Designation: D7788 – 14 (Reapproved 2023)

Standard Practice for Collection of Total Airborne Fungal Structures via Inertial Impaction Methodology[1]

This standard is issued under the fixed designation D7788; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this practice is to describe procedures for the collection of airborne fungal spores or fragments, or both, using inertial impaction sampling techniques.

1.2 This practice is not intended to limit the user from the collection of other airborne particulates that may be of interest and captured through this technique.

1.3 This practice presumes that the user has a fundamental understanding of field investigative techniques related to the scientific process, and sampling plan development and implementation. It is important to establish the related hypothesis to be tested and the supporting analytical methodology needed in order to identify the sampling media to be used and the laboratory conditions for analysis.

1.4 This practice does not address the development of a formal hypothesis or the establishment of appropriate and defensible investigation and sampling objectives. It is presumed the investigator has the experience and knowledge base to address these issues.

1.5 This practice does not provide the user sufficient information to allow for interpretation of the analytical results from sample collection. It is the user's responsibility to seek or obtain the information and knowledge necessary to interpret the sample results reported by the laboratory.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D3195/D3195M Practice for Rotameter Calibration

D4840 Guide for Sample Chain-of-Custody Procedures

D6044 Guide for Representative Sampling for Management of Waste and Contaminated Media

D7391 Test Method for Categorization and Quantification of Airborne Fungal Structures in an Inertial Impaction Sample by Optical Microscopy

3. Terminology

3.1 *Definitions*—For definitions and terms not listed here, see Terminology D1356.

3.1.1 *inertial impactor, n*—a device designed for the impaction of particles that are separated from the air stream by inertia onto a collection surface. **D7391**

3.1.1.1 *Discussion*—Inertial impactors are available in many designs including "slit" and "circular" jets.

3.1.1.2 *Discussion*—Allows for the identification to genus or group of fungi detected, quantification to spores/m^3, and general assessment of background debris. Identification of pollen, hyphal fragments and other airborne particulate may be included.

3.1.2 *sample, n*—a portion of a population. A portion of material that is taken for testing or record purposes. **D6044**

3.1.3 *sample, representative, n*—a sample collected in such a manner that it reflects one or more characteristics of interest (as defined by the project objectives) of a population from which it is collected. **D6044**

[1] This practice is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.08 on Assessment, Sampling, and Analysis of Microorganisms.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.3.1 *Discussion*—Populations of airborne fungal spores are typically not homogeneous.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aerodynamic diameter (d_a), n*—the diameter of a unit density sphere having the same inertial properties as the particle under analysis under the same conditions.

3.2.1.1 *Discussion*—For fungal spores this is generally based on a water droplet, (spherical particle) having a density of 1 g/cm^3. Aerodynamic diameter has been developed to categorize the sizes of particles of different shapes and densities with a single dimension. The aerodynamic diameter is not necessarily equal to the physical diameter due to variations in shape or density.

3.2.2 *calibration impactor, n*—a designated cassette, or media unit, placed in the sampling assembly during calibration or verification of the air flow rate.

3.2.3 *chain of custody (COC) record, n*—a document that provides for the traceable transfer of field samples to the analytical laboratory. It may or may not be combined with the field data sheet.

3.2.3.1 *Discussion*—Additional guidance can be found in Guide D4840.

3.2.4 *collection or capture efficiency, n*—the percentage of a specified substance retained by a sampling device.

3.2.4.1 *Discussion*—Collection or capture efficiency is a function of the geometries of the impactors and the air flow rate, the jet dimensions and jet to plate distance, and the aerodynamic diameters, shape, density and surface morphology of the airborne particles.

3.2.5 *field data sheet, n*—a record that provides a reference document for information directly related to the sample collection event, including pre- and post-calibration data.

3.2.6 *fungal structure (sing.), n*—a collective term for fragments or groups of fragments from fungi, including but not limited to conidia, conidiophores, hyphae and spores.

3.2.7 *fungus (sing.), fungi, (pl.), n*—eukaryotic, heterotrophic, absorptive organisms that usually develop a rather diffuse, branched, tubular body (that is, network of hyphae) and usually reproduce by means of spores (**1**).[3] The terms 'mold' and 'mildew' are frequently used by laypersons when referring to various fungal colonization.

4. Significance and Use

4.1 This practice is intended for the collection of airborne fungal spores or fragments, or both, using inertial impaction.

4.2 It is the responsibility of the user to assure that they are in compliance with all local, state and federal regulations governing the inspection of buildings for fungal colonization and the collection of associated samples.

4.3 This practice is intended to provide the user with a basic understanding of the equipment, materials and instructions necessary to effectively collect air samples using an inertial impactor.

4.4 This practice, when properly executed, may also be used for the evaluation of other types of airborne particles with the capturing characteristics appropriate for inertial impactor, and for which appropriate analytical methods exist. Such particles may include dust mites, skin cells, pollen, and other materials.

5. Preparation of Sampling Equipment

5.1 *Equipment List:*

5.1.1 *Sampling Assembly*—The combination of components from the pump/fan system through to the sampling media (for example cassette, slide) including any transport tubing, flow controller and connectors. The configuration may be an integrated assembly or components that have been configured with an external pump/fan.

NOTE 1—Rotary vane, diaphragm, linear magnetic, piston and fan driven devices may have the open flow capacity for specific impactors; however, resistance to flow through the impactor can dramatically reduce flow rates. Care must be taken to select a pump and calibrator that are compatible with impactors to set and measure flow rates properly.

5.1.1.1 Use an inertial impactor with a d_{50} collection efficiency less than or equal to a 3.0 µm d_a in accordance with the manufacturer's recommended flow rate, sample time, and sample orientation. Record these parameters.

NOTE 2—Use collection efficiency data available from manufacturers' technical reports or from peer-reviewed published data.

NOTE 3—All bioaerosol impactors operate on the same principles regardless of the operating parameters. However, all impactors are not equally effective or efficient in trapping particles from an air stream. Published data investigating some common fungi in airborne samples discusses these differences and how they affect collection efficiency (**2-5**).

5.1.1.2 For external pump/fan assemblies, use flexible tubing and connectors appropriate for secure connection of impactor to pump/fan.

5.1.2 *Primary flow calibration device* with a measuring range appropriate for the system and with a ±5 % tolerance of the desired flow rate.

5.1.3 *Secondary flow calibration or verification device,* for example, rotameter or other device used to check system performance in the field.

5.1.4 *Stop watch* or other timing device capable of measuring time in increments of minutes and seconds (one second resolution).

5.1.5 *Field data sheet.* Refer to 6.6.

5.1.6 *Support stand (optional).* Allows for consistent sample collection height.

5.2 *Assembly Calibration:*

5.2.1 Calibrate or verify airflow through the assembly configuration that will be used in the field. For example, do not calibrate with one length of tubing and sample with a different length of tubing.

5.2.2 Use a primary or a calibrated secondary flow device to verify the airflow rate passing through the sampling assembly. The investigator should be aware that it is the airflow rate through the impactor, not the pump/fan that shall be calibrated.

5.2.3 Verify the secondary flow device using a primary calibration device in accordance with the manufacturer's recommendations.

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

5.2.4 Integrated sampling assemblies may not be capable of being calibrated by the user. Follow manufacturer's instructions when user calibration is not possible.

5.2.5 Verify and record the airflow prior to and following field sampling. If the result of the post-field verification check is greater than ±10 % of pre-field verification, either (*1*) discard any samples collected, re-adjust the sampler as necessary, and re-sample; or (*2*) note any airflow rate variations in the field notes and any data interpreting documents, recording the magnitude of the change and averaging the airflow rates (Practice D3195/D3195M). Use this average airflow rate to calculate sample volume.

6. Sample Collection

6.1 *Preliminary Considerations:*

6.1.1 Inspect the collection media and discard any that are damaged, expired, or compromised.

6.2 *Sample Position and Conditions:*

6.2.1 Position inertial impactor to allow the free flow of air around it.

6.2.2 Record sampling conditions including time, date, and location. If relevant, record other conditions such as; temperature, relative humidity, air movement (that is, wind, fans, HVAC), height above ground, and occupant activity during sample collection.

6.3 *Sampling Time:*

6.3.1 Record the sampling time in minutes and seconds.

6.3.2 Sampling time is determined by the manufacturer's recommendation and professional judgment.

6.4 *Sample Labeling:*

6.4.1 Label each sample with a unique identifier. Media manufacturer's unique number (for example, serial number) may be used.

6.4.2 Record sample unique identifier on a field sheet, logbook, or chain of custody (COC) record, or combination thereof.

6.5 *Sample Orientation:*

6.5.1 Follow manufacturer's recommendations.

6.6 *Field Data Sheet:*

6.6.1 Record the following on the field data sheet:

6.6.1.1 Sampling date,

6.6.1.2 Project name and project location(s),

6.6.1.3 Investigator's name(s),

6.6.1.4 Type of sampling assembly,

(1) Assembly pump/fan identifier may be appropriate.

6.6.1.5 Pre- and post-verification data,

6.6.1.6 Unique sample identifiers,

6.6.1.7 Sample locations,

6.6.1.8 Sampled air flow rate,

6.6.1.9 Sample start time,

6.6.1.10 Sample stop time or duration,

6.6.1.11 Calculated sample volume, and

6.6.1.12 Environmental sampling conditions (refer to 6.2.2).

6.7 *Sampling Assembly Operation:*

6.7.1 Prepare the sampling assembly.

6.7.2 Remove and maintain control of any protective covers for the media and install media in the sampling assembly.

6.7.3 Start pump/fan and record start time or duration where operation is on a timer.

6.7.4 After sampling, turn pump/fan off and record stop time.

6.7.5 Reseal the media, with the protective covers if any, and remove from system.

NOTE 4—Use of timers may be helpful when operating multiple pump/fans simultaneously.

NOTE 5—Minimize influence on the sample collection from operator proximity to the sample inlet.

6.8 *Sample Submittal for Analysis:*

6.8.1 Submit samples for analysis with COC.

6.8.2 The COC includes:

6.8.2.1 Name and signature of investigator;

6.8.2.2 Date, time, and signature of releasing party;

6.8.2.3 Name and contact information of responsible party (that is, investigator's employer);

6.8.2.4 Project identification (that is, project identifier or site location, or both); and

6.8.2.5 List of all samples being submitted.

6.8.3 Communicate the following analytical request information:

6.8.3.1 Contact information for analytical report receipt, if different than submitter's information;

6.8.3.2 Analytical method requested (that is, Test Method D7391 or other applicable method);

6.8.3.3 Turn-around time requested;

6.8.3.4 Sample volume or sample time and flow rate; and

6.8.3.5 Special or unique instructions, if applicable.

6.8.4 Sample transport for analysis.

6.8.4.1 Protect samples from damage and temperature extremes.

6.8.4.2 Ship samples with a trackable carrier or hand deliver.

7. Interferences and Limitations

7.1 The investigator must understand the purpose of the project and consider interferences and limitations. Predictable and unpredictable errors associated with sampling methods exist.

7.1.1 Predictable errors include, but are not limited to collection efficiency, system design variations (Guide D6044).

7.1.2 Unpredictable errors include, but are not limited to inherent variation in the concentration of airborne fungal structures, changes in environmental conditions, equipment malfunction, etc.

7.2 The collection efficiency of the system may be affected by extremes in temperature, relative humidity, atmospheric pressure, wind speed, and direction.

7.3 The overall effectiveness and collection efficiency of an inertial impaction sampler is a function not only of system design and operation but also of fungal structure size, density, morphology (shape and roughness), concentration, and the amount of non-fungal airborne debris. The investigator should be aware that not all types and sizes of fungal structures are