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# Filter Efficiency Test Systems

## Highlights:

On-line testing

Coarse, fine and ultra fine

Ventilation control



## Automatic Real Time Filter Efficiency Control

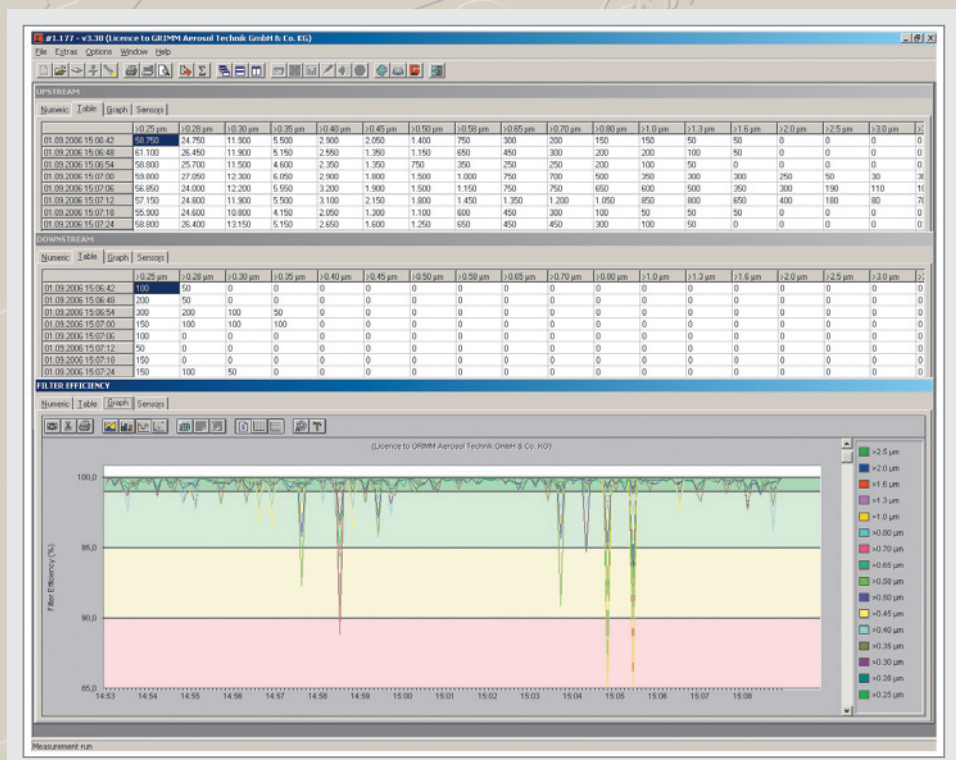
## Applications:

EN 779

EN 1822

ASHRAE 52.2

ISO 16232



# On-line Filter Efficiency Monitoring and Exhaust Air Control

## GENERAL INFORMATION

Filters are classified by the type of their performance. There are many classes, starting from simple F6 to F9 pre-filters up to high efficiency filters F12-19, from underground traffic exhaust systems to high quality clean rooms.

The **diagram on the right** shows the size relation of the different PM dust classes and today interest lies mainly in the red field.

The need for a regular control of the filters as well as the exhaust air is understandable, since these outlets indicate the production air quality or on tunnels the outgoing exhaust air quality. This is very important because above can be gardens, playgrounds and other public places.

Exhaust air in Europe and United States has been traditionally classified as PM<sub>10</sub>, but is now replaced by **PM<sub>2.5</sub> in µg/m<sup>3</sup>**. Since this is the finer dust size fraction, the risk focus is now driven from the inhalable to the thoracic and the very fine alveolic dust, since the related epidemiological risk is considerably greater than with large dust particles (e.g. sand, etc.).

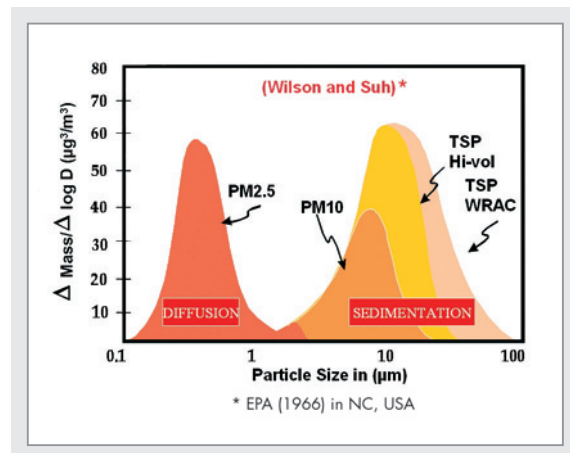
To fulfil the need for **monitoring GRIMM** has developed real time fine dust monitors and there are today hundreds of these units used in national networks and industry.

As requested in most modern standards, the filter efficiencies is not expressed in total dust (TSP) but in **concentrations by size range**, so the filter performance and the most penetrating particle size (MPPS) can be determined.

**Grimm has developed** therefore portable and stationary real time filter testers which can measure and express:

- The **efficiency by size class** as counts and in percent by measuring before and after the test filter.
- Express the **outlet air dust values** in PM<sub>10</sub> and PM<sub>2.5</sub>, so a comparison between the data from the ambient environmental monitoring system can be made.
- Simultaneously the **wind speed**, air temperature and respective relative humidity of the air are also measured.

The measured sample is also collected on a **47 mm removable filter for further analysis**.



## MEASURING PRINCIPALS

1. **Grimm spectrometers** work with laser light and measure the scattering energy of each particle as relative size. Therefore these instruments are ideal for a fast and accurate determination of the particle number concentration and their size distribution. The instruments now can convert the counts to their respective dust mass by size fraction by using the C Factor.
2. **High counting performance** is obtained by very fast particle detection (concentration up to 2.000.000 particles/l) as well as single counts for clean rooms.
3. **High size resolution** is obtained by using over 30 size channels from 0.25 µm to 30 µm and results are presented from one second intervals upwards.
4. Data acquisition and presentation is easy with the **GRIMM software for Filter efficiency**. Results can be expressed in:
  - Size distribution upstream of the filter
  - Size distribution downstream of the filter
  - Efficiency of filter by particle size in %
  - Penetration through test filter in %
  - PM<sub>10</sub> and PM<sub>2.5</sub> air outlet
  - Wind speed, humidity and temperature
  - Instrument diagnostics etc.
5. Sampling is done by a special **isokinetic sampling pipe**, at wind speeds from 2 to 25 m/sec., whereby the pressure difference between the duct and the pump is automatically compensated.

## Portable FILTER TEST Systems, FFT 7.300

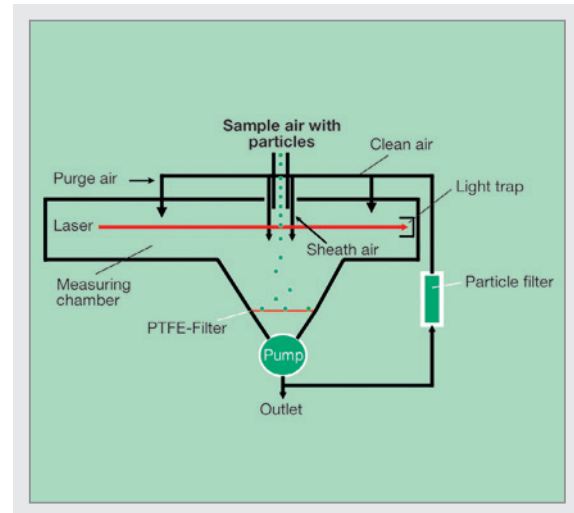
### PRINCIPAL FUNCTION

All Grimm dust monitors utilize a built-in flow-controlled pump to draw the sample in through the sampling head at a rate of 1.2 l/min. A specific **isokinetic sampling system** (see front page picture) is used to collect the dust coming in a specific wind direction. On this sampler the sampling head is exchangeable, depending the air speed in the test duct. See also EN 2066, (section 3), sampling methods at high air velocities.

This patented dust monitor takes the sampled air from the isokinetic pipe straight into a high resolution optical cell in such a way, that only one particle after the other can cross the laser illuminated cell (see diagram on the right). When such a particle passes the light beam, a scattering signal is generated and collected at 90° on a photo-diode. This signal is then classified by a pulse height analyzer by its size and stored in the appropriate data register. A microprocessor converts the result to the display every 6 seconds as particle size distribution in 31 different channels from 0.25 µm to 30 µm (or as related mass in µg/m<sup>3</sup>.)

In each portable unit it is also possible to capture the sample on a **47 mm PTFE filter** for subsequent gravimetric and chemical analysis of the measured material.

Below shows the **monitor 1.109 is connected to a Laptop.**



### FILTER MEASUREMENT METHODS

**The simplest approach** is to first measure downstream of the test filter and then upstream at different points of the filter system with one unit. Please note that during this time the air flow and the aerosol concentration must remain the same.

However if there are variations of air flow and/or aerosol concentration then our **dual system model 7.300**, consisting of two of the same models, is recommended. Hereby one unit measures before and one after the test filter. Both units are connected to one PC and now the test system can vary the dust load and air flow. Results can be seen in real time on the PC.

Key Specification of 1 unit:	Model 1.109	Model 7.309 fine	Model 7.310 coars
<b>Application</b>	<b>Dual mode unit</b>	<b>Fine fraction unit</b>	<b>Coarse fraction unit</b>
Measurement range	0.25 – 32 µm in	0.27 – 2,0 µm in	0.7 – 50 µm in
Size resolution	31 size channels	12 size channels	12 size channels
Particle number in counts/litre	1 to 2.000.000	1 to 2.000.000	1 to 1.000.000
Dust Mass in µg/m <sup>3</sup>	1 to 100.000	counts only	1 to 150.000
Reproducibility at max. range	+ – 3%	+ – 5%	+ – 10%
All units have the same weight: 2,5 kg (4.4 lb) / and dimension: 24 x 12 x 6 cm (with model 165 40 x 40 x 20 cm)			

The availability of a real-time, direct-reading, **portable battery operated filter tester** that displays concentrations and even single counts is an important develop-

ment in the industrial and environmental monitoring field and will have a significant impact on future regulations for finer particle sizes and higher efficiency measurements.

## Stationary Optical Filter Test System, FFT 7.209

The need for a **stationary real-time dust size** distribution monitor for the continuous analysis of the air quality was obvious. Therefore GRIMM designed a 19" rack system, model 7.209, which integrates two optical monitors with large pumps; the principal functions are the same as outlined for the model 7.309.

**This 19" rack** unit is specially designed for remote use, has two isokinetic sampling pipes with air return systems and operates fully PC controlled.

Results are expressed as **filter efficiency** values by size in counts or percent or as **PM<sub>10</sub>** and **PM<sub>2.5</sub>** in accordance to EN standards.

**Aerosol Generators** help to generate fine dust concentrations for the test purpose. Hereby Grimm can offer a wide range of different portable and stationary systems for Aerosol generation:

- From liquid carriers,      • For dry powder as carrier,
- Made by combustion,      • Special applications.

### APPLICATIONS

**Large ventilation systems** used in tunnels or bunkers often need permanent filter control systems for security and /or filter maintenance controls.

**Results** are stored internally via data logger but also transmitted in 1 second intervals. Therefore a permanent control of the filtration and ventilation is assured at all times.



One **complete system** 7.209 consists of two monitors, each with an 1.152 isokinetic sample probe and a sensor 1.154 for humidity, air temperature and wind speed.

#### Key Specifications of the 7.209 Monitoring System

Spectrometers	Two systems with large air pump
Flow rate	72 litres per hour (volume controlled)
Measurement principle	90° orthogonal light scattering
Measurement range	0.25 – 32 µm in 31 size channels
Particle number	1 to 2.000.000 counts per litre
Dust mass	0.1 to > 100.000 µg/m <sup>3</sup>
Reproducibility	+/- 3% of total range
Dimensions	19", 6HE and weight 5 kg (33 lb)

#### Sample system

two isokinetic samplers  
wind speed from 2-25 m/sec  
with 4 different sampling heads  
with 1 m sample pipe,  
made in stainless steel  
and access for optional diluter  
as well as climatic sensors

## Stationary Ultra Fine Filter Test System, UFT 7.700

**HEPA + ULPA**-grade filters deliver extremely high efficiency (99.99995% at MPPS) and they are for use in semiconductor manufacturing.

**GRIMM manufactures** one of the most advanced filter tester available for such filters, in accordance to the

- EN 1822-2 for flat filters,
- EN 1822-3 and 4 for complete filters

This is the choice for completing efficiency-versus-particle-size curves and determining the most-penetrating particle size (MPPS).

**This technology** is based on two of our Condensation Particle Counters (CPC) used to measure concentrations upstream and downstream of the media and allows efficiency measurements to 99.999999% (penetrations to 0.000001%).

**Our UFT 7.700** also presents not only data on filter efficiency but also on pressure resistance, air flow, and time of test, it allows the operator to operate and see all info on the computer screen and have full-page printouts.

Dealer:

*The European Leader in Particle Measurement Technology*