



DRAFT INTERNATIONAL STANDARD ISO/DIS 19713-2

ISO/TC 22/SC 7

Secretariat: DIN

Voting begins on:
2008-08-04

Voting terminates on:
2009-01-04

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Road vehicles — Inlet air cleaning equipment for internal combustion engines and compressors —

Part 2:

Fractional efficiency testing with coarse particles (5 μm to 40 μm optical diameter)

Véhicules routiers — Équipement d'épuration d'air d'entrée pour moteurs à combustion interne et compresseurs —

Partie 2: Contrôle d'efficacité fractionnelle avec grosses particules (diamètre optique de 5 μm à 40 μm)

(standards.iteh.ai)

ICS 43.060.20

[ISO/DIS 19713-2](https://standards.iteh.ai/catalog/standards/sist/eabb56f3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2)

<https://standards.iteh.ai/catalog/standards/sist/eabb56f3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/DIS 19713-2](https://standards.iteh.ai/catalog/standards/sist/eabb56b3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2)

<https://standards.iteh.ai/catalog/standards/sist/eabb56b3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

Copyright notice

This ISO document is a Draft International Standard and is copyright-protected by ISO. Except as permitted under the applicable laws of the user's country, neither this ISO draft nor any extract from it may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, photocopying, recording or otherwise, without prior written permission being secured.

Requests for permission to reproduce should be addressed to either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Reproduction may be subject to royalty payments or a licensing agreement.

Violators may be prosecuted.

Contents

Page

Foreword	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Test equipment, accuracy and validation	4
4.1 Measurement accuracy.....	4
4.2 Test stand configuration.....	5
4.3 Test conditions	12
4.4 Validation	12
4.5 Reference air cleaner assemblies/air filter elements.....	13
4.6 Routine operating procedure	13
5 Fractional efficiency test	13
Annex A (informative) Test report	15
Annex B (normative) Efficiency data reduction	17
Annex C (normative) Pressure loss data reduction.....	24
Annex D (informative) Determination of maximum efficiency aerosol concentration	25
Annex E (normative) Accuracy requirements, validation, and routine operation	26
Annex F (informative) Particle diameters	29
Annex G (normative) Aerosol isokinetic sampling	31
Annex H (normative) Fractional efficiency, $E_{r,i}$ (%)	35
Bibliography.....	36

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19713-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

ISO 19713 consists of the following parts, under the general title *Road vehicles — Inlet air cleaning equipment for internal combustion engines and compressors*:

- Part 1: Fractional efficiency testing with fine particles (0,3 µm to 5 µm optical diameter)
- Part 2: Fractional efficiency testing with coarse particles (5 µm to 40 µm optical diameter)

Introduction

The following engine air cleaner/filter fractional efficiency test standard has been developed to cover traditional and new particulate air filters to remove airborne contaminants specifically to protect the engine.

Air cleaner fractional efficiency is one of the main air cleaner performance characteristics. This test standard has been established to address the measurement of this parameter. The objective of this procedure is to maintain a uniform test method for evaluating fractional efficiency of air cleaners and air filters on specified laboratory test stands.

The data collected according to this test standard can be used to establish fractional efficiency characteristic for air cleaners and filters tested in this manner. The actual field operating conditions, including contaminants, humidity, temperature, mechanical vibration, flow pulsation, etc. are difficult to duplicate. However, with the procedure and equipment set forth, comparison of air filter fractional efficiency may be made with a high degree of confidence.

Annexes B, C, E, G and H are normative. Annexes A, D, and F are informative.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO/DIS 19713-2](https://standards.iteh.ai/catalog/standards/sist/eabb56B-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2)

<https://standards.iteh.ai/catalog/standards/sist/eabb56B-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/DIS 19713-2

<https://standards.iteh.ai/catalog/standards/sist/eabb56B-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

Road vehicles — Inlet air cleaning equipment for internal combustion engines and compressors —

Part 2:

Fractional efficiency testing with coarse particles (5 µm to 40 µm optical diameter)

1 Scope

This part of ISO 19713 describes laboratory test methods to measure engine air cleaner and filter performance by fractional efficiency test from 5 µm to 40 µm using ISO 12103-1 test dusts. See ISO 19713-1 for fractional efficiency test for particles from 0,3 µm to 5 µm. Performance includes, but is not limited to, air flow restriction or pressure loss, initial and incremental fractional efficiencies during dust loading.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 19713-1, *Inlet air cleaning equipment for internal combustion engines and compressors — Part 1: Fractional efficiency testing with fine particles*

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

ISO/DP 11841, *Road vehicles and internal combustion engines - Filter vocabulary — Part 1: Definitions of filters and filter components*

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

ISO/TS 11155-1, *Road vehicles - Air filters for passenger compartment — Part 1: Test for particulate filtration*

ASTM F 328, *Practice for determining counting and sizing accuracy of an airborne particle measurement device using near-mono-dispersed spherical particular materials (ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, USA)*

ASHRAE 52.2, *General Method of testing general ventilation air-cleaning devices for removal efficiency by particulate size (ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329, USA)*

3 Terms and definitions

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

3.1

air cleaner assembly

the air cleaner assembly includes the air cleaner housing and the air filter element

3.1.1

single stage air cleaner

air cleaner which does not incorporate a separate pre-cleaner

3.1.2

multistage air cleaner

air cleaner consisting of two or more stages, the first usually being a pre-cleaner, followed by one or more filter elements

NOTE If two elements are used, the first is called the primary element and the second one is called the secondary element.

3.1.3

pre-cleaner

device usually using inertial or centrifugal means to remove a portion of the test dust before reaching the filter element

3.2

air filter element

the actual filter supported and sealed within the air cleaner assembly

3.3

test air flow rates

a measure of the volume of air passing through the test duct per unit time

NOTE Expressed in cubic meters per second (m³/s).

ITIH STANDARD PREVIEW
(standards.iteh.ai)

3.4

pressure loss

permanent pressure reduction due to a decrease in the flow energy (velocity head) caused by the filter (Pa at standard conditions of 20 °C and 101,3 kPa)

<https://standards.iteh.ai/catalog/standards/sist/eabb56B-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

3.5

fractional efficiency, $E_{f,i}$ (%)

ability of the air filter to remove particles of a specified size expressed as a percentage for particle size i

$$E_{f,i} = \frac{C_{1i} - C_{2i}}{C_{1i}} \times 100 \tag{1}$$

where: C_{1i} = number of particles per unit volume of specified size, i upstream
 C_{2i} = number of particles per unit volume of specified size, i downstream

3.6

definition of different fractional efficiencies

3.6.1

fractional efficiency before dust loading

efficiency before the collected particles have any measurable effect on the efficiency of the filter under test

NOTE The collected particles can affect the measured filter efficiency before enough aerosol is collected to have any measurable effect on the filter pressure loss.

3.6.2

incremental fractional efficiency

efficiency, determined at the specified flow rate as a function of particle size at 10 %, 25 %, 50 % and 100 % of filter life, which is determined by pressure loss across the filter as the filter is loaded with ISO 12103-1 test dust.

NOTE 1 The filter pressure loss (ΔP_i) values at which the incremental fractional efficiencies are measured can be calculated from: the initial pressure loss (ΔP_o), the fraction of filter life (ΔL_i), and the specified terminal pressure loss (ΔP_d). See Equation 2.

$$\Delta P_i = \Delta P_o + \Delta L_i \times (\Delta P_d - \Delta P_o) \quad (2)$$

NOTE 2 If necessary, the requester and the tester may agree upon different criteria for incremental fractional efficiency.

3.7

fractional penetration, $P_{f,i}$ (%)

ratio of the concentration of particles of specified size exiting the filter to the concentration of particles of specified size entering the filter expressed in a percentage for particle size i

$$P_{f,i} = 100 - E_{f,i} \quad (3)$$

3.8

test dust loading

mass of test dust collected by the air cleaner assembly or air filter element at a specified flow rate expressed in grams

3.9

particle measurement device / aerosol spectrometer

instrument for sizing and/or counting aerosol particles

NOTE Recommended particle counters are optical particle counters (OPC) or other counters demonstrating good correlation in measuring particle sizes such as aerodynamic particle counters (APC).

3.10

test aerosol

particles suspended in air, used for filter efficiency evaluation or dust loading

<https://standards.iteh.ai/catalog/standards/sist/eabb56b3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

3.10.1

fractional efficiency test aerosol

aerosol used to measure the efficiency of the test filter, the concentration of which is low enough to prevent coincidence related errors in the particle counters, and does not change the filter efficiency due to loading; for this part of ISO 19713, the KCl (potassium chloride) test aerosol shall be used

NOTE The aerosol charge is reduced so that it approximates a Boltzman equilibrium charge distribution. The requirements for the efficiency challenge aerosol are given in sections 5.2.9 and 5.2.10.

3.10.2

loading test aerosol

aerosol used to load the filter, the concentration of which is high enough to allow loading of the filter in a reasonable amount of time; for this part of ISO 19713 for single-stage air cleaner assemblies and air filter elements, ISO 12103-1 A2 test dust and for pre-cleaners and multistage air cleaner assemblies ISO 12103-1 A4 test dust shall be used

NOTE The requirements for the loading test aerosol are given in section 5.2.12.1.

3.11

correlation ratio, R

ratio of the number of particles observed at the downstream sampling location to the number of particles at the upstream sampling location when no filter is installed in the test system

NOTE 1 This number may be greater or less than 1.

NOTE 2 The method of calculating the correlation ratio is given in Annex B.

3.12

Log mean diameter, D_{li}

weighted mean diameter calculated by

$$D_{li} = (D_i \times D_{i+1})^{1/2} \tag{4}$$

where

D_{li} = log mean diameter.

D_i = lower threshold of particle size range.

D_{i+1} = upper threshold of particle size range.

3.13

geometric (volume equivalent) diameter, $D_{g,i}$

diameter of a sphere with the same volume as the particle being measured

NOTE For a spherical particle, it is the diameter of the sphere.

3.14

optical (equivalent) diameter, $D_{o,i}$

diameter of a particle of the type used to calibrate an optical sizing instrument that scatters the same amount of light as the particle being measured

NOTE Optical diameter depends on the instrument, the type of particle used to calibrate the instrument (usually polystyrene latex spheres), the optical properties of the particle being measured, and the size of the particle.

3.15

aerodynamic (equivalent) diameter, D_{ae}

diameter of a sphere of density 1 g/cm³ with the same terminal velocity due to gravitational force in calm air, as the particle being measured

NOTE 1 The aerodynamic diameter will be used to report results to avoid different diameter measures due to different sizing and counting techniques.

NOTE 2 Annex F provides additional information about aerodynamic diameter.

3.16

High Efficiency Particulate Air HEPA

for this part of ISO 19713, HEPA is defined as a filter having 99,95 % efficiency at most penetrating particle size (class H13 according to EN 1822) or 99,97 % (or higher) fractional efficiency at 0,3 µm using DOP aerosol as defined by IEST RPCC001 recommended practice

3.17

neutralization

aerosol whose charge distribution is reduced until it provides a Boltzman equilibrium charge distribution

4 Test equipment, accuracy and validation

4.1 Measurement accuracy

Accuracy requirements are given in Annex E, Table E.1.

4.2 Test stand configuration

Complete OEM air cleaner assemblies or individual air filter elements may be tested. The test stand shall consist of the following major components and shall be arranged as shown in Figure 2.

NOTE 1 Depending on configuration results may vary.

NOTE 2 Air cleaner assembly orientation will affect performance. It is recommended that air cleaner assemblies will be oriented and tested as installed in the vehicle.

Figure 2 shows a set up to measure the performance of an air cleaner assembly.

Figure 3 shows a recommended air cleaner housing to measure the performance of a panel type air filter element.

Figure 4 shows a recommended air cleaner housing to measure the performance of a cylindrical type air filter element

4.2.1 Unit under test

The unit under test may be an air cleaner housing with filter element or elements or it may be a housing designed to hold a filter element with appropriate inlet and outlets. The unit under test may be or may include a pre-cleaner. The scope of this test procedure does not include the testing of air cleaner systems without tubular inlet and outlet connections. However designs such as perforated or louvered inlet systems could be tested with the unit under test inside a plenum that would include a tubular inlet. Non-tubular air cleaner systems outside the scope of this test procedure may still be evaluated as agreed upon between the tester and customer.

(standards.iteh.ai)

4.2.1.1 Air cleaner assembly

Air cleaner assemblies will be evaluated using the set up shown in Figure 2. ISO/DIS 19713-2
53cba51eb3f9/iso-dis-19713-2

4.2.1.2 Evaluating panel air filter elements

In general, panel type air filter elements may be tested using the recommended housing shown in Figure 3.

4.2.1.3 Evaluating cylindrical/round air filter elements

Figure 4 shows a recommended housing to test cylindrical type air filter elements. This housing design is similar to the one recommended in ISO 5011.

4.2.2 Ducting

Upstream and downstream cylindrical ducting shall be made of conductive material and all components shall be commonly grounded from the aerosol inlet section to the downstream sampling section.

4.2.3 Air flow conditioning

Inlet air shall be conditioned according to requirements of ISO 5011 ($23\text{ °C} \pm 5\text{ °C}$ and $55\% \text{ r.h.} \pm 15\% \text{ r.h.}$). The inlet air shall be filtered with a HEPA filter if the background particle concentration exceeds the definition in Annex E.

4.2.4 Test configurations

The upstream and downstream ducting can be constructed vertically (recommended), horizontally or a combination based on space constraints. The example in this procedure shows a vertical configuration to test both air cleaners and panel type air filters. Preferable the particle samplers should be located vertically in each test section, which reduces the probability of particle loss and enable sampling of large particle sizes of

interest. The underlying test system design will reduce particle losses and meet the requirements of Table E.1 and E.2 in Annex E.

4.2.5 Air flow ducting

The test system should be capable of handling user specified flow rates. Further, the test system will maintain the required flow rates with air cleaner assembly pressure loss up to 10 kPa. Primary duct sizing shall conform to the following 'nominal' duct diameter and Reynolds Numbers in Table 1 below. Higher and lower flow rates may use duct sizes scaled appropriately.

Table 1 — Duct diameter vs. flow range

Nominal duct diameter mm	Area m ²	Velocity m/s	Flow range low m ³ /h	Flow range high m ³ /h	Reynolds Number	
					at low flow	at high flow
50	0.00202	11.6	85	425	40.407	202.034
100	0.0081	5.8	170	850	40.407	202.034
150	0.0182	5.2	340	1.700	53.876	269.378
200	0.0324	5.8	680	3.400	80.813	404.067

NOTE A 10 µm particle with a specific gravity of 2 settles at about 6 x10⁻³ m/s in still air. At the minimum velocity of approximately 5.1 m/s this would result in a 10 mm drop in that 10 µm particle over a 3 m run.

4.2.6 Inlet filtration

iTeh STANDARD PREVIEW

Test inlet air flow shall be filtered with a HEPA filter to remove the majority of ambient aerosol if required according to Annex E.

4.2.7 Flow uniformity

<https://standards.iteh.ai/catalog/standards/sist/eabb56b3-60c3-41ad-a769-53cba51eb3f9/iso-dis-19713-2>

The test system shall be designed to provide uniform and steady air flow to the air cleaner assembly or to the air filter element under test as stated in the test set up.

NOTE Uniform air flow is required in sections where isokinetic samplers are located when evaluating air cleaner assemblies. Proper flow distribution will facilitate a representative aerosol sample being drawn by the isokinetic samplers. Refer to 5.2.9.3 for flow uniformity measurements.

4.2.8 Leakage

It is important to minimize leakage into the test system to obtain valid data. Depending on where the leakage occurs, it can cause major errors in particle counting.

As a minimum all connections and joints should be checked for visual leakage using soap bubbles. Any known soap solution can be used for the test. Preferably, the soap solution [foam] will be applied using a brush at all connections and joints. Leaks are especially important on the clean side of the air cleaner.

4.2.9 Fractional efficiency test aerosol generator

The aerosol generator for fractional efficiency tests shall provide a stable and homogenous aerosol concentration and size distribution. The size distribution of the aerosol shall have sufficient particles for statistical evaluation in each size class as explained in Annex B.6. If high-resolution particle spectrometers are used, size classes may be combined to achieve the required counts. The total concentration of the aerosol in the test duct shall not exceed the limit of the particle counter discussed in 5.2.13.2. The efficiency test aerosol concentration shall be low enough so there is no change in efficiency during the test as described in 6.1. (i.e. no loading effects).

4.2.9.1 Aerosol generation

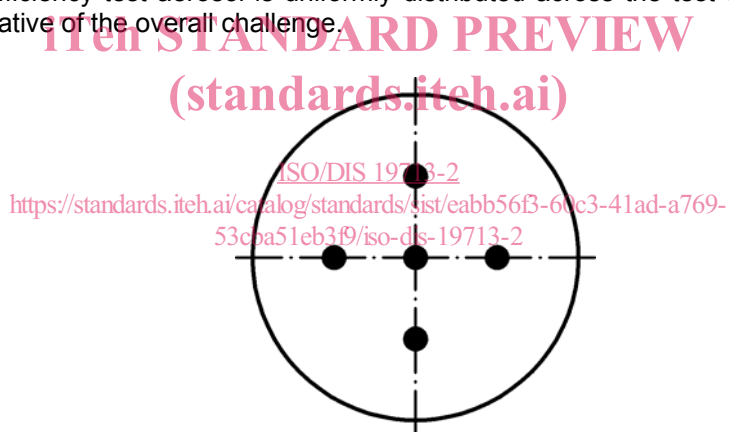
Test dust and aerosol generation shall follow ISO 5011 subclause 6.2.1 through 6.2.5.

4.2.9.2 Aerosol dispersion

The efficiency test aerosol should be injected with the air flow according to Figure 2 (refer to ISO 5011 subclause 6.2.1 through 6.2.5.).

4.2.9.3 Aerosol uniformity

During Validation of uniformity and concentration of the efficiency test aerosol, no air cleaner shall be installed in the location of the test filter (see Figure 2). Instead, a smooth straight pipe or an elbow may be used. The uniformity of the particle size distribution and the concentration of the test aerosol used for fractional efficiency tests may be verified by use of a particle-sizing instrument that will also be used in the test system. This particle-sizing instrument shall draw samples upstream and downstream of the air cleaner mounting position using the isokinetic samplers. For each test duct the minimum and maximum flow rate will be used for this evaluation [refer table 1] Samples shall be drawn by the isokinetic samplers along a diameter at 3 locations. Locations will be 0,15 D, 0,5 D and 0,85 D [refer to Figure 1]. The measurements will be performed in a plane along two perpendicular diameters. A minimum of 3 samples shall be drawn at each sampling location, and the resulting number distribution shall be averaged. As far as possible, the samples will be taken at random. The average values for each reported particle-size range shall not vary by more than $\pm 10\%$ for channels less than $15\ \mu\text{m}$ particles and $\pm 20\%$ for channels greater than $15\ \mu\text{m}$ particles among the 5 locations. This indicates that the efficiency test aerosol is uniformly distributed across the test duct, and that the centerline sample is representative of the overall challenge.



NOTE Sampling positions horizontal: $0,15 \times$ tube diameter; $0,5 \times$ tube diameter; $0,85 \times$ tube diameter
Sampling positions vertical: $0,15 \times$ tube diameter; $0,85 \times$ tube diameter

Figure 1 — Location of isokinetic sampling points for validation.

4.2.10 Aerosol neutralizer for coarse test dust

Neutralization is not used in this part of the standard.

4.2.11 Upstream and downstream sample probes

Sampling probes shall be isokinetic (local velocity of duct and probe to be equal) to within $\pm 20\%$. The same probe design should be used upstream and downstream the filter. Sampling probes shall be located on the centreline of the test duct. Sample probes shall be located at least 7 diameters downstream of any bends, reducers, expanders etc. The sampling probe shall be at least 4 diameters upstream of any bends, reducers, expanders etc. The samplers will also be located in the centre of duct. The probes shall be made of electrically conductive metallic tubing with a smooth inside surface. The design of the probes and sampling lines will reduce particle losses. The inlet of the sampling probes shall be sharp edged and shall be located near the centre of the duct. Both the upstream/downstream sampling lines should be identical, straight (or no