THE CAMFIL GROUP

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COMFORT

ISO 16890 New standard for Air Filter Efficiency

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International Organization for Standardization

ISO16890

Air Filters for general ventilation

ISO 16890 (all parts) refers to particulate air filter elements for general ventilation having an ePM_1 efficiency less than or equal to 99 % and an ePM_{10} efficiency greater than 20 % when tested per the procedures defined within parts 1-4 of ISO 16890.

EN779: 2012 - test

0,4 µm particle (by classification)

Dust feeding and particle efficiency measure – in steps up to 450 Pa final pressure drop => average efficiency

Conditioning (discharging) of a piece of media (F7 – F9) in Isopropanol liquid

Minimum Efficiency (ME) (Defines the filter class in F7 – F9)

Dust: ASHRAE

ISO16890 - test

Particulate matter efficiency (ePM)

ePM_x – mass concentration of particles with an optical diameter of > 0,3 µm and x µm

Average efficiency = Mean value of initial eff and conditioned efficiency (5 cycles á 30 sec)

Conditioning (discharging) of a complete filter in IPA vapour chamber – 24 hours

Dust: ISO A2 / AC Fine

EN779: 2012 - test reporting

Table 1— Classification of air filters[1)]

Group	Class	Final test pressure drop Pa	Average arrestance (Am) of synthetic dust %	Average efficiency (E_m) of 0,4 µm particles %	Minimum Efficiency[2)] of 0,4 µm particles %
Coarse	G1	250	$50 \le A_m < 65$	-	-
	G2	250	$65 \le A_m < 80$	-	
	G3	250	$80 \le A_m < 90$		
	G4	250	$90 \le A_m$	-	
Medium	M5	450	-	$40 \le E_m < 60$	
	M6	450	-	$60 \le E_m < 80$	
Fine	F7	450	-	$80 \le E_m < 90$	35
	F8	450	-	$90 \le E_m < 95$	55
	F9	450	-	$95 \le E_m$	70

Has to be reached

Sets filter class for F7, F8 and F9

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ISO16890 – test reporting

1.1 Classification

The initial gravimetric arrestance and the three efficiency values ePM_1, $ePM_{2,5}$ and ePM_{10} and the minimum efficiency values $ePM_{1,\ min}$ and $ePM_{2.5,\ min}$ shall be used to classify a filter in one of the four groups given in Table 1.

Has to be reached

Table 1 – Filter groups

Group name	Requirement			Class reporting value
	$ePM_{1,\ min}$	$ePM_{2,5,\ min}$	ePM_{10}	
ISO Coarse	—	—	< 50%	Initial grav. arrestance
ISO ePM10	—	—	≥ 50%	ePM_{10}
ISO ePM2,5	—	≥ 50%	—	$ePM_{2,5}$
ISO ePM1	≥ 50%	—	—	ePM_1

The standard is valid for air flow rates between 900 – 5400 m^3/h (0,25 m^3/s - 1,5 m^3/s)

ISO16890 50% becomes + 60%

Example:

EN779:2012

Hi-Flo II XLT7 (F7) ME +50 % 0,4µm → **ISO16890**

ISO ePM$_1$ 63% (calculated)

ISO16890

ME for PM$_1$ ≥ 50% → **EN779:2012**

Standard-Flo F7 ME ≈40-45 % 0,4µm

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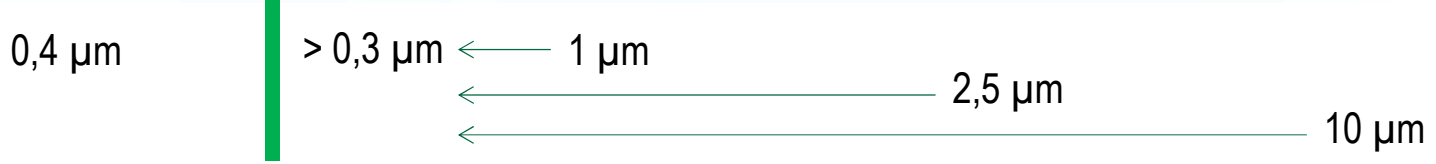
Filter class
EN779 / ISO16890

Filter class	PM1	PM2.5	PM10
M5	<20%	<40%	>50%
M6	<40%	50-60%	>60%
F7	50-75%	>70%	>80%
F8	70-85%	>80%	>90%
F9	>85%	>90%	>95%



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ISO 16890, new global test standard for air filter

The standard has (4) parts:

1. Classification (16890-1)
2. Test method (16890-2)
3. Dust loading (16890-3)
4. Conditioning, ME (16890-4)
   (ME, Minimum Efficiency)

International Organization for Standardization

ISO 16890, new global test standard for air filter

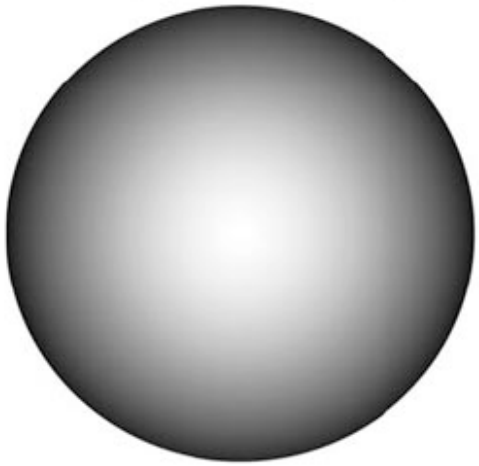
16890-2 Efficiency test method …..

- Combines ASHRAE 52.2 and EN-779 to one document
- Pressure drop and efficiency same as in EN779 & ASHRAE
- DEHS particles for PM_1
- KCL (salt) particles for $PM_{2.5}$ and PM_{10}

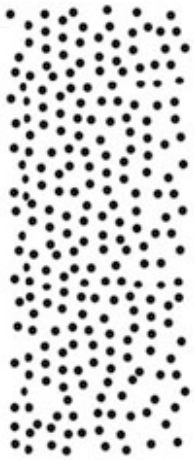
Number particle concentration and mass concentration

Mass:	70 %	22 %	8 %
Number:	1 %	9 %	90 %

1 microparticle
60 µm diameter
(size of human hair)

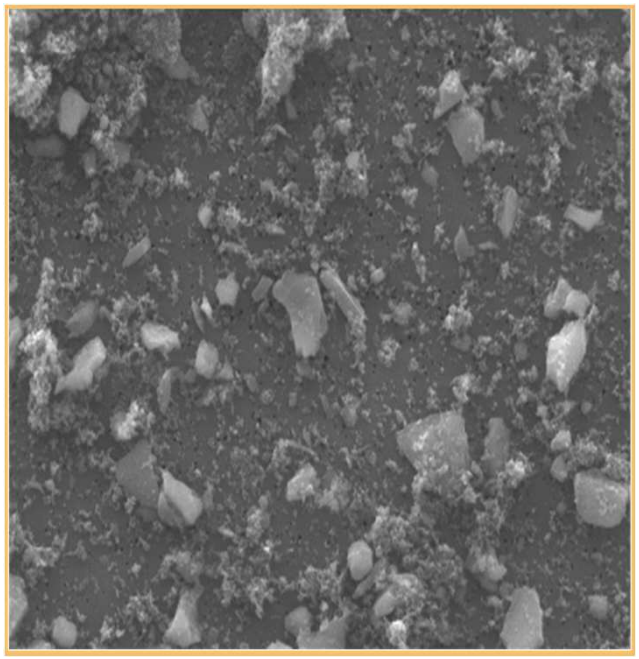


1 million particles
600 nm diameter



1 billion nanoparticles
60 nm diameter

ISO 16890, new global test standard for air filter



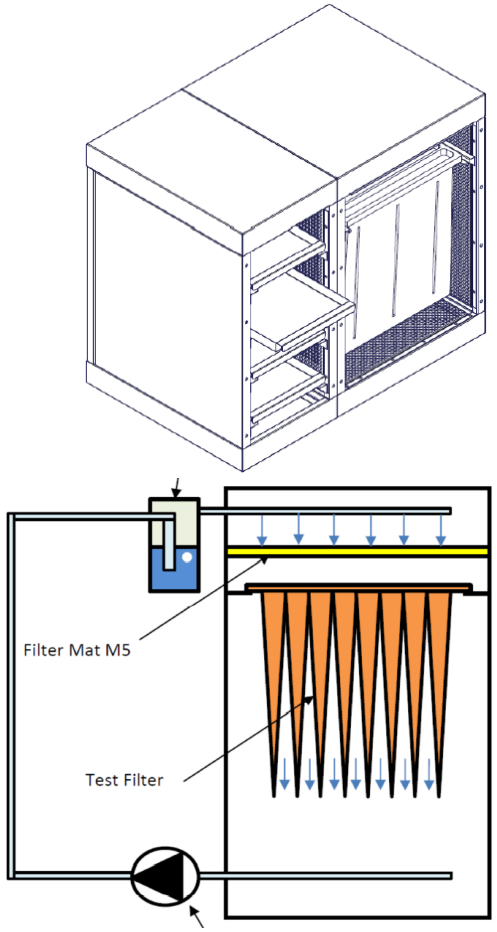
ISO 12103 PT 1. A2 / AC Fine
Mineral Flour , 0-80µm

16890-3 Dust holding capacity…..

- Additional for filter in group ePM_{10} , $ePM_{2,5}$ and ePM_1
- Dust loading (Arrestance) - Corse
- 100% ISO Fine (AC fine)
- Gives higher dust holding in g (≈double)
- Final resistance 300 Pa > 50% ePM_x
- Final resistance 200 Pa Coarse

ISO 16890-3:201x - AIR FILTER TEST RESULT SUMMARY					**Testing Organization** Name Address Phone
GENERAL					
Test ID:		Date of test:		Operator:	
			Air flow measurement:		Test device obtained from:
DEVICE TESTED					
Model:		Manufacturer:		Filter dimensions (W x H x D) (mm):	
Type of media:		Net effective media area (m^2):		Construction: *(# pleats, pockets, etc.)*	
Filter/media electrostatic charge:		Media colour:		Media adhesive:	
Device Condition: *(clean/initial, used, conditioned per ISO 16890-4, tested per ISO 16890-2, etc.)*					
Other descriptive information:					
TEST DATA SUMMARY					
Test air flow rate (m^3/s):	Test air temperature (ºC):	Test air RH (%):		Loading dust:	
RESULTS					
Resistance to air flow (Pa)		Dust loading results			
Measured:	Rated Initial:	Initial arrestance [%]	Average arrestance [%]	Test Dust capacity [g]	
	Rated Final:				
	Rated Final:				
Test Device Photo					

ISO 16890, new global test standard for air filter

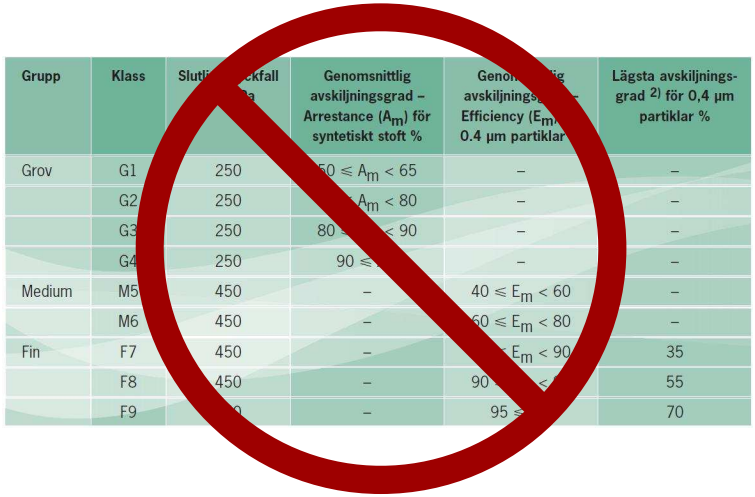


16890-4 Conditioning / Discharge

- IPA vapor from isopropanol

  Tuff method for discharging, 24h
- Not destructive, fiber structure remain
- Complete filter in the rig

ISO 16890, the new global filter test standard



Grupp	Klass	Slutl…ckfall …a	Genomsnittlig avskiljningsgrad – Arrestance (A_m) för syntetiskt stoft %	Genom…ig avskiljnings… – Efficiency (E_m) 0.4 µm partiklar	Lägsta avskiljnings-grad [2] för 0,4 µm partiklar %
Grov	G1	250	50 ≤ A_m < 65	–	–
	G2	250	… A_m < 80	–	–
	G3	250	80 … < 90	–	–
	G4	250	90 ≤ …	–	–
Medium	M5	450	–	40 ≤ E_m < 60	–
	M6	450	–	60 ≤ E_m < 80	–
Fin	F7	450	–	… E_m < 90	35
	F8	450	–	90 … <	55
	F9	…	–	95 ≤	70

Group name	**Examples**
ISO Coarse	ISO Coarse 55 %
ISO ePM_{10}	ISO ePM_{10} 55 %
ISO $ePM_{2.5}$	ISO $ePM_{2.5}$ 55 %
ISO ePM_1	ISO ePM_1 55 %

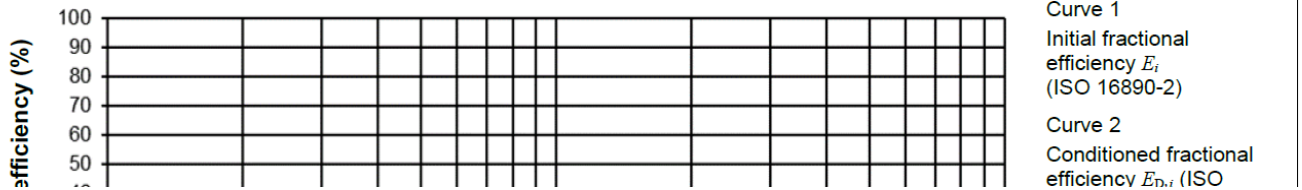
16890-1 Classification …..

- Efficiency in the report is the **AVERAGE** of initial and discharged
- ePM_1, $ePM_{2.5}$ and ePM_{10} **EFFICIENCY** shall be stated in the report
- ePM_1 and $ePM_{2.5}$ **MINIMUM** efficiency ME shall be stated in the report
- Value shall be **ROUNDED DOWN** to a multiple of 5%

ISO 16890 – Air Filter Test Results								
			Testing organisation: Name Address Phone					
GENERAL								
Report no.:			Date of report: yyyy-mm-dd					
Supervisor:			Device obtained (when and how obtained)					
Test(s) requested by:								
DEVICE TESTED								
Model:	Manufacturer:		Construction:					
Type of medium:	Net effective filtering area:		Filter dimensions (width × height × depth): mm × mm × mm					
TEST DATA AND ATTACHED TEST REPORTS								
Test air flow rate: m^3/s	Test report to ISO 16890-2		Report no.					
	Test report to ISO 16890-3 (optional)		Report no.					
	Test report to ISO 16890-4		Report no.					
RESULTS								
Initial pressure differential: Pa	Initial grav. arrestance: %		$ePM_{1,\ min}$ %	$ePM_{2.5,\ min}$ %	ISO rating			
Final test pressure differential: Pa / Pa / Pa	Test dust capacity: g / g / g		ePM_1 %	$ePM_{2.5}$ %	ePM_{10} %	**ISO ePM__ __%**		
Remarks:								

All actual ePM values to be reported

The classification



ISO 16890, the new global filter test standard

RESULTS					
Initial pressure differential: Pa	Initial grav. arrestance: %	$ePM_{1,\ min}$ 61 %	$ePM_{2.5,\ min}$ 73 %		ISO rating **ISO ePM1 60%**
Final test pressure differential: Pa / Pa / Pa	Test dust capacity: g / g / g	ePM_1 63 %	$ePM_{2.5}$ 75 %	ePM_{10} 85 %	

RESULTS					
Initial pressure differential: Pa	Initial grav. arrestance: %	$ePM_{1,\ min}$ 43 %	$ePM_{2.5,\ min}$ 58 %		ISO rating **ISO ePM2.5 55%**
Final test pressure differential: Pa / Pa / Pa	Test dust capacity: g / g / g	ePM_1 47 %	$ePM_{2.5}$ 63 %	ePM_{10} 78 %	

< 50%

Classification table

PM1 classification	PM2,5 classification	PM10 classification	Coarse
ePM1[95%] ePM1[90%] ePM1[85%] ePM1[80%] ePM1[75%] ePM1[70%] ePM1[65%] ePM1[60%] ePM1[55%] ePM1[50%]	ePM2.5[95%] ePM2.5[90%] ePM2.5[85%] ePM2.5[80%] ePM2.5[75%] ePM2.5[70%] ePM2.5[65%] ePM2.5[60%] ePM2.5[55%] ePM2.5[50%]	ePM10[95%] ePM10[90%] ePM10[85%] ePM10[80%] ePM10[75%] ePM10[70%] ePM10[65%] ePM10[60%] ePM10[55%] ePM10[50%]	Arrestance reported in full 10%
Requirement: > 50% initial eff > 50% discharged eff	Requirement: > 50% initial eff > 50% discharged eff	Requirement: > 50% initial eff No discharge requirement	No discharge requirement

Principle is – round down to nearest 5%

PM2,5(95%)

PM2,5(85%)

PM2,5(80%)

PM2,5(75%)

PM2,5(70%)

PM2,5(65%)

PM2,5(60%)

PM2,5(55%)

PM2,5(50%)

F

M5 8F

9

M6 7

PM 2,5

PM 10

PM1

PM1(95%)

PM1(85%)

PM1(80%)

PM1(75%)

PM1(70%)

PM1(65%)

PM1(60%)

PM1(55%)

PM1(50%)

PM10(95%) PM10(85%) PM10(80%) PM10(75%)

PM10(55%) PM10(60%) PM10(65%) PM10(70%)

PM10(50%)

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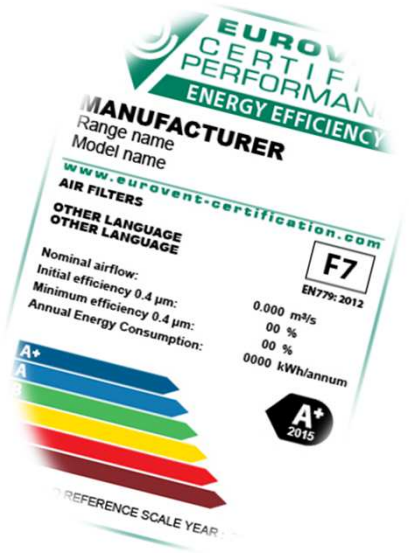
EUROVENT

Internal working group draft

04.06.2016

EUROVENT 4/21 - 2017

Energy Efficiency Evaluation of Air Filters for General Ventilation Purposes



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ISO16890 and Eurovent Energy Efficiency Classification

Filter class 2015	M5	M6	F7	F8	F9
ME	-	-	ME ≥ 35%	ME ≥ 55%	ME ≥ 70%
	MM=250 g ASHRAE			MF=100 g ASHRAE	
A+	0 – 450 kWh	0 – 550 kWh	0 – 800 kWh	0 – 1000 kWh	0 – 1250 kWh
A	>450 kWh – 600 kWh >	550 kWh – 650 kWh	>800 kWh – 950 kWh	>1000 kWh – 1200 kWh	>1250 kWh – 1450 kWh
B	>600 kWh – 700 kWh	>650 kWh – 800 kWh	>950 kWh – 1200 kWh	>1200 kWh – 1500 kWh	>1450 kWh – 1900 kWh
C	>700 kWh – 950 kWh	>800 kWh – 1100 kWh	>1200 kWh – 1700 kWh	>1500 kWh –2000 kWh	>1900 kWh – 2600 kWh
D	> 950 – 1200 kWh	> 1100 kWh – 1400 kWh	> 1700 kWh – 2200 kWh	> 2000 kWh – 3000 kWh	> 2600 kWh – 4000 kWh
E	>1200 kWh	>1400 kWh	>2200 kWh	>3000 kWh	>4000 kWh

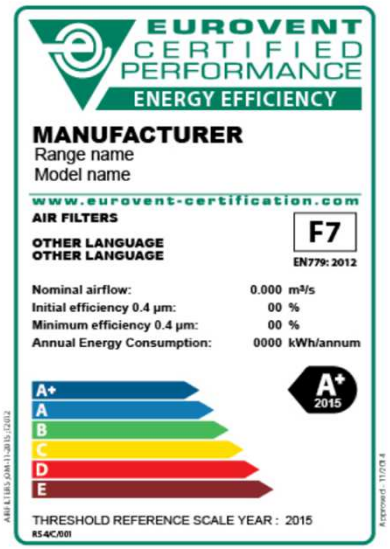
- ❑ Round Robin tests are provided by six labs and 36 filter types
- ❑ Target is to get close to existing classification table

ISO16890 and Eurovent Energy Efficiency Classification

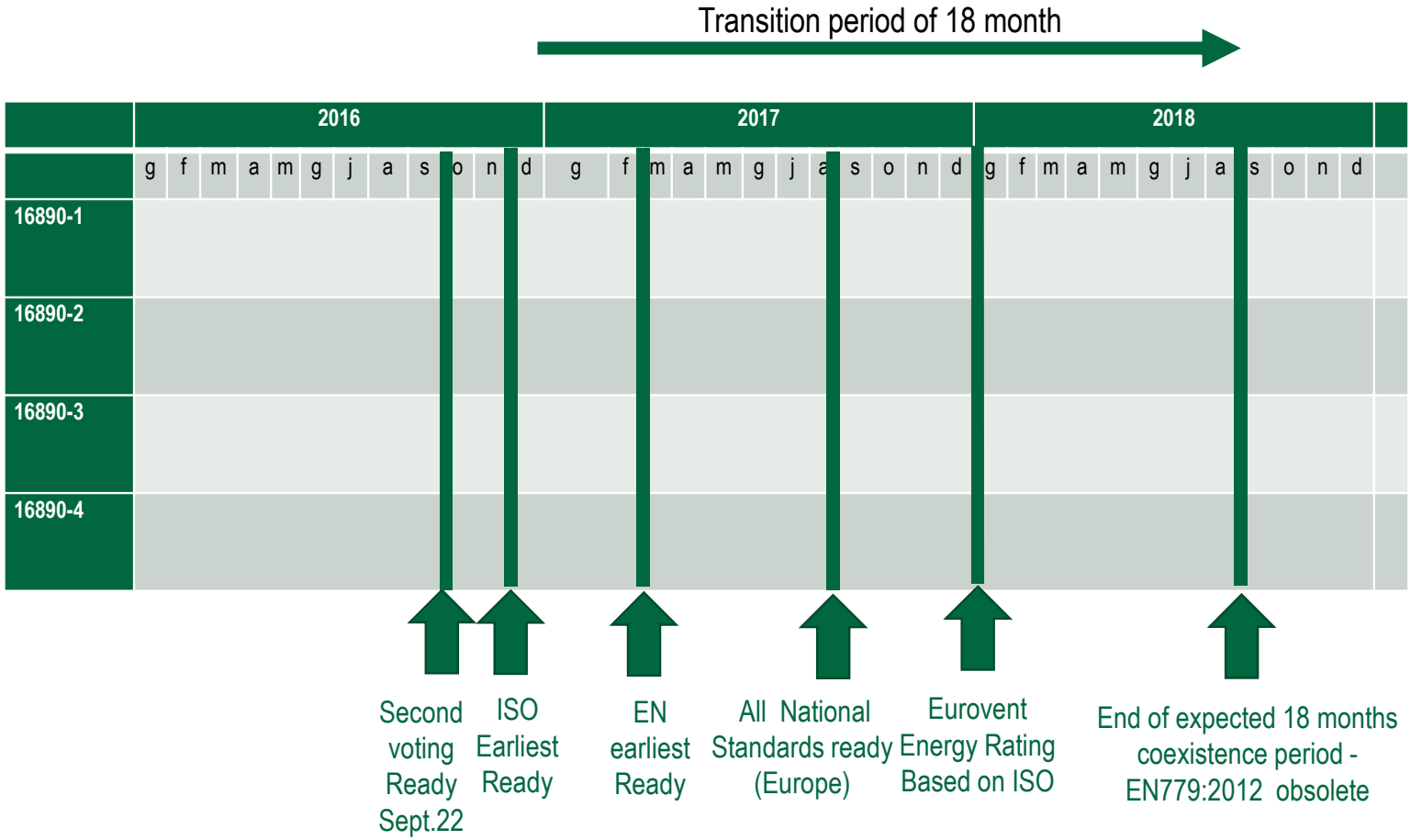
Implements 2018

	ePM_{10}	$ePM_{2,5}$	ePM_1
Atm. Dust conc.	35 µg/m³	21 µg/m³	16 µg/m³
Volume flow rate	3400 m³/h	3400 m³/h	3400 m³/h
Operating hours / a	6000 h	6000 h	6000 h
Total dust fed PM_x	714 g	428 g	326 g
AC Fine dust fed ISO 12249-2 (draft)	**700 g**	**400 g**	**300 g**

EN779:2012	250g	100g
	M5-M6	F7 – F9



ISO 16890 Timeline



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CLEAN PROCESS

ISO 16890 in Clean Process Industries
- Hospitals
- Food and Beverage
- Life Science

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HOSPITALS

- **”Open window effect” –** patients are more vulnerable to dangerous airborne particles.
- PM1 particles are the s**mallest** and **most** dangerous particulate matter
- PM1 can bypass the human body’s natural defenses
- Viruses and smaller bacteria belong to PM1 fraction (0,3 – 1µm)

✓ Only PM1 filters provide significant protection against those.

✓ Compared to F7 an ePM1 50% filter means an improvement of **15-20% less dangerous PM1 particles**

✓ Also complies with the VDI6022 hygenic guideline that requires ePM1 filter for final stage in hospitals.

✓ Cleaner system means saving money through more efficient heat exchangers and less cleaning.

✓This increases protection of patients, better recovery time and more efficient hospitals.

FOOD & BEVERAGE INDUSTRY

- The F&B industry needs Clean Air to protect organoleptic characteristics of products
- The biggest enemies are spores and bacteria (within PM2.5 fraction)
- But is 50% efficiency enough?
- At least +70% efficiency against PM2.5 should be used – thus, an ePM1 filter is the only choice

✓ With ePM1 filter, the industry gets 15 – 20% less PM1 particles and in consequene:

✓ Better quality of products through increased cleanliness in manufacturing

✓ Improved shelf life of products, therefore less waste / more revenue

✓ Increased pre-filter efficiency – translates to BIGGER energy savings and LONGER life-time of HEPA filters

✓ Compliance and readyness for audits soon only with ISO16890 filters

✓ Protection of their own people

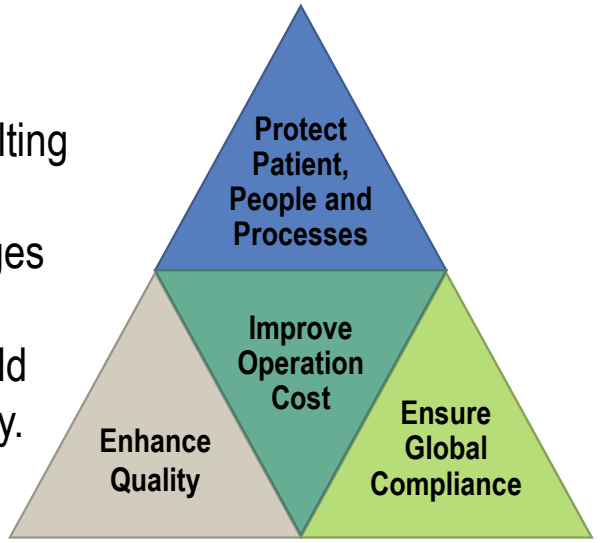
EN779 – TYPICAL EFFICIENCIES OF AIR FILTERS AGAINST PM1 AND OTHER FINE DUST MASS CONCENTRATIONS

Filter class	PM1	PM2.5	PM10
M5	<20%	<40%	≥50%
M6	<40%	≥50%	≥60%
F7	≥50%	≥70%	≥80%
F8	≥70%	≥80%	≥90%
F9	≥80%	≥90%	≥95%

PHARMACEUTICAL INDUSTRY

- Most sensitive products require highest degree of cleanliness
- ISO16890 ensures a better protection than EN779 in many ways:
- ePM1 50 is up to 25% more efficient than F7
- F9 before the HEPA filter, which is now an ePM1 80% - that itself has an increase in requirements (untraceable media sample discharge at EN779, ISO requires full filter discharge)

- ✓ This results in improved predictability, control and timing of the system i.e. no sudden efficiency drop after discharge
- ✓ ISO 16890 enhances the quality by requiring a more stable continuous efficiency, resulting in better HEPA protection
- ✓ ISO 16890 improves operation costs with bigger energy savings and less HEPA changes for the pharmaceutical industry
- ✓ ISO 16890 ensures global compliance - multinational pharmaceutical companies should now be able to **compare**, **improve** and **standardize** their quality-related SOPs globally.



CAMFIL CLEAN AIR SOLUTONS WILL HELP