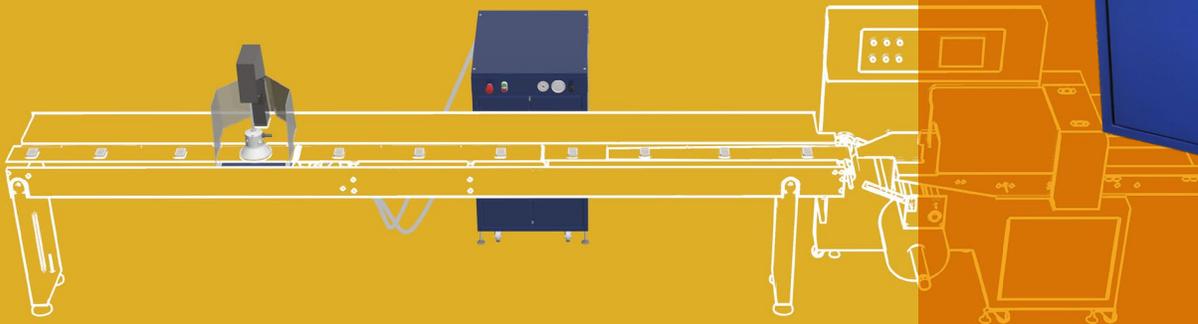
The Automated Filter Tester 8150 utilizes an innovative concept for aerosol delivery that reduces the number of valves and improves uptime. For especially tight spaces, the photometer box can be split from the base unit. The 8150 operates through a modern PLC-driven interface and contains a comprehensive set of internal diagnostics to provide you with complete confidence of your filter efficiency measurements.

For maintenance, troubleshooting, or determination of optimal settings during process characterization, the 8150 can be operated outside of the production line environment by the Production Line Simulator 8150-PLS as an optional accessory.

Benefits of using the 8150 in the production line

The model 8150 has been optimized for demanding in-line production testing applications. Notable benefits include:

- Fast measurements down to less than 4 seconds for high throughput
- Excellent agreement with the model 8130A that is used in certification and QA/QC labs
- Compact footprint and modern communications for ease of integration
- Two simultaneously measuring photometers for best performance
- Supports compliance with standards such as NIOSH 42 CFR 84 and EN143/EN149
- Intelligent design and diagnostics for increased uptime
- Robust design for longevity



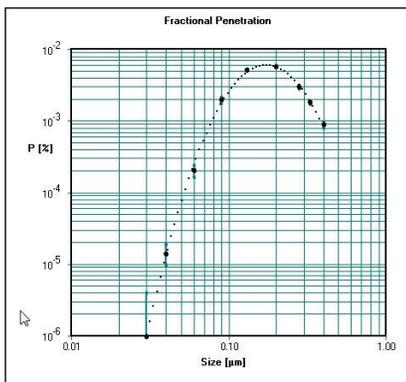
HEPA and ULPA Filter Testing

HEPA and ULPA filters are used in hospitals, operating rooms, laboratories, clean rooms and other places that require low concentrations of particles and bacteria. Filter quality is measured by determining the fractional filter efficiency (or penetration) and the most penetrating particle size (MPPS).

Measure filter performance at individual particle sizes with highest sensitivity

The Automated Filter Tester 3160 determines the pressure drop and fractional filter efficiency at different particle sizes in order to obtain the MPPS of HEPA and ULPA filters and filter media. The system is designed to comply with the test requirements of EN 1822 parts 3 and 5 as well as ISO 29463. Filter tests are performed automatically following user-specific test parameters and up to 99.999999% (eight 9s) fractional filter efficiencies.

The 3160 uses a bank of atomizers and the research grade TSI® Electrostatic Classifier to challenge a filter or filter media with known-size, monodisperse particles. Two new generation Condensation Particle Counters (CPCs) simultaneously count the upstream and downstream particles while the software calculates the penetration value. Filters can be sequentially challenged with up to 11 different monodisperse particle sizes in the range from 15 to 800 nm. The penetration value for each particle size is obtained. At the end of a test, the model 3160 generates a curve of penetration vs. particle size and produces a summary of test results, including the MPPS.



MPPS and fractional penetration results measured with Automated Filter Tester 3160



Automated Filter Tester Specifications

Model	8130A	3160	8150
Measurement Application	Loading and Quality Control Tests	MPPS	Quality Control in Production
Maximum Efficiency	99.9999%	99.999999%	99.9999%
Aerosol Type ^d	DOP, PAO, DEHS, Paraffin, and other oils or NaCl	DOP, PAO, and other oils or NaCl	DOP, PAO, DEHS, Paraffin, and other oils
Aerosol Generation	Atomizer	Atomizer with Classifier	Atomizer
Count Median Diameter ^b	0.2 µm (Oil) or 0.075 µm (NaCl)	N/A	0.2 µm
Geometric Standard Deviation ^b	<1.6 (Oil) or < 1.86 (NaCl)	<1.3	<1.6
Flow Rate	10 to 110 L/min	5 to 100 L/min	10 to 120 L/min
Resistance	0-150 mm H ₂ O (0-1470 Pa)		
Particle Detection	Light Scattering Photometer	Condensation Particle Counter	Light Scattering Photometer
Typical Test Length	10 sec	30 sec to 20 min ^c	<6 sec
Data Reporting	Touch screen and RS-232	PC with Integrated Software	Modbus TCP/IP
Operation	Stand Alone Tester/Automated Production Lines	Stand Alone Tester	Integrated in Automated Production Lines
Compliance	US 42 CFR part 84, EN 143, JMOL, ISO 23328-1	EN 1822 parts 3 and 5	US 42 CFR part 84, EN 143/149

a EN versions (for equivalent results to EN 143 standard) available (8130A-EN)
 b EN version CMD and GSD are different. See 8130A spec sheet for more information
 c Efficiencies higher than 99.9999% require longer than typical testing times
 d Aerosol abbreviations: DOP (dioctyl phthalate), PAO (polyalpha olefin), DEHS (di-ethylhexyl sebacate)



Air Cleaner Testing

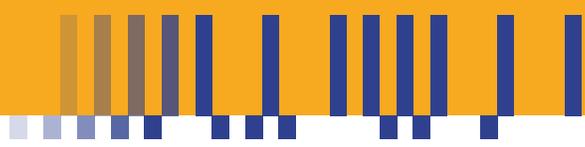
People in industrialized countries spend most of the day indoors. Airborne particulates (solid particles or liquid droplets) are either transported indoors from outdoor environments, or the particles directly result from indoor sources like smoking, cooking, housework and many more. Indoor measured particle concentrations can be very high in cities or from the sources listed above. Inhalation of particulates has been linked to increased risk for a number of adverse health effects. Awareness is continuing to increase in workplaces as well as private homes; more and more are being outfitted with air cleaners.

In order to ensure the quality of air cleaners/ purifiers and give a quantitative performance verification the Association of Home Appliance Manufacturers (AHAM) has created a certification program. This is offered by independent laboratories. This program provides a uniform and commercially practical verification of manufacturers' Clean Air Delivery Rates (CADR) for tobacco smoke, dust and pollen. The method and requirements are specified in the most recent edition of the ANSI/AHAM AC – 1 Standard "Method for Measuring Performance of Portable Household Electric Room Air Cleaners". In addition, some countries developed additional standards that must be met when selling air cleaners in that country, for example, China with GB/T 18801-215.



TSI provides components for air cleaner test systems, most of which are listed in Annex A of the AHAM standard. Some component examples include:

- Fluidized Bed Aerosol Generator 3400A
- Aerosol Neutralizer 3012
- Filtered Air Supply 3074B
- Aerodynamic Particle Sizer 3321 (optional with model 3302A Aerosol Diluter) for dust/pollen counting
- Laser Aerosol Spectrometer 3340A for cigarette smoke detection
- Optical Particle Sizer 3330



Ventilation Filter Testing

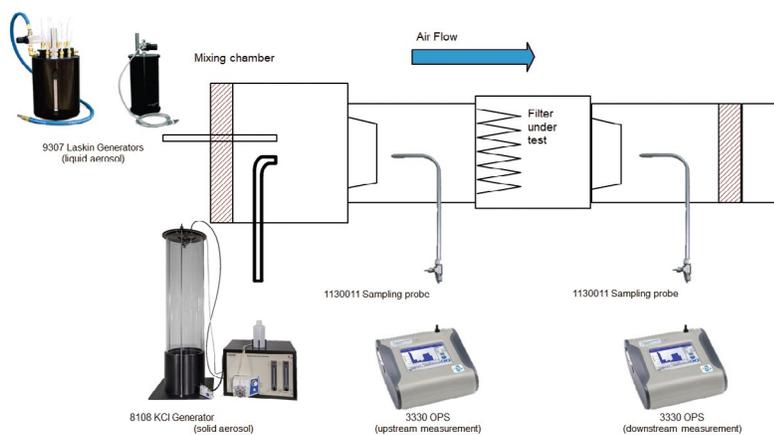
Air filters used for general ventilation are widely used in heating, ventilation and air-conditioning (HVAC) applications in buildings. Similar filters are also used in cabin air filtration and engine air intake filtration where these filters lower the concentration of particles and improve the (indoor) air quality. Currently two main standards are used to ensure performance criteria: ASHRAE 52.2 in the United States and ISO 16890 which replaced EN 779.

In order to work towards testing ventilation filters in a manner that reflects the nature (and terminology) of particulate matter (PM) pollution, ISO 16890 specifies that filter efficiencies will be determined by how successful filters remove PM1, PM2.5, and PM10 particle sizes. KCl salt particles are now generated and measured in the size range from 0.3 to 10 μm using 8 to 12 size bins. For more information on how the ISO 16890 compares to EN 779 and ASHRAE 52.2 please refer to the application note on tsi.com: "ISO 16890-2 Air Filters for General Ventilation: Determining Fractional Efficiency" (AFT-005).

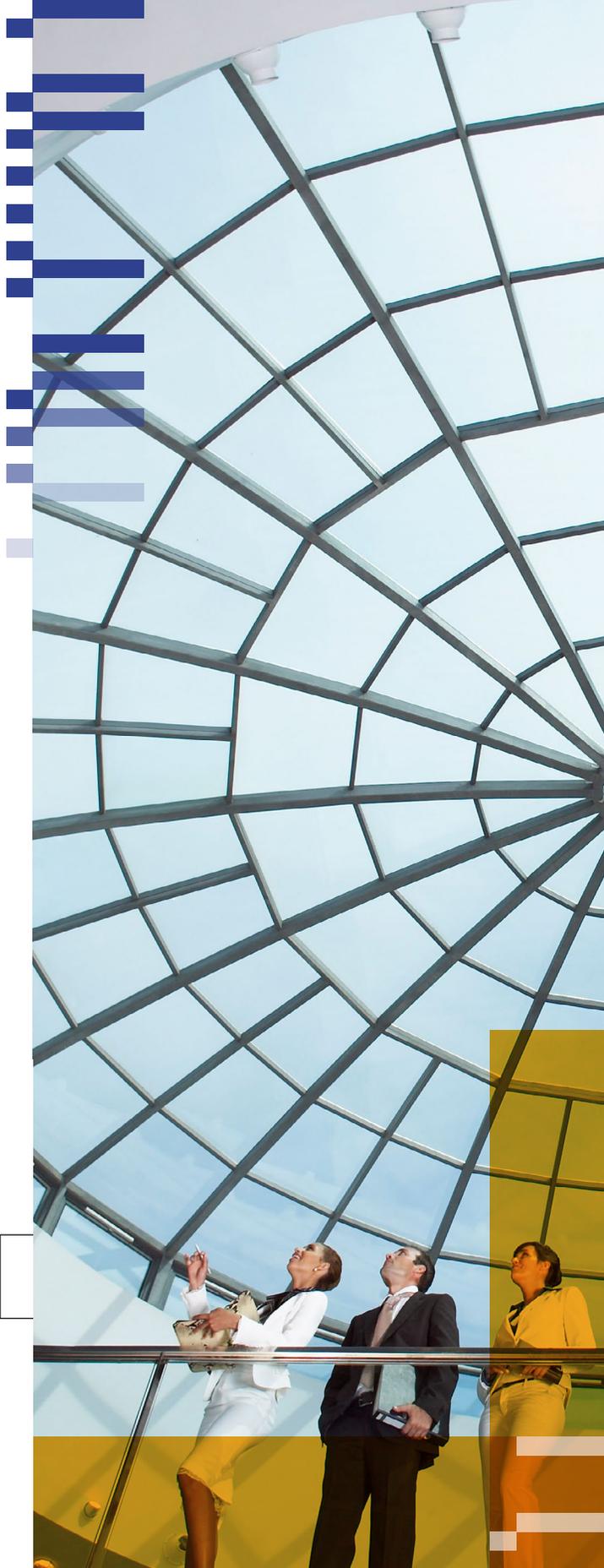


Standards specify requirements that the test equipment must meet to determine filter efficiency as a function of particle size. TSI® focuses on providing high-end components necessary to comply with these requirements. Filtration professionals can use the following components that comply with each of these key steps: particle generation, particle sampling, and particle measurement:

- Laskin Generator 9307-6 or 9307
- Large Particle Aerosol Generator (KCI) 8108
- Isokinetic Sampling Probe and Coupler PN 113011
- Optical Particle Sizer 3330
- Depending on further requirements in development or quality assurance, the following additional instruments are used by manufacturers:
- Aerodynamic Particle Sizer® (APSTM) 3321
- Condensation Particle Counters (CPCs) series 375x
- Scanning Mobility Particle Sizers™ (SMPS™) spectrometers series 3938



ISO 16890-2 setup with TSI component recommendations



Standards and Regulations

Air and gas filter testing methods are largely determined by standards and regulations. A large number of standards exist, each one appropriate for the application that category of filters is designed to be used for. Test standards, to a large extent, define the users filter testing needs. The table below gives examples of standards and which combinations of components are needed to test to the standards.

Filter Type	Standard Number	OPS	APC	Photometer	CPC	Electrostatic Classifier	Neutralizer	Generator
Ventilation	ASHRAE 52.2	■	■				■	KCl/Dust
Ventilation	ISO 16890	■	■					KCl/Oil/Dust
Automotive Cabin Air	DIN 71460-1	■					■	Dust
Automotive Cabin Air	ISO TR 11155-1	■					■	KCl/Dust
Automotive Engine Intake	ISO 17913	■						KCl
Crankcase Ventilation	ISO 20654	■						KCl
Compressed Air	VDI 3926-2	■						Dust
Vacuum Cleaner	ASTM F1977-04	■					■	KCl
Vacuum Cleaners	EN 60312 / IEC 60312	■						Dust
Cleanable Filters	ISO 11057 / VDI 3926-1	■						Dust
Air Cleaner	AHAM AC-1-2013	■	■					Dust
HEPA-ULPA Media	ISO 29463-3		■*		■	■		Oil
HEPA-ULPA Panels	ISO 29463-5	■	■		■	■		Oil
HEPA-ULPA Panels	IEST RP-CC001/CC007	■	■		■	■	■	Oil
HEPA-ULPA Cannisters	MIL-STD-282		■		■	■	■	Oil
HEPA-ULPA Media	IEST RP-CC022		■		■	■		Oil
Medical Face Mask	ASTM F2299-03		■					PSL
Respirator	42 CFR part 84			■			■	Oil & NaCl
Respirator	EN 143 and 149			■				Oil/NaCl/Dust
Respirator	ISO 16900			■				Oil & NaCl
Medical Ventilator	ISO 23328-1			■				NaCl
Military Respirator	MIL-STD-282			■	■			Oil
Barrier Face Covering	ASTM F3502			■			■	NaCl

* Size range or resolution or not fully satisfied with this detector

LEARN MORE

To learn more about Filter Testing, please visit [tsi.com/filter-testing/](https://www.tsi.com/filter-testing/)

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