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Household and similar electrical air cleaning appliances - Methods for measuring the performance —

Part 2-1: Particular requirements for determination of particle reduction

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HOUSEHOLD AND SIMILAR ELECTRICAL AIR CLEANING APPLIANCES –
METHODS FOR MEASURING THE PERFORMANCE –****Part 2-1: Particular requirements for determination of particle reduction**

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IEC 63086-2-1 has been prepared by subcommittee 59N: Electrical air cleaners for household and similar purposes, of IEC technical committee 59: Performance of household and similar electrical appliances, in co-operation with ISO technical committee 142: Cleaning equipment for air and other gases. It is an International Standard.

It is published as a double logo International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
59N/XX/FDIS	59N/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

In this standard, the following print types are used:

- **terms defined in Clause 3 of IEC 63086-1: bold type**
- **terms defined in Clause 3 of IEC 63086-2-1: bold type.**

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63086 series, published under the general title *Household and similar electrical air cleaning appliances – Methods for measuring the performance*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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HOUSEHOLD AND SIMILAR ELECTRICAL AIR CLEANING APPLIANCES – METHODS FOR MEASURING THE PERFORMANCE –

Part 2-1: Particular requirements for determination of particle reduction

1 Scope

This part of IEC 63086 specifies test methods for measuring the performance of electrically powered household and similar **air cleaners** intended for the reduction of particulate pollutants.

NOTE The limits of measurability for the **CADR** are described in Annex A.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 63086-1:2020, *Household and similar electrical air cleaning appliances – Methods for measuring the performance – Part 1: General requirements*

ISO 12103-1, *Road vehicles – Test dust for filter evaluation – Part 1: Arizona test dust*

ISO 29463-1, *High efficiency filters and filter media for removing particles from air – Part 1: Classification, performance, testing and marking*

ISO 5011:2020, *Inlet air cleaning equipment for internal combustion engines and compressors – Performance testing*

EN 1822-1, *High efficiency air filters (EPA, HEPA and ULPA) – Part 1: Classification, performance testing, marking*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 63086-1:2020 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

aerosol

suspension of fine solid particles or liquid droplets in air or another gas

3.1.2

smoke aerosol

aerosol produced by burning tobacco with air forced through a cigarette's filter

3.1.3**salt aerosol**

aerosol produced by atomization of an aqueous potassium chloride (KCl) solution with subsequent drying

3.1.4**dust aerosol**

aerosol produced by dispersion of commercially available test powder

3.1.5**pollen aerosol**

aerosol produced by dispersion of naturally occurring particulate matter from plants

Note 1 to entry: In this document, non-defatted paper mulberry pollen including fragments are used.

3.1.6**natural decay rate**

reduction rate of the **target pollutant** in the **test chamber** due to natural factors, principally sedimentation, agglomeration, surface deposition, chemical reaction, and air exchange

Note 1 to entry: The unit is per hour (h^{-1}).

3.1.7**total decay rate**

reduction rate of the **target pollutant** in the **test chamber** due to the combined effect of the **natural decay rate** and the **operation decay rate**

Note 1 to entry: The unit is per hour (h^{-1}).

3.2 Abbreviated terms

APS	aerodynamic particle sizer
CADR	clean air delivery rate
CPC	condensation particle counter
DUT	device under test
HEPA filter	high-efficiency particulate air filter
KCl	potassium chloride
OPC	optical particle counter
RH	relative humidity

4 Aerosol measurement instruments**4.1 General**

Calibration of all **aerosol** measurement instruments shall be performed at least annually in accordance with the manufacturer's instructions. A check of the zero counting rates shall be performed regularly by sampling with a high-efficiency particulate air (HEPA) filter on the sample intake. The HEPA filter shall be at least of class H13 in accordance with EN 1822-1 or ISO 35H in accordance with ISO 29463-1.

The maximum measurable particle number concentration of the **aerosol** measurement instruments should be higher than the initial particle number concentration required by the respective test methods. Otherwise, a dilution system shall be used to operate the condensation particle counter in the permissible particle number concentration range. If possible, dilution should be avoided to exclude a potential source of error. If it is not avoidable, the dilution ratio shall be checked regularly.

NOTE This document always refers to the particle number concentration, which is expressed in cm^{-3} .

4.2 Aerosol transport

The transport tubing for **aerosols** shall consist of conductive materials, such as metal or carbon embedded silicon, to avoid electrostatic effects and excessive losses. Similarly, all valves and connectors on the **aerosol** transport path shall also consist of conductive materials. The length of the tubing shall be as short as possible to avoid excessive losses due to diffusion.

4.3 Condensation particle counter

A condensation particle counter (CPC) is based on counting **aerosol** particles by first enlarging them by using the particles as nucleation centres to create droplets in a supersaturated gas and then counting them by optical means. Both n-butanol and water can be used as working fluids. CPC can have different lower detection limits (D_{50}), which are typically in the range between $0,0025 \mu\text{m}$ and $0,015 \mu\text{m}$. As the particle number concentration of the used **salt aerosol** is negligible in this particle size range, the exact value of D_{50} does not significantly influence the results. It is recommended to use a CPC with a high analysed flow rate as higher counting rates increase the statistical accuracy.

4.4 Optical particle counter

An optical particle counter (OPC) – also known as optical **aerosol** spectrometer – is based on detecting the light scattered by individual **aerosol** particles. The OPC shall count and size individual **aerosol** particles in the $0,1 \mu\text{m}$ to $10 \mu\text{m}$ range. The counting efficiency of the OPC shall be $\geq 50 \%$ for $0,1 \mu\text{m}$ particles. The OPC shall have a minimum of six equally logarithmically spaced particle size channels per decade.

4.5 Aerodynamic particle sizer

An aerodynamic particle sizer (APS) is based on the acceleration of **aerosol** particles in a nozzle. Due to their longer relaxation time, the time of flight of larger particles between two laser beams is longer than for smaller particles. The APS shall count and size individual **aerosol** particles at least in the particle size range from $5 \mu\text{m}$ to $10 \mu\text{m}$. The counting efficiency of the APS shall be 100% in this particle size range. The APS shall have a minimum of six equally logarithmically spaced particle size channels per decade.

5 Aerosol generation

5.1 Salt aerosol

The **salt aerosol** shall consist of polydisperse solid-phase (dry) KCl particles generated from an aqueous KCl solution using a mass concentration of 50 g KCl per 1 l of de-ionized water. Long-term storage of the salt shall be in accordance with Annex B. Figure 1 gives two examples of common systems for generating the **aerosol**. The **salt aerosol** is generated by feeding compressed particle-free air to the atomizer. Varying the operating air pressure of the generator allows control of the time to reach the initial particle number concentration. Spray nozzles producing size distributions with mode values above $0,1 \mu\text{m}$ shall not be used. The **aerosol** leaving the atomizer shall be dried with a silica gel diffusion dryer or mixing with a sufficient flow of dry air below the efflorescence humidity of KCl to ensure a solid-phase **aerosol**. It shall be checked periodically that the relative humidity of the air leaving the diffusion dryer is less than 55% RH. The dried **salt aerosol** is introduced into the **test chamber** via tubes or hoses.

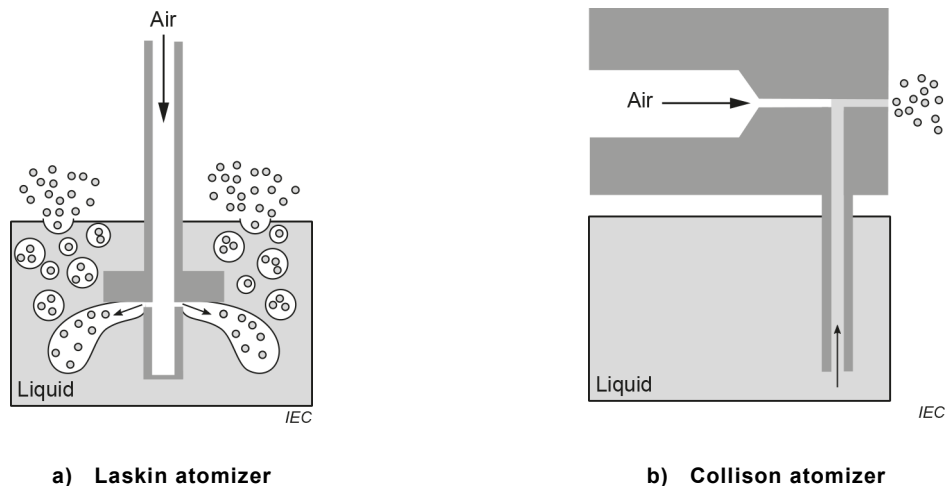


Figure 1 – Schematic of a Laskin atomizer (a) and a Collision atomizer (b)

NOTE Experimental data for several **air cleaners** have shown that the **CADR** measured with non-neutralized and neutralized **salt aerosol** particles does not significantly differ. Thus, neutralization of the generated **salt aerosol** before entering the **test chamber** is optional.

5.2 Smoke aerosol

5.2.1 Type of cigarettes

Cigarettes with filters and a maximum tar content of 8 mg per cigarette shall be used. It is recommended to use reference cigarettes, such as 1R6F reference cigarettes provided by the University of Kentucky¹. To increase the reproducibility of test results, each laboratory shall always use the same cigarettes. Before changing to a new type of cigarette, **CADR** tests for the same **DUT** with the old and new cigarettes shall be performed and compared. Long-term storage of the cigarettes shall be in accordance with Annex B.

5.2.2 Smoke aerosol generation

The cigarette(s) used for testing shall equilibrate for at least 24 h at (23 ± 2) °C and (50 ± 5) %RH before use. Two different examples of **smoke aerosol** generators are shown in Figure 2.

- a) The cigarette is placed in a glass hood. Air is extracted either from the **test chamber** or the surrounding after filtration by a pump, filtered and fed into the glass hood. By the arising overpressure, the smoke of the burning cigarette is pressed through the cigarette's filter and fed into the **test chamber** via tubes or hoses.
- b) The cigarette is placed in an ejector pump based on the Venturi effect. A compressed air source followed by a maintenance unit (including a water separator, particle and oil filter and pressure control valve) provides a constant flow through the ejector pump. The smoke of the burning cigarette is sucked by the arising underpressure through the cigarette's filter and transported with the main flow inside the **test chamber** via tubes or hoses. The cigarette smoke generation system is located inside an enclosure that is vented to the outside.

¹ The 1R6F reference cigarette supplied by the University of Kentucky is an example of a suitable product available commercially. The exact nomenclature of the current batch of cigarettes can change over time. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this/these product(s).

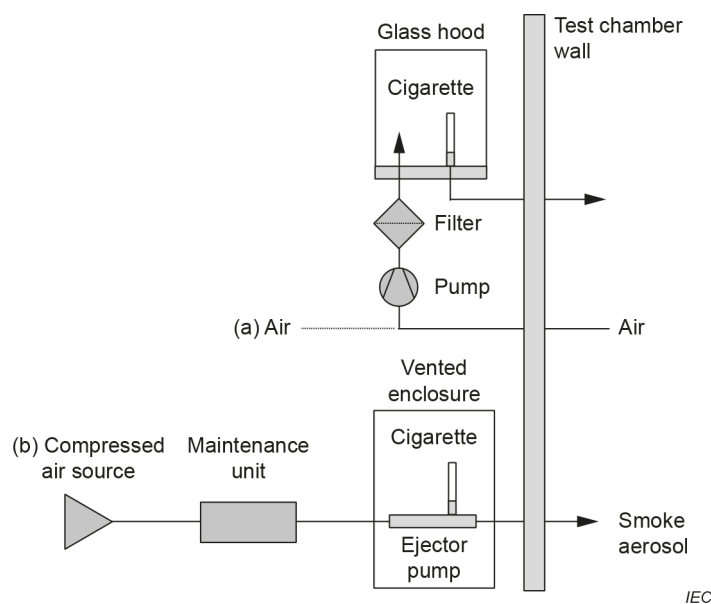


Figure 2 – Schematic of two possible methods to generate the smoke aerosol

NOTE 1 Equilibration of the cigarettes can either take place in a regulated climate cabinet or in a desiccator containing a specific saturated salt solution. To prepare the salt solution, first NH_4Cl (at least 99,5 % purity) and then KNO_3 (at least 99 % purity) is added to de-ionized water until the solution is fully saturated. The cigarettes are placed on a platform above the saturated salt solution in the desiccator. If the humidity in the desiccator drops over time, the exhausted solution is replaced by a fresh one.

NOTE 2 There are commercial **smoke aerosol** generators available that can be used for smoke generation. They are typically based on principle a).

NOTE 3 The cigarettes can be lighted using either a manual lighter or an automatized solution.

5.3 Dust aerosol

5.3.1 Type of dust

Commercially available ISO 12103-1, A2 fine test dust shall be used. Long-term storage of the dust shall be in accordance with Annex B.

5.3.2 Dust aerosol generation

The test dust shall be put for 24 h in a desiccator (container with a drying agent) with a relative humidity below 20 %RH before use. Two examples of **dust aerosol** generation methods are shown in Figure 3.

- The **dust aerosol** can be continuously dispersed with a powder disperser based on the principle shown in Figure 3a. The dust is filled little by little into the cylindrical solid material reservoir and uniformly compressed with a tamper. The dust is conveyed onto a rotating brush at a controlled feed rate. An adjustable flow of compressed air streams over the brush and tears the particles out of the brush.
- Alternatively, a light-duty dust injector (see ISO 5011:2020, Figure B.2) can be used as shown in Figure 3b. The injector shall be operated such that the required particle number concentrations listed in Table 2 are reached. These particle number concentrations are considerably lower than those required by ISO 5011:2020. The test dust is filled in a small funnel connected to the suction port of the ISO 5011:2020 dust injector. Filtered compressed air is fed into the dust injector for a short time by opening a ball valve.

As both generation principles can lead to highly charged particles, the **dust aerosol** shall be neutralized before entering the **test chamber** with an ^{85}Kr neutralizer or an equivalent method, such as soft X-rays or bipolar corona discharge.