



ENERGY STAR® Room Air Cleaners Version 2.0 Specification Discussion Guide

October 2018

I. Overview

The U.S. Environmental Protection Agency (EPA) is pleased to share with stakeholders the ENERGY STAR Version 2.0 Room Air Cleaners Discussion Guide. We invite stakeholder input to inform development of the ENERGY STAR Version 2.0 Room Air Cleaners Specification. Please submit comments on the Discussion Questions below, as well as data, to: roomaircleaners@energystar.gov by November 27, 2018.

EPA will host a webinar on November 7, 2018 from 2 – 4 PM Eastern Time to seek input from stakeholders on the topics below. Please register to attend the webinar [here](#).

II. Background

We believe that the time is ripe for a revision of the ENERGY STAR Room Air Cleaners Specification. Since EPA last partnered with stakeholders to finalize the first Room Air Cleaners Specification in 2004, the room air cleaners market has evolved significantly. Specifically, technology advances have resulted in efficiency gains. These efficiency gains are reflected in the ENERGY STAR dataset, enabling utility incentives at significantly higher levels of efficiency, with a good selection of models that meet these levels. Bolstering the timeliness of an update is the just-released EPA Indoor Air Guidance (see: <https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home-printable>), which emphasizes the effectiveness of room air cleaners for consumer health.

Stakeholder engagement is key to the success of the ENERGY STAR program. As such, EPA has drafted this Discussion Guide to seek early insights and feedback on this planned revision. EPA looks forward to working with all stakeholders to revise the ENERGY STAR Room Air Cleaners Specification.

III. Scope

In the Version 1.2 specification, EPA includes all products that meet the definition of a Room Air Cleaner, with the exception of:

- (1) Combination products
- (2) Ozone generators

EPA plans to continue to exclude these product types. Further, EPA has learned from the EPA Residential Air Cleaners Technical Summary¹ that some air cleaners can emit potentially harmful byproducts (e.g. formaldehyde, carbon monoxides, fragrance etc.). EPA intends to exclude product types that produce harmful byproducts.

Discussion Questions

1. Are there other product types EPA should consider excluding based on health concerns?
2. How would EPA verify that these contaminants are excluded? Are they reported in the owner's manual?

¹ EPA Indoor Air Quality, Residential Air Cleaners Technical Summary, https://www.epa.gov/sites/production/files/2018-07/documents/residential_air_cleaners_-_a_technical_summary_3rd_edition.pdf

IV. Efficiency and Performance

To assess appropriate efficiency criteria for a Version 2.0, EPA evaluated the current ENERGY STAR Qualified Product List, along with other market data.

1) ENERGY STAR Qualified Product List (QPL) Efficiency Assessment

The Clean Air Delivery Rate (CADR) is the industry metric for determining product performance, and is measured in terms of cubic feet per minute (CFM). The larger the CADR, the greater the capacity to deliver clean air. CADR/Watt is the metric referenced by ENERGY STAR to determine the product's energy efficiency. The current ENERGY STAR criteria are set at 2.0 CADR/Watt.

EPA reviewed the performance data of ENERGY STAR qualified products, specifically, how product efficiency improved since the Version 1.0 Specification was released in 2004. Figure shows the trend toward greater efficiency (based on when ENERGY STAR models were available on the market). The trendline on this graph begins at just greater than 2 CADR/Watt (the Version 1 ENERGY STAR level) for products available when the ENERGY STAR specification first took effect, and ends around 4 CADR/Watt for products released in 2018. Note that many products perform at 6 CADR/Watt and some products are even above 8 CADR/Watt.

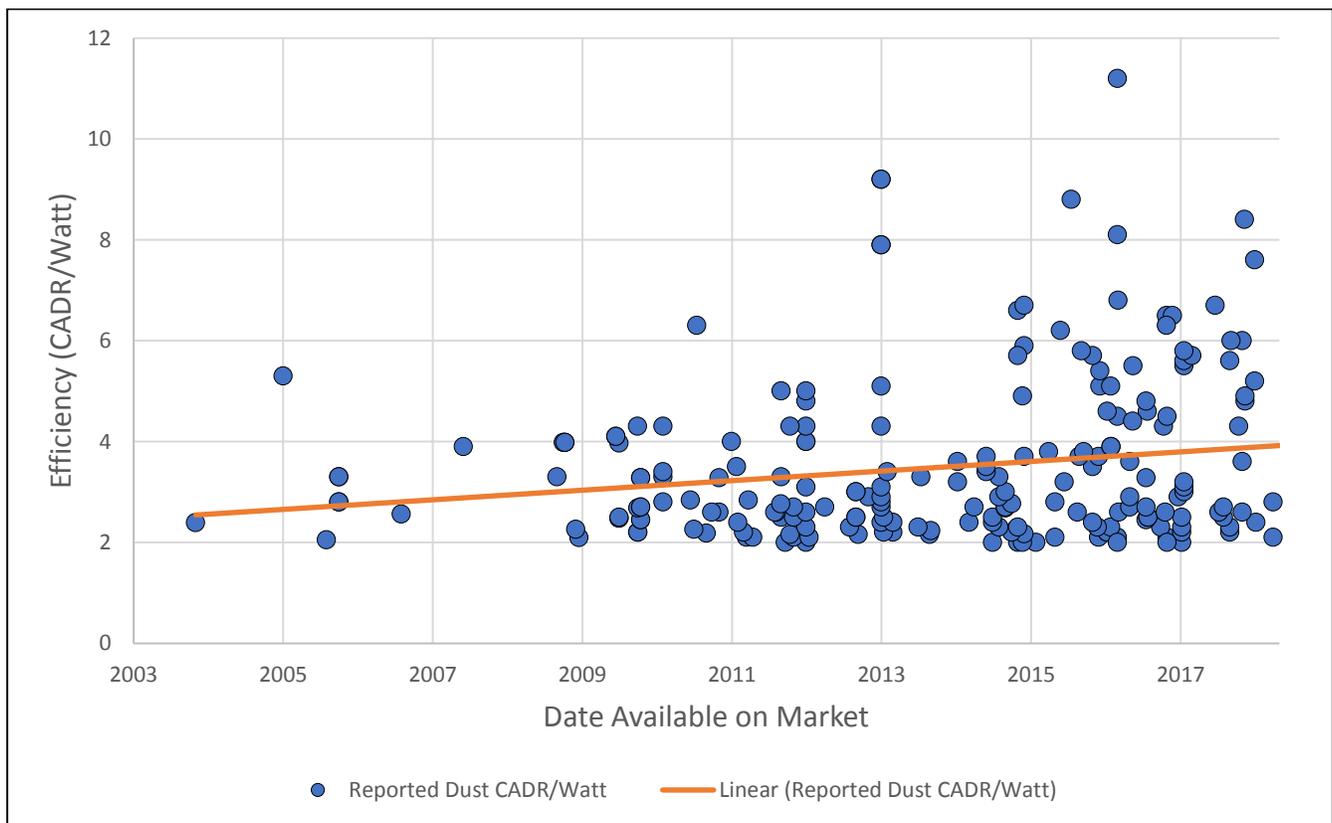


Figure 1: ENERGY STAR QPL Efficiency of Products Available on the Market from 2003 to Present and Linear Trendline

2) ENERGY STAR Retail Product Platform Incentive Levels

Further, data shared by ENERGY STAR Retail Products Platform (ESRPP) partners offers further insights into current product performance. ESRPP is a collaborative midstream initiative of ENERGY STAR, energy efficiency program sponsors, retailer partners, and other key stakeholders that is facilitated by EPA. ESRPP offers a gateway for energy efficiency programs to capture energy savings for specific product types at a significantly lower cost than current programs incur. Room air cleaners are one of the product categories

included in the ESRPP program, and ESRPP utilities offer incentives for selling more efficient room air cleaners.

ESRPP utility partners have included requirements for room air cleaner efficiency incenting higher levels of efficiency with significant dollars and they are seeing a response in the market. In fact, the ENERGY STAR dataset shows that 64% of qualified models can meet a significantly higher level of efficiency, demonstrating that ENERGY STAR levels need to be revised in order to be a better tool for ESRPP partners.

EPA investigated product advancements to understand what improvements have been made to room air cleaners since the 2004 Version 1.2 Specification.

A) Technological Advancements

Based on research and recent conversations with stakeholders, EPA learned about the following efficiency advancements made over the past decade:

- a) The primary source of reduced energy consumption, and improvement in efficiency is the motor:
 - i. Several stakeholders noted significant efficiency gains in the motor that are attributed in part to a shift from alternating current (AC) motors to direct current (DC) motors. DC motors meet the same performance at a higher efficiency in most cases. Also, products with DC motors can be tested to the ANSI/AHAM AC-1 test procedure. However, the cost difference between an AC motor and a DC motor may increase the retail price.
 - ii. EPA heard from a stakeholder that some ENERGY STAR qualified products also employ more efficient AC motors.
- b) Certain products on the ENERGY STAR Qualified Product List achieve a CADR/Watt that significantly surpasses the ENERGY STAR criteria because they use a combination of technologies to optimize fan speed.

Discussion Questions

3. Request for Data: EPA welcomes stakeholder data on the efficiency of non-ENERGY STAR products.
4. Other Technological Advancements: EPA is interested in understanding the prevalence of DC motor products in the market today and in the near future. EPA is also interested in feedback on new technology that may be implemented, or a new product type that may increase a product's energy efficiency.

B) Network-Connected Products

EPA has learned that there are network-connected air cleaners on the market that allow consumers to interact with the product by using a mobile device or a computer. One feature of network-connected products EPA learned about is the ability of the product to adjust the settings to local air quality levels. Additionally, there are room air cleaners that incorporate sensors that adapt to room conditions to reduce air flow (and thus, power consumption) once acceptable contamination levels are reached.

Discussion Questions

5. Prevalence and efficacy of connected products: EPA would appreciate feedback on the prevalence and efficacy of network-connected room air cleaners in adjusting settings to respond to local air quality.
6. Prevalence and efficacy of sensors: EPA would like feedback on both the prevalence of sensors in room air cleaners and their efficacy in adjusting settings to respond to room conditions.
7. Consumer value of network-connected air cleaners: EPA would like to understand better the full consumer value offered by a network-connected product. In particular, EPA seeks insights into health, comfort, and energy savings benefits.
8. Demand Response: EPA received a request to establish optional connected criteria/demand response criteria to give guidelines for partners on how their products respond to utility signals.

EPA seeks feedback on grid benefit as well as any health risks associated with decreasing the product's operation speed due to a demand response event?

C) Efficiency and Product Size

EPA received feedback from stakeholders that it's more difficult to meet the ENERGY STAR criteria for smaller products, because larger capacity room air cleaners are inherently able to achieve higher efficiency. In response, EPA analyzed the efficiency and size of products listed on the ENERGY STAR Qualified Product List (QPL).

Currently available products with larger CADR sizes are on average more efficient. At the same time, all of the products with the highest efficiency have a smaller CADR size as shown in Figure 2 below².

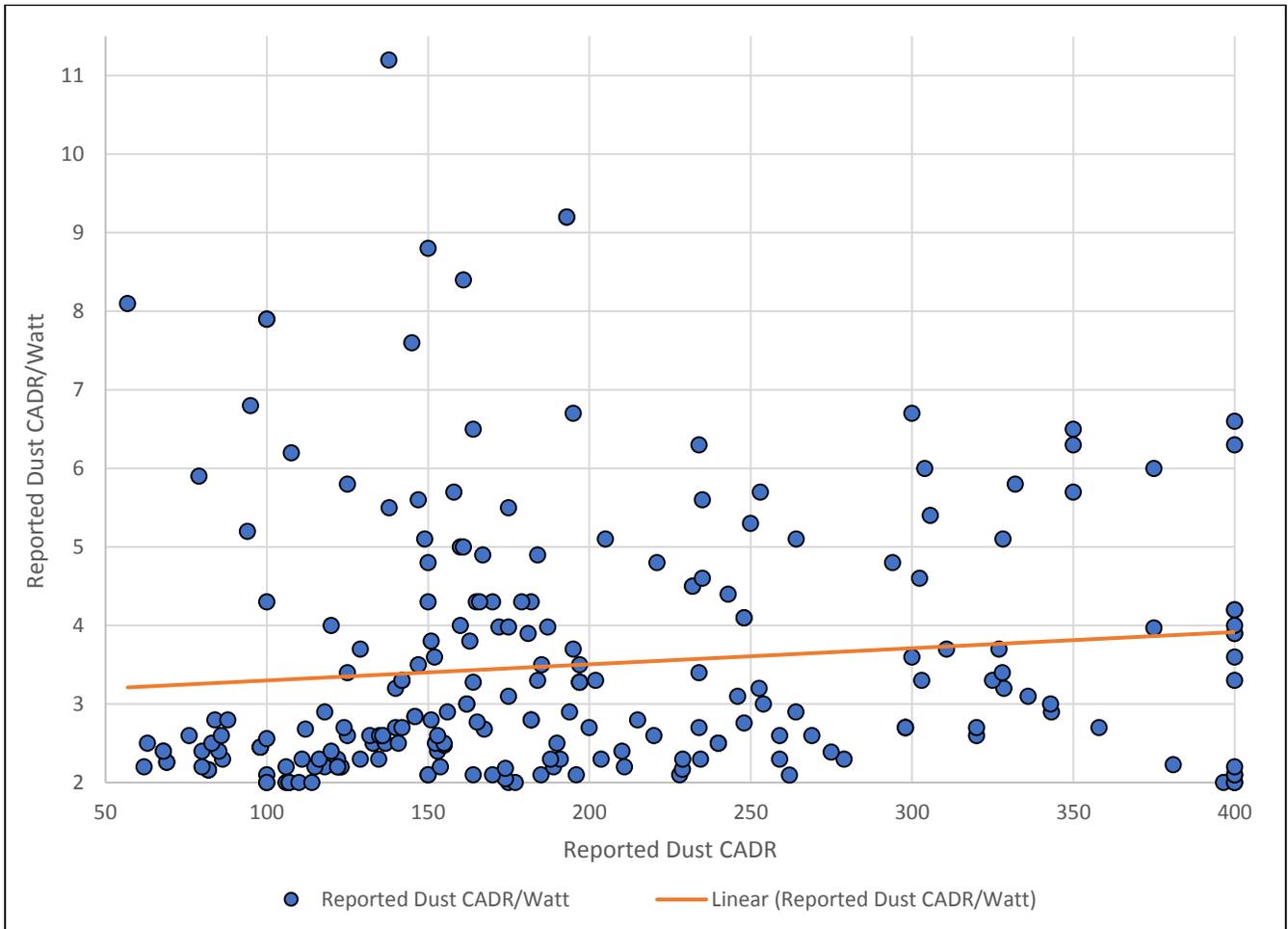


Figure 2: ENERGY STAR QPL Efficiency of Products as Capacity Increases – Linear Trendline

In Table 1, EPA recreated the typical size bins used by utilities participating in the ENERGY STAR Retail Products Platform (this program described in detail above, in Section IV.2).

² The CADR/Watt and CADR shown in Figure 2 were measured using dust as the pollutant.

Table 1: ENERGY STAR QPL Average Efficiency per Size Bins

Size Bins	# Products per Bin	Average Efficiency (CADR/Watt)
CADR < 100	25	2.88
100 ≤ CADR < 150	56	3.36
150 ≤ CADR < 200	65	3.68
CADR ≥ 200	89	3.63
Total	235	3.50

In consideration of the differences in efficiency distribution by product size demonstrated above and potential differences in consumer utility, EPA is considering evaluating efficiency criteria based on a product's size.

Discussion Question

9. What motivates consumer purchases for specific sizes of air cleaners? What drives higher efficiency in larger units? If EPA were to bin products by size, what boundaries for the CADR size bins should EPA consider when proposing new criteria?

D) Smoke and Pollen CADR

The Version 1.2 efficiency criteria are based on dust CADR, but the ANSI/AHAM AC-1-2015 test procedure measures CADR for smoke and pollen particles as well.

The Association of Home Appliance Manufacturers (AHAM) Verification Program for Room Air Cleaners calculates the appropriate room size for a given room air cleaner based on the Smoke CADR metric: Room Size = Smoke CADR * 1.55 (this CADR calculation is based on the assumption that the air cleaner will reduce the concentration of smoke particles in a room by 80%). It appears that retailers use this calculation to direct consumers to a specific room air cleaner for their space. EPA learned from recent conversations with stakeholders that Smoke CADR is increasingly used to measure room air cleaner performance.

Discussion Question

10. The Agency understands that smoke pollutants can have the greatest health risk for the general population (all ages, all degrees of allergenicity). In addition, some room air cleaners may be designed to optimize the removal of a specific pollutant type that is of the greatest concern for a consumer – smoke, dust, or pollen. EPA would appreciate stakeholder feedback on establishing energy efficiency requirements for smoke and pollen removal efficiency, in addition to dust. Do consumers select products based on pollutant type addressed? Does addressing all three types of pollutants extend greater benefit to consumers?

E) Filter Performance

The ENERGY STAR Version 1.2 Specification does not reference specific filter types, nor does it define them. After review of the EPA Air Cleaner Consumer Guide, EPA believes that filter type does influence the performance of a room air cleaner. As a result, EPA researched filter types, and defined those most applicable to room air cleaners.

- a) High efficiency particulate air (HEPA, sometimes referred to as True-HEPA) filters are defined by an AHAM standard.
 - i. ANSI/AHAM AC-1-2015 defines HEPA as an air filter with greater than or equal to 99.97% removal of carcinogen, dioctyl phthalate, at 0.3 µm diameter. The fractional efficiency of such filters can be verified using Mil-Std-282 or IEST-RP-CC001.3. High efficiency fibrous media filters, or HEPA filters, have been found in literature to generally be the most effective¹.

- b) HEPA-type filters range from any efficiency up to that achieved by HEPA filters.
- c) Charcoal or Active Carbon filters are designed to remove gases, while the HEPA filters are intended to remove particles³.

Discussion Questions

- 11. For products that use a filter, EPA is considering requiring a specific filter type (i.e., HEPA) or a minimum filter efficiency to ship with products that qualify for ENERGY STAR. Should EPA identify these using the ANSI/AHAM definition or another industry accepted definition?
- 12. Are there filter types EPA should consider excluding from being shipped with ENERGY STAR products?
- 13. Do most room air cleaner filters undergo efficiency testing, or is this typically only carried out for those that meet the HEPA standards?

F) Room Air Cleaners Fan Noise

The EPA Residential Air Cleaners Technical Summary¹, published July 2018, discusses how the amount of noise generated by fans in room air cleaners can be a concern for consumers, who have cited noise as a reason for decreasing the speed of their air cleaner (thereby lowering the health benefits) - or even turning it off and/or not using it. The Technical Summary states that room air cleaner products achieve best air cleaning performance at maximum fan speed, resulting in noise levels that may be too high for consumers.

EPA has reviewed the ANSI-AHAM AC-2-2006 Method for Sound Testing of Portable Household Electric Room Air Cleaners, which offers a test method for measuring the sound power and loudness of portable household electric room air cleaners.

Discussion Questions

- 14. Do manufacturers include metrics on air cleaner noise on product packaging? If so, what metrics?
- 15. Is ANSI-AHAM AC-2-2006 the most appropriate method on which to base a noise floor?
- 16. Is there an appropriate sound performance floor for room air cleaners such as one based on that for a room air conditioner?
- 17. What options are available to manufacturers to reduce a product's noise when at maximum fan speed?

G) Standby Power

The standby power of products on the ENERGY STAR QPL demonstrates that products of all capacities far exceed the standby performance currently required by the ENERGY STAR specification. EPA is anticipating making this requirement more stringent.

³ EPA Indoor Air Quality, Guide to Air Cleaners in the Home, https://www.epa.gov/sites/production/files/2018-07/documents/guide_to_air_cleaners_in_the_home_2nd_edition.pdf

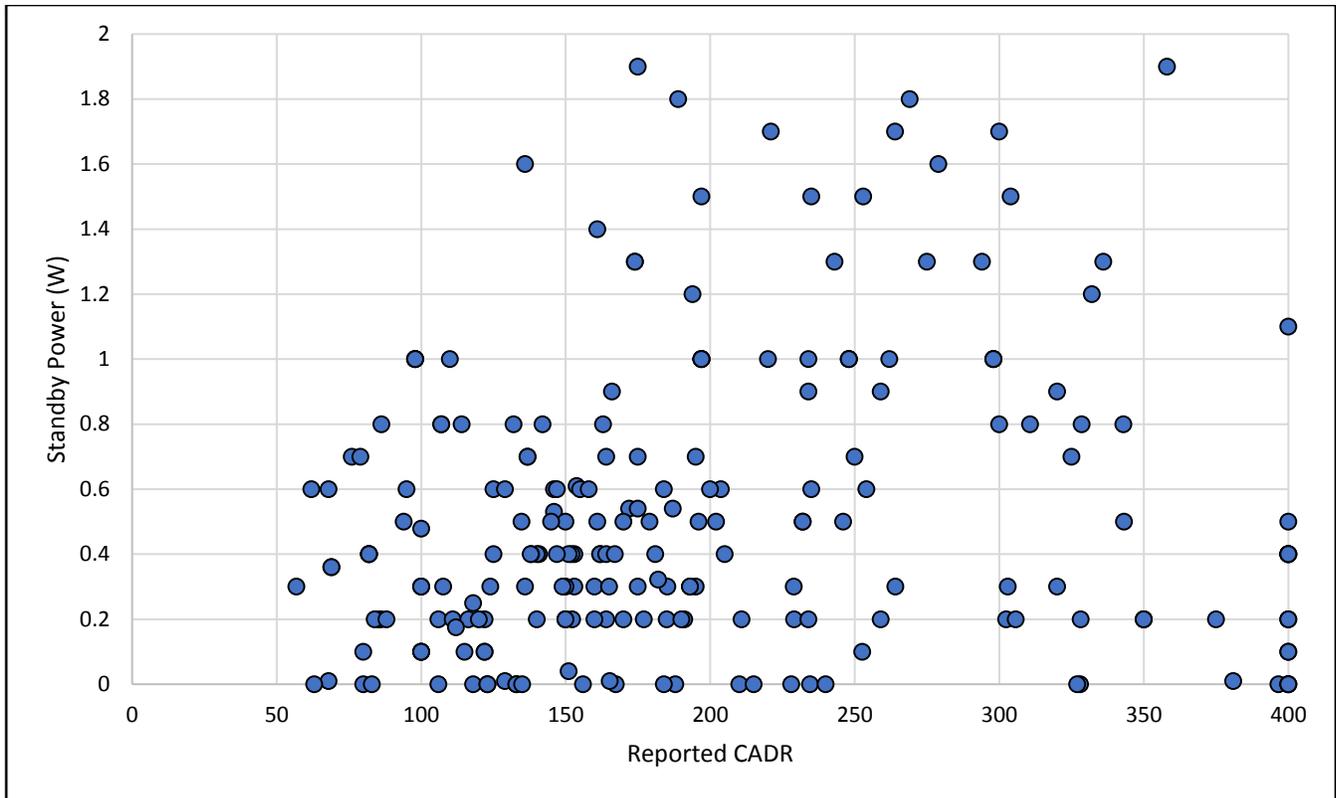


Figure 3: ENERGY STAR QPL Standby Power

Discussion Question

18. What functions, if any, delivered in standby mode may be limited by a decreased standby limit?

V. Market Assessment

Since the Version 1.2 Specification has been in effect since 2004, EPA reviewed the room air cleaner market to determine what has changed in the past decade. Specifically, EPA reviewed ENERGY STAR market penetration and industry product availability data, manufacturer and retailer websites. EPA reached out to stakeholders to inform this market analysis.

1) Growing ENERGY STAR Market Penetration

The ENERGY STAR Unit Shipment Data Summary Report shows that market penetration of ENERGY STAR certified room air cleaners has been steadily growing in recent years reaching 39% for 2017. Additionally, EPA received data from ENERGY STAR Retail Products Platform (ESRPP) utility participants that shows sales percentages for major big box stores in active utility markets are significantly higher.

Discussion Question

19. Are there other trends that EPA should consider regarding the room air cleaner market?

2) ENERGY STAR Product Availability

EPA analyzed data from the AHAM Certification Program for room air cleaners to determine the availability of both ENERGY STAR and non-ENERGY STAR certified models participating in the AHAM Verifide program⁴. ENERGY STAR certified models represent 68% of the room air cleaner models available in the database.

⁴ AHAM, "Room Air Cleaners", http://www.ahamdir.com/aham_cm/site/pages/index.html?code=r.rac.AboutThisProgram, accessed 4/25/2018.

Discussion Question

- 20. EPA welcomes stakeholder data, industry trends, and other information that may provide additional insight into the room air cleaner market.

VI. Testing

The test method referenced in the Version 1.2 ENERGY STAR Specification is ANSI/AHAM AC-1-2006. EPA is aware of a more recent version of the AHAM Standard, and intends to update the test method reference to ANSI/AHAM AC-1-2015.

EPA found substantive changes in the test set up section between the ANSI/AHAM AC-1-2006 and the updated ANSI/AHAM AC-1-2015. Some of the significant changes to test set up include:

- Addition of definitions and conditions for the Cigarette Humidity Chamber and the Particle Number Concentration:

3.9 Cigarette Humidity Chamber

A chamber able to maintain a temperature of 39 °F ± 3.6 °F (4°C ± 2°C) and relative humidity of (50 ± 10) %, for the long-term storage of test cigarettes

3.143.10 Particle Number Concentration

Number of particles per cubic centimeter of room air.

3.10.1 Initial Concentration

The particulate concentration at the start of test time (t=2 for smoke test, t=0 for dust or pollen test).

3.10.2 Background Concentration

The particulate concentration in the test chamber before the particulate is introduced to the chamber.

- Different voltage level required during operation:

4.2.34.1.2 Voltage

Operate air cleaner at (~~120~~115 ± 1) Volts.

DOE and EPA are reviewing the test procedure requirements for room air cleaners to assess whether the test procedure provides results that are representative of current typical consumer settings and usage, and whether opportunities are available to provide greater differentiation to recognize more efficient products, while maintaining product performance and minimizing the overall test burden. DOE and EPA have identified several areas for investigation for which additional analysis and testing may be warranted.

DOE and EPA welcome feedback from commenters on these issues, and would welcome opportunities to collaborate with manufacturers in testing products, identifying key technologies, and selecting key models for testing. DOE and EPA recognize that some of the areas described below could represent significant changes to the current testing methodology. Depending on the nature of any such test procedure investigations, certain areas could be evaluated for implementation in a future ENERGY STAR specification revision for room air cleaners.

1) Contaminate Level

Room air cleaners are currently tested in a relatively heavily contaminated room, which may not be representative of typical consumer usage conditions.

Discussion Questions

21. DOE and EPA welcome feedback on an adjustment in contaminate level to potentially be more representative of typical consumer conditions.
22. DOE and EPA are interested in feedback on the feasibility of varying contaminate levels depending on test unit features (e.g., size, power draw, other) that may indicate the expected contaminate level for that particular unit in the field.
23. DOE and EPA are interested in the potential of testing at different contaminate levels to further differentiate the room air cleaner market.

2) Contaminate Type

ANSI/AHAM AC-1-2006 includes three tests that assess the performance of a room air cleaner with dust, pollen, and cigarette smoke. The current ENERGY STAR performance criteria are based only on the dust contamination performance in ANSI/AHAM AC-1-2006.

Discussion Questions

24. DOE and EPA welcome feedback on whether dust contamination is most representative of typical consumer usage, and whether pollen and cigarette smoke, or a different contaminate not currently tested, should also be considered for the ENERGY STAR performance criteria.
25. DOE and EPA are interested in feedback on the impact of contaminate particle size on test repeatability.
26. DOE and EPA also welcome feedback on the applicability and repeatability of filling a test room with multiple contaminants simultaneously to measure the full range of performance for a product, and how that may impact test burden.

3) Control Speed

ANSI/AHAM AC-1-2006 requires that room air cleaners be tested at the highest air cleaning mode setting. DOE and EPA note that this approach does not incentivize the development of more efficient controls, motors, and fans that could be designed to operate more energy-efficiently at lower speeds, while maintaining air cleaning performance. For example, DOE is aware of room air cleaners that incorporate sensors and variable-speed operation that adapt to room conditions to reduce air flow (and thus, power consumption) once acceptable contamination levels are reached.

Discussion Question

27. DOE and EPA welcome feedback on an appropriate control speed setting for testing room air cleaners.

4) Test Duration

The rating period for testing room air cleaners is currently 20 minutes and begins with an initial contamination level. DOE and EPA note that some advanced filter technologies are more effective than traditional filters (e.g., activated carbon filters that have significantly higher surface area and attract organic compounds), yet their performance benefits are not captured in a 20-minute test, as they tend to filter air more slowly than other traditional technologies.

Discussion Question

28. DOE and EPA welcome feedback on the applicability of a longer rating test period for air cleaners to incentivize advanced technologies.

5) Filter Condition

Room air cleaners are currently tested with a new filter installed prior to each test. This may not be representative of typical operation, where a filter may be used for extended periods of time, resulting in increased static pressure and changes to the performance of the filter. Further, testing with a used filter could differentiate new technologies that may continue to operate efficiently with a used filter or after a significant period of time, as opposed to traditional filters.

Discussion Question

29. DOE and EPA welcome feedback on the applicability of a used filter test and how performance may vary as filter usage time increases.

VII. Request for Feedback

EPA requests feedback on these - and any other related issues or concerns - **by November 27, 2018**. Please send comments to roomaircleaners@energystar.gov.

Registration for the Version 2.0 Room Air Cleaners Discussion Document webinar on **November 7th, 2018 from 2 - 4 PM Eastern Time**, is available [here](#). For any questions about this specification, please contact Robert Burchard, EPA, at Burchard.Robert@epa.gov or (202) 343-9126 Emmy Feldman, ICF, at Emmy.Feldman@icf.com or (202) 862-1145. For questions about the test method for Room Air Cleaners, please contact Stephanie Johnson, DOE, at Stephanie.Johnson@ee.doe.gov or (202) 287-1943.