# TECHNICAL BULLETIN

## Reading an ASHRAE Test Report

End users, especially for HVAC type products, can find all sorts of product performance information comparing one product against another to assist in computing the best return on an investment. The American Refrigeration Institute (ARI) provides testing to compare one air conditioner to another, one furnace to another or one heat pump to another, etc. Underwriters Laboratories provides certification that products will meet certain code requirements. For air filters the Standard which evaluates one filters performance against another using laboratory-defined parameters is ASHRAE Standard 52.2, Method of Testing General Ventilation Air- Cleaning Devices for Removal Efficiency by Particle Size.

Laboratory testing of air filters has been available in one form or another since the 1950's. The original testing Standard was published by the National Bureau of Standards. In 1968 the American Society of Refrigeration, Heating and Air-Conditioning Engineers (ASHRAE) accepted the publishing responsibility which has advanced over the years as the cognizant Committee adapted each new version to evolving testing technology. In 1999, ASHRAE introduced Standard 52.2.

MERV, or minimum efficiency reporting value, was established to allow users a way to evaluate one filter versus another. The higher the MERV, the more efficient the air filter. For more information on the test see Camfil's ASHRAE Test Guide.

**Appendix J**

The ASHRAE 52.2 Standard Committee has been debating the issue of filters that drop in efficiency since the first version of the Standard. Although the Committee knew the issue had to be addressed the division was clearly along the lines of each manufacturer's interests and it became clear that consensus could not be reached. The alternative solution added an optional test method and placed the method in the Appendices so there would be a clear procedure, defined by the industry experts, for users who wanted confirmation assurance that the proposed filters would perform as expected through their entire life. Appendix J was created and defined as the 'conditioning step'. For additional information on Appendix J see Camfil Technical Bulletin, ASHRAE 52.2 Appendix J.

*Some manufacturers cut corners, either short-cutting defined test procedures in their own labs or requesting that independent laboratories do so.*

Appendix J is titled Optional Method of Conditioning a Filter Using Fine KCl Particles to Demonstrate Efficiency Loss That Might be Realized in Field Applications. The Committee incorporated ASHRAE funded research, independent papers and the knowledge of members of the Committee to create the Appendix.

The procedure spans eight pages and mirrors most of the procedures prescribed in the Standard. The results can expose air filters that are not capable of performing at their published MERV throughout their life.

**Proper Testing is an Expense**

An ASHRAE Standard 52.2 test can cost $1500 per filter or more. The additional Appendix J procedure can add 60% to that cost to provide a MERV-A. Camfil has one of the foremost air filter testing laboratories in the country. They also operate multiple live test ducts evaluating filters' performance using actual atmospheric conditions. Camfil's budget for testing the filters used in your system is hundreds of thousands of dollars per year. Our customers demand it.

Camfil test reports provide all of the data for the base of Standard 52.2 and Appendix J; no shortcuts, no missing data. Customers want filters that perform at their rated efficiency. They expect a MERV 14 to be a MERV 14 at three months, six months, even two years down the road. Appendix J testing is indicative of continued maintained MERV efficiency throughout the life of the filter.

Although all test result factors should be considered important, maintained efficiency should be a concern for all involved. Camfil publishes all related data on the front page of every Camfil test report along with four additional pages of supporting data detailing all of the parameters used in the testing. This is consistent with the ASHRAE reporting requirements.

Air filters are often viewed as a commodity and their relationship to protecting health and equipment is often overlooked. Whether a filter is performing properly is difficult to discern as the type of particles that cause ill health are sub-micron in size and not visible. ASHRAE Standard 52.2 Appendix J offers a tool to expose filters that are designed to get an order, not provide critical contaminant capturing performance.

There will always be some manufacturers or vendors that cut corners to reduce their expense, an expense passed on to the customer in poor air quality.

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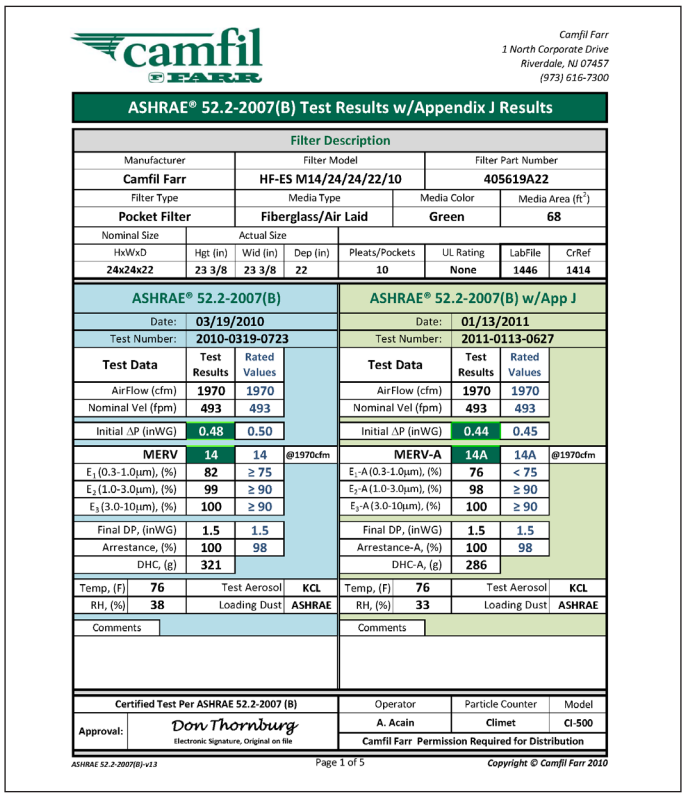
## Reading an ASHRAE Test Report

The following is a review of a test report that includes all of the criteria and steps as required by Standard 52.2 as published by the American Society of Heating, Refrigeration and Air-Conditioning Engineeers. Critical items include:

A complete description of the filter being tested including the manufacturer's part number.

All reporting data required by the Standard should be lsted, including airflow, initial resistance, the MERV at airflow, $E_1$, $E_2$ and $E_3$ values from which the MERV is derived, final resistance matching test definition, dust holding capacity (DHC) and Arrestance in percent.

Operating conditions during the test including, temperature, relative humidity, test aersol and loading dust. The operating parameters are 50° F to 100° F, 20% to 65% relative humidity, KCl test aersol and ASHRAE Test Dust respectively. Any variance from the above can skew the results and present information not valid for a filter to filter comparison.



camfil FARR

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**ASHRAE® 52.2-2007(B) Test Results w/Appendix J Results**

| Filter Description | | | | | | | |
|---|---|---|---|---|---|---|---|
| Manufacturer | Filter Model | | | Filter Part Number | | | |
| Camfil Farr | HF-ES M14/24/24/22/10 | | | 405619A22 | | | |
| Filter Type | Media Type | | | Media Color | | Media Area (ft²) | |
| Pocket Filter | Fiberglass/Air Laid | | | Green | | 68 | |
| Nominal Size | Actual Size | | | | | | |
| HxWxD | Hgt (in) | Wid (in) | Dep (in) | Pleats/Pockets | UL Rating | LabFile | CrRef |
| 24x24x22 | 23 3/8 | 23 3/8 | 22 | 10 | None | 1446 | 1414 |

| ASHRAE® 52.2-2007(B) | | | | ASHRAE® 52.2-2007(B) w/App J | | | |
|---|---|---|---|---|---|---|---|
| Date: | 03/19/2010 | | | Date: | 01/13/2011 | | |
| Test Number: | 2010-0319-0723 | | | Test Number: | 2011-0113-0627 | | |
| Test Data | Test Results | Rated Values | | Test Data | Test Results | Rated Values | |
| AirFlow (cfm) | 1970 | 1970 | | AirFlow (cfm) | 1970 | 1970 | |
| Nominal Vel (fpm) | 493 | 493 | | Nominal Vel (fpm) | 493 | 493 | |
| Initial ΔP (inWG) | 0.48 | 0.50 | | Initial ΔP (inWG) | 0.44 | 0.45 | |
| MERV | 14 | 14 | @1970cfm | MERV-A | 14A | 14A | @1970cfm |
| $E_1$ (0.3-1.0μm), (%) | 82 | ≥ 75 | | $E_1$-A (0.3-1.0μm), (%) | 76 | < 75 | |
| $E_2$ (1.0-3.0μm), (%) | 99 | ≥ 90 | | $E_2$-A (1.0-3.0μm), (%) | 98 | ≥ 90 | |
| $E_3$ (3.0-10μm), (%) | 100 | ≥ 90 | | $E_3$-A (3.0-10μm), (%) | 100 | ≥ 90 | |
| Final DP, (inWG) | 1.5 | 1.5 | | Final DP, (inWG) | 1.5 | 1.5 | |
| Arrestance, (%) | 100 | 98 | | Arrestance-A, (%) | 100 | 98 | |
| DHC, (g) | 321 | | | DHC-A, (g) | 286 | | |
| Temp, (F) 76 | Test Aerosol | KCL | | Temp, (F) 76 | Test Aerosol | KCL | |
| RH, (%) 38 | Loading Dust | ASHRAE | | RH, (%) 33 | Loading Dust | ASHRAE | |
| Comments | | | | Comments | | | |

| Certified Test Per ASHRAE 52.2-2007 (B) | | Operator | Particle Counter | Model |
|---|---|---|---|---|
| Approval: | Don Thornburg<br>Electronic Signature, Original on file | A. Acain | Climet | CI-500 |
| | | Camfil Farr Permission Required for Distribution | | |

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The test date should be five years old or less.

Professional labs include a file designator or test number to allow users to confirm the data.

The Appendix J portion of the Standard requires that the entire test be repeated on a second filter as it is physically impossible to run both tests on the same filter as each test is destructive.

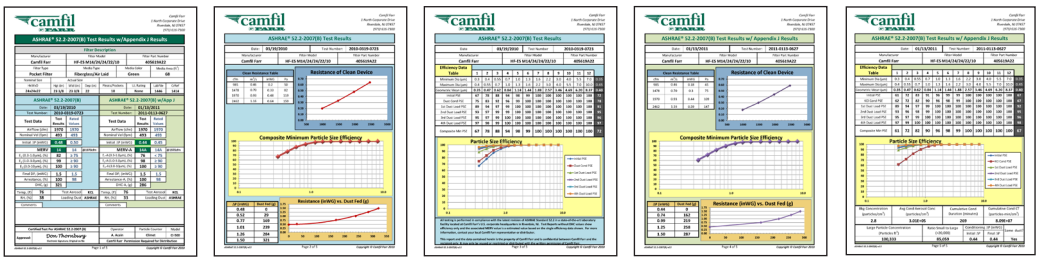
The second filter is tested using all of the previous testing requirements as listed for ASHRAE Standard 52.2.

The value that is determined by this additional testing is presented as MERV-A.

Significant factors that can seriously affect the results include:

- An airflow other than the Standard-defined 1970 cfm. Reducing the velocity below this volume will seriously skew the resistance values, dust holding capacity and other testing data.
- A test aerosol or loading dust other than what is defined in the Standard.
- Temperature and relative humidity values outside the parameters of those published in the Standard.
- Using the same filter for both the base test and the Appendix J test.

Any variance from the information presented on this page leaves the report open to a possible misinterpretation of the results as the purpose of a Standard is to prescribe criteria that allows testing under industry recognized criteria consistent with a proper engineering and laboratory approach.



Camfil Farr not only supplies the main page of the report but also includes all of the required base information to allow in-depth filter performance evaulation.

# Reading an ASHRAE Test Report

Testing standards are guidelines that are established by consensus and approved by a recognized body, in this case the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), that provide guidelines or definitions of procedures to ensure consistent results when the prescribed procedure is completely adhered to.

There are many reputable laboratories in North America providing information that allows end users to evaluate products so users may receive the best return on their investment. There are other facilities that simply skip some of the intricacies of the Standards as published by the recognized authorities. We have even seen offers from some testing laboratories offering an assurance of a 'good report' if they have their products tested at their facility — a clear conflict based upon the financial interests of the lab and not the interest in improving the industry of protecting the customer.

When evaluating a report look for the following items:

*Were all of the critical parameters of the Standard adhered to?*

Airflow - 492 fpm, or 1970 cfm for full size air filter.
Temperature - 50° F to 100° F (10° C to 38° C).
Relative Humidity - 20% to 65%.
Test Aerosol Defined - Should be potassium Chloride (KCl).
Loading Dust - Should be ASHRAE Test Dust.
Appendix J Test Aerosol - Should be potassium Chloride (KCl).

*Was the airflow velocity less than 492 fpm or 1970 cfm for a full size filter?*

If the velocity used in the test does not match the defined test airflow requirement then the results can be misleading. Pressure drop values will be much lower, in any air filter, and efficiency may increase. As an example, a Camfil Farr 30/30 will have a pressure drop of 0.32" w.g. at 1970 cfm but have a pressure drop of only 0.08" w.g. at 1200 cfm and its dust holding capacity will increase at least three fold. When comparing one air filter against another using the ASHRAE Standard the baseline testing velocity must be the same or the comparison has no value.

*Does the report include Appendix J of ASHRAE 52.2?*

Some filters lose efficiency over time and this additional step of testing provides the end user with a confidence level that the efficiency of the filter when it is installed will be the same throughout the life of the filter. This is especially important with higher efficiency filters designed to protect the health of building occupants; filter that drop in efficiency typically suffer the most in the smaller lung-damaging particle size ranges. The MERV listed o the test report should match the MERV-A of Appendix J of that report.

*What equipment was used to evaluate the air filters during the test? Is the equipment identified clearly on the report?*

The test should be certified by an engineer, with additional details that should include test duct operator, manufacturer and model of the particle counter(s). Only specific particle counter models have the ranges as required in the details of the Standard. The Standard does allow the use of two particle counters, or one counter with a U-shaped duct, but that information must clearly be noted on the test report.

*It is apparent that two individual air filters were used for the individual portions of the test?*

If there is only data for one filter, or if the data matches in both sections, it is unlikely that the entire test was performed and corners were cut. Data from one filter to another varies based upon construction variances.

*Were all the steps performed including testing duct preparation?*

The Standard requires confirmation of background concentration testing, aerosol concentration measurements and particle size ratios. Additional items that should be reported include cumulative conditioning duration, cumulative conditioning counts and the conditioning with potassium chloride (KCl). Dust holding capacity for both the Standard test and the MERV-A conditioned filter test should also be reported.

*Does the report clearly distinguish data between the two tests?*

Appendix J values should be clearly identified. If not it is possible that results were extrapolated and the testing data is suspect.

Can the testing lab confirm the values on the test report?

The information on who to contact should be noted clearly on the report. The lab should also be willing to send hard copy of the report to the user for verification without charge.

*Is the test certified by a resident mechanical engineer?*

A mechanical engineer requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, structural analysis, and electricity. ASHRAE tests should always be run under the guidance of a mechanical engineer.

*Does the laboratory accept visitors for viewing the procedure?*

Camfil entertains visitors almost every week throughout the year. Most of those visitors find our testing laboratories to be the highlight of their visit. Many send filter from their facilities for testing while they can observe.

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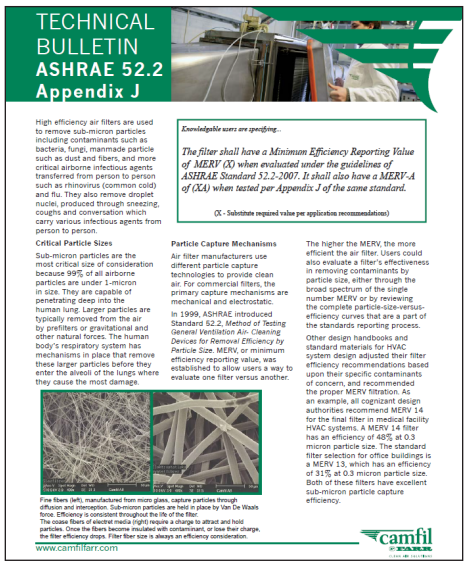
## Reading an ASHRAE Test Report

Camfil's main ASHRAE Testing Facility is located at our North American Headquarters in Riverdale, New Jersey. The facility also includes four additional testing ducts that are designed to evaluate air using real conditions over time. The information gathered from the real life testing allows Camfil to partner with Standard writing organizations and author testing improvements to benefit air filter users.

Standards typically incorporate accelerated procedures to be cost-effective. Our real life testing ducts allow Camfil to provide highly accurate data as to how a filter will perform under ambient conditions.

The above photo shows Camfil's carbon testing laboratory where gaseous contaminant removal air filters can be evaluated. A state-of-the-art facility unparalleled in the industry, it demonstrates Camfil's commitment to providing improved air quality through air filtration.



TECHNICAL BULLETIN
ASHRAE 52.2
Appendix J

High efficiency air filters are used to remove sub-micron particles including contaminants such as bacteria, fungi, manmade particle such as dust and fibers, and more critical airborne infectious agents transferred from person to person such as rhinovirus (common cold) and flu. They also remove droplet nuclei, produced through sneezing, coughs and conversation which carry various infectious agents from person to person.

*Knowledgeable users are specifying...*

*The filter shall have a Minimum Efficiency Reporting Value of MERV (X) when evaluated under the guidelines of ASHRAE Standard 52.2-2007. It shall also have a MERV-A of (XA) when tested per Appendix J of the same standard.*

(X - Substitute required value per application recommendations)

**Critical Particle Sizes**

Sub-micron particles are the most critical size of consideration because 99% of all airborne particles are under 1-micron in size. They are capable of penetrating deep into the human lung. Larger particles are typically removed from the air by prefilters or gravitational and other natural forces. The human body's respiratory system has mechanisms in place that remove these larger particles before they enter the alveoli of the lungs where they cause the most damage.

**Particle Capture Mechanisms**

Air filter manufacturers use different particle capture technologies to provide clean air. For commercial filters, the primary capture mechanisms are mechanical and electrostatic.

In 1999, ASHRAE introduced Standard 52.2, *Method of Testing General Ventilation Air- Cleaning Devices for Removal Efficiency by Particle Size*. MERV, or minimum efficiency reporting value, was established to allow users a way to evaluate one filter versus another.

The higher the MERV, the more efficient the air filter. Users could also evaluate a filter's effectiveness in removing contaminants by particle size, either through the broad spectrum of the single number MERV or by reviewing the complete particle-size-versus-efficiency curves that are a part of the standards reporting process.

Other design handbooks and standard materials for HVAC system design adjusted their filter efficiency recommendations based upon their specific contaminants of concern, and recommended the proper MERV filtration. As an example, all cognizant design authorities recommend MERV 14 for the final filter in medical facility HVAC systems. A MERV 14 filter has an efficiency of 48% at 0.3 micron particle size. The standard filter selection for office buildings is a MERV 13, which has an efficiency of 31% at 0.3 micron particle size. Both of these filters have excellent sub-micron particle capture efficiency.

Fine fibers (left), manufactured from micro glass, capture particles through diffusion and interception. Sub-micron particles are held in place by Van De Waals force. Efficiency is consistent throughout the life of the filter.
The coarse fibers of electret media (right) require a charge to attract and hold particles. Once the fibers become insulated with contaminant, or lose their charge, the filter efficiency drops. Filter fiber size is always an efficiency consideration.

www.camfilfarr.com

**Camfil Technical Bulletin: ASHRAE 52.2 Appendix J**

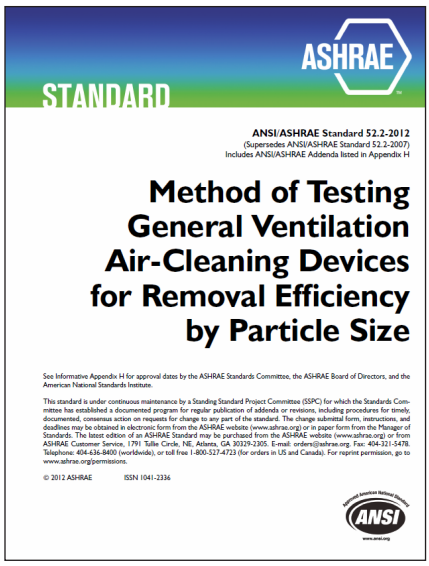
What are the differences between fibers used in different air filters to capture particles and how can those differences affect the air quality in your building? Why should your facility require the additional test of Appendix J when evaluating filters for your facility?

Critical particle sizes related to human health, filter capture mechanisms and a detailed description of the intricacies and development of Appendix J of Standard 52.2 are reviewed.

Contact your local Camfil Distributor or Representative, or contact Camfil for your copy.

**ASHRAE Standard 52.2-2012**

The latest version of the Standard referenced in this bulletin is available for order through the ASHRAE Bookstore. www.ashrae.org



ASHRAE
STANDARD

ANSI/ASHRAE Standard 52.2-2012
(Supersedes ANSI/ASHRAE Standard 52.2-2007)
Includes ANSI/ASHRAE Addenda listed in Appendix H

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

See Informative Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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