



Lindbergs Ventilation AB  
Väst kustvägen 400  
254 77 FLENINGE

## Testing of Air Filter according to EN779:2002

(2 appendices)

An annual test according to CR055 (Certification rules for air filters) has been performed according to EN 779:2002.

The report of the production inspection is P800136-11.

### Tested item

Lindbergs Ventilation AB, F6 Microglas, art.nr 600150M10, 592 mm x 592 mm x 500 mm, 10 pocket air filter.

Lindbergs Ventilation AB, F6 Microglas, art.nr 600150M10, filter medium samples from a 592 mm x 592 mm x 500 mm, 10 pocket air filter (for discharging test).

The items were sent to SP by Lindbergs Ventilation AB and were received by SP on June 29, 2011.

The items were without visible defects.

### Date and Place

The test was carried out at SP's laboratory of Energy Technology in Borås, Sweden on February 24-27, 2012. Discharging test was carried out on February 16-17, 2012.

### Test method

The test was carried out according to standard EN 779:2002.

### Results

The results are presented in appendix 1 and are valid only for the items tested.

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## Measurement equipment

- Pressure gauge Furness FC016, SP's inventory no. 202 587 (static P Filter)
- Pressure gauge Furness FC016, SP's inventory no. 202 588 (static P Flow)
- Pressure gauge Furness FC012, SP's inventory no. 201 690 ( $\Delta P$  Filter)
- Pressure gauge Furness FC012, SP's inventory no. 201 691 ( $\Delta P$  Flow)
- Particle counter Las-X II, SP's inventory no. 701 378
- Auto sampler, SP's inventory no. 201 455
- Barometer, Druck DPI 260, SP's inventory no. 201 637
- Temperature and RH, Testo 635, SP's inventory no. 900 065
- Weighing scale, Mettler PC16, SP's inventory no. 202 741
- Flow meter, MFS-C-250, SP's inventory no. 202 742
- Flow meter, MFS-C50, SP's inventory no. 202 190
- Kr-85 Aerosol Neutralizer, TSI, SP's inventory no. 202 635

## Uncertainty of measurement

The uncertainty of the Air flow is better than  $\pm 5 \%$

The uncertainty of the Pressure Drop is better than  $\pm 3 \%$

The uncertainty of the Temperature is better than  $\pm 0.5 \text{ }^\circ\text{C}$

The uncertainty of the Relative Humidity is better than  $\pm 4 \%$  RH

The uncertainty of the Atmospheric Pressure is better than  $\pm 2 \text{ mbar}$

The uncertainty of the Measured mass is better than  $\pm 0.1 \text{ g}$

The method error in determination of the filtration efficiency is:

$\eta = 0\text{-}90 \%$ :  $\pm 0.1$  of penetration value [%]

$\eta = 90\text{-}99 \%$ :  $\pm 0.2$  of penetration value [%]

$\eta = 99\text{-}99.99 \%$ :  $\pm 0.5$  of penetration value [%]

$\eta > 99.99 \%$ :  $\pm 1$  of penetration value [%]

The uncertainty of the filtration efficiency according to EN 779:2002 is presented in the appendix.

## SP Technical Research Institute of Sweden Energy Technology - Combustion and Aerosol Technology

Performed by

Examined by

Christian Mossberg

Marie Rönnbäck

## Appendices

1. Test results according to EN779:2002

2. Picture of tested item

Appendix 1

Testing organisation: SP Technical Research Institute of Sweden Report no.: PX14794B

**EN 779:2002 AIR FILTER RESULTS**

GENERAL

Test no.: SP201202241	Date of test: 24/02/2012 - 27/02/2012	Supervisor: CM
Test requested by: SP Technical Research Institute of Sweden	Device receiving date	
Device delivered by: Lindbergs Ventilation AB	29/06/2011	

DEVICE TESTED

Model: F6 Microglas, art.nr 600150M10	Manufacturer: Lindbergs Ventilation AB	Construction: Pocket filter, 10 pockets
Type of media: Glass	Net effective filtering area: 6.0 m <sup>2</sup>	Filter dimensions (width x height x depth): 592 mm x 592 mm x 500 mm

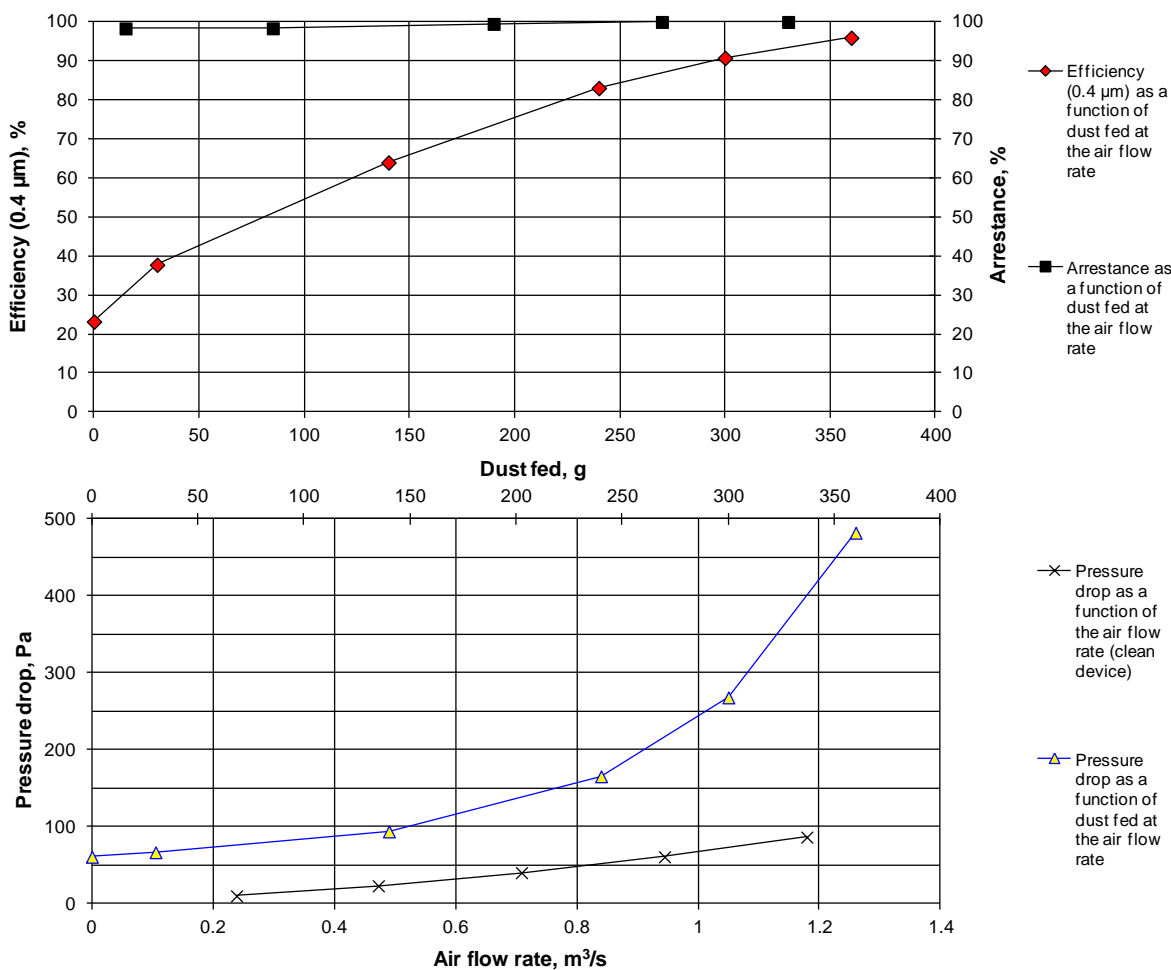
TEST DATA

Test air flow rate: 0.944 m <sup>3</sup> /s	Test air temperature: 27 to 31 °C	Test air relative humidity: 11 to 21 %	Test aerosol: DEHS	Loading dust: ASHRAE 52/76
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RESULTS

Initial pressure drop: 61 Pa	Initial arresstance: 98 %	Initial efficiency (0.4 µm): 23 %	Dust holding capacity: 286 / 320 / 348 g	Untreated/ discharged efficiency of media (0.4 µm, Annex A): 29 % / 20 %
Final pressure drop: 250 / 350 / 450 Pa	Average arresstance: >99% / >99% / >99%	Average efficiency (0.4 µm): 63% / 65% / 68%	Filter class (450 Pa): F6	Remarks:

Note: The performance results are only valid for the tested item and cannot by themselves be quantitatively applied to predict efficiency and lifetime in service



Appendix 1

**EN779:2002 - Efficiency after different dust loading phases**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s

Particle size		Efficiency %											
Interval µm	Mean µm	Pressure drop, Pa and Dust fed, g											
		61 0	Pa g	67 30	Pa g	94 140	Pa g	165 240	Pa g	268 300	Pa g	482 360	Pa g
0.12 - 0.15	0.13	17.0 ± 1.6		27.4 ± 1.9		51.6 ± 1.9		71.0 ± 0.8		81.5 ± 0.9		89.9 ± 0.8	
0.15 - 0.20	0.17	14.9 ± 1.5		26.3 ± 1.1		52.0 ± 1.5		71.8 ± 0.9		81.8 ± 0.6		90.5 ± 0.3	
0.20 - 0.25	0.22	16.5 ± 1.4		27.9 ± 1.8		54.0 ± 1.1		74.2 ± 0.7		83.5 ± 0.8		92.2 ± 0.7	
0.25 - 0.35	0.30	18.5 ± 0.8		30.6 ± 1.4		58.6 ± 0.9		77.8 ± 0.5		87.2 ± 0.5		93.3 ± 0.5	
0.35 - 0.45	0.40	23.2 ± 1.0		37.7 ± 1.4		64.0 ± 1.1		83.0 ± 0.5		90.8 ± 0.4		95.9 ± 0.3	
0.45 - 0.60	0.52	28.8 ± 1.1		46.0 ± 1.3		72.7 ± 1.1		88.3 ± 0.2		93.8 ± 0.5		97.7 ± 0.3	
0.60 - 0.75	0.67	36.3 ± 2.1		54.7 ± 2.0		78.8 ± 1.9		91.8 ± 0.6		96.5 ± 0.4		98.7 ± 0.2	
0.75 - 1.00	0.87	45.0 ± 2.6		61.6 ± 2.0		84.5 ± 1.1		95.0 ± 0.2		97.7 ± 0.3		99.3 ± 0.2	
1.00 - 1.50	1.22	55.4 ± 2.7		72.8 ± 1.9		90.4 ± 1.3		97.1 ± 0.4		99.2 ± 0.5		99.6 ± 0.3	
1.50 - 2.00	1.73	70.1 ± 1.7		82.0 ± 1.1		94.3 ± 0.8		99.0 ± 0.3		99.6 ± 0.1		99.8 ± 0.2	
2.00 - 3.00	2.45	87.3 ± 2.0		95.3 ± 1.6		98.9 ± 0.9		99.7 ± 0.3		99.9 ± 0.2		100.0 ± 0.0	
3.00 - 4.50	3.67	99.3 ± 2.1		100.0 ± 0.0		100.0 ± 0.0		100.0 ± 0.0		100.0 ± 0.0		100.0 ± 0.0	

NOTE The uncertainty of the measured efficiencies is reported on a 95 % confidence level.

**EN779:2002 - Average efficiency at different final pressure drops**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s

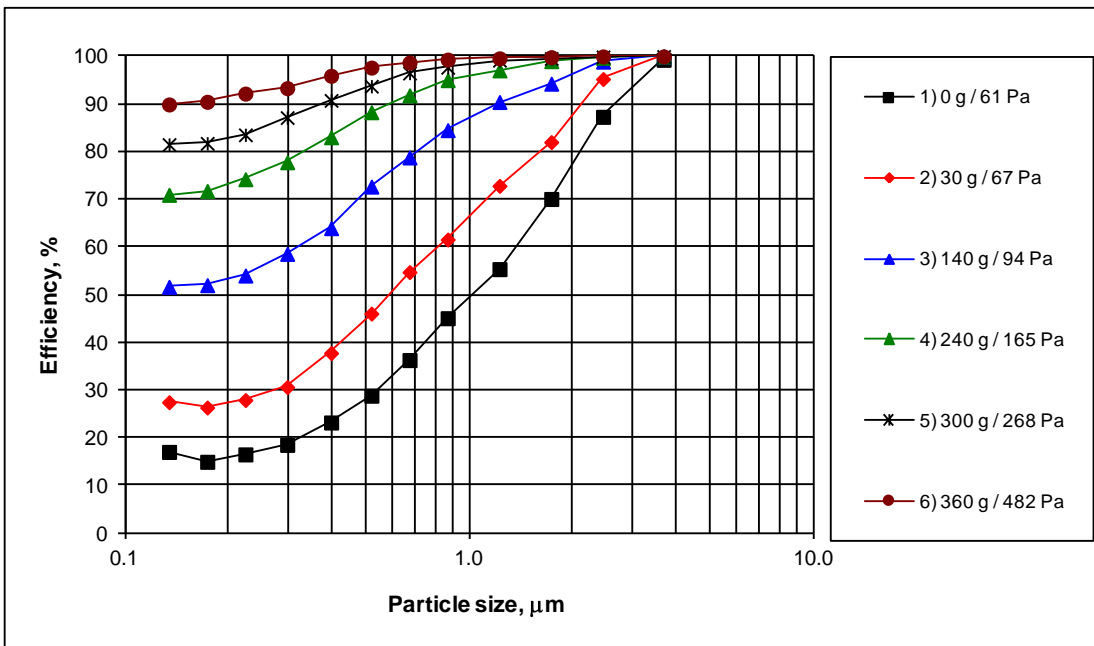
Particle size		Average efficiency %					
Interval µm	Mean µm	Final pressure drop					
		250	Pa	350	Pa	450	Pa
0.12 - 0.15	0.13	51.3 ± 1.7		54.5 ± 1.5		57.1 ± 1.4	
0.15 - 0.20	0.17	51.3 ± 1.3		54.5 ± 1.2		57.2 ± 1.1	
0.20 - 0.25	0.22	53.3 ± 1.3		56.5 ± 1.2		59.1 ± 1.1	
0.25 - 0.35	0.30	56.9 ± 1.0		60.1 ± 0.9		62.6 ± 0.8	
0.35 - 0.45	0.40	62.5 ± 1.1		65.5 ± 1.0		67.8 ± 0.9	
0.45 - 0.60	0.52	69.6 ± 1.0		72.1 ± 0.9		74.1 ± 0.8	
0.60 - 0.75	0.67	75.5 ± 1.6		77.7 ± 1.4		79.3 ± 1.3	
0.75 - 1.00	0.87	80.7 ± 1.2		82.4 ± 1.1		83.8 ± 1.0	
1.00 - 1.50	1.22	86.7 ± 1.3		88.0 ± 1.2		89.0 ± 1.1	
1.50 - 2.00	1.73	91.7 ± 0.8		92.5 ± 0.7		93.1 ± 0.7	
2.00 - 3.00	2.45	97.7 ± 0.9		97.9 ± 0.9		98.1 ± 0.8	
3.00 - 4.50	3.67	100.0 ± 0.1		100.0 ± 0.1		100.0 ± 0.1	
Dust holding capacity		286	g	320	g	348	g
Filter class		-		-		F6	

NOTE The uncertainty of the measured efficiencies is reported on a 95 % confidence level.

Appendix 1

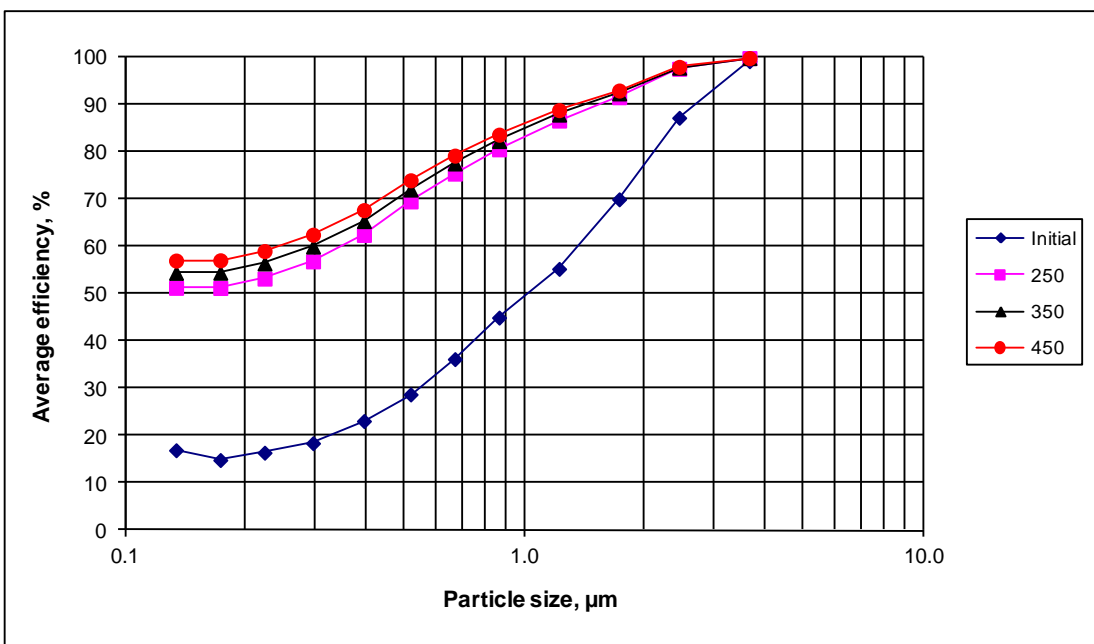
**EN779:2002 - Efficiency after different dust loading phases**

Air Filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s



**EN779:2002 - Initial and average efficiency at different final pressure drops**

Air Filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s



Appendix 1

**EN779:2002 - Air flow rate and pressure drop after different dust loading phases**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s

Date	Dust fed m <sub>tot</sub> g	Air flow meter				Filter						
		t <sub>f</sub> °C	p <sub>sf</sub> Pa	dp <sub>f</sub> Pa	q <sub>m</sub> kg/s	t °C	φ %	p <sub>a</sub> kPa	ρ kg/m <sup>3</sup>	q <sub>v</sub> m <sup>3</sup> /s	Δp Pa	Δp <sub>1.20</sub> Pa
Clean filter												
24/02/2012	0	27.5	40	32	0.27	27.5	20.2	98.2	1.134	0.239	10	10
24/02/2012	0	27.7	99	124	0.54	27.7	20.0	98.2	1.134	0.473	23	23
24/02/2012	0	27.8	178	277	0.80	27.8	20.2	98.3	1.134	0.709	40	40
24/02/2012	0	27.2	278	491	1.07	27.2	21.3	98.4	1.138	0.945	61	61
24/02/2012	0	27.3	397	763	1.34	27.3	20.7	98.5	1.139	1.179	86	86
Clean filter pressure drop is proportional to (q <sub>v</sub> ) <sup>n</sup> , w here n = 1.34												
Dust loading phase												
24/02/2012	30	28.3	282	489	1.071	28.3	19.3	98.4	1.134	0.944	67	67
24/02/2012	30	30.9	280	485	1.062	30.9	16.7	98.4	1.124	0.945	66	66
27/02/2012	140	29.0	309	498	1.090	29.0	12.0	100.2	1.153	0.945	94	94
27/02/2012	140	30.2	308	496	1.085	30.2	11.0	100.2	1.149	0.945	94	93
27/02/2012	240	30.6	367	495	1.084	30.6	10.8	100.3	1.148	0.944	166	165
27/02/2012	240	31.3	361	494	1.081	31.3	10.2	100.3	1.145	0.944	164	163
27/02/2012	300	30.2	448	496	1.086	30.2	11.2	100.3	1.150	0.944	269	268
27/02/2012	300	31.7	447	494	1.081	31.7	10.4	100.3	1.145	0.945	266	265
27/02/2012	360	31.1	625	494	1.082	31.1	11.8	100.3	1.146	0.944	484	482
27/02/2012	360	32.7	620	492	1.077	32.7	11.0	100.3	1.140	0.945	482	480

2 = after dust increment  
 1 = before next dust increment

Symbols and units

- |                    |   |                |   |
|--------------------|---|----------------|---|
| dp <sub>f</sub>    | air flow meter differential pressure, Pa                        | q <sub>m</sub> | mass flow rate, kg/s                              |
| m <sub>tot</sub>   | total mass of dust fed to filter, g                             | q <sub>v</sub> | air flow rate filter, m <sup>3</sup> /s           |
| Δp                 | measured filter pressure drop, Pa                               | t <sub>f</sub> | temperature at air flow meter, °C                 |
| Δp <sub>1.20</sub> | filter pressure drop at air density 1.20 kg/m <sup>3</sup> , Pa | t              | temperature upstream of filter, °C                |
| p <sub>a</sub>     | absolute air pressure upstream of filter, kPa                   | φ              | relative humidity upstream of the filter, %       |
| p <sub>sf</sub>    | air flow meter static pressure, kPa                             | ρ              | air density upstream of filter, kg/m <sup>3</sup> |

Appendix 1

**EN779:2002 - Pressure drop and arrestance after different dust loading phases**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202241  
 Test aerosol: DEHS  
 Air flow rate: 0.944 m<sup>3</sup>/s

Date	$\Delta p_1$	dm	m <sub>tot</sub>	$\Delta p_2$	m <sub>1</sub>	m <sub>2</sub>	$\Delta m$	m <sub>d</sub>	A	A <sub>m</sub>
	Pa	g	g	Pa	g	g	g	g	%	%
24/02/2012	61	30	30	67	2614.2	2614.7	0.5	0.0	98.3	98.3
27/02/2012	66	110	140	94	2614.7	2616.5	1.8	0.0	98.4	98.4
27/02/2012	93	100	240	165	2616.5	2617.0	0.5	0.0	99.5	98.8
27/02/2012	163	60	300	268	2617.0	2617.0	0.0	0.0	100.0	99.1
27/02/2012	265	60	360	482	2617.0	2617.0	0.0	0.0	100.0	99.2

Symbols and units

- A arrestance, %
- A<sub>m</sub> average arrestance, %
- dm dust increment, g
- $\Delta p_1$  pressure drop before dust increment (air density 1.20 kg/m<sup>3</sup>), Pa
- $\Delta p_2$  pressure drop after dust increment (air density 1.20 kg/m<sup>3</sup>), Pa
- m<sub>d</sub> dust in duct after device, g
- m<sub>1</sub> mass of final filter before dust increment
- m<sub>2</sub> mass of final filter after dust increment
- m<sub>tot</sub> total mass of dust fed to filter, g
- $\Delta m$  mass gain of final filter, g

**Mass of tested item:**

Clean filter:	2 605.3 g
After complete test:	2 953.7 g

**Test dust**

ASHRAE 52/76, Particle Technology Ltd.  
 Batch no: 7681

Appendix 1

**EN 779:2002 - Efficiency and pressure drop of untreated filter material**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202162  
 Test aerosol: DEHS  
 Discharging method: Isopropanol  
 Air flow rate: 14.5 l/s  
 Media velocity: 0.16 m/s  
 Size of material sample: 924 cm<sup>2</sup>

Particle size µm		Sample 1	Sample 2	Sample 3	Average
		Efficiency %			
Interval	Mean	Pressure drop			
		39 Pa	39 Pa	38 Pa	39 Pa
0.12 - 0.15	0.13	20.8 ± 2.6	24.0 ± 3.6	22.4 ± 2.8	22.4
0.15 - 0.20	0.17	20.3 ± 2.2	24.0 ± 2.1	20.1 ± 2.4	21.5
0.20 - 0.25	0.22	20.4 ± 2.6	22.6 ± 2.1	20.4 ± 2.9	21.1
0.25 - 0.35	0.30	21.9 ± 2.4	26.0 ± 2.4	22.7 ± 2.3	23.6
0.35 - 0.45	0.40	28.4 ± 1.6	31.1 ± 2.1	27.4 ± 1.9	28.9
0.45 - 0.60	0.52	36.8 ± 2.3	39.0 ± 2.2	37.3 ± 2.0	37.7
0.60 - 0.75	0.67	43.9 ± 2.4	45.7 ± 2.3	44.6 ± 2.5	44.7
0.75 - 1.00	0.87	53.4 ± 1.5	56.5 ± 2.8	53.4 ± 2.7	54.4
1.00 - 1.50	1.22	64.2 ± 2.8	66.3 ± 2.1	64.0 ± 2.8	64.8
1.50 - 2.00	1.73	75.5 ± 1.6	78.3 ± 1.4	74.8 ± 1.9	76.2
2.00 - 3.00	2.45	91.7 ± 1.3	91.7 ± 1.6	91.5 ± 1.6	91.6
3.00 - 4.50	3.67	99.4 ± 1.6	98.0 ± 3.2	99.0 ± 3.0	98.8

NOTE The uncertainty of the measured efficiencies is reported on a 95 % confidence level.

**EN 779:2002 - Efficiency and pressure drop of discharged filter material**

Air filter: F6 Microglas, art.nr 600150M10  
 Test no.: SP201202162  
 Test aerosol: DEHS  
 Discharging method: Isopropanol  
 Air flow rate: 14.5 l/s  
 Media velocity: 0.16 m/s  
 Size of material sample: 924 cm<sup>2</sup>

Particle size µm		Sample 1	Sample 2	Sample 3	Average
		Efficiency %			
Interval	Mean	Pressure drop			
		36 Pa	35 Pa	36 Pa	36 Pa
0.12 - 0.15	0.13	15.2 ± 3.2	14.7 ± 2.0	15.4 ± 2.5	15.1
0.15 - 0.20	0.17	14.7 ± 2.2	12.8 ± 2.8	14.3 ± 2.9	13.9
0.20 - 0.25	0.22	14.7 ± 3.0	13.9 ± 2.2	12.9 ± 2.1	13.8
0.25 - 0.35	0.30	16.3 ± 2.4	15.0 ± 1.6	14.9 ± 1.2	15.4
0.35 - 0.45	0.40	21.6 ± 3.4	18.5 ± 3.0	20.3 ± 2.9	20.1
0.45 - 0.60	0.52	27.3 ± 2.9	25.9 ± 3.1	25.6 ± 2.6	26.3
0.60 - 0.75	0.67	34.8 ± 3.3	32.7 ± 2.8	30.8 ± 3.0	32.8
0.75 - 1.00	0.87	43.0 ± 2.9	39.1 ± 2.4	40.7 ± 1.8	41.0
1.00 - 1.50	1.22	53.6 ± 2.2	49.1 ± 3.0	50.2 ± 4.0	51.0
1.50 - 2.00	1.73	66.8 ± 1.6	63.3 ± 1.8	64.9 ± 3.6	65.0
2.00 - 3.00	2.45	86.2 ± 1.9	84.7 ± 1.2	83.3 ± 2.4	84.7
3.00 - 4.50	3.67	98.6 ± 2.4	96.9 ± 3.4	99.2 ± 2.0	98.2

NOTE The uncertainty of the measured efficiencies is reported on a 95 % confidence level.



## Appendix 2

