

2004
STANDARD for

PERFORMANCE
RATING OF
COMMERCIAL
AND
INDUSTRIAL
AIR FILTER
EQUIPMENT



ANSI/ARI
Standard 850

IMPORTANT

SAFETY DISCLAIMER

ARI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in according with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

ARI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. ARI does not certify or guarantee that any tests conducted under its standards/guidelines will be non-hazardous or free from risk.

Note:

This standard supersedes ARI Standard 850-93.

TABLE OF CONTENTS

SECTION	PAGE
Section 1. Purpose	1
Section 2. Scope.....	1
Section 3. Definitions	1
Section 4. Classifications	2
Section 5. Test Requirements	3
Section 6. Rating Requirements	4
Section 7. Minimum Data Requirements for Published Ratings	5
Section 8. Operating Requirements	5
Section 9. Marking and Nameplate Data	5
Section 10. Conformance Conditions	5

APPENDICES

Appendix A. References – Normative.....	6
Appendix B. References – Informative.....	6
Appendix C. Method of Test for Ozone Concentration for Group III Air Filter Equipment – Normative	7

PERFORMANCE RATING OF COMMERCIAL AND INDUSTRIAL AIR FILTER EQUIPMENT

Section 1. Purpose

1.1 Purpose. The purpose of this standard is to establish for commercial and industrial Air Filter Equipment: definitions; classifications; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

1.1.1 Intent. This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to factory-made Air Filter Equipment and Air Filter Media as used in such equipment, for removing particulate matter, when used in environmental conditioning of inhabited spaces in commercial and industrial facilities.

2.2 Exclusions. This standard does not apply to the following:

2.2.1 Air Filter Equipment and Air Filter Media for removing particulate matter, when used in industrial or commercial processes not associated with environmental conditioning of inhabited space.

2.2.2 Air Filter Equipment when used in removing abnormally high concentrations of specific contaminants.

2.2.3 Appliances which include Air Filter Equipment in combination with fans, coils, dampers, etc., but can be applied to the Air Filter Equipment as used therein.

2.2.4 Residential air filter equipment covered by ARI Standard 680.

2.2.5 This standard is not intended to apply to HEPA Filters.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the current edition of *ASHRAE Terminology of Heating, Ventilation, Air Conditioning and Refrigeration* unless otherwise defined in this section.

3.1 Air Filter Equipment. Air cleaning equipment used for removing particulate matter.

3.2 Air Filter Media. The part of the Air Filter Equipment which is the actual particulate removing agent. In the case of Group III equipment (Section 4), the terms charging section and/or collecting section shall be used.

3.3 Average Atmospheric Dust Spot Efficiency. The average value of the dust-spot efficiencies made on a single filter during the loading test, weighted by dust fed to the filter during the intervals between successive dust-spot tests.

3.4 Average Synthetic Dust Weight Arrestance. The average value of arrestances made on a single filter during the loading test, weighted by the synthetic dust fed to the filter between successive arrestance measurements.

3.5 Dust Holding Capacity. For disposable and manually renewable devices, the average arrestance multiplied by the amount of ASHRAE dust fed to the device measured to the nearest gram. Dust is fed until either of these conditions occurs:

- a. The resistance of the device reaches the Rated Final Resistance.
- b. Two consecutive arrestance measurements are less than 85% of the maximum arrestance measured during the run. In this case, the Dust-Holding Capacity shall not include dust captured during or after a feed increment in which arrestance has fallen below 85% of the maximum value.
- c. The arrestance is less than 75% of the peak value.

3.6 HEPA Filter (High Efficiency Particulate Air). A disposable extended media dry-type filter in a rigid frame having minimum particle-collection efficiency of 99.97% for 0.3 micron thermally-generated dioctyl phthalate (DOP) particles (as measured in accordance with MIL-STD 282).

3.7 Initial Atmospheric Dust Spot Efficiency. The initial measure of the ability of the device to remove atmospheric dust from the test air. The measurement is made by

comparing the light transmission of stains on paper targets sampling air upstream and downstream of the device.

3.8 Initial Resistance. The resistance of the device with no dust load, operating at its rated flow.

3.9 Published Rating. A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit the application. These values apply to all units of like nominal capacity and type (identification) produced by the same manufacturer. As used herein, the term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.9.1 Application Rating. A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.9.2 Standard Rating. A rating based on tests performed at Standard Rating Conditions.

3.10 Rated Final Resistance. The maximum operating resistance at which the device should be replaced or renewed, as recommended by the manufacturer.

3.11 Rating Conditions. Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

3.11.1 Standard Rating Conditions. Rating Conditions used as the basis of comparison for performance characteristics.

3.12 Sealing Means. Edge seals to prevent air by-pass under maximum rated operating conditions.

3.13 "Shall" or "Should." "Shall" or "should" shall be interpreted as follows:

3.13.1 Shall. Where "Shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.13.2 Should. "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.14 Standard Equipment. The minimum assembly of components required to qualify equipment within one of the classification groups.

3.15 Support. The means necessary to support the Air Filter Media in the air stream and to prevent air bypass

around the filter assembly under maximum rated operating conditions.

Section 4. Classifications

4.1 Groups. For the purpose of this standard, Air Filter Equipment and Air Filter Media are classified into groups:

- Group I - Unit or panel
- Group II - Extended surface
- Group III - Electronic air cleaner
- Group IV - Air Filter Media
- Group V - Self-cleaning, self-renewable, or any combination thereof

4.2 Descriptions.

4.2.1 Group I. This group of filters shall include unit or panel type air cleaners. Equipment of this type is characterized by flat shallow assemblies in which the velocity of the air stream approaches the velocity through the Air Filter Media. The equipment may be of the permanent cleanable type, or of the disposable non-renewable type, and may be dry or viscous-coated. Viscous impingement filters are included in this group.

4.2.2 Group II. This group of filters shall include extended surface types. Equipment of this type is characterized by pleated or pocket configuration, wherein the approach velocity of the air stream is substantially greater than the velocity through the Air Filter Media. The equipment may be of the cleanable type or of the disposable type and may be dry or viscous-coated.

4.2.3 Group III. This group of filters shall include electronic air cleaners. Equipment of this type uses high voltage electrostatic principles to collect particulate matter. These filters may be of single-stage or multiple-stage configuration. Part or all of the charging and/or collecting sections may be manually cleanable, automatically cleanable, or disposable.

4.2.4 Group IV. This group shall include all media used for Group I, II, III, or V. Air Filter Media is one component part of Air Filter Equipment; therefore, performance ratings cannot be applied to Air Filter Media alone, but only to Air Filter Equipment in which the media component has been tested. This group is identified for classification purposes only.

4.2.5 Group V. This group of filters shall include self-cleaning, self-renewable, or any combinations

thereof. Equipment of this type is characterized by their automatic, semi-automatic or manual cleaning and/or renewal mechanism. These may include disposable moving curtains, self-cleaning stationary curtains or self-cleaning moving curtains.

4.3 Standard Equipment. Standard and optional Equipment for Groups I, II, III, and V are specified in this section.

4.3.1 Equipment which is classified as Group I or II filters shall consist of:

- a. Air Filter Media
- b. Support
- c. Sealing Means

4.3.2 Equipment which is classified as Group III filters shall consist of:

- a. High voltage power supply - A means of supplying high voltage for the Air Filter Equipment.
- b. Support
- c. Safety controls - A means of positively breaking line voltage power to the device.
- d. Operating controls
- e. Collecting section - A means of collecting particulate matter. Examples are:
 1. Electrically charged plates which may be viscous coated and which may require periodic cleaning.
 2. Electrically charged plates which hold the collected particles plus a secondary downstream filter which collects the reentrained particles.
 3. Media and electrically charged active and/or passive grid(s).
- f. Charging section (multi-stage equipment only) - The section of the equipment which imparts an electrical charge to the particulate matter.
- g. Connectors - A means of transferring high voltage from the power source to the collecting and charging section.

4.3.3 Equipment which is classified as Group V filters shall consist of:

- a. Air Filter Media
- b. Support
- c. Sealing Means
- d. Renewal and/or cleaning means
- e. Operating controls (for automatic equipment only) - manual and/or

automatic means for initiating and terminating the renewal or cleaning cycle.

4.3.4 Optional Equipment. Optional equipment may include: viscous coatings, frames, automatic control systems, wash accessories or washing systems, pre-filters or after-filters.

Section 5. Test Requirements

5.1 Method of Test for Rating. Testing of Groups I, II, III, and V Air Filter Equipment shall be in accordance with ASHRAE Standard 52.1, unless modified below. The equipment shall be tested in accordance with the operating procedure recommended by the manufacturer. Air Filter Equipment in Group V shall be tested using the test program for dust loading effects specified for self-renewable equipment designed to control primarily the resistance of the equipment at or within pre-established limits (12.3.2 of ASHRAE Standard 52.1). This standard does not require that the atmospheric dust spot efficiency test be actually conducted on all Air Filter Equipment; those designated by the manufacturer as having less than 20% atmospheric dust spot efficiency need not be subjected to this test.

5.1.1 Equipment Preparation. The complete air cleaning equipment shall be prepared in accordance with the manufacturer's recommendations. Preparation shall include:

- a. Application (type, amount and method) of viscous coating
- b. Proper mounting of the equipment to ensure the flow of air through the filtering media
- c. All Group III equipment shall be run-in for a period of 24 hours prior to test by applying rated nameplate voltage to the device
- d. Any other preparations that are recommended by the manufacturer in order to demonstrate the device's intended performance. Airflow across the equipment is not required during the run-in period.

5.1.2 Multiple Airflow Rates. When equipment is intended to operate at more than one velocity or airflow rate, the equipment shall be tested at those alternate velocities or airflow rates for which Standard Ratings are published by the manufacturer.

5.2 Method of Testing for Ozone Concentration. Group III Air Filter Equipment shall be tested for ozone

concentration in accordance with Appendix C of this standard.

Section 6. Rating Requirements

6.1 Published Ratings. All Published Ratings shall include Standard Ratings and Standard Rating Conditions, but may also include Application Ratings where a statement of conditions of temperature, humidity, and airflow rate, as well as input voltages (where applicable), are provided.

6.1.1 Standard Ratings. Standard Ratings shall be established at airflow rate(s) selected by the manufacturer for: Initial Resistance, Initial Atmospheric Dust Spot Efficiency, Average Atmospheric Dust Spot Efficiency, Average Synthetic Dust Weight Arrestance, Dust Holding Capacity and input power (for Group III only). All Standard Ratings shall be verified by tests conducted in accordance with Section 5 of this standard.

6.1.2 Values of Standard Ratings. Standard Ratings shall be published only in the multiples and terms shown below:

- a. Rated airflow rate (Maximum and Minimum) - multiples of 50 cfm [0.024 m³/s]
- b. Initial Resistance - multiples of 0.01 in H₂O [2.5 Pa]
- c. Initial and Average Atmospheric Dust Spot Efficiency, and Average Synthetic Dust Weight Arrestance - multiples of 5%. When the Initial Atmospheric Dust Spot Efficiency is reported as "less than 20%," the Average Atmospheric Dust Spot Efficiency shall be reported as "less than 20%."
- d. Dust Holding Capacity - multiples of 10 g (multiples of 10 g/ft² [100 g/m²] for Group V equipment)
- e. Rated input power - multiples of 5 W
- f. Rated Final Resistance - multiples of 0.01 in H₂O [2.5Pa]

6.1.3 Standard Rating Conditions. The conditions of tests for Standard Ratings shall be:

- a. Temperature range of test air -- 35° F [2° C] to 90° F [32° C]
- b. Humidity range of test air -- Not to exceed 85%
- c. Line voltage supply (where applicable) -- Nameplate rated voltage ± 1 V. For multiple voltage equipment the

manufacturer shall designate the test voltage and voltage control set point.

- d. Rated airflow rate(s) -- as designated by manufacturer, cfm [m³/s] ± 2%

6.1.4 Application Rating Conditions. Ratings at conditions other than those specified in 6.1 may be published as Application Ratings, and shall be based on data determined in accordance with Section 5.

6.1.5 Rated Voltage. Rated voltage for 60 Hertz Air Filter Equipment shall be in accordance with the nameplate electrical characteristics (9.1).

6.2 Cleanability Test. This test shall apply to Air Filter Equipment intended to be cleaned rather than replaced. The complete Air Filter Equipment shall be prepared in accordance with the manufacturer's recommendations and applicable Standard Ratings determined in accordance with the requirements set forth in this section. The equipment shall be cleaned by the method prescribed by the manufacturer and, if the equipment is normally viscous-coated, the coating shall be reapplied in accordance with the manufacturer's recommendations. The equipment shall then be retested in accordance with 5.1 to determine the renewed resistance and efficiency in this condition, and the efficiency and arrestance at the first dust increment. This renewed resistance, efficiency and arrestance shall be published along with the Standard Ratings.

6.3 Application Ratings. Whenever Application Ratings are published or printed, the conditions at which these ratings apply shall be shown. Application Ratings shall include, or be accompanied by, the Standard Ratings clearly identified as such.

6.4 Tolerances. Published Ratings shall be such that any sample(s), not exceeding five samples, selected at random and tested in accordance with this standard, shall result in average tested values with an allowance for testing as follows:

6.4.1 The Initial Resistance shall not exceed the published resistance by more than 10% or 0.02 in H₂O [5.0 Pa], whichever is greater.

6.4.2 The Initial Atmospheric Dust Spot Efficiency (E) shall be not less than the published efficiency minus [3 + 0.08 (100 - E)]

6.4.3 The Average Atmospheric Dust Spot Efficiency (E_{avg}) shall be not less than the published efficiency minus [3 + 0.06 (100 - E_{avg})].

6.4.4 The Average Synthetic Dust Weight Arrestance shall be not less than the published arrestance (A_{avg}) minus [2 + 0.06 (100 - A_{avg})].

6.4.5 The Dust Holding Capacity shall be not less than 90% of the published capacity.

6.4.5 The input power shall not exceed 105% of the published input power.

6.4.6 The Rated Final Resistance shall not exceed the published resistance by more than 0.02 in H₂O [5.0 Pa].

Section 7. Minimum Data Requirements for Published Ratings

7.1 *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall include all Standard Ratings. All claims to ratings within the scope of this standard shall include the statement "Rated in accordance with ARI Standard 850." All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of ARI Standard 850." Wherever Application Ratings are published or printed, they shall include a statement of conditions at which the ratings apply.

7.2 As a minimum, the following items shall be published:

- a. Rated airflow rate (maximum and minimum) - multiples of 50 cfm [0.024 m³/s]
- b. Initial Resistance - multiples of 0.01 in H₂O [2.5 Pa]
- c. Initial and Average Atmospheric Dust Spot Efficiency, and Average Synthetic Dust Weight Arrestance - multiples of 5%. When the Initial Atmospheric Dust Spot Efficiency is reported as "less than 20%," the Average Atmospheric Dust Spot Efficiency shall be reported as "less than 20%."
- d. Dust Holding Capacity - multiples of 10 g (multiples of 10 g/ft² [100 g/m²] for Group V equipment)
- e. Rated input power - multiples of 5 W
- f. Rated Final Resistance - multiples of 0.01 in H₂O [2.5 Pa]

Section 8. Operating Requirements

8.1 *Breaching Test (For Groups I, II, V).* Following the standard rating test (or cleanability test, if performed), a breaching test shall be performed.

8.1.1 *Procedure.* The equipment shall be tested at a resistance 50% above the maximum Rated Final Resistance for which the manufacturer publishes ratings. The resistance shall be increased by loading the equipment with lint, fly ash, test dust or any combination thereof uniformly distributed across the face of the equipment. This increased resistance shall be applied for a period of three minutes and reduced to less than 10% of the Rated Final Resistance within two minutes. This reduced resistance shall be accomplished by reducing the test duct airflow. This procedure shall be repeated for four additional cycles.

8.1.2 *Requirements.* During the course of the test, there shall be no evidence of tearing, dislocation from its frame or other damage to the Air Filter Equipment.

Section 9. Marking and Nameplate Data

9.1 *Marking and Nameplate Data.* As a minimum, the nameplate on each commercial and industrial air filter unit shall display the manufacturer's name, model designation, type of unit, and electrical characteristics (for Group III only).

Nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltage ratings shown in Table 1 of ARI Standard 110.

Section 10. Conformance Conditions

10.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all of the requirements of the standard cannot reference, state or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES - NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered part of the standard.

A1.1 ARI Standard 110-2002, *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*, 2002, Air-Conditioning and Refrigeration Institute, 4100 North Fairfax Drive, Suite 200, Arlington, VA 22203, U.S.A.

A1.2 ARI Standard 680-2004, *Residential Air Filter Equipment*, 2004, Air-Conditioning and Refrigeration Institute, 4100 North Fairfax Drive, Suite 200, Arlington, VA 22203, U.S.A.

A1.3 ASHRAE Standard 52.1-1992, *Gravimetric and Dust Spot Procedure for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter*, 1992, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E. Atlanta, GA 30329, U.S.A.

A1.4 ASHRAE *Terminology of Heating, Ventilation Air Conditioning and Refrigeration*, Second Edition, 1991, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E. Atlanta, GA 30329, U.S.A.

A1.5 U.S. Department of Defense, MIL Standard 282, 1995, United States Department of Defense, 6883 Commercial Drive, Springfield, VA 22159-0500, U.S.A.

A1.6 U.S. Department of Health, Education and Welfare, Food and Drug Administration in the *Federal Register*, Volume 39, No. 75, Page 13773 et seq., April 17, 1974, United States Department of Health and Human Services, 200 Independence Avenue, S.W., Washington, DC 20201, U.S.A.

APPENDIX B. REFERENCES - INFORMATIVE

None.

APPENDIX C. - METHOD OF TEST FOR OZONE CONCENTRATION FOR GROUP III AIR FILTER EQUIPMENT- NORMATIVE

Ozone Concentration Requirements (For Group III Equipment). In conformance with the Regulation published by the U.S. Department of Health, Education and Welfare, Food and Drug Administration in the *Federal Register Volume 39*, no Group III equipment shall have a maximum ozone concentration in the effluent air exceeding 0.050 ppm.

C1 Purpose. The purpose of this appendix is to provide test procedures for establishing an ozone concentration level for Group III Air Filter Equipment.

C2 Scope. The test procedures provided in this appendix are for use with Group III Air Filter Equipment mounted in the ASHRAE duct system described ASHRAE Standard 52.1.

C2.1 Exclusions. This appendix is not applicable to field tests or to tests conducted in enclosed space applications.

C3 Ozone Monitoring Instrument. An ozone monitor that approved by the U.S. Environmental Protection Agency for ambient air monitoring shall be acceptable for determining the ozone level in the duct.

C3.1 Calibration. The calibration of the ozone monitor shall be done according to the procedures outlined in the instrument manufacturer's instruction manual.

C3.2 Reference Standard. The reference standard for calibrating the ozone monitor shall be in accordance with the procedures outlined in the *Federal Register*.

C4 Recording Instrument. A recorder that is compatible with the recorder output of the ozone monitor shall be used.

C5 Electrical Measurements. Electrical measurements shall be taken with indicating instruments. Ionizer and collector voltages shall be recorded and shall be expressed to the nearest 100 V, DC. The ionizer current shall be recorded and shall be expressed to the nearest 0.05 mA, DC.

C6 ASHRAE Duct. The ASHRAE duct system described in ASHRAE Standard 52.1 shall be used for this test.

C7 Location of Ozone Monitor's Sampling Tube. The ozone monitor sampling tube shall be located immediately

adjacent to the downstream sampler and shall point directly into the air stream.

C8 Performance of Test. The test shall be started only after a state of equilibrium has been reached. Prior to the start of this test, the ozone background level shall be measured with the Air Filter Equipment off.

C8.1 Power Supply Voltage. The voltage input shall be set at the nameplate voltage. Ionizer and collector voltage shall be within the normal operating voltage per the manufacturer's instructions. If adjustable without the use of tools, ionizer voltage and collector voltage shall be adjusted to the maximum level.

C8.2 Ozone Background Level. Tests shall proceed only after the background level of ozone in the air passing through the duct has been established with the equipment off. The ozone measurement shall be recorded when the ozone reading reaches a steady state level.

C8.3 Ozone Measurements. The Air Filter Equipment shall be turned on and ozone measurements shall be recorded when the ozone reading reaches a steady state level. The concentration shall be recorded to the nearest 0.001 ppm.

C8.4 Airflow Rate. Readings by which to determine the airflow rate through the filter shall be recorded, as directed in ASHRAE Standard 52.1.

C8.5 Background Check. After the ozone measurement has been recorded, the Air Filter Equipment shall be turned off and the resulting reading recorded.

C8.6 Recorded Ozone Concentration. The two ozone background readings shall be averaged, and the result subtracted from the concentration measured in C8.3. This value shall be recorded as the ozone concentration.

C8.7 Determination of Airflow Rate. The airflow rate shall be calculated as provided in ASHRAE Standard 52.1, and recorded.

C9 General Test Data. The following data shall be recorded for each Air Filter Equipment tested for ozone concentration.

- a. Air filter manufacturer - name and address
- b. Location of test facility - company name and address
- c. Date of test run
- d. Observers - responsible engineers and technicians
- e. Designation of unit
 - 1. Model number
 - 2. Manufacturer's serial number
 - 3. Ionizer current - expressed to the nearest 0.05 mA, DC
 - 4. Ionizer and collector voltages - expressed to the nearest 100 V, DC
 - 5. Nameplate voltage
- f. Designation of ozone monitor
 - 1. Model number
 - 2. Manufacturer's serial number
 - 3. Calibration date
- g. Airflow rate, cfm [m³/s]
- h. Duct air temperature, dry-bulb reading °F [°C]
- i. Duct air temperature, wet-bulb reading °F [°C]
- j. Relative humidity, %
- k. Barometric pressure (Absolute) in Hg [kPa]
- l. Air nozzle diameter, in [mm]
- m. Pressure drop across nozzle, in H₂O [kPa]
- n. Sampling point - the distance of the sampling tube from the Air Filter Equipment - expressed to the nearest 0.50 ft [150 mm]
- o. Description of recorder (if used)
 - 1. Manufacturer's name
 - 2. Model number
- p. All ozone concentrations, ppm

Other information, such as photographs, the weather conditions at the time of the test, etc., should be recorded.

C10 Maximum Ozone Concentration in Effluent Air (C_{Max}).

$$C_{Max} = C \frac{Q}{Q_{min}}$$

Where:

- C = Ozone concentration of test
- Q = Airflow rate during test, cfm [m³/s]
- Q_{min} = Manufacturer's minimum published airflow rate, cfm [m³/s]