# ANSI/ASHRAE Standard 52.2

ASHRAE Standard 52.2 was originally released as a standard in 1999. This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC), which has established a documented program for regular publication of addenda or revisions. The most recent publication is ASHRAE Standard 52.2-2017. The title of the standard is:

*"Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size"*

As the name implies, the standard provides a methodology for determining a filter's efficiency in removing various sizes of particles as the filter becomes loaded. The standard also measures the filter's resistance to airflow when clean. In 2008, the arrestance test and dust holding capacity (DHC) from ASHRAE Standard 52.1 were added to ASHRAE Standard 52.2.

Removal efficiency is calculated by counting the number of particles upstream and downstream of the filter through a range of particle sizes, detailed in the table below. The challenge aerosol is poly-dispersed solid-phase (dry) potassium chloride (KCl) particles generated from an aqueous solution. The removal efficiency is measured when the filter is clean and after each of 5 incremental dust loadings as the filter is loaded to its final resistance. Fractional efficiency curves are developed for the clean filter and after each dust loading. A composite minimum efficiency curve is developed, which reflects the lowest efficiency for each particle size from the 6 curves.

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*Source: ASHRAE www.ashrae.org*

| Range | Size Range Lower Limit (µm) | Size Range Upper Limit (µm) | Range Geometric Mean Particle Size (µm) |
|---|---|---|---|
| 1 | 0.30 | 0.40 | 0.35 |
| 2 | 0.40 | 0.55 | 0.47 |
| 3 | 0.55 | 0.70 | 0.62 |
| 4 | 0.70 | 1.00 | 0.84 |
| 5 | 1.00 | 1.30 | 1.14 |
| 6 | 1.30 | 1.60 | 1.44 |
| 7 | 1.60 | 2.20 | 1.88 |
| 8 | 2.20 | 3.00 | 2.57 |
| 9 | 3.00 | 4.00 | 3.46 |
| 10 | 4.00 | 5.50 | 4.69 |
| 11 | 5.50 | 7.00 | 6.20 |
| 12 | 7.00 | 10.00 | 8.37 |

The composite minimum efficiency curve has all of the detailed data to make an appropriate filter selection. For example, if filters are being used to clean the air supplied to a paint booth where particles 4 micron and larger can cause a defect in the painted finish, filters that remove 100% of the particles in range 9 through range 12 when tested can be selected. However, to simplify the selection and specification of air filters, the test standard provides an "overall" reporting value of a 52.2 evaluated air filter expressed as the Minimum Efficiency Reporting Value (MERV).

MERV is a single number on a 16 point scale that is determined by placing the efficiencies of the 12 size ranges from the composite minimum efficiency curve into three larger groups as follows:

**E1** = Ranges 1 to 4 (0.3 to 1.0 µm)

**E2** = Ranges 5 to 8 (1.0 to 3.0 µm)

**E3** = Ranges 9 to 12 (3.0 to 10 µm)

The efficiency for each group is arrived at by averaging the composite minimum efficiencies of the 4 ranges.

| Range | Size | Group |
|---|---|---|
| 1 | 0.30 to 0.40 | E1 |
| 2 | 0.40 to 0.55 | E1 |
| 3 | 0.55 to 0.70 | E1 |
| 4 | 0.70 to 1.00 | E1 |
| 5 | 1.00 to 1.30 | E2 |
| 6 | 1.30 to 1.60 | E2 |
| 7 | 1.60 to 2.20 | E2 |
| 8 | 2.20 to 3.00 | E2 |
| 9 | 3.00 to 4.00 | E3 |
| 10 | 4.00 to 5.50 | E3 |
| 11 | 5.50 to 7.00 | E3 |
| 12 | 7.00 to 10.00 | E3 |

The average particle-size efficiency (PSE) for each group is referenced against the MERV parameters (see table below). Moving up from the bottom of the table, the MERV rating will be in the left hand column of the first row, where that PSE for each group generates a true statement. For example, if the PSE for Range 3 is 81%, and the PSE for Range 2 is 42%, the filter would be MERV 9 (Range 1 efficiency is not taken into consideration for MERV 9).

**Minimum Efficiency Reporting Value (MERV) Parameters Table**

| Standard 52.2 Minimum Efficiency Reporting Value (MERV) | Composite Average Particle Size Efficiency, % in Size Range, μm | | | Average Arrestance, % |
|---|---|---|---|---|
| | Range 1 0.30-1.0 | Range 2 1.0-3.0 | Range 3 3.0-10.0 | |
| 1 | N/A | N/A | $E_3 < 20$ | $A_{avg} < 65$ |
| 2 | N/A | N/A | $E_3 < 20$ | $65 \leq A_{avg}$ |
| 3 | N/A | N/A | $E_3 < 20$ | $70 \leq A_{avg}$ |
| 4 | N/A | N/A | $E_3 < 20$ | $75 \leq A_{avg}$ |
| 5 | N/A | N/A | $20 \leq E_3$ | N/A |
| 6 | N/A | N/A | $35 \leq E_3$ | N/A |
| 7 | N/A | N/A | $50 \leq E_3$ | N/A |
| 8 | N/A | $20 \leq E_2$ | $70 \leq E_3$ | N/A |
| 9 | N/A | $35 \leq E_2$ | $75 \leq E_3$ | N/A |
| 10 | N/A | $50 \leq E_2$ | $80 \leq E_3$ | N/A |
| 11 | $20 \leq E_1$ | $65 \leq E_2$ | $85 \leq E_3$ | N/A |
| 12 | $35 \leq E_1$ | $80 \leq E_2$ | $90 \leq E_3$ | N/A |
| 13 | $50 \leq E_1$ | $85 \leq E_2$ | $90 \leq E_3$ | N/A |
| 14 | $75 \leq E_1$ | $90 \leq E_2$ | $95 \leq E_3$ | N/A |
| 15 | $85 \leq E_1$ | $90 \leq E_2$ | $95 \leq E_3$ | N/A |
| 16 | $95 \leq E_1$ | $95 \leq E_2$ | $95 \leq E_3$ | N/A |

Filters that have a Range 3 value of less than 20% undergo an Arrestance test to establish the MERV.

The arrestance test is also useful for comparing filters, particularly those that are MERV 10 and less. The removal efficiency tests to establish MERV are conducted with a dry aerosol. Some filters show declining efficiency values in Range 3 as the particle size gets larger. This is because the larger dry KCl particles do not adhere as well to dry clean media. A filter's ability to stop and retain the large KCl particles does not necessarily translate into a greater ability to capture dirt. There are MERV 9 and 10 filters that have lower arrestance values (capture less dirt) than MERV 8 filters. It is a good idea to compare the arrestance values and dust holding capacity (DHC) of filters MERV 10 and below to ensure you are getting good filtration value.

**Appendix J**

There have been many studies globally that have demonstrated a loss in efficiency in some filters as they are exposed to sub-micron particles. Appendix J was added to ASHRAE Standard 52.2 in 2008 as a non-ANSI approved, optional conditioning step to provide a method of identification of the drop in efficiency. The reported value per Appendix J is referred to as MERV 'A'. Filters tested per Standard 52.2 with the Appendix J option have both a MERV and a MERV 'A.'

A motion at the ASHRAE meetings in New York City in 2014 to make appendix J a mandatory part of the standard was subsequently voted down. For the time being, it remains an optional appendix.