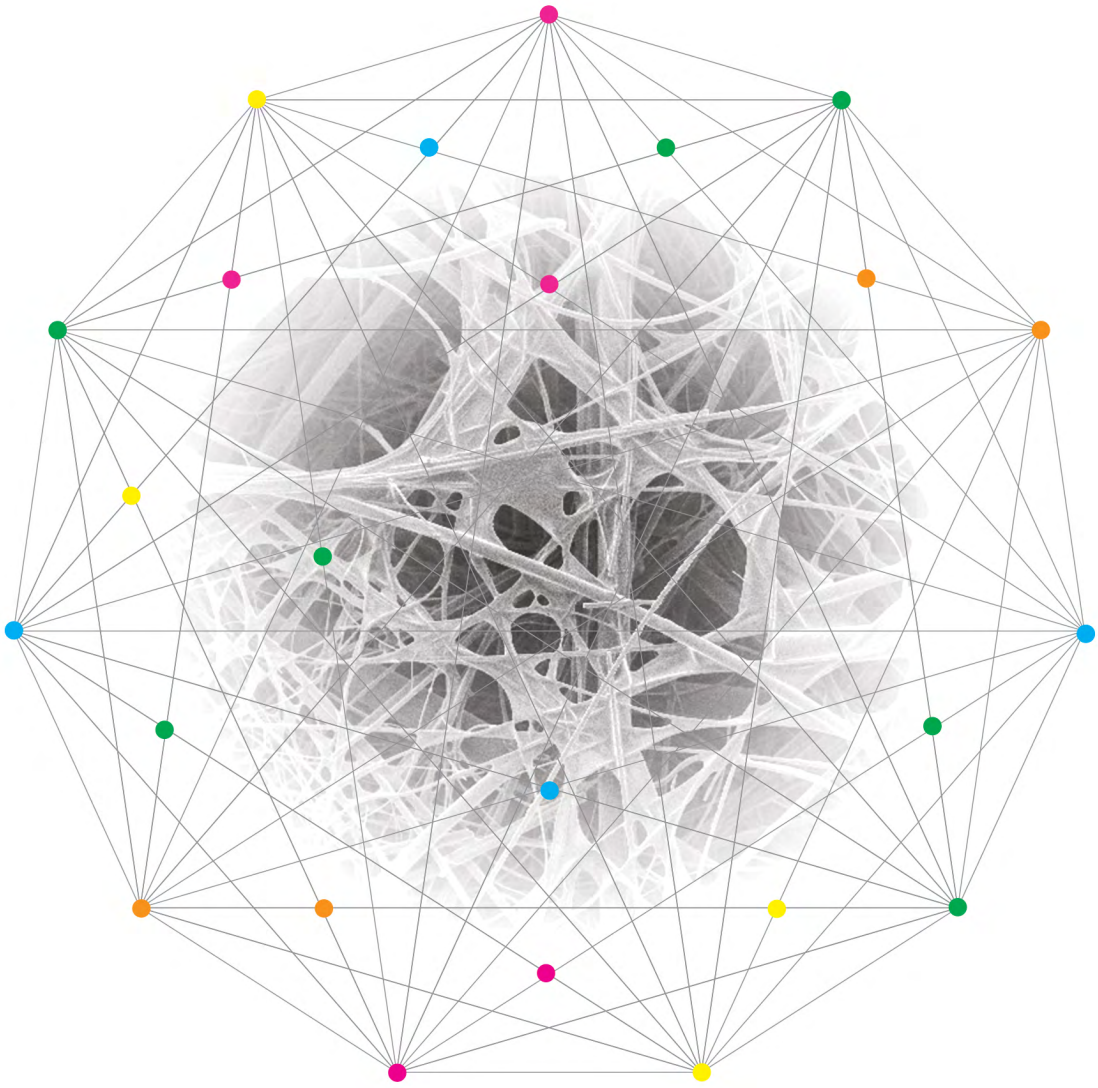
FILTER TESTING FOR AIR FILTER AND MEDIA EFFICIENCY MEASUREMENT



UNDERSTANDING, ACCELERATED

TRUSTED BY FILTER MANUFACTURERS AROUND THE GLOBE

TSI has automated filter testers (AFTs) and components that can be used for filter testing and are used to comply with various testing standards and regulations around the globe. TSI AFTs are designed for measuring filtration efficiencies of media and a variety of air filters, including very high-efficiency filters, respiratory filters, cartridges, and protective garments using submicron poly- and monodisperse oil and/or sodium chloride aerosol.

TSI AFTs have proven track records of durability, reliability, and minimal maintenance. Models 8127 and 8130 can be integrated into high volume production lines or as stand-alone testers for loading or quality control testing for efficiencies up to 99.999% (five 9's). For more efficient filters, Models 3160 and 3140 determine efficiencies up to 99.999999% (eight 9's). Model 3160 combines an Electrostatic Classifier with dual Condensation Particle Counters (CPCs) to measure most penetrating particle size (MPPS) from 15 to 800 nm using monodisperse particles. Model 3140 features a polydisperse oil aerosol generator and CPCs making it an ideal choice for quality control testing of high efficiency filters.

TSI also offers a Component Filter Test System (CFTS) Model 3150- consisting of a software and hardware module- to provide an off the shelf solution for all your custom filter testing needs. Pre-configured to work with TSI's world class detectors and sizers, the CFTS provides a platform for numerous filter testing applications and can be configured to read signals from a wide variety of flowmeters, pressure transducers and sensors (temperature, pressure and relative humidity) to automate data collection. It can also provide signals to control blower flow, sampling valves, aerosol generators etc. Whether designing a new test duct or updating an existing system the CFTS provides an easy to use system with the flexibility to meet your filter testing needs.

Additionally, all the filter testers are backed by TSI's commitment to provide superior customer support and service.

Features and Benefits

+ Solutions for all your filter testing needs
+ Simple, fast, and automated operation
+ Measurement of efficiencies up to 99.999999% (eight 9's)
+ Determination of most penetrating particle size (MPPS)
+ Stable aerosol generators for highly repeatable and reproducible measurements
+ Designed for manufacturing environments and quality control testing

Automated Tester Accessories

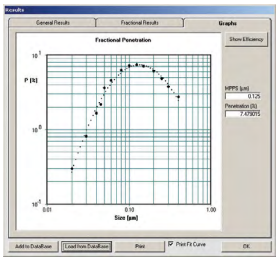
TSI also offers a variety of optional accessories to diversify the capability and applicability of the automated filter testers. Individual models may also have additional accessories (refer to model specific information sheet).

Custom Filter Holders

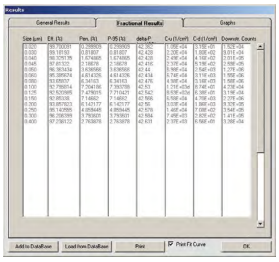
TSI has an experienced design team and a fully-equipped machine shop to address special requirements from our customers. Over the years, TSI has designed and built more than 100 custom filter holders to accommodate testing filters with different shapes and sizes. We are ready to serve the specific needs you have. Please contact your TSI representative for details about the customized solutions we offer.

External Adapter

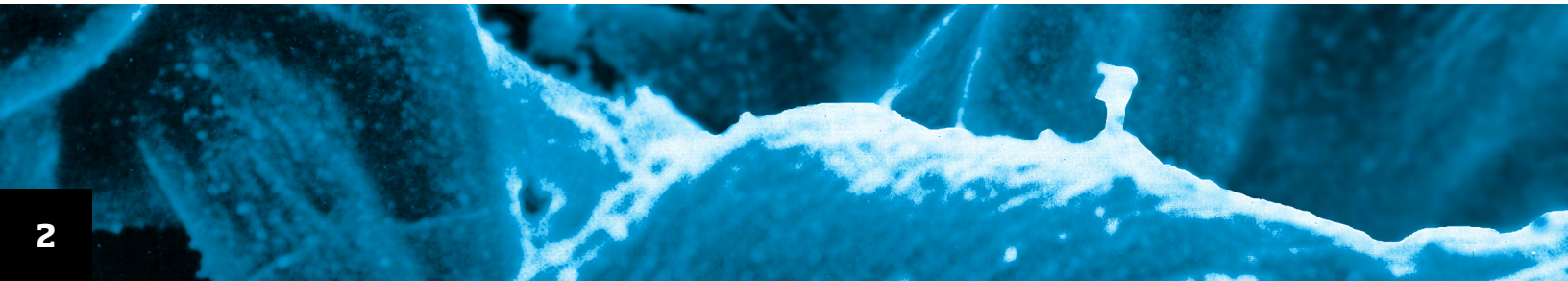
The Model 8107 External Adapter allows users to test tubular, rectangular or other irregular shaped filter cartridges that have their own housing.



MPPS results from Model 3160



MPPS results from Model 3160





Model 8127 and 8130



Model 3160

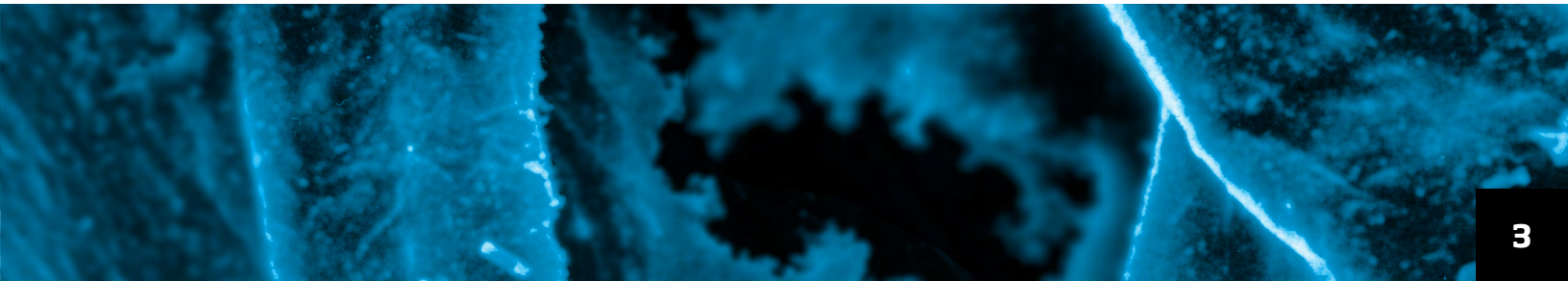


Model 3140

AUTOMATED TESTER SPECIFICATIONS

Model	8127[a]	8130[a]	3160	3140
Measurement Application	Loading and Quality Control Tests		MPPS	Quality Control Test
Maximum Efficiency	99.999%		99.999999%	99.999999%
Aerosol Type[d]	DOP, PAO, DEHS, Paraffin, and other Oils	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)	0.2 µm (Oil) or 0.075 µm (NaCl)	N/A	0.19 µm
Geometric Standard Deviation[b]	<1.6 (Oil)	<1.6 (Oil) or < 1.86 (NaCl)	<1.3	<1.6
Flow Rate	15 to 100 L/min		5 to 100 L/min	
Resistance	0-150 mm H_2O (0-1470 Pa)			
Particle Detection	Light Scattering Photometer		Condensation Particle Counter	
Typical Test Length	10 sec		30 sec to 20 min[c]	< 1 min[c]
Data Reporting	Alpha-Numeric Display and RS-232		PC with Integrated Software	
Operation	Stand Alone Tester/Automated Production Lines		Stand Alone Tester	
Compliance	US 42 CFR part 84, EN 143, JMOL, ISO 23328-1		EN 1822 parts 3 and 5	N/A

[a] EN versions (for equivalent results to EN 143 standard) available (8127-1-EN, 8130-1-EN)
[b] EN version CMD and GSD are different. See 8127/8130 spec sheet for more info
[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)



BRINGING IT ALL TOGETHER

COMPONENT FILTER TEST SYSTEM

TSI offers a Component Filter Test System (CFTS Model 3150) for those applications that are not possible with TSI's automated testers.

For the wide range of flow rates and particle sizes needed to meet the requirements of the many filter testing standards and research needs, an automated tester is not always practical. Building a filter test system from components is often the best way to satisfy your measurement needs. TSI has developed the CFTS as an easy to use system that integrate all the necessary parts of this type of system. The Component Filter Test System (CFTS) Model 3150 is an instrument platform that connects to the components for air filter testing applications.

Flexibility

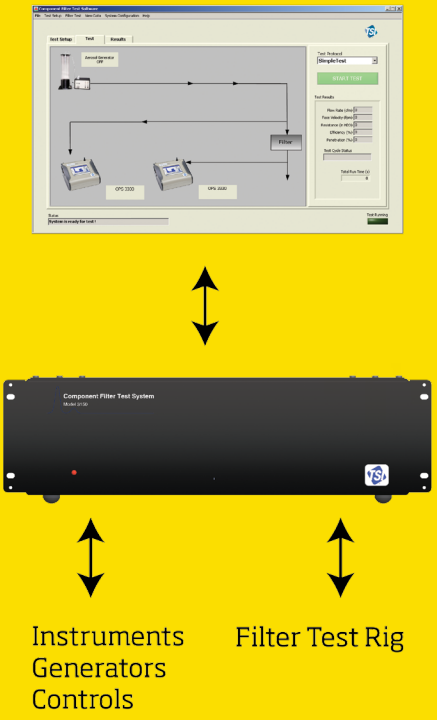
Filters are used for a wide variety of application and are therefore tested to a variety of filter test standards. To satisfy these many requirements you need a filter testing system that is flexible enough to change to meet those requirements. The CFTS system is designed for flexibility.

CFTS is structured as a core platform which controls the filter test. Its graphical user interface is used to define the test layout and procedures as well as being your interface for running the test. The CFTS has drivers to communicate with the particle instruments and is the interface for reading sensors and controlling flow. During testing it collects, saves and exports the data needed for test reports.

Complete Solution

As an instrument manufacturer TSI builds many of the instruments that can be used in these types of systems. Some components of these systems are best obtained locally (such as sheet metal work and welding needed to build duct segments) or from suppliers that specialize in those products (such as blowers, blower controls, pressure transducers and other sensors). While many components can be controlled or read manually it is desirable to integrate as much of a system as possible to provide an easier to use automated platform for filter testing. The CFTS system provides the connections and software to make configuration of these systems easier. No longer is custom software is no longer required for every component change.

CFTS: HOW IT WORKS





STANDARDS AND REGULATION

Air and gas filter testing methods are largely determined by standards and regulations. 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 extend, 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	CFTS	OPS	APC	Photometer	CPC	Electrostatic Classifier	Neutralizer	Generator
Ventilation	ASHRAE 52.2	x	x	x				x	KCl/Dust
Ventilation	EN779	x	x	x					Oil/Dust
Automotive Cabin Air	DIN 71460-1	x	x					x	Dust
Automotive Cabin Air	ISO TR 11155-1	x	x					x	KCl/Dust
Automotive Engine Intake	ISO CD/DIS 17913	x	x						KCl
Crankcase ventilation	ISO/DIS 20654	x	x						KCl
Compressed Air	VDI 3926-2	x	x						Dust
Vacuum Cleaner	ASTM F1977-04	x	x					x	KCl
Vacuum cleaners	EN 60312 / IEC 60312	x	x						Dust
Cleanable filters	ISO 11057 / VDI 3926-1	x	x						Dust
Air Cleaner	AHAM AC-1-1988	x	x	x					Dust
HEPA-ULPA Media	EN 1822-3	x		x*		x	x		Oil
HEPA-ULPA Panels	EN1822-5	x	x	x		x	x		Oil
HEPA-ULPA Panels	IEST RP-CC001/CC007	x	x	x		x	x	x	Oil
HEPA-ULPA Cannisters	Mil Std	x		x		x	x	x	Oil
HEPA-ULPA Media	IEST RP-CC001/CC007	x		x		x	x		Oil
Medical Face Mask	ASTM F2299-03	x		x					PSL
Respirator	42 CFR part 84	x			x			x	Oil & NaCl
Respirator	EN 143 and 149	x			x				Oil/NaCl/Dust
Medical Ventilator	ISO 23328-1	x			x				NaCl
Military Respirator	Mil Std	x			x	x			Oil

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



WHY CFTS?

TSI's CFTS provides a solution for the entire air filter test market due to its ability to be configured without the need of software customization. Small filter media test stands or large, high flow rate filter test benches can all be operated with the CFTS. Whether you are building your own customized test rig, updating an existing test system or developing your system, with the help of a system integrator, TSI's CFTS provides the platform on which you can build your system.

Designing a Component System

All filter test systems require some source of particle generation. In fact, multiple generators are often needed, and because generated particles can be highly charged, some form of neutralization is needed.

Pressure transducers are often used both to measure the pressure drop across the filter under test but also for measuring pressure drop across the flow measurement device. This can be an orifice, a laminar flow element, or a flow nozzle.

To control the flow rate on high flow systems large blowers are frequently controlled using variable frequency drives. These can be controlled manually or with a control voltage.

Finally, the particles used to test the filter must be detected. Detectors include: Photometers (total light scatter detectors) optical particle counters (which give particle size based on light scatter) and condensation particle counters (CPCs) that detect and count particles down to very small sizes (10 nm and smaller). With CPCs a size selection device such as an Electrostatic Classifier is often used.

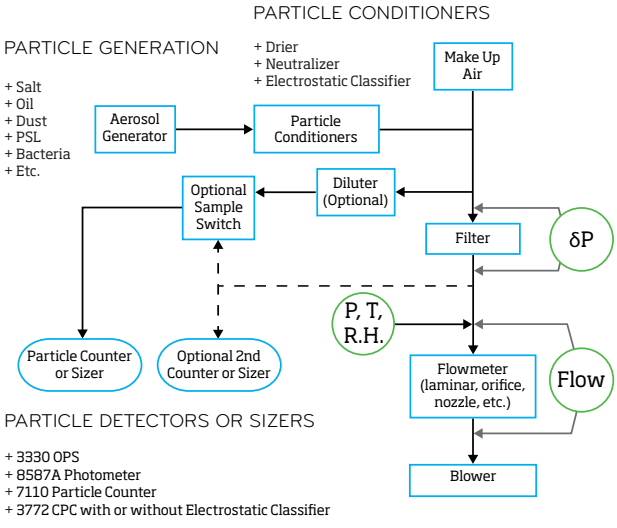
TSI Components

TSI Instruments (e.g. Photometer, OPS, APC, CPC, Electrostatic Classifier) can be used for a wide range of applications in the whole filter test market. In addition, all our aerosol generators and many of our aerosol measurement accessories can be used for filter testing. With the addition of the CFTS we can now offer solutions to potential users instead of "just" instruments.

CFTS Connections

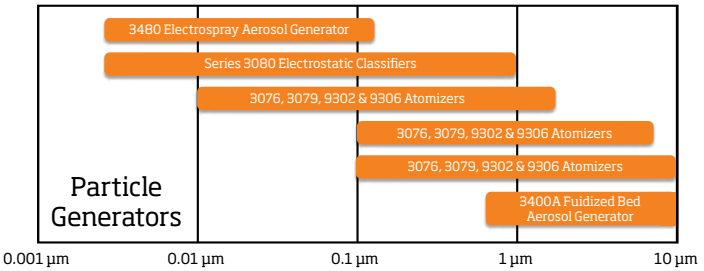
CFTS is able to measure flow using a variety of flow measurement techniques and to control blowers to the required flow. It has multiple ports used to read temperature, pressure and relative humidity and make flow corrections and log sensor data for test reports.

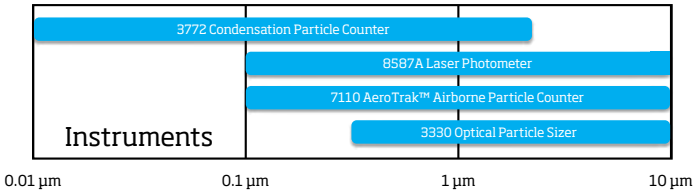




COMPONENTS AVAILABLE FROM TSI

TSI has a range of particle generators, conditioners, detectors and sizers. The following is a list of some models that are currently available and supported with the CFTS system. As needs for other products are identified and new products are developed TSI will add to this list.





Particle Generators:

3076	Constant Output Generator
8108	Large Particle Aerosol Generator
9306	Six-jet atomizer
9307	Oil Droplet Generator (Laskin Nozzle)
8118A	Salt Generator (used in 8130 AFT)
1081414R	Oil Generator (used in 8127/8130 AFT)
8118A-EN	Salt Generator (Used in 8130-EN AFT)
1081414R-EN	Oil Generator (used in 8127/8130 -EN)

Particle Conditioners:

3077(A)	Aerosol Neutralizer (Radioactive)
3054(A)	Aerosol Neutralizer (Radioactive)
3087	Advanced Aerosol Neutralizer (Non-Radioactive)
308003	Electrostatic Classifier (w/o neutralizer or DMA)
3081	Long DMA (use with Electrostatic Classifier)
3332	Diluter (-10 and -100 versions)
33302A	Diluter (-10 and -100 versions)

Particle Detectors and Sizers:

3330	Optical Particle Sizer
3772	Condensation Particle Counter
8587A	Laser Photometer
7110-5	AeroTrak Remote Particle Counter

Instrument	Size Range	Concentration	Flow Rate	Count/Size
3330 OPS	0.3 - 10 µm	0 - 3000 /cm³	1 L/min	Up to 16 size bins
3772 CPC	0.01 - 2 µm	0 - 10000 /cm³	1 L/min	Total Count
8587A	>0.1 µm	1 µg/m³ - >200 mg/m³	2.0 L/min	Not Applicable
7110 Particle Counter	0.1 - 10 µm	0 - 40,000/ft³ (0 -1.4/cm3)	1 CFM (28.3 L/ min)	6 Size Bins



Model 3772



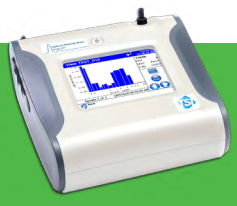
Model 8587A



Model 8180A



Model 7110-5



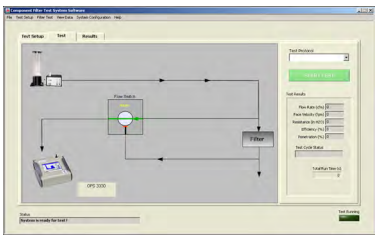
Model 3330

FILTER TESTING OVERVIEW

CFTS Software - System Configuration

Using System Configuration you can select dual counters or a single counter with a valve to select upstream or downstream. Different detectors can be used and when a CPC is selected you can use an Electrostatic Classifier.

Different Aerosol generator and neutralizers can also be selected along with diluters (when needed) for measuring upstream of the test filter



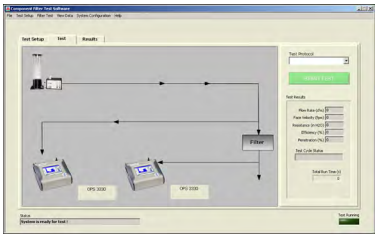
One OPS With Up/Down Switch

Specifications

Model 3150

Communication

Interfaces	2 USB ports
Serial I/O	4 ports RS 232



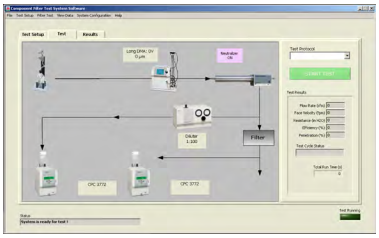
Two OPS Instruments

Analog Input

Up to 8 channels
Analog Output
2 channels (0 to 10 V, 4 to 20 mA only with external adapter)

Digital Input

TTL-Level, up to 8 channels



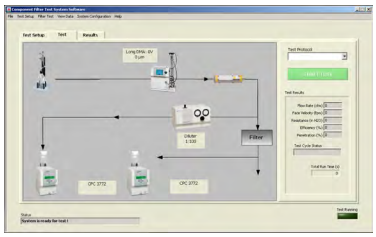
Classified aerosol with CPCs and Non-Radioactive Neutralizer

Digital Outputs

Up to 12 channels
12 or 24 VDC selectable

Measured Parameters (if sensors are connected)

Filter Penetration and Efficiency
Filter Resistance (differential pressure across filter)
Filter flow rate
Temperature
Pressure
Relative Humidity



Classified aerosol with CPCs and Radioactive Neutralizer

Software

Supplied with Component Filter Test System Software

UNDERSTANDING, ACCELERATED

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