

Guidelines on measurement and assessment of and protection from airborne fungi and related contaminants in indoor workplaces

The following guidelines provide instructions and recommendations for the measurement of airborne fung concentrations in indoor working environments, the assessment of contamination levels, and protective measures according to the levels of contamination, with a main focus on salvage operations for water-damaged cultural properties.¹

These guidelines form a pair with the “Manual for human body protection from airborne fungi.”

1 Measurement methods

Environment during measurements

Airborne fung measurements are conducted under usual working conditions. As a general rule, the windows of the room are kept closed during measurements. If windows are opened, measurements are taken after the windows have been closed for at least 3 hours.

Equipment

Measuring equipment should conform to ISO (International Organization for Standardization) standards..

Method

Measurements are taken at the center of the room at a height of approximately 1 meter from the floor. If it is difficult to place the measuring instrument accordingly, measurements performed at a stable location in the vicinity are acceptable.

- 1) Sterilize the necessary parts of the measuring instrument with cotton moistened with alcohol.
- 2) Set the volume of air to be sampled (e.g., 100 L, 200 L, 250 L, and 500 L).
- 3) Place the culture medium to be used on the measuring instrument.

Select a type of agar medium from the following two options depending on the conditions: a. culture medium for hygrophilous species and b. culture medium for xerophilous species.

- a. Antibiotic-amended potato dextrose agar medium, antibiotic-amended Sabouraud glucose agar medium
 - b. M40Y agar medium, DG 18 agar medium
- 4) After completing air sampling, remove the agar medium and record the measurement location.
 - 5) Record the date, time, weather, measurement point, temperature and humidity, media used, air sampling volume, and other necessary information. If air conditioning equipment, air cleaners, and blowers are running, this should also be noted.

Culturing/observation/counting

- 1) After collecting, secure the culture medium with adhesive tape or rubber bands to prevent contamination, and place it in a plastic bag or container.
- 2) Culture in an incubator at 25–28°C.
- 3) Count the colonies appearing on the culture medium after approximately 3 days. Do not flip over the medium while counting.

¹ This document was created by the Cultural Heritage Disaster Risk Management Center and the Tokyo National Research Institute for Cultural Properties, both founded by the National Institutes for Cultural Heritage, in reference to the “Indoor environment maintenance management standards relating to floating molds inside the Kawasaki City Museum” (supervised by the Center for Fungal Consultation, Japan; created by the Kawasaki City Museum) established on February 18, 2021. The non-profit organization Center for Fungal Consultation, Japan provided recommendations in the preparation of the document.

- 4) Transfer any culture media showing the rapid growth of fungi after 3 days to a separate bag or container.
- 5) Continue the incubation and count the final number of colonies after 7 days. In addition, confirm whether they are single or multiple species.

2 Assessment standards

- 1) Standards required for emergency treatment and storage facilities
 - (1) Work area (e.g., workrooms and storage rooms where water-damaged cultural properties are handled)

Less than 1,000 cfu/m³
 - (2) General business areas (e.g., offices and meeting rooms)

Less than 200 cfu/m³
- 2) Terminology on the degree of contamination

2,000 cfu/m ³ or more.....	Strongly contaminated
1,000 cfu/m ³ or more and less than 2,000 cfu/m ³ ...	Contaminated
200 cfu/m ³ or more and less than 1,000 cfu/m ³	Semi-clean
Less than 200 cfu/m ³	Clean

If the concentration is 600–1,000 cfu/m³ for a single or multiple species of fungi, the degree of contamination is considered to be “contaminated” or “strongly contaminated.”

* The assessment above focuses on the number of culturable airborne fungi. Since unculturable fungi and fungal fragments may also cause respiratory allergy pathologies and other diseases, it is advisable to measure all airborne particles in addition to the above.

3 Protective measures

- 1) Strongly contaminated/Contaminated

Wear anti-dust masks (DS2 or better filtering performance) in work areas.² Goggles are recommended to be carried and worn at all times. Isolation caps or other head protection should be worn. Workwear should be disposable personal protective equipment (e.g., a non-woven fabric coverall cleanroom suit) or general industrial workwear. The aforementioned masks should also be worn in general business areas.
- 2) Semi-clean/Clean

Wear masks with at least DS1 or DS1-equivalent dust filtering performance or non-woven masks that conform to the Japanese Industrial Standards in work areas. General industrial workwear should be worn.

Regardless of pre- or post-fumigation, protective measures for Strongly contaminated or Contaminated conditions should be followed when working in areas with severe fungal contamination (moving mold-covered cultural properties in and out of the work area, cleaning these items, unveiling of sticky paper, and any other work) for long working hours.

No special considerations are required for masks and workwear in general business areas.

² There are three categories of disposable industrial masks for solid particles: DS3, DS2, and DS1, which have passed the national requirements provided by the Ministry of Health, Labor, and Welfare. The larger the number is, the higher the particle collection efficiency is, but the harder it is to breathe. To obtain more information on anti-dust masks and other protective equipment, see “Manual for human body protection from airborne fungi.”