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Test dusts for evaluating air cleaning equipment

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National foreword

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Foreword

This document (EN ISO 15957:2015) has been prepared by Technical Committee ISO/TC 142 “Cleaning equipment for air and other gases” in collaboration with Technical Committee CEN/TC 195 “Air filters for general air cleaning” the secretariat of which is held by UNI.

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Foreword

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The committee responsible for this document is ISO/TC 142, *Cleaning equipment for air and other gases*.

Introduction

Filters are subjected to evaluation of their initial performance and dust-loaded performance in laboratory tests using specified test dusts. The results are to reflect the performance of the filter as installed in a building. However, since the properties of atmospheric aerosols vary to a large extent regionally, seasonally, and according to weather conditions, test data obtained with a given test dust seldom accurately predict the filter performance as actually used. In addition to this, the test results with a given test dust might not be in agreement with those obtained by other laboratories because the filter performance is affected by many factors such as particle size distribution, particle agglomeration, and electrical charge. Despite these problems in testing filter performance, the test data are used for the classification of filters, estimation of energy consumption, Life Cycle Cost (LCC), and Life Cycle Assessment (LCA).

The test dust used for evaluating initial performance and loaded performance of filters can have a different specification from the dust used to achieve filter loading.

This International Standard does not control the specification, manufacturing, or use of test dusts. It describes the properties of test dusts which can be used to load filters, and the requirements for test dust generation that will ensure that useful laboratory test results are obtained in order to mimic the actual use as much as possible.

INTERNATIONAL STANDARD **ISO 15957:2015(E)**

Test dusts for evaluating air cleaning equipment

1 Scope

This International Standard defines the properties of load test dusts used for heating, ventilation, and air conditioning (HVAC) air filters as well as air cleaning equipment in laboratories. Test dusts used for evaluation of efficiency performance are not included.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For updated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO/TS 21220, *Particulate air filters for general ventilation — Determination of filtration performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
dust feeder
device which is used to distribute test dust to the filter

3.2
median diameter
diameter of the particle for which the cumulated volume fraction is equal to 50 % on a cumulated volume particle size distribution curve

3.3
undersize
percentage in volume of particles smaller than a specified particle size in a particle size distribution

3.4
particulate matter
PM
size fraction of the natural aerosol (liquid and solid particles) suspended in ambient air, with the symbol PM*x* where *x* defines the size range of the aerodynamic diameter

Note 1 to entry: The following particle size fractions are used in this International Standard.

Fraction	Category	Size range µm
PM10	Thoracic fraction	≤10
PM2,5	Respirable fraction	≤2,5

Note 2 to entry: The collection efficiency of the correct equipment at the considered diameter is equal to 50 %.

4 Test dusts designation

Load test dusts belong to one of four categories, according to the composition, the particle median diameter, and the particle density as shown in Table 1.

Table 1 — Load test dusts

Categories	Composition	Median diameter µm	Density g/cm^3
L1	Mixture of: — Arizona desert sand 72 %[a] — Carbon 23 % — Milled Cotton linters 5 %	 Conforms to ISO 12103-1, A2 Not defined Not defined	 Conforms to ISO 12103-1, A2 Not defined Not defined
L2	Arizona desert sand[a]	Conforms to ISO 12103-1, A2	Conforms to ISO 12103-1, A2
L3	KANTO loam (sintered)	1,7–2,5	2,9–3,1 (for reference)
L4	Mixture of: — Arizona desert sand[a] 93,5 % — Milled cotton linters 6,5 %	 Conforms to ISO 12103-1, A2 Not defined	 Conforms to ISO 12103-1, A2 Not defined
L1 test dust is the same as the commercially available dust used for ANSI/ASHRAE Standard 52.2 testing. The details conform to the description of the standard. L2 test dust is the same as ISO 12103-1, A2 Arizona test dust. The details conform to the description of the standard. L3 test dust is the same as SAP14-12 Test Powders 3-3. The details conform to the description of the standard (SAP: Standard of Association of Powder Process Industry and Engineering, Japan). L4 test dust is the same as ANSI/AHRI 680. The details conform to the description of the standard. [a] See ISO 12103-1.			

5 Chemical composition

The chemical composition of each test dust shall meet the requirements of Table 2.

Table 2 — Chemical composition (mass fraction, %)

L1	L2	L3		L4
ISO 12103-1, A2 72 %	Conforms to ISO 12103-1, A2	SiO_2	34 to 40	ISO 12103-1, A2 93,5 %
		Al_2O_3	26 to 32	
		Fe_2O_3	17 to 23	
Carbon black 23 %		CaO	0 to 3	Milled cotton linters 6,5 %
		MgO	0 to 7	
Milled cotton linters 5 %		TiO_2	0 to 4	
		Loss on ignition	0 to 4	

6 Particle size distribution

The particle size distributions of L1, L2, and L4 test dust conform to ISO 12103-1, A2 for the Arizona desert sand component of the mixture. The carbon black and cotton linters conform to ANSI/ASHRAE Standard 52.2 testing.

The particle size distribution of L3 test dust shall meet the requirements of Table 3.

Table 3 — Particle size distribution of L3 test dust

Undersize, volume fraction (%)	Particle size, µm	
	Minimum	Maximum
10	0,89	1,3
20	1,2	1,7
30	1,4	2,0
40	1,5	2,3
50	1,7	2,5
60	1,8	2,7
70	2,0	2,9
80	2,4	3,5
90	2,9	4,2

7 Particle size analysis procedure

7.1 L1 test dust

The particle size analysis procedure conforms to ISO 12103-1, A2 for the Arizona desert sand component of the mixture. There is no particle size analysis procedure for the carbon black and cotton linters components.

7.2 L2 test dust

The particle size analysis procedure conforms to ISO 12103-1, A2.

7.3 L3 test dust

The particle size analysis procedure conforms to SAP14-12 Test Powders 3. Laser diffraction scattering is used for the measurement. For the measuring device and the measurement conditions, the specification approved by the test dust supplier, APPIE (Association of Powder Process Industry and Engineering, Japan) is used.

7.4 L4 test dust

The particle size analysis procedure conforms to ISO 12103-1, A2 for the Arizona desert sand component of the mixture. There is no particle size analysis procedure for the cotton linters component.

8 Production methods

8.1 L1 test dust

This test dust is produced by mixing the three components listed in Table 1. The detailed procedure conforms to ANSI/ASHRAE Standard 52.2.

8.2 L2 test dust

This test dust is collected from a selected area of Arizona desert, jet-milled and classified to the specified particle size.

8.3 L3 test dust

KANTO loam is sintered for two hours, jet-milled and classified to the specified particle size.

8.4 L4 test dust

This test dust is produced by mixing the two components listed in Table 2. The detailed procedure conforms to ANSI/AHRI Standard 680.

9 Properties

9.1 L1 test dust

This mixture of three components has been used for many years in testing air cleaning equipment. The mixture properties can vary depending on the supplier and on conditions of storage and transportation.

9.2 L2 test dust

This test dust contains coarse particles, but with very few larger than 100µm. The adhesive force is small so that the particles are easily re-suspended. This particle mixture generally gives a small pressure drop increase when loaded on a filter, leading to a large consumption of test particles.

9.3 L3 test dust

This test dust contains no particles larger than 10µm. It gives filter test results similar to L1 test dust, but the increase in pressure drop with dust load is low compared to the L1 test dust.

9.4 L4 test dust

Mixture of L2 test dust and milled cotton linters but not carbon black. This particle generally gives small pressure drop increase when loaded to a filter, leading to a large consumption of test particles.

10 Application

10.1 General

The most appropriate test dust can be selected from the L1, L2, L3, and L4 test dusts based on the actual filter use.

10.2 L1 test dust

This load test dust simulates the aerosol size distribution in urban areas. It is appropriate for testing primary filters (pre-filters) because the dust contains cotton linters.

10.3 L2 test dust

This test dust simulates an aerosol with PM10 particle size distribution.

10.4 L3 test dust

This load test dust simulates an aerosol with PM2,5 particle size distribution.

It is appropriated for testing secondary filters (the filters behind pre–filters) since the dust contains no cotton linters.

10.5 L4 test dust

This load test dust simulates the aerosol size distribution in residential areas.

11 Related standards

11.1 L1 test dust

ANSI/ASHRAE Standard 52.2, *Method of testing general ventilation air-cleaning devices for removal efficiency by particle size*

EN 779, *Particulate air filters for general ventilation — Determination of the filtration performance*

11.2 L2 test dust

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

ISO 29461-1, *Air intake filter systems for rotary machinery — Test methods — Part1: Static filter elements*

11.3 L3 test dust

SAP14-12 Test Powders 3

JIS Z 8901, *Test Powders 1*

JIS B 9908, *Test method of air filter units for ventilation and electric air cleaners for ventilation*

11.4 L4 test dust

ANSI/AHRI Standard 680(I-P), *Performance Rating of Residential Air Filter Equipment*

12 Requirements for load test dust distribution

The particle size distribution of load test dust delivered to the filter varies according to the dust dispersion method and any particle agglomeration that can take place when the concentration is high. The particles are usually highly charged. Therefore, special precautions are required.

— The dust feeder shall disperse particles at ideally primary particle size (no agglomeration) and supply the dispersed particles at a constant feed rate.

— The load test dust shall be dried prior to use, and dry air shall be fed to dust feeder to disperse the particles.

— The dust feeder design and the compressed air flow rate are defined in ISO/TS 21220.

— The tube connected to the outlet of the dust feeder shall be electrically conductive and straight. When use of an elbow is necessary, the curvature of the elbow shall be kept as large as possible in order to minimize the collision of dispersed particles with the wall which can lead to electrical charging of particles. The air flow rate in the outlet of the dust feeder shall be checked periodically.

— The particle concentrations shall be uniform and the size distribution of the test dust shall be constant upstream of the test filter. In order to make the aerosol concentration uniform in the cross section of the duct, the straight section of duct upstream of the filter shall be longer than three times of the duct diameter, and the flow shall not be turbulent. The length of straight duct upstream of the filter should be longer when the flow velocity is high. The uniformity of particle concentrations in the duct cross section shall be checked.

— The aerodynamic particle size distribution for loaded dust in the upstream duct shall be checked periodically using the suitable devices such as Multi-stage Cascade Impactor (non-biological) or other devices to verify the particle dispersion performance of the dust feeder. Isokinetic sampling should be employed.

Annex A
(normative)

Material safety

A.1 Physical data

Physical data to each L1, L2, L3, and L4 dust are shown in Table A.1.

Table A.1 — Physical data

	L1	L2	L3	L4
Melting point (°C)	1 723	1 723	>1 000	1723
Specific gravity	Arizona 2,65 Carbon 2,16 Cotton 1,5	2,65	2,9 – 3,1	Arizona 2,65 Cotton 1,5
Solubility in water	Insoluble	Insoluble	Insoluble	Insoluble
Appearance	Gray/black fine powder	Brown fine powder	Reddish brown fine powder	Gray fine powder
Flammability	Conforms to flammability of Cotton linters 210 °C	Non flammable	Non flammable	Conforms to flammability of Cotton linters 210 °C

A.2 Safety data

Common safety data to all test dusts, L1, L2, L3, and L4 are shown in Table A.2.

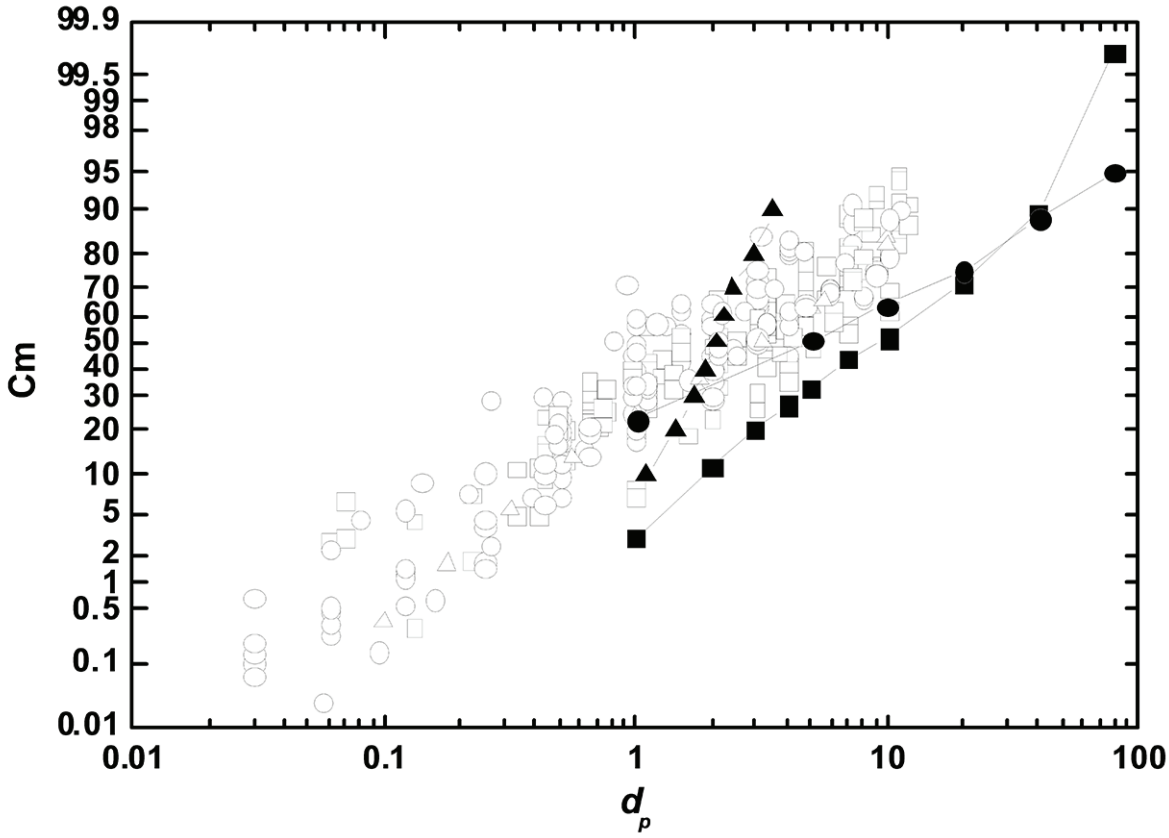
Table A.2 — Safety data

Cautions on handling and storage	Handle and store carefully so as not cause scattering or dust emission. Store in an airtight container at room temperature.
Disposal:	Disposal shall be in accordance with local regulations.
Spillage or leakage	Sweep and collect the scattered substance into containers. Clean up using a vacuum cleaner, damp dust cloth, and so on.
First aid measures: 1. Eye contact	 Flush eyes thoroughly with clean water. Get medical attention if irritation persists.
2. Skin contact	Clean the dust from the affected area and wash thoroughly with soap and water.
3. Inhalation	Move the affected person to a place in fresh air.
4. Ingestion	Rinse mouth with water. Get medical care if necessary.

Annex B
(informative)

Literature review of mass size distribution of atmospheric aerosol particles

Figure B.1 shows the logarithm-normal probability graph for particle size distributions of L1, L2, and L3 test dust and a literature review of mass-basis size distributions of atmospheric aerosol particles in Asia, Europe, and America. Measured diameters of ambient aerosol particles vary from 0,03 µm to 10 µm. The Mass Median Aerodynamic Diameter (MMAD) ranges from 0,5 µm to 5 µm approximately. The size distributions of test dusts L1 and L3 are in comparatively good agreement with those of ambient aerosols.



Key

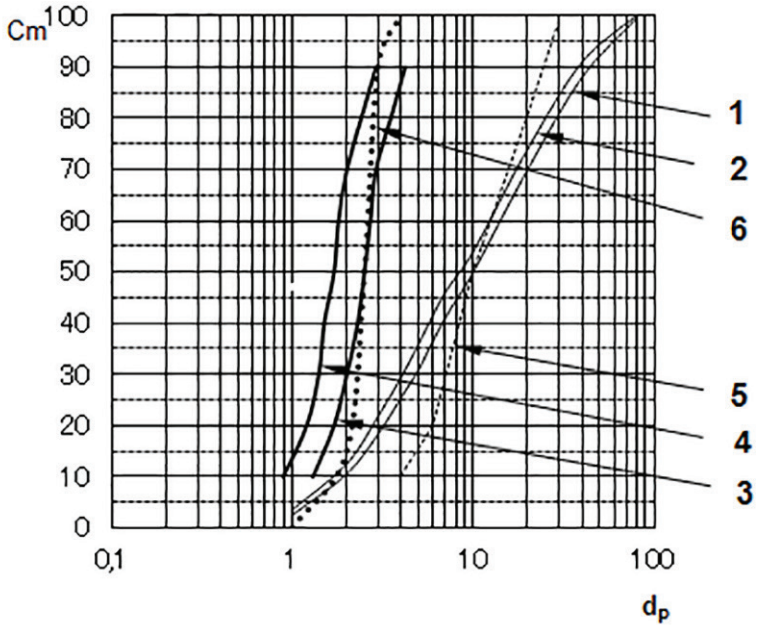
Cm	cumulative undersize mass fraction (%)
d_p	particle diameter (µm)
○	Europe
□	Asia
△	North America
—●—	L1 test dust
—■—	L2 test dust
—▲—	L3 test dust

Figure B.1 — Measured examples of particle size distribution of atmospheric aerosol particles (cited in L. Bao and others as listed in the Bibliography)

Annex C
(informative)

Comparison of particle size distributions

Figure C.1 shows a comparison of the size distribution curves of two of the four load test dusts, L2 and L3. The size distribution of L2 dust is similar to that of PM10. The size distribution of L3 dust is similar to that of PM2,5.



Key

Cm cumulative undersize volume or mass fraction (%)
d_p particle diameter (µm)
1 L2 dust upper limit (volume-based)
2 L2 dust lower limit (volume-based)
3 L3 dust upper limit (volume-based)
4 L3 dust lower limit (volume-based)
5 PM10 (mass-based)
6 PM2,5 (mass-based)

Figure C.1 — Comparison of the particle size distributions of L2 and L3 test dusts, and their relationship to PM10 and PM2,5 fractions

Bibliography

[1] EN 779:2012, *Particulate air filters for general ventilation. Determination of the filtration performance*

[2] ANSI/ASHRAE Standard 52.2:2012, *Method of testing general ventilation air-Cleaning devices for removal efficiency by particle size*

[3] JIS Z 8901:2006, *Test powders and test particles Industrial Test Powders 1 Powders, which exist in the usual environment as a dust, are standardized*

[4] SAP 14-12: 2012 SAP Test Powders 3, *Association of Powder Process Industry and Engineering, Japan*

[5] JIS B 9908:2011, *Test method of air filter units for ventilation and electric air cleaners for ventilation*

[6] Bao L. Investigation on Size Distribution of Ambient Aerosol Particles for ISO Standardization of Test Dusts for General Ventilation Air filters, *Research Conference in Autumn 2011 by The Society of Powder Technology, Japan*

[7] ANSI/AHRI Standard 680(I-P)-2009, *Performance Rating of Residential Air Filter Equipment*

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