3M Construction and Home Improvement Markets Division

3M Center
St. Paul, MN 55144-1000
651 733 1100

August 2, 2013

California Energy Commission
Dockets Office, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

RE: Re: Docket No 12-AAER-2E (Air Filter Labeling)

Attached you will find a proposal from 3M Company in response to the Energy Commission's Air Filter Labeling invitation to Submit Proposals, **Docket # 12-AAER-2E**. Thank you for the opportunity to submit a proposal on this important topic.

If there are any questions about the attached proposal, please contact us.

Sincerely,

Mark D. Sorlien
Technical Director
3M Construction and Home Improvement Markets Division
3M Center, Building 251-1C-09
St. Paul, MN 55144
651-736-6462 mdsorlien1@mmm.com

Proposal for Standards – Air Filter Labeling

Appliance Efficiency Standards and Measures

for California Energy Commission's Invitation to Submit Proposals

Mark D. Sorlien | Technical Director

3M Construction & Home Improvement Markets Division

3M Center, Building 251-1C-09 | St. Paul, MN 55144-1000

Office: 651.736.6462 | Fax: 651.737.5544

mdsorlien1@mmm.com | www.3M.com

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1 Executive summary

3M has long advocated the use of residential HVAC filters to reduce indoor concentrations of airborne contaminants, such as allergens and fine particulate matter (PM2.5). Fine particulate contamination within the home has both indoor and outdoor origins. $PM_{2.5}$ is the one of the most widely studied and recognized measures of fine particulate concentration and its mitigation may provide significant benefits to the welfare of sensitive groups. 3M also recognizes and advocates for the use of low resistance air filters, both for the purposes of maintaining HVAC system efficiency and for maintaining HVAC equipment performance.

While initially these two goals may seem contradictory, they illustrate the critical need for an appropriate balance of properties in HVAC filtration: maintaining a low resistance through the life of a filter while also providing meaningful particulate reduction for both fine and coarse particles.

The current proposal for air filter labeling provides two performance metrics for residential HVAC air filters: one which conveys the fine particle ($PM_{2.5}$) efficiency of the filters, and one which conveys the average lifetime resistance of the filter. The specific aim of this proposal is to not create completely new test methods, but to draw upon the data that is already being generated by filter manufacturers in the ASHRAE 52.2 test method, the current industry standard.

In order to establish a credible labeling system and ensure consistency of results across filter models and manufacturers, an oversight body is needed to validate claimed filter performance and provide for ongoing resubstantiation of performance. We recommend that this body have expertise in HVAC and air filtration, and represent the interests of both the industry and the California Energy Commission (CEC). This oversight body would ideally come from an existing air filter agency, such as ASHRAE, AHRI, or NAFA.

2 Product Description and Proposal Scope

2.1 Technical Description

The products currently addressed are residential HVAC filters. These filters are typically composed of a filter media, either flat or in pleated form, supported by a perimeter frame. Residential filters are typically 1" nominal thickness, although nominal 4" thick filters are becoming more common. Filters are typically used on the return side of central HVAC systems in residential dwellings to both maintain clean heat exchangers for heating and cooling and to help remove smaller particles to improve indoor air quality.

2.2 Technologies and Best Practices for Energy/Water Efficiency

The two ideals of any air filter are low resistance to airflow and high capture efficiency. While initially these two goals may seem contradictory, they illustrate the critical need for an appropriate balance of properties in HVAC filtration: maintaining a low resistance through the life of a filter while also providing meaningful particulate reduction for both fine and coarse particles.

The best practices in residential air filtration rely upon providing high particle removal efficiency while maintaining a low resistance through the life of the filter. This optimized approach is in direct contrast to two of the common approaches: 1) low pressure drop filters which have almost zero fine particle efficiency (e.g. fiberglass), and 2) high efficiency filters which have a high initial resistance and/or very poor dust loading characteristics, which result in a high resistance over the filter's use.

2.3 Design Life

A three month life claim is the industry standard for residential 1" filters, although 1" fiberglass filters are commonly claimed at one month life. Residential 4" filters are commonly 6 months to one year of recommended life. It is important to note that an industry-wide test method does not exist for determining the useful life of a residential air filter.

2.4 Manufacturing Cycle

It is very common to see changes to products at retail in this category approximately every one to two years. For a given filter model, changes are often apparent at-shelf (e.g. construction changes, packaging changes, etc.) every two to three years.

2.5 Product Classes

All air filters intended for residential central HVAC systems should be included. Logical product classes would be distinguished by the nominal thickness of the filter. One-inch and four-inch nominal filter sizes are the most common in this market.

3 Unit Energy/Water Usage

Air filters do not directly consume energy. However, as part of the central HVAC system, they may contribute to the system's energy consumption. In ASHRAE Research Project RP-1299 (noted in the bibliography), Stevens found that the difference from low to high pressure drop filters (although the filter pressure drop at standard test conditions was not provided) decreased air conditioning EER by 2 to 7%. While the sample size represented two air conditioning units (and zero heating units), it does provide some insight into the order of magnitude of energy consumption which can be attributed to the air filter.

3.1 Duty Cycle

Typical residential HVAC systems are used in a demand, or automatic, mode. In this operational mode, the central fan only runs when the thermostat calls for heating or cooling, plus a small transition period. As such, the consumption of fan energy is typically significantly less than 100% duty cycle. Several published studies, as well as data gathered internally, suggest that an average duty cycle during the peak three months of winter or summer is in the 25-30% range.

3.2 Efficiency Levels

Not applicable

3.3 Energy and/or Water Consumption

Not applicable

4 Market Saturation and Sales

4.1 California Stock and Sales

Not provided at this time

4.2 Efficiency Options: Current Market and Future Market Adoption

Not applicable

5 Statewide Energy Usage

Not applicable

6 Proposal

6.1 Summary of proposal

The current proposal for filter air labeling provides two performance metrics for residential HVAC air filters: one which conveys the fine particle (PM2.5) efficiency of the filters, and one which conveys the average lifetime resistance of the filter. The specific aim of this proposal is not to create completely new test methods, but to draw upon the data that is already being generated by filter manufacturers in the ASHRAE 52.2 test method, the current industry standard.

A well-defined and maintained program will allow consumers to make more educated purchasing decisions as it relates to the particle removal efficiency and energy efficiency impacts of HVAC filters. Additionally, a clearly defined program will allow consumers to compare products and manufacturers to compete on a level playing field, which will allow more innovative products and technologies to stand out.

Two existing industry tests or rating systems are compared:

- Many of the MERV (minimum efficiency reporting value) levels as defined by the ASHRAE 52.2 standard, particularly those found in residential HVAC filtration, are determined either solely or largely by the large particle efficiency of a filter (E3, or the 3-10 μm average particle-removal efficiency). The large particle efficiency may have very little relation to the fine particle removal efficiency of the filter, depending on the mechanisms used to capture the large particles. While larger particles will settle out of the air relatively quickly, fine particles remain suspended in the air for much greater periods of time and are more likely to be inhaled by building occupants. Therefore, MERV does not communicate to consumers the ability of a filter to remove fine particles from the air.
- ANSI/AHRI Standard 680 includes a filter performance test which is similar to, although different from, ASHRAE 52.2. The use of a test method different from the industry-standard ASHRAE 52.2 test would be burdensome to manufacturers and create unnecessary redundancies in product development and commercialization. Additionally, the rating label for AHRI 680 provides a large amount of information that is more designed for the filtration professional than for the general public. AHRI 680 does include a list of tolerances on claimed values, which are a good step toward providing consistent representation of product performance.

6.2 Implementation Plan

Several procedural items are critical to establishing credible and repeatable energy efficiency and filtration efficiency ratings:

- It is widely recognized that significant lab to lab variation exists for air filter testing. Sources of variation include differences in particle counters, particle generators, humidity levels, operating procedures, airflow rates, etc. Testing should be performed at a single test laboratory, or a set of approved laboratories which have shown very consistent correlation through round robin testing which covers the range of expected filter efficiencies encountered in residential HVAC.
- Well-defined procedures for determining and maintaining claimed values should be established. For example, it is recommended that target/mean filter performance is allowed as the maximum claimed rating, and that a tolerance specification be established which provides a tolerance for the periodic retesting (i.e. that re-tested filters fall within a certain range of the claimed values).
- Ongoing verification of performance should be maintained, with periodic re-testing of filters to ensure that original package claims are being maintained.

- Laboratories would be approved by a regulatory or oversight body, as recommended in Section 8.4. This body would also be responsible for ensuring the quality and consistency of performance claims on air filters sold with the new labels.

6.3 Proposed Test Procedure(s)

Particle size distributions for $PM_{2.5}$ are reported in the literature, and the variation in mass-based distributions illustrates the broad range of particle sizes which can contribute to total $PM_{2.5}$ mass. In some instances, very fine particles (0.3 to 1.0 microns) form a substantial portion of the $PM_{2.5}$ mass; in other instances, larger particles (1 to 2.5 microns) form the dominant portion of the mass. Accordingly, no single challenge can truly represent all $PM_{2.5}$. However, the industry standard test for determining filter efficiency, the ASHRAE 52.2 test, reports particle size efficiency across the majority of the particle size distribution which contributes to $PM_{2.5}$ mass. It is proposed that an equal-weighting of the first eight efficiency channels, encompassing all of "E1" (0.3-1 μm) and "E2" (1-3 μm) from ASHRAE 52.2, can provide a meaningful "$PM_{2.5}$" efficiency measurement. This range of eight channels covers a geometric mean particle size range from 0.35 to 2.57 microns. This approach would not require new test methods to be developed; rather it uses the industry standard test which the vast majority of filter manufacturers already use.

Metric 1: $PM_{2.5}$ efficiency = $\frac{\sum_{i=1}^{i=8} CHANNEL\ EFFICIENCY_i}{8}$

The second critical parameter for air filter performance is the resistance of the filter. The initial resistance is clearly important, but equally important is also how the filter loads through its expected life. While it is possible to include typically measured (as per ASHRAE 52.2) metrics such as initial filter resistance, final filter resistance, and dust holding capacity, providing too much information may be overly confusing to all but the filtration professional. Additionally, numerous internal in-home studies during peak usage seasons (e.g. the dead of winter in St. Paul, MN) have shown that the final median resistance of many residential HVAC filters only increases by 30 to 50%, which is well below the final resistance often specified in dust holding capacity tests. Therefore, dust holding capacity at 1.0 or even 0.5 inches of water final resistance may not adequately describe filter performance in use.

We recommend that a "lifetime average resistance" metric be developed and communicated on the air filter labels. This "lifetime average resistance" will be based on a combination of the initial pressure drop and how the filter is expected to load throughout its useful life. It is recommended that this "lifetime average resistance" rely on data already being measured through the industry-standard ASHRAE 52.2 test, as best as possible. This single metric for the filter's resistance will provide a more meaningful and clearer message to consumers about a filter's expected behavior over its life.

Metric 2: Lifetime average resistance – A metric like this does not exist today and additional development is needed. We recommend a collaborative effort between the CEC and Filter Manufacturers to develop the Lifetime average resistance metric.

This dual-metric proposal is highly preferred over a single emphasis on air filter resistance. A single focus on air filter resistance omits a critical parameter of the filter and one which can provide a substantial indoor air quality benefit – the particle capture efficiency of the filter. Furthermore, emphasis on merely obtaining the lowest resistance filter may cause consumers to select filters with efficiency so low as to unsatisfactorily maintain the cleanliness of the HVAC equipment, which defeats the purpose of energy efficiency over the long run.

Several additional details for a successful testing plan are proposed:

- Testing should be performed at a single, defined face velocity; the standard test velocity of 1.5 m/s is recommended.
- Manufacturers should be allowed to test a single standard filter size (or having several size options for manufacturers to choose from, for example 20x25" and 24x24") and use the efficiency and resistance data for all sizes (for two dimensional variations, not including thickness variations) of the same model filter. This is an appropriate and recommended procedure that is common in the industry. While slight variations in properties may exist due to different filter frame effects, etc., on different sized filters, it is not feasible to test every size of filters with the same general construction (i.e. same media, pleat density, etc.). Many models of filters have dozens of different two-dimensional sizes, and independently testing each size would be an overly burdensome requirement for manufacturers that would provide little, if any, consumer benefit.

6.4 Proposed Regulatory Language

The desire is to cover all disposable residential air filters which are intended for use in a central HVAC system. Accordingly, the scope would include all manufacturers of such products to be sold in the state of California.

7 Technological Feasibility

An air filter labeling program would make clearer the differences in performance between various manufacturers' products, which will likely highlight some products which have a better efficiency/resistance relationship and others which do not. Technologies for improving the efficiency/resistance relationship are related to media production parameters, media treatments, and filter construction variables. Some of these variables are available on the open market, or in open patent art, while others have been patented by various companies.

8 Economic Analysis

Zero or very little cost to the consumer is expected due to air filter labeling

8.1 Incremental First Costs

A number of products with excellent efficiency/resistance relationship exist on the market today. It is currently difficult to predict the costs associated with improving lesser products.

8.2 Incremental Operating Costs and Savings

Undetermined at this time

8.3 Infrastructure Costs and Savings

Undetermined at this time

8.4 State or Local Government Costs and Savings

One of the key elements of a successful introduction of an air filter labeling program is ensuring that a level playing field is created for all manufacturers and other participants. The current state of the air filter market is one in which a number of current products do not appear to consistently comply with their package claims.

An oversight body is recommended to manage claimed filter performance and provide ongoing resubstantiation of performance; such a body should have expertise in HVAC and air filtration, and represent the interests of both the industry and the CEC. This oversight body would ideally come from an existing air filter agency, such as ASHRAE, AHRI, or NAFA. At a minimum, the body would review filter data submitted from 3rd party testing at approved laboratories, provide manufacturers with a "maximum allowed rating," ensure that periodic (e.g. every one or two years) resubstantiation occurs and that the filter performance is maintained, and provide challenge procedures for filters which appear to be erroneously marked. The estimated costs of such a body are beyond the scope of the current proposal.

Additional details are included in Section 6.2

8.5 Business Impacts

A clearly defined program will allow consumers to compare products and manufacturers to compete on a level playing field, which will allow more innovative products and technologies to stand out. This should provide incentives for manufacturers to innovate on products, materials, and processes.

8.6 Lifecycle Cost and Net Benefit

Not applicable

9 Savings Potential

Not applicable

10 Acceptance Issues

The current proposal relates to air filter labeling, which would be uniformly applied to all residential HVAC air filters. To gain the maximum consumer benefit, a series of public awareness activities should be undertaken so that the general public is aware of the new labeling and understands how to make an informed decision with the newly available information. Furthermore, a series of consumer research activities are encouraged so that the verbiage on the final label most clearly communicates the information to consumers; for example, is $PM_{2.5}$ a term enough consumer are familiar with, or would another phrase be more meaningful? Conversely, even if consumer awareness is low for $PM_{2.5}$, it is quite likely that the broad incorporation of this metric into filter communications will help drive public awareness of this important topic.

11 Environmental and Societal Impacts

Filter labeling which provides a means to compare filter efficiency on a consistent basis across brands should allow California residents to make informed choices about improving the air quality within their homes. Accordingly, while difficult to quantify, improved air quality and the potential health benefits of lower fine particle exposure may be experienced by the portion of the population which migrates to higher efficiency filters. Additionally, if greater scrutiny and transparency is provided for filter resistance over the life of the filters, consumers may be able to better avoid excessively-high resistance filters which can have detrimental effects to HVAC system operation.

12 Federal Preemption or Other Regulatory or Legislative Considerations

The current proposal is not believed to conflict with any current federal, state, or local statues, ordinances, or regulations.

13 Methodology for Calculating Cost and Savings

Not applicable

14 Bibliography and Other Research

1. Stephens, Brent; A. Novoselac; and J. Siegel. “The Effects of Filtration on Pressure Drop and Energy Consumption in Residential HVAC Systems (RP-1299).” HVAC&R Research Vol. 16 No. 3 (May 2010): 273-294.

APPENDIX: Cost Analysis Assumptions

Not applicable