### Comparison of EU Standards to ASHRAE 52.1, 52.2 (MERV Ratings)

#### Standard European Filter Classification

<table>
<thead>
<tr>
<th>Filter</th>
<th>General properties</th>
<th>Class</th>
<th>Effect</th>
<th>Applications</th>
</tr>
</thead>
</table>
| **Basis filters** | | EU1 | Protects against insects and fibers. Limited effect against larger pollen (<70%) | Window units  
Heat exchangers  
Air heaters  
Fiber filters in textile industry |
| | In general:  
- produced in synthetic fibers  
- efficient for particles > 4-5 mm  
- air speed < 2.5 m/s  
- start pressure drop approximately 50 Pa  
- final pressure drop approximately 150 Pa | EU2 | Effective against larger pollen (>85%) and larger atmospheric dust. Limited effect against dust and blacking particles | Heating and cooling units in  
electrical transformers  
garages  
industrial halls  
offices in industry |
| | | EU3 | Effective against larger pollen (>85%) and larger atmospheric dust. Limited effect against dust and blacking particles | Heating and cooling units in  
electrical transformers  
garages  
industrial halls  
offices in industry |
| | | EU4 | Limited effect against dust and blacking particles | In addition to EU3 kitchens and spray paint work shops |
| **Fine filters** | | EU5 | Effective against pollen and finer atmospheric dust  
Considerable effect against smoke. No effect against tobacco smoke | Churches, sport halls, department stores, schools, hotels  
Food stores |
| | In general:  
- produced in glass fibers  
- efficient for particles > 0.1 mm  
- air speed < 2-3 m/s  
- start pressure drop approximately 50-100 Pa  
- final pressure drop approximately 200-250 Pa | EU6 | As EU5 | As EU5 |
| | | EU7 | Effective against pollen and blacking dust | As EU6 and food industry, laboratories, theatres, hospital rooms, data rooms |
| | | EU8 | Very effective against particles and blacking. Very effective against microbes. Effective against tobacco smoke. | Operating theatres, production rooms for fine optics and electronics.  
Hospital examination rooms. |
| | | EU9 | As EU8 | As EU8 |
In general:
- produced in glass fibers in combination with separators of paper, plastic or aluminum
- efficient for particles > 0.01 mm
- air speed < 0.5 - 1.0 m/s
- start pressure drop approximately 250 Pa
- final pressure drop according life span and economy

Typically, a EU3 filter would be used for pre-filtering, coupled to an EU6 or EU7 main filter. This gives approximately 97% efficiency down to 2.5 mm and between 44% (EU6) and 55% (EU7) at 0.1mm. Subject to good design and building air tightness, this filtration approach is therefore potentially effective at reducing the higher end of respirable particle concentration. To reduce fine particle concentration (e.g. below 2.5 mm) by a greater amount, however, high efficiency (HEPA) filters in the EU10-14 range must be considered.

In the European Union, filtration performance is governed by a Standard ‘EU’ rating which categorizes filtration performance by means of the efficiency with which it can trap particles of varying size. The classification system is presented in the Figure.

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**Filter Specification: United States**

In the United States, filtration is covered by ASHRAE Standard 52.2-1999. This classifies performance by particle removal efficiency using a standard Minimum Efficiency Reporting Value (MERV). There are a total of 16 performance ranges covering efficiency in three particle size ranges (i.e. range 1: 0.3-1.0mm, range 2: 1.0 -
3.0mm and range 3: 3.0 - 10.0mm). A MERV value of 1 covers the lowest performance filters with an efficiency of < 20% for range 3 particles. A MERV value of 10, equates to a filter with a 50 - 65% efficiency for range 2 (>85% for range 3). A MERV value of 16 equates to a filter with > 95% performance in all three ranges.

**Minimum Efficiency Reporting Value**, commonly known as MERV Rating is a measurement scale designed in 1987 by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to rate the effectiveness of air filters. The scale "represents a quantum leap in the precision and accuracy of air-cleaner ratings"[1] and allows for improved health, reduced cost and energy efficiency in Heating, Ventilation and Air Conditioning (HVAC) design. For example, a HEPA filter is often impractical in central HVAC systems due to the large pressure drop the dense filter material causes. Experiments indicate that less obstructive, medium-efficiency filters of MERV 7 to 13 are almost as effective as true HEPA filters at removing allergens, with much lower associated system and operating costs.[2]

The scale is designed to represent the worst case performance of a filter when dealing with particles in the range of 0.3 to 10 micrometres. The MERV rating is from 1 to 16. Higher MERV ratings correspond to a greater percentage of particles captured on each pass, with a MERV 16 filter capturing more than 95% of particles over the full range.

Below is a table of example MERV ratings:

<table>
<thead>
<tr>
<th>MERV</th>
<th>Min. Particle Size</th>
<th>Typical Controlled Contaminant</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-20</td>
<td>&lt; 0.3 μm</td>
<td>Virus, Carbon dust, Sea salt, Smoke</td>
<td>Electronics &amp; Pharmaceutical manufacturing cleanroom</td>
</tr>
<tr>
<td>13-16</td>
<td>0.3-1.0 μm</td>
<td>Bacteria, Droplet nuclei (sneeze), Cooking oil, Most smoke and insecticide dust, Most face powder, Most paint pigments</td>
<td>Hospital &amp; General surgery</td>
</tr>
<tr>
<td>9-12</td>
<td>1.0-3.0 μm</td>
<td>Legionella, Humidifier dust, Lead dust, Milled flour, Auto emission particulates, Nebulizer droplets</td>
<td>Superior Residential, Better Commercial, Hospital Laboratories</td>
</tr>
<tr>
<td>5-8</td>
<td>3.0-10.0 μm</td>
<td>Mold, Spores, Dust mite debris, Cat and dog dander, Hair spray, Fabric protector, Dusting aids, Pudding mix</td>
<td>Better Residential, General Commercial, Industrial workspaces</td>
</tr>
<tr>
<td>1-4</td>
<td>&gt; 10.0 μm</td>
<td>Pollen, Dust mites, Cockroach debris, Sanding dust, Spray paint dust, Textile fibers, Carpet fibers</td>
<td>Residential window AC units</td>
</tr>
</tbody>
</table>
Understanding the differences between HEPA in the USA and the EU

HEPA filters are composed of a mat of randomly arranged fibers. The fibers are typically composed of fiberglass and possess diameters between 0.5 and 2.0 micrometers. Key factors affecting function are fibre diameter, filter thickness, and face velocity. The air space between HEPA filter fibres is much greater than 0.3 μm. The common assumption that a HEPA filter acts like a sieve where particles smaller than the largest opening can pass through is incorrect. Unlike membrane filters, where particles as wide as the largest opening or distance between fibers cannot pass in between them at all, HEPA filters are designed to target much smaller pollutants and particles. These particles are trapped (they stick to a fibre) through a combination of the following three mechanisms:
1. **Interception**, where particles following a line of flow in the air stream come within one radius of a fibre and adhere to it.

2. **Impaction**, where larger particles are unable to avoid fibers by following the curving contours of the air stream and are forced to embed in one of them directly; this effect increases with diminishing fibre separation and higher air flow velocity.

3. **Diffusion**, an enhancing mechanism is a result of the collision with gas molecules by the smallest particles, especially those below 0.1 µm in diameter, which are thereby impeded and delayed in their path through the filter; this behavior is similar to Brownian motion and raises the probability that a particle will be stopped by either of the two mechanisms above; it becomes dominant at lower air flow velocities.

Diffusion predominates below the 0.1 µm diameter particle size. Impaction and interception predominate above 0.4 µm. In between, near the Most Penetrating Particle Size (MPPS) 0.3 µm, both diffusion and interception are comparatively inefficient. Therefore, the HEPA specifications use the retention of these particles to define the filter.

**HEPA as Defined by the United States Department of Energy**

HEPA stands for "High-Efficiency Particulate Air"[^1]. A HEPA filter is a type of air filter that satisfies certain standards of efficiency such as those set by the United States Department of Energy (DOE). By government standards, a HEPA air filter must remove 99.97% of all particles greater than 0.3 microns from the air that passes through.

**HEPA as defined by the European Union**

The specification usually used in the European Union is the European Norm EN 1822:2009. It defines several classes of HEPA filters by their retention at MPPS:

<table>
<thead>
<tr>
<th>HEPA class</th>
<th>retention (total)</th>
<th>retention (local)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E10</td>
<td>&gt; 85 %</td>
<td>---</td>
</tr>
<tr>
<td>E11</td>
<td>&gt; 95 %</td>
<td>---</td>
</tr>
<tr>
<td>E12</td>
<td>&gt; 99.5 %</td>
<td>---</td>
</tr>
<tr>
<td>H13</td>
<td>&gt; 99.95 %</td>
<td>&gt; 99.75 %</td>
</tr>
<tr>
<td>H14</td>
<td>&gt; 99.995 %</td>
<td>&gt; 99.975 %</td>
</tr>
<tr>
<td>U15</td>
<td>&gt; 99.9995 %</td>
<td>&gt; 99.9975 %</td>
</tr>
<tr>
<td>U16</td>
<td>&gt; 99.99995 %</td>
<td>&gt; 99.99975 %</td>
</tr>
</tbody>
</table>

[^1]: HEPA as Defined by the United States Department of Energy

[^2]: HEPA as defined by the European Union
| U17 | > 99.99995 % | > 99.9999 % |