

Occupational Spectrometer and Fine Dust Monitor DUSTcheck™ Model 1.108

Simultaneous Real-Time Dust
Mass Measurement with the
Model 1.101 of * **Inhalable,**
* **Thoracic and**
* **Alvelolic Part**

And with the model 1.108
In addition in **15 different Sizes**
* **Particle Size and Counts** or
* **Dust Mass Distribution**(in $\mu\text{g}/\text{m}^3$)



These enhanced aerosol spectrometers from GRIMM™ are the world's smallest battery operated portable aerosol spectrometers. Above picture shows at left the model 1.101 for Occupational use (white) and at the right the silver painted **15 channel Model (1.108)**. Results are stored on the data logging card in real time as counts and/ or as mass distribution. The system operates with the GRIMM software programs. In front is the CD-ROM and the data logger card shown .

All our monitors are Spectrometer (*and not a Nephelometer*), so we can measure each particle by size and therefore establish the correct aerosol size distribution at all times. Combined with our patented dual technology, we first get results in real-time of the particle size distribution determined by laser light scattering and then we can analyse the sampled aerosols on an integrated filter for mechanical or chemical speciation in the laboratory.

Why SPECTROMETRY

... AND NOT NEPHELOMETRY

INTRODUCTION

In the history of dust measurement filters and impactors were the first gravimetric methods to determine dust load in workplace environment. The main disadvantage of those methods was that solely average values could be obtained and no real-time evaluation of the dust load was possible. The first limits for working environment were defined as the number of total airborne particles (maximum allowable concentration – MAC, TWA). Short-term maxima of exposition could not be measured.

NEPHELOMETER

In the middle of the last century dust monitoring systems based on the principle of light scattering were developed. Dust-loaded air passes through a measurement chamber where the particles are illuminated by a light source and the resulting scattered light is detected under a certain detection angle. The resulting signal of the scattered light is output as “total dust load”. Using this measurement technique no discrimination of particle sizes is possible. These measurement instruments are known as nephelometers. The advantage of this measurement technique compared to the method using filters is that the results are available in real-time and for each process a direct correlation of cause and effect can be made.

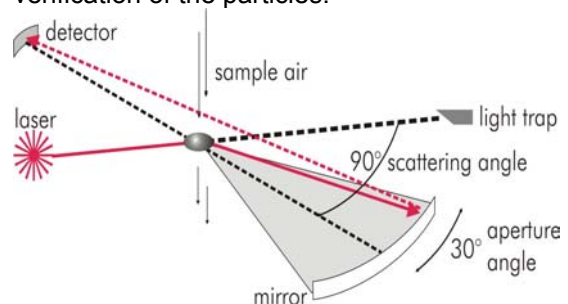
The convention of Johannesburg in 1959 set standards that required to divide the total dust into fine dust and airborne particles. As a consequence the nephelometers had to: be combined with cyclones or impactors in order to divide the total dust into the fine dust fractions prior to the measurement, eliminate humidity (especially for ambient air), not change size distribution of particles (would lead to immense errors for mass evaluation).

SPECTROMETER

As a defined mass of particles per volume air can be obtained either by few coarse particles or by a large amount of small particles more sophisticated measurement technologies are required. For evaluation it is essential to obtain measurement data in real-time of the various particle sizes (e.g. corresponding EN 481 or establishment of a correction-factor with the theoretically calculated dust mass.

PM₁₀, PM_{2.5} and PM₁ simultaneously and real-time) in mass per volume ($\mu\text{g}/\text{m}^3$). These requirements are met with measurement of scattered light for a wide range of particle sizes. However, there are several requirements to fulfill:

each particle has to be measured separately, a large number of particles per liter has to be measured, the scattering angle has to be chosen in a way that the refractive index becomes negligible, the optics has to be protected against contamination, the measured particles are collected on a replaceable PTFE-filter to allow gravimetric, chemic or microscopic evaluation and verification of the particles.



Measurement principle of the aerosol spectrometer 1.101 and 1.108 series. For both dust measurement in workplace environment and for the evaluation of suction and filter systems the importance of the total dust impact has been decreasing since approx. 1970. At the same time the occupational medicine takes the number-, mass- and surface-concentration of dust particles increasingly into account, for limits in mass per volume (mg/m^3) are not significant for the health hazards of the dust. The possible impact on human health depends on the composition of the dust, the size distribution and on the superficial bound substances. Small particles hardly contribute to the total mass, but due to their large number they increase the surface area dramatically.

Additionally, they enlarge the health hazard because they infiltrate deep into the human respiratory system. As a consequence EN 481 and ISO 7708 were introduced in 1993 and 1995 respectively for workplace environment.

Theory of Operation

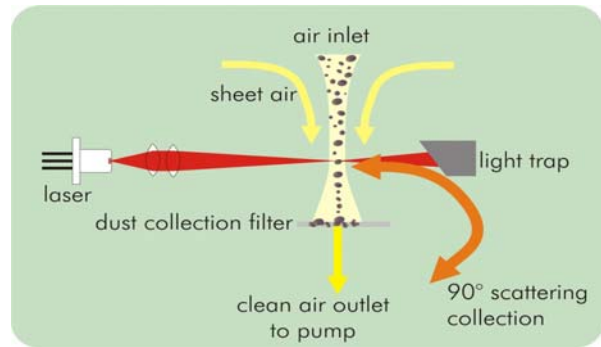
The **portable GRIMM # 1.108 Industrial Occupational Dust Monitor** provide single particle count and size classification in real time. The sample air with various size particles is drawn constantly through the flat light beam, produced by a focused laser diode. Each scattered signal from a single particle is detected by 90-degree by a high speed photo diode, so particle color changes can be neglected. Each signal is then counted and classified in 15 different size channels by an integrated pulse height analyzer. These counts can shown each second, six seconds or each minute on an attached computer as:

- **Particle Counts**, to concentrations of 2.000.000 Particles /lt. without range change or dilution necessary. But it is also possible to be used as a single particle counter for gray rooms.
- **Dust Mass Distribution Analyzer** showing results in 15 mass rangess(like impactors) but in real time as mass up to 100 mg/m³.
- **Occupational Dust Analyzer** showing simultaneously the inhalable, thoracic and alveoli mass up to 100 (with the 1.101 up to 65 mg/m³)
- The selected data as well as **service data** are also stored in the data logger and the instrument's internal memory by date and time.
- In addition a **removable 47 mm Ø PTFE filter** is incorporated collecting ALL the measured dust, so an appropriate density correction and sample analysis is possible at any later date
- This filter (as shown below) is the base for classical mass monitoring and in accordance to many **standards**.



- **Field Mass Calibration** to the "local dust conditions" can be made anywhere in the e

The diagram below shows the concept of a typical GRIMM DUST MONITOR



Professional Dust Monitoring requires that the following basic conditions are properly maintained:

- **The sampling method** must be in accordance to the application to ensure proper reproducibility, as outlined in the next page.
- **A precision Laser** with high quality **quartz collimators** guaranteeing exact particle size identification, even at 15 different sizes is needed.
- **Accurate Mass determination program**, only via particle sizing, assures superior precision and eliminates the need of impactors or cyclones at the sample inlet.
- **Continuous Optical chamber protection** by use of clean sheath air eliminates contamination of the optic, so signal drift due to long use is next to impossible,
- **Constant sample flow at all times**, as the dust load on the filter is constantly in creasing with time. The sample flow is fixed at 72 liters/hour at all times, maintained by an internal flow controller.
- **An insensitive optical bench system to vibration** and a rigid construction of the monitor assures accurate results.
- **Universal data acquisition** and Remote control, via PCMCIA modem card is available, enabling transmission of data via cellular and/or telephone hard lines. (Not jet available in certain countries)
- **Low consumables**, even the industrial type battery and filters are easily available

Principal Function

Software Presentation

The **32-bit program** operates all **GRIMM's 1.100 Occupational Dust Monitors**. The minimum requirement is a Pentium processor and the use of WINDOWS 95 or later software version. Naturally runs this software also with WINDOWS 2000 and an NT networks.

This user-friendly program will guide the customer in setting all the measurement parameters, which are then stored directly in the dust monitor. All steps are supported with a HELP and TUTORIAL program. In general, the program permits the setting up of all operating parameters such as:

SELECTION of the desired operating mode, starting of instrument, even remotely, the pre-selectable alarm level, the sampling location, any optional sensor settings, as well as the data display modes on the computer such as accumulative, differential, sliding average, colors of channels, zoom axis, etc.

OPERATION

- **The start /stop** is pre-selectable and so are the measurement interval times from 6 sec to 60 minutes,(even a 1 sec mode is possible).
- Also **the Service** data are shown and stored, so there is a full protocol of the instrument performance available at any time.
- **The control of the monitor** performance is done automatically, such as ZERO count test at the start, the sample air flow control, the particle size range as well as the power management and battery charge request
- **If monitor is used with the outdoor weather housing** it will control the integrated ventilation and heating system as well as the dehumidification system automatically.

Data presentation possibilities in Real-time and simultaneous with the 1.101 are:

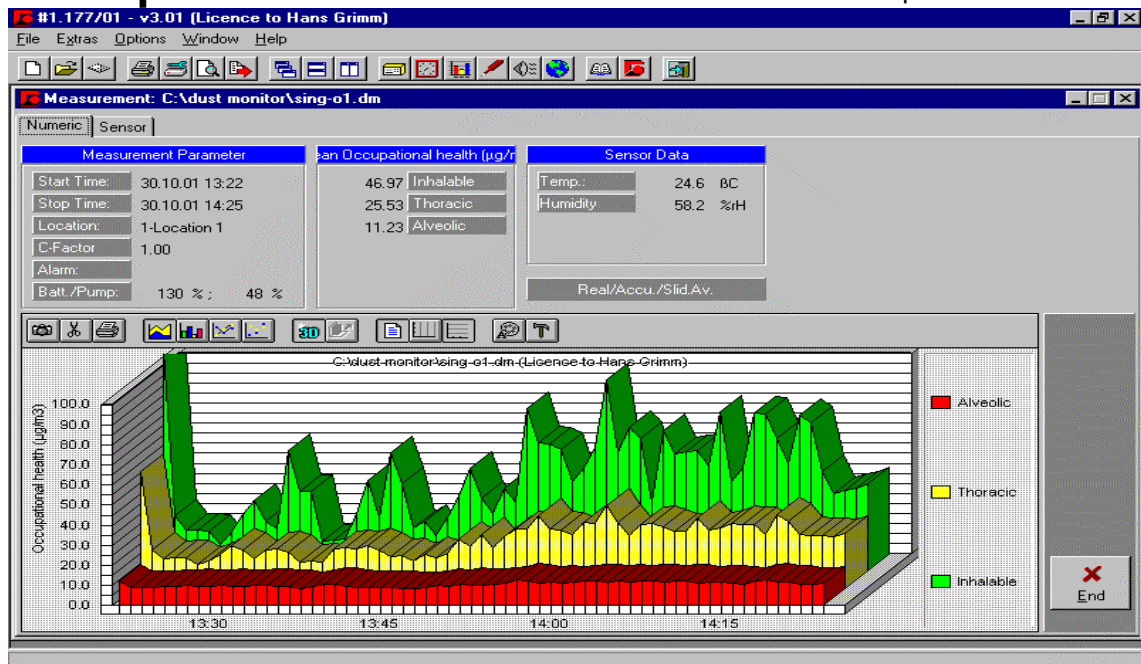
- **Occupational** as Inhalable, Thoracic and Alveolic values,
- **EPA environmental** PM₁₀ and the PM_{2.5} values

In addition with the 1.108 it is possible to present:

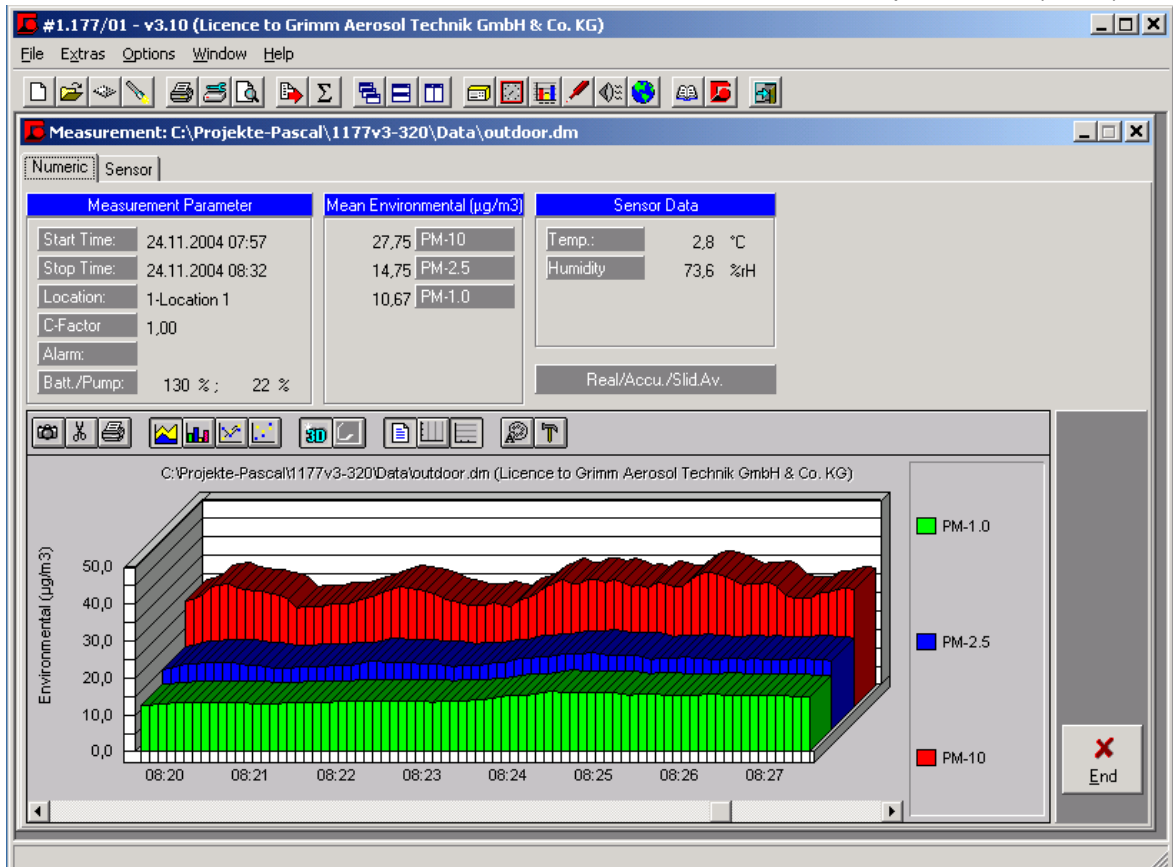
- **Particle size distribution** in count mode in 15 channels,
- **Mass distribution in accumulative** and differential mode in $\mu\text{g}/\text{m}^3$.
- As mean value of all three occupational modes,
- As Surface area by mode,
- Of the instrument's performance for possible error messages,
- Of attached sensors (such as Temp. and rel.-Humidity, wind-speed and air pressure),
- Print out of raw data directly from the instrument ,
- Or transmission of data via Modem.
- Obtain raw data simply by exporting in ASCII mode to EXXEL.

Results obtained with the 1.101 Spectrometer

Occupational as Dust Mass distribution over time of all three parameters:



Environmental Dust Mass distribution over time of all three parameters (1.108):

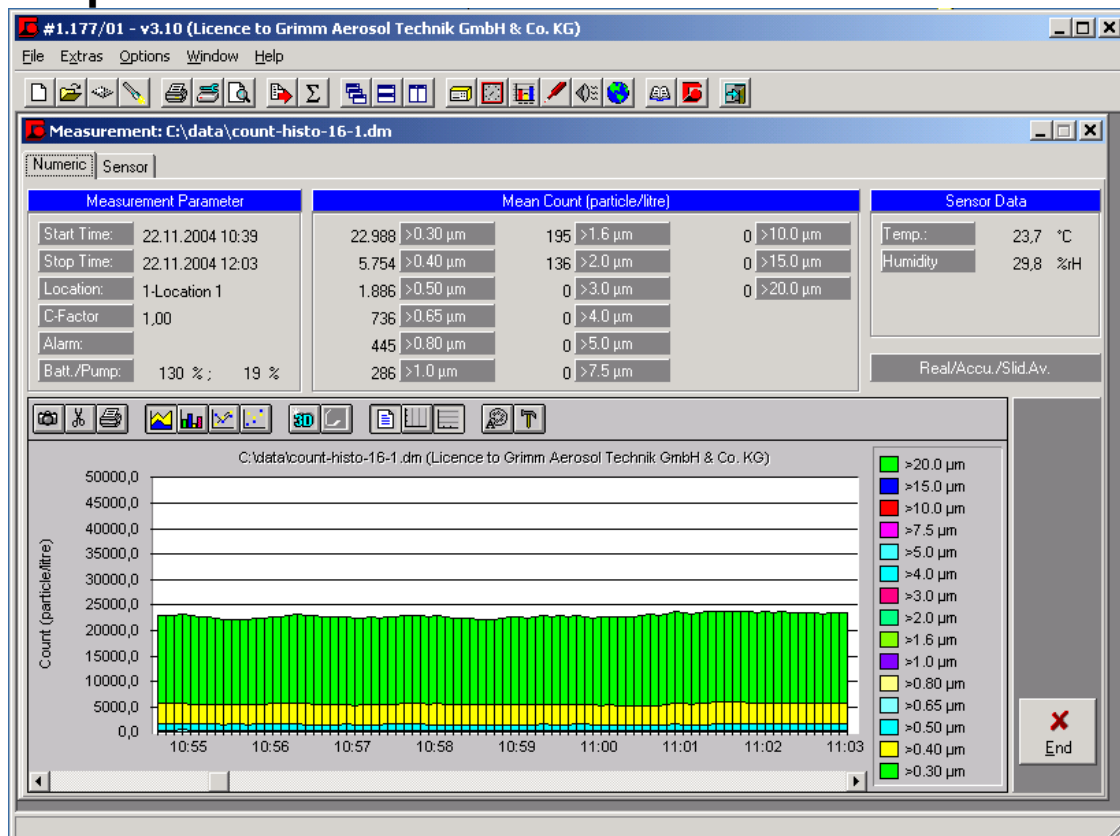


Model 1.108 can in Addition to the 1.101 data shown above

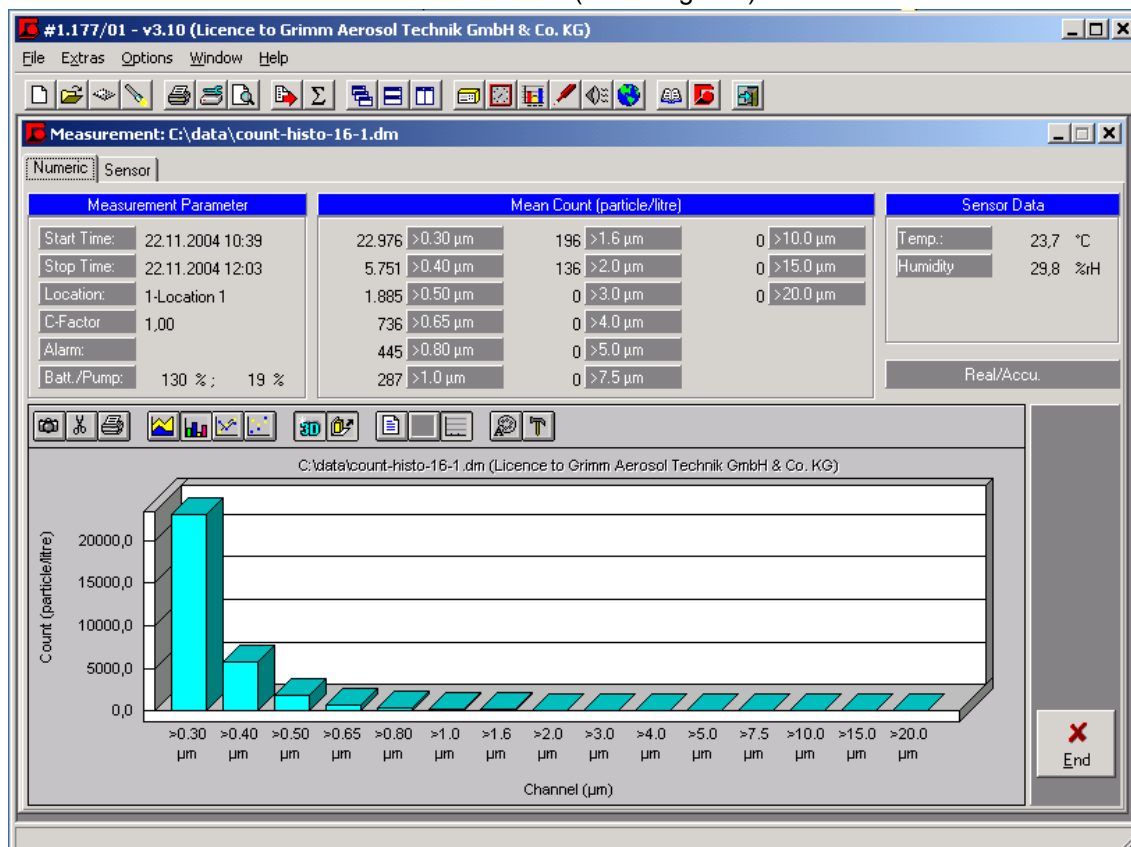
Numeric Results in EXEL® as Particle Concentration in 15 Size Channels:

Microsoft Excel - count-table-min-1.txt

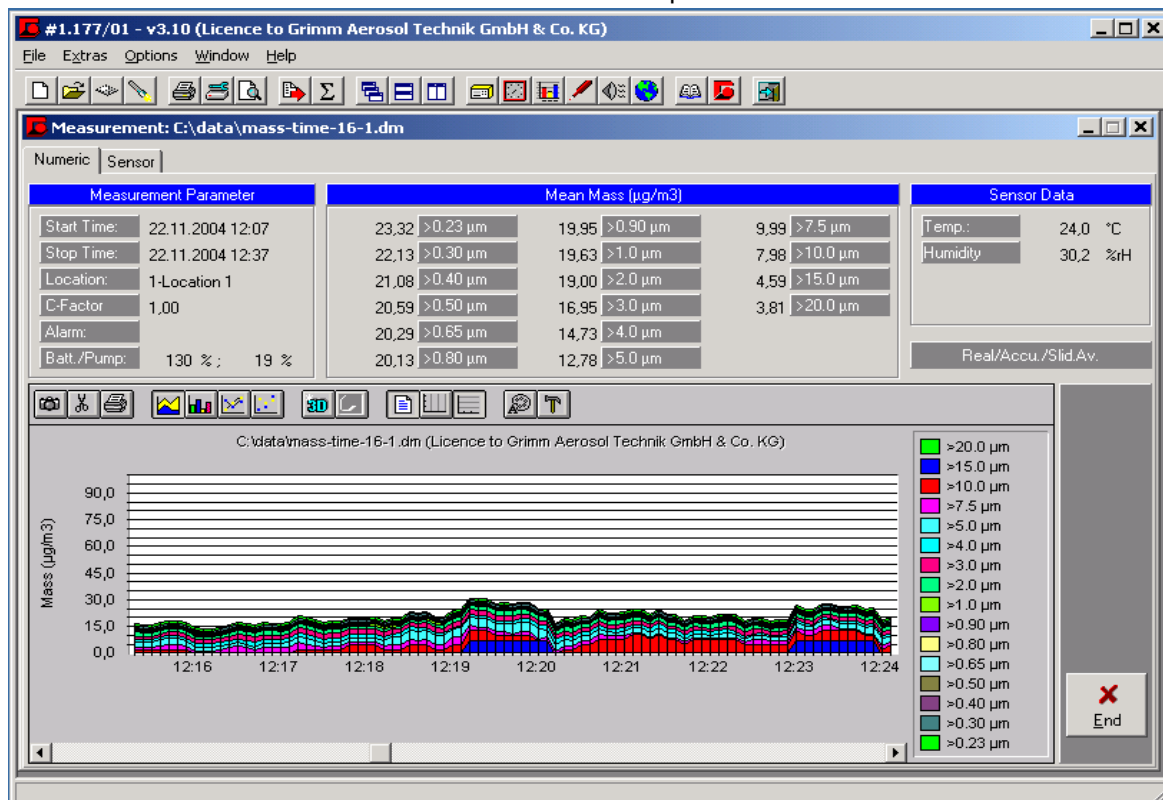
Graphic Count Concentration in 6 sec intervals of all 15 Size Channels:



Mean Count Distribution (as Histogram) over 15 Size Channels:



Particle Mass Concentration per 6 sec of all 16 different Size Channels:



GRIMM Sampling Methods

Work place sampling



The picture above shows the standard 1.101 Dust Monitor with the short radial sampling pipe at the air inlet connection (upper right side). Also shown is an acoustical and optical alarm signal unit attached to the RS-232 port. The alarm levels are user-selectable.

Occupational Health

Our samplings requirements comply to "Johannesburg convention" assuring air flow rates are similar to human inhalation condition. This means an open radial sampling head is required, completely made in stainless steel and inside polished, see above picture.

The complete 1.101 to 1.108 range of instrument can be used for workplace monitoring. These units can be used

- **on a shoulder strap** to monitor dust levels while in motion (to find in a Production hall /tunnel the max. concentration point)
- **Research studies**, mainly with animals for epidemiological use (to determine the dangerous particulate size and the appropriate hazard).
- For **Filter efficiency testing** with the above shown isokinetic sampler by

Ventilation-Ducts Sampling



The above picture shows our Isokinetic sampler used for dust monitoring with the model 1.108 (and other high wind speed devices).

Industrial Applications

Many dust related applications are intentions for product improvements, such as:

measuring after and than before the test filter. For more details ask for our 7.000 FILTER TEST brochure.

- **Trouble shooting**, will locate and pinpoint areas of excessive particulate emission, such as vaporization of cooling oil, etc..
- **Process monitoring** from low pharmaceutical count concentration to heavy dust emissions,
- **Filter Efficiency Testing** (such as in Ventilation or exhaust pipes)
- **Outdoor health inspection** (as mobile stationary location in mining, construction and other large sites, for continuous work environment monitoring).

Stationary Outdoor Monitoring

If need for long term monitoring occurs, mainly in mining and factory fence controls, than an often an OUTDOOR installation is also required. However to protect the monitor from rain and heat /frost a most chemicals at all times a strong resistant weather housing is needed.

Therefore a special housing, model 1.164 has been designed, witch can be mounted at a wall or post or platform easily. Simply enter your monitor 1.108 at any time into this housing and the unit will remain protected and at room temperature at all times.

The instrument operation, data acquisition and the software program remains unchanged.



The picture above shows the out-door housing, (Model 1.164). The sampling pipe is on top on the right side, an optional temperature and humidity sensor on top on the left side shown.

NOTE: The unit will all times see and count ALL the particle present in the air.

There is NO need to attach your computer permanently to the **DUSTcheck**.

Dilution Systems

Some applications require the use of a diluter, since the dust concentration to be measured exceeds the concentration range of the monitor.



T The picture above shows a 10:1 (or 100:1) diluter unit, attached directly to the dust monitor (model 1.104 to 1.109).

The advantage of this diluter is, that he

- Is very small and fits directly on to the monitor,
- Does not need any extra power supply and therefore ideal for field use,
- Communicates directly with the monitor and does not need any operational adjustment.
- And is easy to maintain

Optional GAS Monitoring

It is possible to connect to the 1.108 up to three additional sensors to one dust monitor, this can our climatic sensors, but also "OTHER" sensors, as long as the output of this sensors is

- Linear over the full range
- 0 to 2 Volt
- and they have their own power supply.

The specific sensor offsets can be entered via our software into the program, so results are stored with the dust values at the same data logger card (and immediately available via RS-232) and graphically shown in real time.

GRIMM DUSTcheck™

Model Nr.	1.108	1.101
Application	Industrial	Occupational
Measurement Method	Laser Light Scattering	Laser Light Scattering
Size Channels	15	none
Channels from 0.1 to 1 µm 9 x NANO	0.3 / 0.35 / 4.0 / 0.45 / 0.5 / 0.6 / 0.7 / 0.8 / 1	none
Channels from 1 to 10 µm 5 x FINE	2 / 3 / 5 / 7.5 / 10 /	none
Channels from 10 to 40 µm 2x COARSE	15 / > 20	none
Min. Particle size (µm)	0.3	0.5
Max. Particle size (µm)	> 20	> 15
Dust Mass Range (µg/m³)	0.1 to 100.000	1 to 65.000
Occupational (in 3 modes)	yes	yes
Counting Mode	yes	no
Mass Sizing Mode	yes	no
Environmental	no	no
For outdoor use with 1.164	yes	no
Air flow (Lt/h)	72	36
47mmØ Filter	Yes	no
Internal Data logger (Kb)	80	80
External Data Port	Yes (up to 6 Mb)	no
RS-232 port	Yes	Yes
USB Connection	Adapter	Adapter
Tel-Modem Port	yes	no
Lead Battery for 8h use	Yes	Yes
Adjustable clock	Yes	Yes
Isokinetic sampling	Yes	no
Optional Clima Sensors	Yes	no
Athm.-Air Pressure Sensor	yes	no
Accessories	Yes	no
Instrument colour	silver	white

General Specifications for 1.101 & 1.108 Instruments:

- Measurement mode : Continuous,
- Results displayed in 0.1 min or 1 min
- Flow +- 2% stability, independently of dust load on filter, automatic control,
- Clean additional sheath air of 0.4 lt./min.
- Resolution +- 5% µg/m³
- Reproducibility in R² up to 0.95 in mass
- Size calibration with NBS Latex
- Mass calibration with Stearin dust
- Operating temp + 4 to 45 °C (35-110 °F)
- Storage temp. -20 to 60 °C (4 -140 °F)
- Data storage card: 512- 6012 Kb
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- Power supply 110 or 220 VAC

INSTRUMENT DATA

- Display LCD 2x16 characters
- Presentation Results updated each 6 sec
- Mean value of the mass and air volume
Date, time, location, C-factor, and alarm.
- Keyboard 10 key foil membrane
- Key action Confirmed acoustically

SOFTWARE PROGRAM

The 1.177 Windows 98 version as 32bit Software for all the 1.100 units. Allows data presentation, depending on the model of
 * Inhalable, Respirable and Thoracic values
 * or as Dust Mass distribution
 or as Particle count and size distribution

*

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- Reproducibility in R^2 up to 0.95 in mass
- Size calibration with NBS Latex
- Mass calibration with Stearin dust
- Operating temp + 4 to 45 °C (35-110 °F)
- Storage temp. -20 to 60 °C (4 -140 °F)
- Data storage card: 512- 6012 Kb
- Power supply 110 or 220 VAC
- Internal 80 Kb memory
- Lead battery, internally rechargeable power for 7h of operation
- Serial port RS-232
- mode selection can be programmed with the key board
- Weight 2.5 kg (5.5lb.)
- Size 24x12x6 cm (9.5 x5x.5")

Specifications in this brochure are subject to *changes without notice. GRIMM and its logo are trademarks*

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GRIMM AEROSOL

TECHNIK GmbH & CO KG

Dorfstrasse 9, D-83404 Ainring,
Germany

Tel: ++49-8654-578-0, Fax ++49-8654-
57835

Homepage: www.grimm-aerosol.com

Emails. export@grimm-aerosol.com

With a world-wide representation network