

# Product Performance Barometers

## HEPA Filter Testing

### HEPA/ULPA Cleanroom Filter Testing in Camfil Facilities

#### Filter Classifications

Quite a few inaccuracies and erroneous "jargon" are commonplace in the high efficiency filtration industry. One of the key issues pertains to nomenclature (i.e., HEPA, ULPA, VLSI, SULPA, etc.). This issue involves misconceptions regarding a filter's efficiency and the relationship to particle size.

CEN, the *Comite European de Normalization*, has developed a Standard, EN 1822:2009, based on particle counting at the Most Penetrating Particle Size (MPPS). This European Standard applies to High Efficiency Particulate Air (HEPA) and Ultra Low Penetration Air (ULPA) filters used in the field of ventilation and for technical processes (e.g., for clean room technology or applications in the nuclear and pharmaceutical industries).

Key definitions from this Standard include:

**Penetration** — the ratio of the particle count downstream of the filter to the particle count upstream.

**Efficiency** — the ratio of the number of particles captured by the filter to the number of particles challenging the filter.

**Overall Efficiency/Penetration** — the efficiency/penetration averaged over the "superficial/useable" face area of a filter element under given operating conditions of the filter.

**Superficial/Useable Face Area** — the cross-sectional area of the filter element, through which the air passes.

**Local Efficiency/Penetration** — the efficiency/penetration at a specific point on the superficial/useable face area of the filter element under given operating conditions of the filter.

**Leak Threshold** — local penetration greater than or equal to five (5) times the filter's overall penetration.

Filter Class	Overall Value % Efficiency	Overall Value % Penetration	Local Value % Efficiency	Local Value % Penetration
E 10	85	15		
E 11	95	5		
E 12	99.5	0.5		
H 13	99.95	0.05	99.75	0.25
H 14	99.995	0.005	99.975	0.025
U 15	99.9995	0.0005	99.9975	0.00025
U 16	99.99995	0.00005	99.99975	0.000025
U 17	99.999995	0.000005	99.9999	0.00001

This Standard allows a classification of filters in terms of efficiency and is, therefore, useful for both buyer and seller.

### Basic Test Protocols

#### Leak Scanning

Camfil leak tests each Megalam Panel and Ducted Ceiling Module HEPA/ULPA filter. Testing is performed in Class 100 (M3.5) clean zones within a Class 100,000 (M5.5) cleanroom. All testing is conducted per the controlled and documented procedures of Camfil's ISO 9001 certified quality system.

To enhance upstream sampling capability, leak-scanning systems are equipped with dilution equipment for measuring high particle concentrations. Probe geometry has been optimized to maximize traverse rate and eliminate undetected leaks while maintaining isokinetic sampling. The entire face of the filter is scanned with overlapping strokes, including the media to frame interface. DEHS is Camfil's standard liquid challenge aerosol. By request we can also test with the solid aerosol Polystyrene Latex Spheres (PSL).

Any leak with a penetration exceeding five (5) times the filter's average rated penetration, is repaired per industry standards or customer specifications. Polyurethane and other repair materials are available upon request.

Menu-driven, computer controlled auto-scanning is utilized for standard filter configurations. Manual scanning is performed for small quantity, custom filter designs/sizes and leak repair.

#### Filter Media Efficiency Testing

Per Camfil raw goods supplier specifications, suppliers are required to test each master roll of Camfil filtration media for efficiency, utilizing Condensation Nuclei Counters (CNC) & Q127 Penetrometers. Test results are submitted to Camfil for review & material acceptance prior to release authorization.

#### Filter Efficiency Testing

**Manual Scan:** Camfil's computer integrated system gathers efficiency information from a fully encapsulated filter. The system features simultaneous upstream and downstream data collection. If the efficiency is lower than specified, the filter is rejected.

**Auto-Scan:** The discrete data points generated during the scan test are integrated to calculate the test filters global efficiency. If the efficiency is lower than specified, the filter is rejected.

## Product Performance Barometers

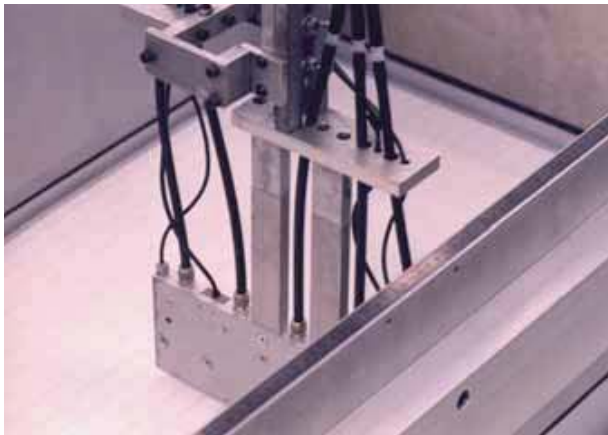
### Filter Media Pressure Drop Testing

Per Camfil specifications, approved suppliers test each lot of media for pressure drop. Test results are submitted to Camfil for review & material acceptance prior to release authorization.

### Filter Pressure Drop Testing

**Manual Scan:** During the test, the system continuously monitors and collects filter pressure drop data. If the pressure drop is higher than specified, the filter is rejected.

**Particle Counter Scanning:** If a particle count is detected, the operator checks the area for continuous counts. If continuous counts in excess of the specified leakage threshold are detected, the leak is repaired.



### Auto-Scan Testing

#### Auto-Scanning Protocol

Camfil Auto-Scanners have been designed to detect pinhole leaks in HEPA/ULPA filters. The test apparatus is an automated, computer-controlled system, utilizing multiple particle counters for accuracy.

DEHS is the standard challenge aerosol. To further enhance system sensitivity, Camfil uses advanced dilution equipment for measuring high upstream particle concentrations. The automated system eliminates the possibility of incorrect test results that can result from human error. The computer interface controls filter airflow rate, test aerosol injection, particle counting upstream and downstream of the test filter, probe traverse rate, data reduction and data storage.



HEPA filter with label of test results.

### UL 900

Camfil Megalam Panel and Ducted Ceiling Module type HEPA/ULPA filters are listed with Underwriters Laboratories per UL 900, "Standard for Test Performance of Air Filter Units".

### Factory Mutual

Camfil's Megalam Panel and Ducted Ceiling Module type HEPA/ULPA filters meet the approval requirements of Factory Mutual Research Corporation (FM) for product construction of limited combustibility, when installed in an approved ceiling grid. For this approval, FM tests the filter as a component in a complete ceiling grid system.

During the ten (10) minute fire exposure test for Factory Mutual Standard FM-4920 ceiling system approval, there was no visible ignition of the Camfil filter, and no flame spread. For this test, the ceiling system tested was composed of a third party ceiling grid, third party gel sealant, and Camfil filter. The complete system passed all technical requirements of the standard.

#### References:

Printed copies of referenced documents may be purchased from the following entities:  
CEN, European Committee for Standardization, 36 rue de Stassart, B - 1050 Brussels, Tel: + 32 2 550 08 11; Fax: + 32 2 550 08 19  
IEST, Institute of Environmental Sciences and Technology, 5005 Newport Drive, Suite 506, Rolling Meadows, IL 60008, Phone: (847) 255-1561; Fax: (847) 255-1699  
Factory Mutual, 1301 Atwood Avenue, P.O. Box 7500, Johnston, R.I. 02919, Phone: (401) 275 3000; Fax: (401) 275 3029