BSR/ASHRAE/IAQA 3210P

Second Public Review Draft

Standard for the Assessment of Educational Facilities for Moisture Affected Areas and Fungal Contamination

Second Public Review (November 2017)
(Draft Shows Complete Proposed New Standard)

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TABLE OF CONTENTS

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FOREWORD

BSR/ASHRAE/IAQA (IAQA is an independent subsidiary of ASHRAE) Standard 3210 is the latest standard, since the first public review, for the assessment of education facilities for moisture affected areas and fungal contamination. It is intended for those with an interest in properly assessing moisture affected areas and fungal contamination with an emphasis placed on those providing professional fungal assessment services.

To provide consistency, a standard of practice and improve the assessments of educational facilities, a standard practice is needed to guide assessor(s) through the proper assessment to obtain a healthy indoor environment for educational facilities. Other standards may establish more specific requirements that apply to diverse facilities in schools. This standard is not intended to limit the level of service provided or recommendations made by the assessor(s). The assessor(s) assessing the facility are encouraged to consider all aspects to maintain a healthy indoor environment.

This "Standard for the Assessment of Education Facilities for Moisture Affected Areas and Fungal Contamination" does not address all of the possible site hazards and safety concerns that the assessor could encounter during an assessment. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of all facility specific requirements and the Local, State, Federal and Tribal regulatory standards before conducting projects under this standard.

1. PURPOSE

The purpose of this standard is to provide a uniform and repeatable procedure to identify areas in buildings and facilities and their associated materials, equipment and systems that are subject to moisture or are suspected of fungal contamination or adverse conditions associated with the observance of fungal contamination.

2. SCOPE

This standard applies to the conduct of an on-site assessment of buildings and facilities, or portions thereof, that are used for educational purposes to determine if and to what degree they are *contaminated* with *fungi*. This standard does not apply to biological contamination beyond fungal growth.

3. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

3.1. General

Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this standard. These definitions are applicable to all sections of this standard. Terms that are not defined shall have their ordinary accepted meanings within the context in which they are used. Ordinarily accepted meanings shall be based upon standard American English language usage as documented in an unabridged dictionary accepted by the adopting authority.

Informative Note: Throughout the standard words defined in this section are italicized.

3.2. Definitions

allergen: substance (such as *fungi*) that can cause an allergic reaction.

amplification: is an indication gathered through visual observation of fungal growth or interpretation of analytical data indicating greater *concentrations* of *fungi* or fungal growth than those present in the unaffected areas.

asthma: a respiratory condition marked by spasms in the bronchi of the lungs, causing difficulty in breathing. It usually results from an allergic reaction or other forms of hypersensitivity.

associated conditions: a broad category of observations which indicate previous and current conditions symptomatic of fungal growth including but not limited to: staining, historical report of dampness, bubbled paint, swollen wood,

excessive garbage, increased insect activity, and malodor.

assessment: the process and report documentation as described in this Standard, as performed by a qualified assessor.

bioaerosols: airborne particles that originate from living organisms. They may be alive or dead.

bulk sampling: the collection of fungal growth or substrate material(s).

chain of custody (COC): a procedure whereby steps are taken after a sample is secured to maintain the integrity of the sample and document the chronological documentation showing the date, time, name, and signature of everyone handling the sample from initial *sampling* through laboratory analysis and reporting.

concentration: the abundance of a constituent divided by the total volume of a mixture.

condensation: a deposit of *moisture* from air that contains water vapor onto surfaces that are cooler than that air.

condition 1 (normal fungal ecology): an indoor environment that may have settled spores, fungal fragments or traces of actual fungal growth whose identity, location, and quantity are reflective of a normal fungal ecology for a similar clean and dry indoor environment.

condition 2 (settled spores or fungal fragments): an indoor environment which is primarily *contaminated* with settled spores or fungal fragments that were dispersed directly or indirectly from a *Condition 3* area, and which may have traces of actual fungal growth.

condition 3 (actual growth): an indoor environment *contaminated* with the presence of actual mold growth, associated spores, and fungal fragments. Actual fungal growth includes growth that is active or dormant, visible or hidden.

conducive conditions: any currently present condition supportive or potentially supportive of fungal growth including but not limited to, *moisture* related event(s) or other occurrences that support fungal growth such as elevated *humidity* or damp building materials.

confined space: any space that has limited or restricted means of entry or exit; is large enough for a person to enter to perform tasks and is not designed or configured for continuous occupancy.

contaminated: the presence of indoor fungal growth or fungal spores, whose identity, location, and quantity are not reflective of a normal fungal ecology for similar indoor environments

crawl space: an accessible or inaccessible area under a structure.

damp condition: a specific area or material with *moisture*/*humidity* levels significantly greater than typical conditions for the site. The identified area can be localized or encompass significant portions of the building.

dew point: the temperature at which the water vapor in a sample of air at constant barometric pressure condenses into liquid water at the same rate at which it evaporates.

dry standard: the expected moisture level in building material established by comparing affected *moisture* content conditions to unaffected areas of the building.

educational facility: any building, structure, or facility and systems thereof, temporary or permanent in nature, used for or in connection with the conduct or operation of an educational institution. An *educational facility* includes but is not limited to child development centers (pre-school and daycare facilities); elementary, secondary, high schools and junior colleges; colleges and universities.

evidence: observations or data that assists an individual to establish a particular conclusion.

fungi: a kingdom of heterotrophic single-celled, multi-nucleated, or multi-cellular organisms, including yeasts, *fungi* and mushrooms that are parasitic in nature, reproduce both sexually or asexually, can start amplifying independent of the parent mycelium, have their genetic material bound by a membrane and do not contain any chlorophyll.

habitable space**:** building space intended for continual human occupancy; such space generally includes areas used for living, sleeping, dining, and cooking but does not generally include bathrooms, toilets, hallways, storage areas,

closets, or utility rooms.

humidity: the amount of *moisture* in the air determined from the ratio of the actual *moisture* to the saturated *moisture* at a given temperature expressed as a percentage or stated as "*relative humidity*."

HVAC: HVAC (heating, ventilation, and air conditioning) is a major sub-discipline of mechanical engineering. The goal of HVAC design is to balance indoor environmental comfort with other factors such as installation cost, ease of maintenance, and energy efficiency.

hypothesis: a statement that explains or makes generalizations about a set of facts or data, forming a basis to confirm its feasibility.

impactor: a particle stage *sampling* device used primarily for the purpose of collecting culturable samples in Petri dishes.

indoor air: ambient air contained inside the building envelope.

indoor air quality: the quality of the *indoor air* based on several parameters including, but not limited to temperatures, *humidity* levels, particulates, and other potential contaminants.

indoor environmental quality: the quality of the indoor environment based on several parameters including by not limited to the quality of the *indoor air*, but also other environmental factors such as noise and lighting.

interview: a series of pertinent questions that include, but are not limited to, the following: occupants, date of construction, maintenance history, design alterations, composition material and location.

invasive fungal assessment: the act of conducting observations with activities including but not limited to removing, disconnecting, dismantling, probing, or employing other destructive methods to access any systems, interstitial cavities, structure, or component that would not be taken apart during an ordinary operation or maintenance activity.

judgmental sampling: a non-probability *sampling* technique where areas to be sampled are selected based on the knowledge and professional judgment of the individual conducting the *sampling*.

make-up air: air brought into a building from the outdoors to replace air that is exhausted. Makeup air may or may not be conditioned.

Microbial Volatile Organic Compound (MVOC): Airborne chemical compounds produced by *fungi* which may or may not be detected by human smell and are the source of odors associated with mold *amplification*.

moisture: the presence or amount of water within the building envelope.

moisture affected area: area(s) or surfaces within the area where surface water activity may support fungal growth, or building materials and contents that have become impacted by moisture.

mycotoxins: chemical toxins which may be produced and released by *fungi*.

non-porous: materials that could act as a vapor barrier and which do not absorb water well and are not easily penetrated by liquids.

non-suspect surface: the area on a surface that is similar in material and physical characteristics to the suspect area, but is free of stain, discoloration, blemish or irregular appearance, and appears to be visually free of active or dormant fungal growth.

outdoor air: all air that is outside the building.

post remediation verification: an assessment, which will include visual inspection, olfactory or *sampling* methodologies, to verify that the building systems and contents have been properly remediated.

porous: a material having the ability to allow liquids or gases to pass through it.

quality control (QC): the overall system of activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet desired requirements.

readily accessible: capable of being reached for operation, maintenance, and inspection with limited effort.

relative humidity (RH): the relationship between air volume and the amount of *moisture* it holds at a specific temperature expressed as a percentage of that air's total *moisture* holding capacity.

sampling: the collection of air, surface, dust, or bulk materials to quantify or qualify *fungi* in the educational facility.

scope of work* (SOW)*: a formal document that captures and defines the conditions, work activities, deliverables, and timeline for the assessor(s) conducting the work.

suspect condition(s): indication(s) of *moisture* intrusion or observable characteristics consistent with water-impacted building materials that may support fungal growth.

suspect fungal growth: the area on a surface that is discolored, stained, blemished or exhibiting the characteristics consistent with fungal growth.

ventilation: a method of controlling the indoor environment with air flow.

water damage fungi: *fungi* frequently found in water-damaged buildings including but not limited to: *Aspergillus* and *Penicillium* species, *Acremonium spp*., *Sporobolomyces spp*., *Stachybotrys chartarum, Memnoniella echinata, Tritirachium oryzae, Ulocladium botrytis, U. chartarum, Cladosporium spp*., and *Chaetomium spp*., *Aspergillus fumigatus, A. niger, Penicillium oxalicum, P. thomii*.

3.3. Acronyms

ACCA	Air Conditioning Contractors of America
ACGIH	American Conference of Industrial Hygienists
ACH	Air Changes per Hour
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
Aw	Water activity
CFM	Cubic Feet per Minute
CFU	Colony Forming Units
COC	Chain of Custody
DNA	Deoxyribonucleic Acid
EMC	Equilibrium Moisture Content
EMLAP	Environmental Microbiological Laboratory Accreditation Program
EPA	Environmental Protection Agency
ERMI	Environmental Relative Moldiness Index
FERPA	Family Education Rights and Privacy Act
HEPA	High-Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
IAQA	Indoor Air Quality Association
IECC	International Energy Conservation Code
MERV	Minimum Efficiency Reporting Value

4. COMPLIANCE

4.1. General

This standard provides uniform and repeatable procedures for conducting a non-invasive *assessment* of *educational facilities* for the presence of *moisture affected areas* and suspected fungal contamination or the presence of adverse conditions associated with observable fungal *amplification*. The scope of an *assessment* will vary based on the nature and extent of the concerns expressed by the client and the significance and known facts of the *moisture* problem and the suspect fungal impact as determined by the assessor conducting the *assessment*. The *assessment* process shall include at a minimum the activities in Section 4.2. (See also Normative Appendix A, Table A-1.)

4.2. Minimum Assessment Requirements. The *assessment* shall include at a minimum:

1. Preliminary information gathering
2. A visual *assessment* of *readily accessible* areas for fungal growth in the educational facility.
3. A *moisture assessment* of the educational facility.
4. A *sampling* plan (if required) consisting of surface, air and bulk environmental *sampling* to augment visual observations and field instrument data such as temperatures and *relative humidity*.
5. A written report.

Informative Note: If sampling is conducted, samples should be sent to an accredited facility experienced in environmental microbiology. Sample submissions may include information on locations and methods documented with photographs, site sample sketches, sample logs, COC, etc.

4.3. Facilities. The *educational facility* environment has many unique-use spaces that affect *moisture* and fungal *assessments*. When conducting a preliminary *assessment* the assessor shall gather information on the unique structures of the *educational facility* that warrant additional inspection due to the impact from *moisture* and fungal growth. When applicable, the assessor shall gather information on building use areas that include, but are not limited to:

4.3.1. Sports Facilities. Gymnasiums, weight rooms, indoor aquatic centers, locker rooms, and field houses. These types of facilities are prone to issues such as, but not limited to, inadequate ventilation, maintenance, and high relative humidity.

4.3.2. Art Classrooms. Arts and crafts activities have a potential for creating additional water vapor.

4.3.3. Agriculture Education Facilities. Particularly in rural *educational facilities*, agriculture is taught in non-traditional classrooms. These types of spaces often have water tanks, wash-racks, and other sources of water. Greenhouses and composting centers can be sources of *moisture* and fungal growth.

4.3.4. Science Classrooms. Science classrooms and laboratories occasionally conduct microbiology projects. Demonstrations that use large amounts of water and other student lab exercises may generate large quantities of *moisture*. In addition, laboratories may have exhaust hoods which will affect the building *ventilation*.

4.3.5. Consumer Science Classrooms. *Educational facilities* often have consumer science education or vocational classrooms.

4.3.6. Food Preparation Areas. Food preparation areas, including but not limited to the kitchen and cafeteria, may have water usage, spillage, and steam generation. These areas also contain refrigeration equipment that will generate water condensate which may leak.

4.4. Facility Maintenance. *Educational facilities* have distinct and unique maintenance issues. The assessor shall evaluate if applicable facility or operational plans are lacking and if maintenance is being deferred or is inadequate. The assessor shall review applicable maintenance schedules and records, including work orders, in order to verify that *moisture* and suspect environmental *fungi* complaints have been addressed.

4.4.1. Intermittent Closures. The *educational facility* calendar has the facility closed or on a limited schedule during portions of the year. Outdoor *humidity* and *moisture* can penetrate the facility, which may cause *moisture* or fungal growth. Therefore, during the *assessment*, the assessor shall attempt to evaluate

operational and maintenance practices and environmental conditions during occupied and unoccupied times.

4.4.2. Exterior Irrigation. If misdirected or overwatering conditions are present or have been noted around the facility, the assessor shall note the potential for *moisture* intrusion inside the structure from these systems and document it in the written report.

5. PRELIMINARY ASSESSMENT

5.1. Preliminary Information. Prior to conducting an assessment of the *educational facility***,** the assessor conducting the *assessment* shall collect preliminary information about the facility or portions of the facility to be evaluated. Information and information sources shall include interviews with knowledgeable parties, information about current and previous known leak(s), water and *moisture* event(s), and relevant history from provided source(s).

Informative Note: Interviews with knowledgeable parties can include, but are not limited to: the facility owner, manager, architect, engineers, occupants including teachers, office administration, parents, students, other professionals that have conducted facility assessments or other parties as determined by the authority having jurisdiction.)

5.2. Visual Inspection for Moisture Issues and Concerns. The intent of visual onsite *assessment* is to identify, to the extent pursuant to the processes prescribed in this standard, *moisture-affected areas* and facility deficiencies *conducive* to fungal growth. The assessor shall formulate a *hypothesis* about the origin, identity, location, and extent of *moisture affected areas*, fungal growth, or facility deficiencies. The assessor shall document and prepare a written report of the findings as required in Section 7. The assessor shall evaluate the facility for *moisture* problems including, but not limited to, design defects, construction flaws, deferred maintenance, building systems operation errors, unusual damage, piping leaks, and occupant activities. Attention shall be given to potential cavities, chases, and *crawl space* areas (potential *confined space*) for hidden dampness, as well as the *habitable* interior areas. The source(s) of each moisture/water condition that is identified shall be categorized for potential contamination in accordance with Table 5.2.

Table 5.2 Water Contamination Categories

Category Type	Description
Category 1	Water originates from a sanitary water source and does not pose risk from dermal, ingestion, or inhalation exposure.
Category 2	Water contains contaminates and has the potential to cause discomfort or sickness if contacted or consumed by humans.
Category 3	Water is grossly *contaminated* and can contain pathogenic, toxigenic or other harmful agents (surface water flooding, sewage floods)

5.2.1. Water Contamination. After identifying and categorizing Category 2 or 3 water, as defined in Table 5.2, any handling of the water for observation or collection purposes shall be by trained personnel in accordance with the IICRC S500 or other applicable worker protection requirements as determined by the authority having jurisdiction. The assessor shall document any changes in the category of water contamination over time.

5.2.1.1. Water Contamination Reporting Requirements. For each incidence of *moisture* that is observed, the assessor shall determine and record the information as shown in Normative Appendix A (Table A1) and indicate whether observations and supportive data support a specific conclusion or if additional *assessment* is required in order to support a specific conclusion.

For each instance of observed *moisture* the assessor shall at a minimum determine and report the following information:

1. **Origin** – Indicate where the *moisture* is coming from.

2. **Pathway** – Indicate where the *moisture* is traveling.
3. **State** – Indicate if the *moisture* is a vapor or liquid.
4. **Force** – Indicate if gravity, air pressure, capillary action, or diffusion forces are moving the *moisture* either by a driving or pulling force.

5.2.1.2. Moisture Surveys. *Moisture* surveys shall be conducted with instrumentation that is specifically manufactured for the conditions being assessed. The assessor shall be qualified to proficiently operate and be able to document the proper calibration and the sensitivity of the instrument used. The type of instrument shall be identified in the report. *Moisture* levels shall be measured in suspect areas and documented.

5.3. Visual Assessment of HVAC. This section provides protocol and procedures for the visual *assessment* of HVAC interior surfaces for identifying the presence or absence of *moisture-affected areas* and fungal growth. All local building codes shall be adhered to, including professional licensing if required to access components of the HVAC system.

5.3.1. The assessor shall conduct a visual *assessment* of the interior surfaces of the HVAC system. The assessor shall collect photographic documentation of the current conditions of the interior surfaces of the HVAC system.

5.3.2. The access point shall

1. Allow the assessor to obtain the required photographic documentation and;
2. Support the introduction of daylight and/or electric lighting to evaluate the visually observable conditions of the interior of the ductwork, plenum, or component, and, if applicable collection of tape lift, surface wipe or bulk samples.

5.3.3. Conducting the Visual Assessment. The visual *assessment* shall be conducted in accordance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association) or ASHRAE Standard 180-2012. The visual *assessment* of an HVAC system that does not exceed 2 tons (7 kW) of cooling capacity shall include:

1. At a minimum, the visual inspection of one internal location for all systems that are not connected to (or operate without) ducting.
2. A minimum of one visual assessment in each location: in the return duct, the supply duct, and the HVAC equipment if the HVAC system(s) has return and supply.
3. A visual assessment of the return duct that shall be at a minimum of 3 feet (1 meter) from the HVAC equipment and a minimum of 2 feet (.75 meters) from a supply diffuser in the main duct before there is any branch from the main duct.
4. A visual assessment of the HVAC equipment that shall be located downstream of the outside air/return air mixing chamber and filters. During the visual assessment, the condition of cooling coils shall be documented as per ASHRAE Standard 180. The assessment shall not be limited to the condensate drain pain location.
5. A visual assessment of the supply duct shall be within the main trunk line, downstream of the unit and prior to any branch transitions, a distance from the HVAC equipment that is a minimum of 5 times the diameter of the supply duct at the assessment location.

Exception: Systems without a return duct and open air plenums shall be assessed at the HVAC equipment and the supply duct.

5.3.3.1. Visual Assessment of HVAC Systems Larger than 2 Tons (7 kW). An HVAC system larger than two tons with supply and return duct work shall at a minimum have three assessment locations as defined in section 5.3.3 and address other potential areas for moisture accumulation and fungal growth. Additional assessment locations shall be evaluated during the initial assessment strategy to document potential moisture accumulation and fungal growth as part of the assessment. The actual number of additional assessment locations will depend on type and complexity of the building HVAC system(s).

If humidifiers are present, the humidifiers shall be inspected.

5.3.3.2. Visual Assessment of Multi Zone HVAC System. In a multi-zone HVAC system, *assessment* locations inside the unit(s) and ducting shall be selected on proximity of *moisture* sources and fungal growth and in ducting affected by transport and dispersal of airborne *fungi*.

5.3.3.3. Visual Assessment of Dual Duct Systems. In a dual duct HVAC system, both the hot and cold systems shall be assessed.

5.3.3.4. Visual Assessment of Air Distribution System. In any air distribution system that consists of a multiple unit configuration, each unit shall be individually assessed.

5.4. Adjacent HVAC Systems. HVAC systems in locations of the building that are not directly serving a *moisture-affected area(s)* or area(s) with fungal growth, can also be affected by *moisture* or fungal growth, through various types of pressure differentials. HVAC systems for adjacent or adjoining areas shall be noted in the development of a rationale for conducting an *assessment*.

5.5. HVAC System Samplings. If the assessor determines that surface samples need to be collected, the *sampling* protocol shall record the HVAC components interior surface type, configuration and orientation, and shall be representative of the potentially impacted surface(s). Potential *sampling* surfaces include, but are not limited to:

1. *Porous* surfaces that shall be in a relatively smooth flat area.

Informative Note: It may be necessary to conduct *bulk sampling* to identify what is contained within the *porous* material(s).

2. *Non-porous* materials that shall be sampled in a relatively smooth flat area.

Exception: Samples shall be representative of the materials of construction.

Informative Note: *Sampling* materials and collection procedures for surface and bulk samples are contained in Informative Appendix C.

6. METHOD OF FIELD DOCUMENTATION FOR MOISTURE-AFFECTED AREAS AND FUNGAL CONTAMINATION

6.1. Field Documentation. Field documentation shall include, but not be limited to, the following areas: foundations, exterior evaluation, interior evaluation, crawl/attic area, HVAC system evaluation, and content evaluation.

6.2. Sampling. If *sampling* is necessary, the method shall be documented according to accepted industry standards or practices. If *sampling* is conducted, the assessor shall have the experience, knowledge and training to conduct *sampling*. The assessor shall prepare and document a *hypothesis* and, if applicable, develop and implement a *sampling* plan to support the *hypothesis*.

Informative Note: See Informative Appendix C for additional guidance on *sampling*. See Informative Appendix H, Informative References, for additional guidance.

7. REPORTING

A written report that meets the provisions of this section shall be prepared by the assessor conducting the assessment.

7.1. Report Sections and Content

7.1.1. General Requirements. The assessor's report shall contain the following sections and information:

1. General - Assessor/Company's Name and Address;
2. Educational facility Name and Address;
3. Educational facility Contact Name and Title;
4. Location where *assessment* was conducted;

5. Individual(s) conducting *assessment*;
6. Qualification(s) of individual(s) conducting *assessment*;
7. Date(s) of *assessment*; and
8. *Scope of work*

7.1.2. Executive Summary. The assessor shall include a summary of information, conclusions, and if applicable, recommendations pertaining to the *assessment*.

7.1.3. Table of Contents. The report shall include a table of contents.

7.1.4. Introduction. The report shall include background information the assessor used to conduct the *assessment*. It shall contain as a minimum the following information: *educational facility* name; address of the facility; address of the subject property; individual(s) conducting *assessment* and credentials; company name of individual(s) conducting *assessment*; *assessment* date(s); and concerns of the *educational facility's* representative.

Informative Note: While not required, the assessor may include the following in the introduction: prior history of site and/or building; description of building including building use, building construction and age, occupancy, exterior description of building, description of site, any known *moisture* and fungal concerns, and description of air handling system(s) and operating times.

7.1.5. General Observations. The assessor shall at a minimum include the following in the general observations section of the report:

1. Comments made by occupant(s) concerning health concerns/conditions,
2. Indication of *moisture* or *suspect fungal growth*, and
3. Any reported malodors.

7.1.6. Sampling Conducted. The report shall include information on any *sampling* conducted either during the walk-through *assessment* or on follow up *assessment* dates. The types of *sampling* and the requirements for each are listed below.

7.1.6.1. Direct Reading. If a direct reading of data is conducted it shall include: temperature, *humidity*, and surface *moisture* levels. The location (s) of all direct reading samples shall be noted in the assessor's written report along with the date, time, and results.

7.1.6.2. Long-Term Datalogging. If long-term datalogging is conducted, it shall include, at a minimum, the following conditions in the report: temperature, *humidity*, surface *moisture* levels, and airborne particle counts. The location(s) of all long-term *sampling* shall be noted along with the date(s), time(s), and results in the assessor's written report.

7.1.6.3. Biological Sampling – Non-culture based analysis. If non-culture based biological samples are used the report shall include at a minimum the following: the locations along with the date(s), time(s), and results.

Informative Note: While not required the non-cultured based samples may also include: tape, bulk, swab, and air cassette. If these are done the assessor should consider including that information in the written report.

7.1.6.4. Biological Sampling – Culture-based Analyses. If culture-based biological samples are used the report shall, at a minimum, include the following: the location (s) of all culture-based biological samples along with the date(s), time(s), and results.

Informative Note: While not required, culture-based *sampling*, devices and analysis might include but are not limited to: *impactor*, impinger, filter, swab, bulk, microvac, tape, raised and regular agar plate. If these are used the assessor should consider including that information in the written report.

7.2. Results. The report shall provide tabular and/or graphical information of all the *sampling* results from direct reading, data-logging, and laboratory *sampling* (culturable and non-culturable). As part of the results section, the assessor shall ascertain the connection between each specific fungal growth location and the *moisture*

source when the information is known.

Informative Note: Knowing the *moisture* source(s) and correcting the cause is a key step in eliminating future fungal growth.

7.3. Summary and Conclusions. As part of this section the assessor shall summarize the relationship between the background information, observations, and *sampling* results. The assessor shall provide the client with information about how the conclusions were derived and if any standards and/or guidelines were used.

7.3.1. Reporting of Evidence and Justification of Interpretations

The specific conditions observed as of the time of the assessment may change over time. Therefore, specific measurements of area, types, and density of growth reported shall be included in the report so the conditions can be re-evaluated at later dates, if or when a remediation scope of work is written. These are the minimum reporting requirements.

Project situations will need additional information and diligence to complete a clear and concise assessment with relevant conclusions. The report conclusions shall include the appropriate Outcome (1 to 4) for each area assessed. See Table A1 in Normative Appendix A under associated conditions for area assessed. If there were occupant or client concerns, the report shall document how the concerns were resolved or otherwise addressed by the assessment.

7.3.2. Evidence for Reporting Observable Fungal Growth Shall Include, where Applicable, at a Minimum:

a. Location(s) in building (per *scope of work*)
b. Substrate impacted (materials) and source of *moisture* supporting the observed growth; such as, but not limited to: from *dew point condensation*, soaking, flooding, or leaks.
c. Area or extent of fungal growth with reference to the *Assessment Scope of work* and State or local requirements.
d. Density of colonized surface(s) (as observed).
e. Adjacent structures and assemblies affected.
f. If environmental *sampling* was performed, the laboratory results.

7.3.3. Evidence for Reporting No Observable Fungal Growth shall at a minimum include, where applicable: location(s) in building per *scope of work* where there is no observable *suspect fungal growth* and no fungal associated mal-odors.

7.3.4. Evidence for Reporting Associated Conditions, shall include, where applicable, at a minimum: location(s) in building (per *scope of work*) assessed and *moisture* sources, if identified, i.e., water staining; wet or damp materials; swollen wood; flaking or sagging paint; and potential building defects involving gutters, downspouts, roofing, and flashing that negatively impact the building and promote fungal growth.

7.3.5. Evidence for Reporting no Associated Conditions, shall include, where applicable, at a minimum: location(s) in building (per *scope of work*) that no apparent water stains; no elevated *moisture* present; no swollen wood; no flaking or sagging paint; and no potential building defects involving gutters, downspouts, or flashing that impact the building negatively and promote fungal growth.

7.4. If, based on the information obtained during the *assessment*, the assessor determines recommendations are necessary, the recommendations shall be included in the report for review by the facility management (and all other previously identified person).

7.4.1. Assessor's Signature and Date.

Assessor's reports shall contain the assessor's printed name, signature, qualifications, and date.

7.4.2. Deviations and Exclusions. The assessor shall include limitations and exclusions for the project including but not limited to inaccessible spaces. Limitations and exclusions may be based upon recommendations of the assessor's attorney(s), insurance carrier(s), or other authorities. Deviations from this standard shall be stated, clearly identified, and justified in the report.

7.4.3. Attachments. The following is a list of the minimum attachments the assessor shall include in the report:

1. Previous *assessment* reports provided by the client.
2. Copies of certification(s) and/or licenses of the assessors.
3. Photographs with descriptions.
4. Laboratory results.
5. Datalogger and meter results; and
6. Floor plans with relevant *assessment* information.

Informative Note: A photographic log could be provided with the index number of each picture.

8. SAFETY PRECAUTIONS

8.1. The assessor shall comply with all applicable regulations regarding worker and environmental health and safety including, but not limited to:

1. Confined Space Entry, OSHA Standard 29 CFR 1910.146.
2. Control of Hazardous Energy (Lockout/Tagout), OSHA 29 standard CFR 1910.147.
3. Respiratory Protection Standard, OSHA Standard 29 CFR 1910.134.
4. Personal Protective Equipment (PPE), OSHA Standard 29 CFR 1910.132, 133, 135, & 138.
5. Hazard Communication Standard, OSHA Standard 29 CFR 1910.1200.
6. Various standards under 29 CFR subpart D, walking and working surfaces, including OSHA Standards
7. Scope and Definitions, OSHA Standard 29 CFR 1910.21
8. Training Requirements, OSHA Standard 1910.30.
9. Various standards under 29 CFR subpart F, powered platforms, man lifts, and vehicle- mounted work platforms, including OSHA standards 29 CFR 1910.66 – 1910.68.
10. Fall Protection various standards under 29 CFR 1926 subpart M, fall protection, including OSHA Standards 29 CFR 1926.500 – 1926.504 and subpart M appendices A through E.

Informative Note: For guidance specific to indoor environments containing or potentially containing asbestos, refer to Asbestos, OSHA Standard 29 CFR 1926.1001

8.2. Personal Protective Equipment. The use of Personal Protective Equipment (PPE) shall conform to OSHA regulation 1910.132, 133, 135 & 138. The assessor shall have, as a minimum, and utilize the following PPE as appropriate for the perceived and/or know hazards:

1. Gloves – When there is a potential for direct contact with fungal related matter the use of impermeable gloves will reduce thermal exposure and assist in decontamination of the assessor.
2. Eye protection such as safety glasses, goggles or a face shield, as well as the use of full-face respirators, are important to minimize ocular exposure to fungal related matter and other eye hazards.
3. The assessor shall use Appropriate Respiratory Protection, including training and medical clearance as required by Federal (29 CFR 1910.134) or state programs.
4. Protective clothing such as disposable coveralls and booties to facilitate decontamination.

8.3. Confined Spaces. *Confined spaces* that require permit, as defined by OSHA Standard 29 CFR 1910.146, are not *readily accessible*; however, if the interior of these spaces are observable from outside the space, the space(s) shall be assessed.

See Informative Appendix F - Sampling Methods for additional guidance.

Informative Note: Performing *assessment* for potential growth and *moisture* intrusion in *educational facility* facilities can potentially expose the assessor to various hazards in addition to normal work-related safety issues. Fungal related matter (e.g., spores, hyphal-fragments, *MVOCs*, and *mycotoxins*) are suspected to affect human health in a variety of ways. While OSHA has not issued a Permissible Exposure Limit for fungal related matter, exposure

should be minimized to protect the health and safety of the individual assessor. The wet environment often encountered by the assessor also poses a number of safety hazards. (For additional guidance, refer to Informative Appendix E)

9. REFERENCES

1. ANSI/ASHRAE/ACCA Standard 180-2012, Standard Practice for Inspection and Maintenance of Commercial-Building HVAC Systems
2. ANSI/IICRC S500-2015, Standard and Reference Guide for Professional Water Damage Restoration
3. OSHA Standard 29 CFR 1910.120, Hazard Communication Standard
4. OSHA Standard 29 CFR 1910.131, 133, 135, and 138, Personal Protective Equipment (PPE)
5. OSHA Standard 29 CFR 1910.134, Respiratory Protection Standard
6. OSHA Standard 29 CFR 1910.146, Confined Space Entry
7. OSHA Standard 29 CFR 1910.147, Control of Hazardous energy (Lockout/Tagout)
8. OSHA Standard 29 CFR 1910.21, Scope and Definitions
9. OSHA Standard 29 CFR 1910.30, Training Requirements
10. OSHA Standard 29 CFR 1926 Subpart M, Fall Protection
11. OSHA Standard 29 CFR 1926.500-1926.504 Subpart M, Appendices A through E

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(This appendix is normative and is a part of the standard.)

NORMATIVE APPENDIX A - MINIMUM ASSESSOR QUALIFICATIONS AND ASSESSMENT REQUIREMENTS

Normative Appendix A provides minimum requirements for qualifications for an individual assessor or a team of assessors and minimum requirements for information gathering.

A1. Minimum Assessor Qualifications

The assessor(s) shall have the skill set to provide the design and implementation of the following for a fungal and moisture assessment for an educational facility.

A1.1 Knowledge of Mold Remediation

The assessor shall understand the fundamentals of mold remediation in accordance with the IICRC S520.

A1.2. Preliminary Information Gathering

The assessor conducting the assessment shall gather preliminary information about the educational facility, or portion thereof, to be evaluated in accordance with Section 5.2 and present that information in the written report required in Section 7.

A1.3. Visual Assessment

The assessor conducting the assessment shall conduct a visual assessment of the facility or portions of the facility associated with the scope of the evaluation in accordance with Section 5.2 using the sampling plan developed under Section 6.2.

A1.4. Moisture Assessment

The entity conducting the assessment shall conduct a moisture assessment of the facility or portions of the facility associated with the scope of the evaluation in accordance with Section 5a using the sampling plan developed under Section 6.2.

A1.5. Sampling

If *sampling* is conducted, the assessor conducting the *assessment* shall develop a *sampling* plan in accordance with Section 5.1 based on the preliminary information gathered under Section 5.1. The *sampling* plan shall include how *sampling* will be used in securing the needed data for a visual and *moisture assessment* of *educational facility* or portions of the facility associated with the scope of the evaluation.

A1.6. Written Report

The assessor conducting the assessment shall prepare a written report in accordance with Section 7 based on the information gathered in accordance with Section 5 and analyzed in accordance with Section 6.

The written report shall assign one of four outcomes to each of the areas or items assessed as listed below and shown in Table 5.

TABLE A1 – ASSESSMENT OUTCOMES				
	Outcome 1	**Outcome 2**	**Outcome 3**	**Outcome 4**
Moisture affected areas and suspect fungal contamination and adverse associated conditions were not present or observed.	Yes	N/A	N/A	N/A
Moisture affected areas and suspect fungal contamination were not present, however, adverse conditions were observed.	No	No	Yes	Yes
Moisture affected areas and suspect fungal contamination were present, however adverse associated conditions were not observed.	No	No	No	Yes
Moisture affected areas and suspect fungal contamination were present and adverse associated conditions were observed.	No	Yes	Yes	Yes

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INFORMATIVE APPENDIX B - HVAC ASSESSMENT

This appendix provides additional guidance on HVAC assessments.

B1. HVAC Interior Surface Visual Assessment

Airflow movement in buildings result from the combined action of mechanical ventilation systems and the location of supply and return vent openings, human activity, windows and doors, the differences in continuous operation and intermittent operation, mechanical equipment and duct insulation, ambient air conditions where mechanical equipment and ducts are located, and natural forces. Air pressure differentials created by these forces can transport airborne fungal contaminants by air movement from areas of relatively higher pressure to areas of relatively lower pressure through any available openings. Positively pressurized buildings may have some location(s) (e.g., the outdoor air intake opening) that is under negative pressure relative to the outdoors. Negatively pressurized buildings can have many locations where untreated outdoor air can enter a building through any opening(s).

Outdoor fungi and associated spores can enter a building through the outdoor air vents and the volume can vary depending on which way the wind is blowing from the direction of a fungal amplification source. Different airborne pathways along with intermittent or variable driving forces on HVAC systems can create a situation where a single fungal amplification source may be causing IAQ complaints in areas of the building that are both distant from each other and from the source.

Natural forces may impact air movement between interior zones and between the building's interior and exterior areas. Both stack effect and wind forces can also impact a building's mechanical HVAC system and affect air on patterns and ventilation, especially if the building envelope is not properly sealed. Stack effect is the thermal pressure driven air flow produced by convection (the tendency of warm air to rise). The stack effect's power to move air increases if the upper floors are cooler and especially if there is an attic space which is open to the outdoors. The thermal energy which drives air movement depends on temperature differences (ΔT) and becomes stronger as the temperature difference increases. For example, when 72°F (22°C) air escapes from upper levels of the building into a 0°F (-18°C) attic space, the energy of that 72°F (40°C) ΔT has a very powerful force to drive the indoor air both into the attic space thereby pulling make-up air the from lower to the upper floors. This may cause the building to become negatively pressurized depending on how much outdoor air the building's HVAC system is bringing in. If the outdoor air volume is insufficient to meet this increased air leakage into the attic, then make-up outdoor air may be drawn into and through all openings into the building. In this way, stack effect airflow can transport outdoor fungal spores or their fungal components between floors by way of stairwells, elevator shafts, chases, or any other opening(s).

Wind forces can transport outdoor fungi spores into a building depending on building pressurization and how effectively the building envelope is sealed. Strong winds can sometimes overwhelm a building's positive pressurization and introduce outdoor fungal spores into a building's interior.

The assessor should identify each specific HVAC system, how much outdoor air is being introduced along with how much interior air is being exhausted, the location of the ducts and plenums associated with the each system and if any portion of the system serves moisture affected areas or areas with fungal growth.

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INFORMATIVE APPENDIX C - SAMPLING

C1. Sampling

Sampling is a method the assessor has in order to evaluate the presence and prevalence of both surface and airborne *fungi* in a facility. The assessor should follow standard sample data collection and *quality control* procedures.

C2. Sampling Procedures.

It is recommended that, at a minimum, *sampling* procedures should require the following steps:

a. Each sample collected by the assessor be uniquely identified and entered onto the field data forms before collecting the next sample.
b. Normally, the analytic laboratory provides a data collection form and a chain of custody that provides the essential information for the analysis, but the assessor should ensure that following information is collected:

    1. Field data documentation form
    2. Date and time of sample collection
    3. Outdoor weather conditions (i.e., temperature, *humidity*, precipitation, and wind direction)
    4. Indoor environmental conditions (i.e., temperature, *dew point*, *relative humidity*)
    5. Identify exterior open windows and doors
    6. Identify interior openings (e.g., windows, doors, penetrations)
    7. If the HVAC system is on or off
    8. If the local exhaust *ventilation* systems are on or off
    9. Location of sample (i.e., description and photographs)
    10. Approximate dimensions of sample area
    11. Length of *sampling* interval
    12. Identification of *sampling* equipment, calibration and its identification information
    13. Air *sampling* flow rate
    14. Total volume of air collected
    15. Location and height of the air sample
    16. Expiration date and lot number of *sampling* media
    17. A *Chain of Custody (COC)* documentation should be used to preserve potential legal admissibility of the samples, and
    18. Field observations of conditions that could affect the air *sampling* results such as the presence of plants, animals, people, and food should be captured on data forms and/or photo-documented.

C3. Sampling Regulations

There are currently no federal regulations (by EPA or OSHA) pertaining to procedures for collection of samples for fungal components. An assessor should verify state, local, municipal, and tribal regulations and codes. Organizations such as, but not limited to: EPA, NIOSH, AIHA and ASTM have published guidance on sampling. A carefully designed and executed sampling strategy, in collaboration with an accredited microbiology laboratory, can be an effective component of a fungal assessment.

C4. Airborne Fungi

Since *fungi* are ubiquitous in the outdoor and indoor environments, fungal components are present in the *indoor air* and settled dust in *educational facilities*. Assessors should take into account during any *sampling* effort that *fungi* release spores intermittently and this may affect the *sampling* results. The assessor shall coordinate with the laboratory to ensure that the correct *sampling* methods, media, and analysis are utilized during *assessment*.

When *sampling* for airborne *fungi*, the assessor should consider and document the rationale for the following:

a. Selection of outdoor sample locations: The assessor should collect a reasonable number of samples from the *outdoor air* that would reflect the composition of the ambient air entering the facility.
b. Factors that can influence sample locations include, but are not limited to:
    1. Samples should be collected proximate to the air intake(s) of HVAC. They should be collected as close to the *outdoor air* intake as possible unless adverse conditions at the roof are observed.
    2. Upwind of the facility and at a reasonable distance to reduce the effect of air being discharged.
    3. Away from other facilities and exterior sources of environmental fungal growth.
    4. There can be rapid changes in fungal composition affecting outdoor ambient air, i.e., due to precipitation, high wind, landscaping, snow cover, etc.

    Note: The assessor should use experience and professional judgment when comparing *outdoor air* to *indoor air* locations.
c. When selecting *indoor air sampling* locations, two common indoor areas, complaint, and non-complaint should be included in the collection of samples. The assessor should consider and document the rationale for the number of samples collected that may identify elevated fungal *concentrations*, including but not limited to:
    1. Visual characteristics of fungal growth or conditions capable for supporting fungal *amplification*.
    2. Areas exhibiting malodors or identified as a complaint area by occupant interviews.

C5. Moisture affected areas

When non-complaint area comparable samples are collected, the assessor should consider and document the rationale for:

1. Selecting areas served by different air handling equipment and different entry doorways, and
2. Areas free of malodors and visual fungal growth.

C6. Selection of Outdoor Ambient Air Sampling Equipment

The assessor should consult with the laboratory pertaining to the proper selection of outdoor ambient air sampling equipment. The following provides additional information on culturable and non-culturable ambient air sampling equipment.

a. Culturable *sampling* equipment. Current *sampling* methods typically use the single plate *impactor* for the collection of fungal structures. The multiple-hole *impactor* contains a nutrient agar culture media selection based on *suspect fungal growth*. NIOSH Standard Method 0800 provides the assessor with guidance on using an *impactor* to collect viable *fungi*.
b. Non-culturable *sampling* equipment: The most common type of airborne fungal *sampling* uses particulate trap technologies. Since there are currently no standardized methods, the assessor should consult with the laboratory regarding collection procedures. Fungal and particulate traps samples can identify total airborne spore and fungal particle *concentration* levels and do not differentiate between viable and non-viable.

C6.1 Sampling Plan Development

Prior to collecting field samples, the assessor should clearly define relevant questions to be answered and formulate and state the appropriate hypotheses and decision criteria. Before *sampling* is conducted, the assessor should consult with the laboratory(ies) and obtain recommended forms, *sampling* equipment, tools, and materials.

The *sampling* plan should reference the procedures for collecting, handling, storing, shipping, and analyzing environmental samples. The *sampling* plan may include field forms for documenting pertinent *assessment* data such as but not limited to: timelines, sample locations, chain of custody, photographs, suspect areas and *non-suspect* fungal areas, and site diagrams.

C6.2 Sampling Plan Guidelines

The ability of the assessor to draw accurate conclusions from project data depends on the quality, reliability, and consistency of the data. It is also important that the assessor is experienced and able to understand what data brings value and if other data may be needed. A key factor of data quality is that it accurately represents the conditions of the job site. Other data quality criteria include completeness, reproducibility, accuracy, precision, and integrity. Assessors or clients should balance available project resources with the need to collect quality data sufficient to resolve project questions. For example, assessors may decide not to collect environmental samples due to cost or scheduling issues or that the fungi/moisture concern is readily resolved without environmental sampling (i.e., through the use of a qualified remediation company). Other considerations regarding project data are any limitations imposed by the client, environment, or assessor. Examples of this include, but are not limited to, budget constraints, access to areas in/around the property, available time(s) to access and/or sample the project, and general scope-of-work or areas-of-concern that are identified by the client as being included or excluded in the assessors' services. Finally, in all assessments, whether sampling is performed or not, the assessor shall rely on background data, sensory observations, interviews, building performance data, and basic instrumentation information to support their conclusions.

C6.2.1 Data Evaluation Methods

Data evaluation methods may vary by the type of data collected. At a minimum the assessor should check and validate all collected field data, reduce and summarize the field data in report tables or graphs, and calculate summary statistics for interpretation and presentation in a written project report. The assessor should describe the data limitations which should be clearly stated in the field documentation and project reports. Field conditions, having the potential to bias the project data, should be documented, considered in the interpretation, and accompany that data in the project report.

C6.2.2 Hypothesis Validation

The validation of the *hypothesis* through *sampling* was discussed in Section 6.2. Prior to collecting samples, the assessor should understand what the data are intended to show and how they may be presented and evaluated. The assessor should evaluate whether there is the potential for bias and minimize the impact so as not to produce unreliable data. The scientific method of *hypothesis* testing is preferred in planning and executing a *sampling* effort. A *hypothesis* is a statement that is assumed to be true for the purpose of testing its validity. It is often put in the form of an if-then statement: If A is true, then B should follow. The *hypothesis* statement is either true or false, and should be capable of being tested and confirmed. The *sampling* plan should address the potential errors and limitations of the *sampling*.

C6.2.3 Data Review

The assessor should review data and if the data is inconclusive or inconsistent with other field observations, may recommend that additional or alternative *sampling* method(s) to better evaluate the *suspect condition(s)*. The use of equipment such as particle counter, hygrometer, etc. for the collection for preliminary information may help the assessor interpret data variability.

C6.3 Sampling Design and Fungal "Judgmental Sampling"

If fungal *sampling* (bulk, surface, dust or air) is used during a *moisture assessment*, assessors typically use *judgmental sampling*. Suspect material or known impacted areas are normally selected for *sampling* and then compared to background or non-impacted areas to document building contamination.

In *judgmental sampling*, the selection of *sampling* units (number and location and/or timing) is based on

knowledge of the site conditions, ecology of fungal growth and professional judgment. For projects using *judgmental sampling*, conclusions can only be drawn on the basis of professional judgment. The usefulness of *judgmental sampling* will be based on the study objectives, the study size and scope, knowledge of method limitations, and the degree of professional judgment of the project team. *Judgmental sampling* is distinguished from statistical-based *sampling* in that conclusions and inferences are based on professional judgment.

C6.4 Environmental Sampling

Other common types of environmental *sampling* design are simple random *sampling*, stratified *sampling*, systematic and grid *sampling*, ranked set *sampling*, adaptive cluster *sampling*, and composite *sampling*. When appropriate, these probability based designs may be used to develop quantitative conclusions about the sampled population. Additional *sampling* design information can be found in:

Sampling and Analysis of Indoor Organisms, Yang and Heisohn, *2007.*

Bioaerosols: Assessment and Control. Macher, American Conference of Governmental Industrial Hygienists, 1999.

Recognition, Evaluation, and Control of Indoor Mold. American Industrial Hygiene Association, 2008.

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INFORMATIVE APPENDIX D - ASSESSMENT INFORMATION AND INTERPRETATION

This appendix discusses the basic concepts of data analysis and interpretation, the evaluation of data according to decision criteria, and how to put it all together for a preliminary opinion of *moisture* and fungal growth.

As every facility is unique, the assessor should understand why certain data needs to be collected and how that information will be evaluated prior to data collection, in order to have consistency with the building *assessment*.

D1. Holistic process for information and data interpretation

Information and data generated during an *assessment* requires an assessor to use a consistent and formal approach to data analysis and interpretation to accurately make determinations of whether or not fungal growth or the *associated conditions* supportive of fungal growth are present.

Interpreting *assessment* information and data is often a step wise process. The data is usually generated from background information, interviews and obtained during on site evaluation(s) (as outlined in Section 4). If *sampling* or advanced building evaluation methods were performed during the *assessment*, the generated data should be interpreted by the assessor in conjunction with the data.

D2. Rationale for consistency in data interpretation

Every facility has its own set of field conditions and building characteristics. Assessors usually have acquired a varied set of education, professional knowledge, and experience. These differences may result in a range of site specific conclusions that may be reached based on factual conditions identified and the assessor's level of professional experience. The objective of any standardized procedure is to achieve a level of consistency and minimize the range of error and variability. For a fungal/moisture assessment, conducted in a sequential stepwise fashion, with each step being focused from information obtained in the prior step, errors can compound themselves if not identified early. The assessor may find it necessary to "reconsider and reinterpret" current information as new information is gathered. Since there may be differences in findings and conclusions an assessor should corroborate findings and conclusions. The intent of this section is to provide a holistic process to minimize extraneous variability to obtain more consistent observations and interpretations of assessment information.

D3. Basic Concepts in Data Analysis and Interpretation

The ability of the assessor to draw accurate conclusions from project data depends on the quality, reliability, and consistency of the data. Data quality is judged by representativeness, completeness, reproducibility, accuracy, precision, and integrity. Assessors should balance available project resources with the need to collect data of sufficient quality to resolve project questions. For example, assessors may decide not to collect environmental samples due to cost or schedule issues or that the fungal/*moisture* concern is readily resolved without environmental *sampling*. The assessor(s) would then need to rely on background data, sensory observations, interviews, building performance data, and basic instrumentation/information to support the conclusions.

D4. Data Analysis Methods.

Data analysis methods may vary by the type of data collected. In general, the assessor

1. checks and validates data,
2. reduces or summarizes the data in tables and graphs, and
3. calculates summary statistics for presentation and interpretation.

The assessor shall describe the data limitations. Data limitations should be clearly stated in the field documentation and project reports. Field conditions that have the potential to bias the project data shall be documented, considered in the interpretation, and accompany that data in the project report.

D5. Validation of Hypothesis Through Sampling

Prior to collecting samples, the assessor should be aware of what the data is intended to show and how it will be presented and analyzed. The scientific method of *hypothesis* testing is preferred in the planning and executing a *sampling* effort. A *hypothesis* is a statement that is assumed to be true for the purpose of testing its validity. It is often put in the form of an "if-then" statement: If A is true, then B should follow. The statement must be one that is either true or false, and be capable of being tested with empirical confirmation or contradiction. The *sampling* plan should address the errors and limitations of the *sampling*.

D6. Data Review

The assessor should review data and if the data is inconclusive or inconsistent with other field observations, he/she may recommend that additional or alternative *sampling* method(s) to better evaluate *suspect condition(s)*. The use of equipment such as particle counter, hygrometer, etc. for the collection for preliminary information may help the assessor interpret data variability.

D7. Interpreting Multi-Sensory Observation and Basic Instrument Data

In carrying out activities under this Assessment Standard as outlined in Section 5, various sensory observations and/or field instrument results may be accumulated.

Observations/results may need to be related to one another, the structure, and various relevant site conditions to be meaningful. The following discussion provides example perspectives on linking sensory observations together and addressing various hypotheses (questions) related to the four potential outcomes from an *assessment* as presented in Section 1 - the presence or absence of fungal growth and the presence or absence of *associated conditions* supportive of fungal growth.

The following provides a general overview of possible ways to use and interpret sensory observations and instrument readings. They describe conditions found in a structure and, where appropriate, provide a basis for *assessment* decisions, and may assist in establishing a *sampling* plan.

The observations and basic data are not all inclusive or intended to address every possible situation encountered. Assessors should be familiar with key references in Section 9 and Informative Appendix H to provide additional information for interpreting building *assessment* data.

Field observations and information can be categorized as: Multi-sensory observation and interpretation, and onsite collected real-time data and interpretation.

The information and data will vary based upon the *scope of work* involved in the *assessment*, such as but not limited to: time, date, temperature, *relative humidity*, particulate matter, *moisture*, and outdoor conditions.

D8. Field Observations

D8.1. Multi-Sensory Fungal Observations

An assessor should utilize sensory observations because fungal growth and the dampness supporting fungal growth may be seen or smelled. Sensory observations from occupants may initiate an *assessment*.

D8.1.1 Vision

Visual observation can be used to detect fungi and identify conditions conducive to fungal growth. The assessor's visual acuity can be improved by using a portable magnifying scope or a high intensity light used parallel to the suspect growth surface. While the color of fungal colonies varies depending upon genus, species, and age, they can assume color variances. Color or color variances are not consistent indicators of the species or severity of fungal growth.

D8.1.2 Odors

Active fungal growth may be accompanied by generation of compounds known as microbial volatile organic

compounds (MVOCs) that may have detectible odors. Different types of fungi may produce various MVOCs at different times during their life cycles, a portion of which are readily perceived by the sense of smell.

D8.1.3 Touch.

Fungal growth may extend above the surface of the substrate, therefore, assessors should limit physical disturbance of suspect fungi to minimize the dispersal of fungal components.

D9. Visual Observations, Multi-Sensory Observations and Interpretation

After site data (i.e., site address, basic building information, complaint, history, etc.) have been collected and reviewed, an assessor begins his/her assessment by "looking at" conditions in the space (the visual assessment), noting the presence/absence of odors (olfaction),and possibly touching surfaces (somatic sensation).

D10. Visual Observation

Suspect visible fungal growth is actually the observation of fungal colonies as discrete spots on a surface or a broad area of growth on a surface (mycelia mat or over lapping colonies). Spores or hyphal fragments are not detectible by the human eye. Government agencies and environmental health professionals, strongly advice that the *moisture* source be corrected and the fungal growth be properly remediated (removed or cleaned) and any fungal debris impacted areas should be properly cleaned to at least background levels.

As mentioned above, the visual identification of visible fungal growth or *associated conditions* may provide either confirmation of the assessor's findings or validate the need for additional data.

Using visual observations of fungal growth or *associated conditions* the assessor should be able to identify one or more outcomes of the Standard.

D11. Multi-Sensory Observations

The use of all senses, excluding visual observation, can be used by the assessor to assist in the identification of areas of suspected fungal growth and *associated conditions*, either inaccessible or not visible.

D12. Interpretation of Building Moisture Assessment Information

Interpretation of assessment observations and collected data related to *moisture* or dampness in a building can generate numerous variations of the two general Outcomes of "No *Associated Conditions*" or "Yes there are *Associated Conditions.*" The assessor may find different conditions in different parts of the building. Therefore, *moisture*/dampness observations and collected data need to be reported by location, material(s), and extent of *moisture*/dampness in the various locations.

The assessor should also report and support the determination for areas of the building that are dry by establishing a building material *dry standard*.

The assessor's typical *scope of work* will also include determining the cause/source of the water leak or dampness and assessing the corrective measures needed. The assessor should consider the history and type of *moisture* problem.

This is because different types of water leaks or *moisture* problems may create outcomes that require different responses. For example, a *condensation* fungal growth (CFG) dampness problem differs from a liquid-induced fungal growth (LFG) problem. A CFG leak, for example, may mean that a surface is not properly insulated or installed or there is excess indoor *humidity*. A LFG leak, for example, may mean that there is a leaking plumbing line or structural failure (i.e., roof leak). The proper interpretation of the *moisture* problem (CFG vs. LFG) will affect the decision making process (i.e., add insulation to wall vs. repair a leaky plumbing line vs. increase *ventilation*, etc.).

D13. Scenarios of Building Moisture Interpretation

The assessor should understand and have experience to evaluate the many various building moisture sources and risk factors.

1. None – all building materials and the design and construction look good and all materials test dry, *relative humidity* is typical for location (often a rare finding given that there has been a request for a fungal/*moisture assessment*).
2. Examples of various observable dry environments include but not limited to: No visible stains but building has problems that are considered to be deficient, i.e., roof damage, plugged floor drains, sprinklers wetting exterior building materials, no bathroom exhaust fans, etc. These deficiencies will likely result in a *moisture* problem.
3. Observable dry conditions
4. Observable *damp conditions* (The identified area can be localized or encompass significant portions of the building.)

D14. Additional Considerations of Assessors

The assessor should be aware of different types of water leaks or *moisture* problems; *condensation*; fungal growth dampness problems; liquid-induced fungal growth problem. A *condensation* fungal growth leak, for example, may mean that a surface is not properly insulated or installed or there is excess indoor *humidity*. A liquid-induced fungal growth leak, for example, may mean that there is a leaking plumbing line or structural failure (i.e., roof leak). The proper interpretation of the *moisture* will affect the decision making process (i.e., add insulation to wall vs. repair a leaky plumbing line vs. increase *ventilation*, etc.).

Below are several examples of interpretations that could be made regarding the information gathered to evaluate building conditions potentially resulting in fungal growth.

1. **Dry Materials –No Associated Conditions Identified** – all building materials evaluated meet the *dry standard* and the indoor *relative humidity* is typical for season and location.
2. **Dry Materials –** The dry conditions below can be used to describe the area(s) based on risk of fungal growth and dampness causation. The area(s) being assessed may have *associated conditions* for area assessed, or *damp conditions*. See Tables D1 and D2 for additional information.

TABLE D1. ASSOCIATED CONDITIONS FOR AREA ASSESSED

Area:_____

Condition	Evidence	Causation	Field Observations
No Associated Conditions	☐ No visible evidence ☐ No fungal associated odors ☐ Building systems operate as intended		
Associated Condition A	☐ No visible evidence of moisture ☐ Fungal associated odors ☐ No identified damp conditions		
Associated Condition B	☐ No visible evidence of moisture ☐ Fungal associated odors ☐ Damp conditions identified		
Associated Condition C*	☐ Visible evidence of moisture ☐ Fungal associated odors ☐ Suspected fungal growth ☐ Evidence of repair	☐ Causation identified ☐ Yes ☐ No	
Associated Condition D*	☐ Visible evidence of moisture ☐ Fungal associated odors ☐ Suspected fungal growth ☐ No evidence of repair ☐ Remaining areas of building have potential moisture issues	☐ Causation identified ☐ Yes ☐ No	
Associated Condition E*	☐ Visible evidence of moisture ☐ Fungal associated odors ☐ Suspected fungal growth ☐ Evidence of repair ☐ Remaining areas appear not to have any identified associated conditions	☐ Causation identified ☐ Yes ☐ No	

*See Moisture Measurement & Dry Standard in Section 4.2.

TABLE D2. DAMP CONDITIONS

Area:_____

Condition	Evidence	Field Observations	Notes
No Damp Condition	No observable evidence		
Damp Condition A	☐ Origin identified ☐ Conditions exist ☐ Remaining areas of building have no identified damp conditions		
Damp Condition B	☐ Origin has been repaired ☐ No damp conditions remain		
Damp Condition C*	☐ Origin has been repaired ☐ Damp conditions remain		
Damp Condition D*	☐ Unknown origin ☐ Damp conditions remain ☐ Remaining areas of building have no identified damp conditions		
Damp Condition E*	☐ Unknown origin ☐ Damp conditions remain ☐ Remaining areas of building have potential unidentified damp conditions		

*See *Damp Condition* in Definitions. See Moisture Measurement & Dry Standard in Section 4.2.

D15. Laboratory Results for Airborne Fungal (Fungal) Samples

Currently, there are no threshold level values for airborne indoor fungal *concentrations*. Setting threshold levels would be difficult for reasons which include limitations in air *sampling* techniques, variability in sensitivity to microbial exposure among the human population, occurrence of a large number of different types of biological and chemical pollutants in indoor environment.

D16. Defining air sampling objectives

A well-defined *sampling* objective helps the assessor to design an appropriate *sampling* strategy which should include the site collected information required and to decide the type of *sampling* techniques used or applied (i.e., viable or non-viable), the minimum number of samples to take, when to take them and how it will affect the resulting data interpretation. A walkthrough visual *assessment* of the building under *assessment* should be conducted prior to designing the *sampling* strategy. The interpretation of airborne *concentration* of indoor *fungi* is primarily based on experience and professional judgment of the assessor. Basic knowledge in ecology of *fungi* would be helpful. For sample results interpretation there are key steps to follow:

Review the air *sampling* objective: for example the primary objective of the *assessment* was to determine if there were elevated fungal spore *concentrations* or indoor *amplification* sources in the complaint area.

Compare total airborne spore *concentrations* from complaint area(s) with those from outdoors and non-complaint area(s). This may answer the question whether levels of spore *concentration* were elevated in complaint area(s) compared to outdoor and non-complaint area(s).

Compare the dominant spore types (and their *concentrations*) from complaint area(s) with those from non-complaint area(s) samples. The objective is to know whether there are *amplification* sources in the complaint area(s). Dominant *fungi* present in complaint area(s) but not in the control samples. For example, if a specific species of *Cladosporium* is dominant in the complaint area(s) but is insignificant in outdoor and non-compliant area(s) sample, we can conclude the source is originating in complaint area(s).

The presence of water damage is an indicator of *fungi*. These are *fungi* frequently found in water damaged buildings. These include but are not limited to *Aspergillus* and *Penicillium* species, *Acremonium spp*., *Sporobolomyces spp*., *Stachybotrys chartarum, Memnoniella echinata, Tritirachium oryzae, Ulocladium botrytis, U. chartarum, Cladosporium spp*., and *Chaetomium spp*. *Fungi* such as *Aspergillus fumigatus, A. niger, Penicillium oxalicum, P. thomii*, and *Cladosporium* species, may also originate from the outdoor environment. Building history i.e., whether there has been previous water problem would give further *evidence* as to whether there was fungal growth in the complaint area(s) room.

D17. Interpretation of Laboratory Results for Airborne Fungal (Mold) Samples

Currently, there are no recognized U.S. authorities who have set values for airborne indoor fungal *concentrations*. Setting threshold levels would be difficult for reasons which include limitations in air *sampling* techniques, variability in sensitivity to microbial exposure among the human population, occurrence of a large number of different types of biological and chemical pollutants in indoor environment. A well-defined *sampling* objective helps the assessor to design an appropriate *sampling* strategy which should include the site collected information required and to decide the type of *sampling* techniques used or applied (i.e., culturable or non-culturable), the minimum number of samples to take, when to take them and how it will affect the resulting data interpretation. (See section 7.4 on defining air *sampling* objectives.) The interpretation of airborne *concentration* of indoor *fungi* is primarily based on experience and professional judgment of the assessor.

The assessor shall compare the suspect area from *non-suspect* areas and outdoors. This includes but is not limited to total airborne and dominant spore types, hyphal fragments, and background debris (and their *concentrations*). The objective is to know whether there are *amplification* sources in the complaint area(s). Dominant *fungi*, or water damage indicator *fungi*, present in area(s) of *assessment*, but not in the baseline/outdoor or *non-suspect* samples. For example, if a specific species of *Cladosporium* is dominant in the complaint area(s) but is insignificant in baseline/outdoor and non-complaint area(s) sample, we can conclude the source is originating in complaint area(s).

See *water damage fungi* in the definitions.

Many factors in a particular environment at the time of *sampling* may affect the data collected during any *sampling* interval. The assessor shall determine the MERV rating of the HVAC air filters. The MERV rating as an efficient filter can capture (arrest) airborne *fungi*. Determine if there are gaps between the filters themselves and the edges of the filter racks which are called "bypass gaps."

The assessor shall verify local code requirements to determine what the current *ventilation* code requires. The assessor shall take into consideration indoor and *outdoor air* filtration and *ventilation* rates. The assessor should note what the stated *outdoor air ventilation* rates are for each section of the building as normally designated on the mechanical section of the building's architectural drawings and specifications.

D18. Fungal Sample Influencers

The assessor should take into considering the following fungal sample influencers, including but not limited to:

1. Time of day
2. Weather conditions
3. Season of the year
4. Building occupant activities and use
5. Indoor environmental conditions
6. Building finishes – e.g., carpet, tile
7. Adjacent buildings/areas, Outdoor use
8. HVAC systems - MERV filtration level, outside air supply
9. Non-occupied areas
10. Open interstitial cavities

D19. Interpretation of Spore Traps

Currently there are no numerical standards for airborne microbial contamination indoors. Suggested guidelines are constantly being reviewed and edited as more information surrounding microbial *indoor air quality* (IAQ) issues is uncovered.

There are many factors which influence spore trap *sampling* and analysis. In addition, there are specific parameters to test hypotheses about the spore trap data collected and their general expectations for the results of these tests.

D19.1. Factors in Evaluation And Interpretation of Spore Traps

Factors considered in evaluating and interpreting spore trap samples include but are not limited to:

1. Air exchange rates and activity levels in a building structure
2. Weather, season of the year and time of day.
3. Geographical differences in terms of fungal taxa and accompanying season variations.
4. Potential bias from infiltration of *outdoor air*, poor housekeeping, excessive indoor *relative humidity* or potential contamination sources (e.g. water intrusion through a basement wall).
5. When unidentified hyaline (clear) or dematicaceous (dark-pigmented) spores are noted on a spore trap sample, it indicates that no particular fungus can be identified. These fungal spores represent yeast-like *fungi* as *Aureobasidium*, *Sporidiobolus*, unidentifiable *Acremonium* species, broad groups that may not permit detection of underlying differences.
6. Spora taxa, listed as a minimum for reporting by ASTM D7391, do not allow for speciation and create broad groups that may not permit detection of underlying differences.
7. The ability to detect smaller spores such as *Penicillium/Aspergillus* will be hindered by lower magnifications used during the analysis. The ASTM D7391 method does provide minimum magnification, but biases can still be present even if the method is followed.

8. Collection efficiencies outdoor in cold weather (<32°F [<0°C]) may be less are likely less than those at higher temperatures.
9. Typical spore trap sample times are short (<15 minutes), thus reflect primarily the time and volume sampled and should be evaluated only in context with the local building site and situation.
10. Water marker or signature fungal spores may include but are not limited to: *Chaetomium*, *Stachybotrys*, *Memnoniella*, *Ulocladium*, *Eurotium*, *Aspergillus*, and *Penicillium*, (Source: AIHA 2008, Recognition, Evaluation, and Control of Indoor Mold.)

D20. Common Criteria to Test Hypotheses

Parameters used as a means of testing hypotheses or constructing aspects of a *hypothesis* for evaluation and *assessment* include, but are not limited to:

1. Comparison of indoor/outdoor *concentration* ratios; total spore count and single fungal taxa counts.
2. Complaint vs. non-complaint areas, or affected vs. non-affected areas; total spore count and single fungal taxa counts.
3. Rank order *assessment* (e.g., Spearman, Kendall, etc.) using *concentration* of the fungal taxa.
4. Presence/Absence of specific fungal taxa or components (e.g., hyphae) either as the predominant taxa or just the mere presence at a location [see below and Spicer].
5. Comparison of the frequency of taxa present (e.g., indoor/outdoor, complaint/non-complaint, etc.).
6. Probability of the occurrence for a particular taxa at a given location.

D21. Pragmatic Rules to Test Hypotheses

In terms of expectations of the testing of these hypotheses, various pragmatic rules should be applied. These should be exercised carefully given the influences of the factors listed above. These include:

1. Conducive associated conditions are suggested by predominant fungal genera that are water indicator or water damage fungi, such as but not limited to: Chaetomium, Stachybotrys Rhodotorula. Aspergillus and Penicillium species, Acremonium spp., Sporobolomyces spp., Stachybotrys chartarum, Memnoniella echinata, Tritirachium oryzae, Ulocladium botrytis, U. chartarum, Cladosporium spp., and Chaetomium spp.
2. Generally and depending on the season, fungal counts indoors should be lower than outdoor counts.
3. Generally, the types of fungi found indoors should be similar to outdoors; although influenced by the type of outdoor-indoor infiltration.
4. The assessor can look for various patterns among the indoor types of fungal species/groups detected:
    a. Increased levels of primary (1st) colonizers in damp or moisture intrusion areas of buildings where Apergilus/Penicillium or Cladosporium are usually noted.
    b. Chaetomium or Stachybotrys are tertiary (3rd) colonizers of indoor materials are usually associated with chronic long standing water/moisture issues in a building.
5. Outdoor levels may be lower than corresponding indoor levels (for example, winter time in the northern U.S.) with an indoor predominance of *Aspergilus/Penicillium* or *Cladosporium* with no significant *amplification* of any *fungi*.

D22. Patterns of Indoor Fungal Taxa

The assessor can look for various patterns among the indoor types of fungal taxa detected such as, but not limited to:

a. Increased levels of primary (1st) colonizers in damp or *moisture* intrusion areas of buildings where *Aspergillus/Penicillium* or *Cladosporium* are usually noted;
b. *Chaetomium* or *Stachybotrys*, tertiary (3rd) colonizers of indoor materials and are usually associated with chronic long standing water/*moisture* issues in a building;
c. the presence of hyphal fragments or fruiting structures noted on spore trap samples which usually indicates

amplification (growth) of *fungi* on building substrates;

d. and ascospores and basidiospores noted on indoor spore trap samples which often represent the entrance of inadequately filtered *outdoor air*. Most indoor materials will not support the growth of these *fungi*.

D23. Outdoor Fungal Taxa

Outdoor levels may be lower than corresponding indoor levels (for example, winter time in the northern U.S.) with an indoor predominance of *Aspergillus/Penicillium* or *Cladosporium* with no significant *amplification* of any *fungi*.

D24. Interpretation of Culturable Air Samples

There are several factors influencing culturable air sampling & analysis. In addition, there are specific parameters to test hypotheses about the culturable air sample data collected and there general expectations for the results of these tests.

The factors considered in evaluating and interpreting culturable air samples are:

1. Air exchange rates and activity levels in a building structure.
2. Weather, season of the year, and time of day.
3. Geographical differences in terms of fungal taxa and accompanying seasonal variations.
4. Potential bias from infiltration of *outdoor air*, poor housekeeping, excessive indoor *relative humidity* or potential contamination sources (e.g. water intrusion thru a basement wall).
5. Not all fungal components are viable, and even if viable, the selection of growth media will affect the ability to culture specific *fungi* or groups or *fungi*. For example, liquid impinger vs. an agar plate, Potato Dextrose Agar (PDA) vs. Malt extract Agar (MEA) vs. Dichloran 18% Glycerol (DG-18) vs. Sabaround's Dextrose (SabDex) Although there are correlations between spore traps and culturable samples, the differences in *sampling* efficiency, viability, and growth potential by media, are such that spore trap and culturable samples should not be compared to each other.
6. Collection efficiencies outdoor in cold weather (<32°F [<0°C]) are likely lower than those at higher temperatures, and media arrangement and samplers collect differently.
7. Typical culturable air sample times are short (1-6 minutes), thus reflect primarily the time and volume sampled and should be evaluated only in context with the local building site and situation. In addition, the collection efficiency can be affected by the time of *sampling*.
8. Because of the shortness of *sampling*, the results can be affected by activity at the time of *sampling*.
9. A number of *fungi* will not culture properly even given several types of agar (e.g., basidiospores, ascospores).

D25. Airborne Fungal Sample Data Interpretation Influencers

Influencers may include but are not limited to:

D25.1. Sampling Area: Location and Geometry

a. Room usage and size to include ceiling height
b. Room/*sampling* area location to the exterior, i.e., interior or exterior
c. The number, location, and quality of windows and doors
d. Exterior weather conditions
e. Indoor environmental conditions
f. Activity level of the *sampling* area prior to or during *sampling*
g. Floor covering(s) and furnishings

D25.2. Filtration & Ventilation of Indoor/Outdoor Air

a. The type of heating and cooling system – air leakage
b. The location and amount of *outdoor air* intake supplied to the room/*sampling* area
c. The MERV rating of the room/sample area air filtration
d. The use of windows & doors during *sampling* activities
e. Room occupancy times and levels
f. Indoor environmental conditions
g. Exterior weather conditions affecting the *outdoor air* supply.
h. HVAC maintenance schedule – coil cleaning & filter replacement schedule

D25.3. Interferences and Incidental Moisture Sources

a. Any special facilities located within the room/sample area such as restrooms, sinks, water fountains, floor drains, and laboratory equipment
b. Background debris levels – e.g., visible dust or cleanliness
c. Communication between occupied and unoccupied spaces, i.e., rooms/*sampling* area, attics, and crawlspaces
d. Facility's maintenance schedule

D26. Putting It All Together for Conclusions and Determination of Severity

D26.1. Evaluation of All Information

The assessor should evaluate all relevant information collected during the building *moisture* and fungal *assessment* to reach defendable conclusions and recommendations. All findings and conclusions should be supported with *evidence* that is consistent with the facts and data identified and supported by the principles of building science and fungal ecology. Cause and effect determinations should be a priority in reporting and documenting the Outcomes 1 – 4 (See Table A1).

D26.2. Consistency of Interrelated Information

The sequential process of both observing conditions and collecting data influences how to select the next investigative procedure to further the *assessment* with a possibility of a modified *hypothesis*. This is critical to support a defensible conclusion as the assessor builds on the prior available relevant information. The decision process may use the following: Background Records and *Interview* Data; Multisensory Observational Data; Real Time Field Measurement Data; Building Performance Data; Fungal or Other Related Laboratory Data. When real data inconsistencies are identified, the assessor shall document and report them as part of the *assessment* findings.

D26.3. Dampness Information

The building dampness / *moisture assessment* data interpretation should provide the information to develop decisions regarding the cause and severity of the building's *moisture* issues. The interpreted data should direct the assessor to the high suspect locations of potential *fungal* growth. Typical information reported would include, but not be limited to: the known *moisture* sources, suspect *moisture* sources, Class/es of water source – 1, 2, or 3 (per IICRC S500), extent of dampness – sq. ft. and percentage of material *moisture*, water migration pathways, water staining but currently dry, any completed repairs or drying data, and surface *condensation* issues. The assessor shall inspect and evaluate *damp conditions* for fungal growth and *associated conditions*. The assessor should identify all excessive *moisture* sources, pathways, and *damp conditions*. It is critical to identify all *moisture* sources that are *conducive* to fungal growth. The assessor should document the completed *moisture* evaluation even if the source of the identified *moisture* remains unknown.

D26.4 Fungi Data Interpretation for Decisions of Severity

The building fungal *assessment* data interpretation should provide the information to develop decisions regarding the severity of the *fungal* problem. The typical *fungal assessment* information to be reported by the

assessor, if *fungi* is identified, would be location by room and surface and substrate, sq. foot of each impacted area, density of growth, colony type/color/mycelia mat, current active growth/i.e., damp or prior growth/i.e., dry, any prior cleanup actions, confidence in the findings – low, med, or high, and any limitations to the visual or *sampling assessment*. The assessor shall evaluate the extent that fungal spores or particles have migrated and impacted other areas of the building (IICRC *Condition 2*). The evaluation of potential *Condition 2* areas requires knowledge of occupant activities, HVAC system operation, and a holistic view of the overall building operation. The assessor should use proper environmental *sampling* and data interpretation when evaluating suspect IICRC *Condition 2*. The *sampling hypothesis* should include a reasonable anticipated level of background *fungi*.

D27. Identified Fungi Severity Information (Visible and/or Sampled)

D27.1 Direct contact hazard to Fungal Growth

The assessor should evaluate the direct surface contact hazard as it relates to the areas in the building where fungal growth was identified. This review should include potential contact by students, teachers, and building staff. Proximity to student and employee work locations is a key factor.

D27.2 Assessment Follow-up Considerations

The assessor should consider the following when determining if there should be *assessment* follow-ups:

1. Need for Immediate corrective actions
2. Need for further *assessment*
3. Need for additional professionals
4. Need for remediation

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX E - HEALTH AND SAFETY

E1. Performing assessment for potential growth and moisture intrusion in educational facility facilities can potentially expose the assessor to various hazards in addition to normal work-related safety issues. Fungal related matter (e.g., spores, hyphal-fragments, MVOCs, and mycotoxins) are known to affect human health in a variety of ways. While OSHA has not issued a Permissible Exposure Limit for fungal related matter, exposure should be minimized to protect the health and safety of the individual assessor. The wet environment often encountered by the assessor also poses a number of safety hazards.

E2. If destructive sampling is necessary, confirm that asbestos, lead or other hazardous materials will not be adversely impacted (according to federal, state, and local guidelines). If the education facility official/building engineer do not know if asbestos, PCBs, lead or other health hazards are present, additional testing may be necessary based on the age of the building. If fungal growth substrates are asbestos or lead-based paint, either known or presumed, the assessor may need additional certification from the state or EPA, and/or OSHA hazard specific training to sample or otherwise disturb these materials.

E3. Disruptive activities which have the potential of exposing occupants (e.g., educational facility staff, students) to contaminants are not recommended. The assessor should take reasonable care to minimize any potential exposure.

E4. If the building *moisture* intrusion is due to sewage or other Category 3 water (IICRC S500) the assessor may need additional precautions, including pre- work immunizations.

E5. If ladders are used to access heights or inspect above ceilings, the assessor must be knowledgeable in ladder safety and working from heights. Inspect all ladders for appropriateness and defects before climbing.

E6. Assessors with allergies, respiratory conditions, asthma, or weakened immune systems should not conduct fungal assessments without proper personal protective equipment and without appropriate medical clearance by a physician.

E7. This standard does not cover climbing on roofs or potential falls from heights over four feet (1.25 meters) where guarding or fall protection may be necessary.

E8. This standard does not cover site hazards and conditions regulated by the Occupational Safety and Health Administration such as lockout/tagout, electrical safety, etc. or established safety protocols.

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INFORMATIVE APPENDIX F – SAMPLING METHODS

F1. General

This appendix provides in depth information for surface sampling Methods and Lab Analysis on:

1. Swab (ASTM D7789)
2. Settled Dust (ASTM E1728)
3. Fungal/Allergen vacuum (ASTM D5755)
4. Bulk (ASTM E2458)
5. Surface contact plates
6. Tape lift surfaces (ASTM D7910)
7. Airborne fungi (ASTM D7391)

F2. Swab

Direct microscopic examination allows rapid determination of fungal structure identification. The resulting information indicates if the fungi identified in the swab sample is the source of fungi colonies, or settled structures released from other areas. Surface swab sample results may be used by the assessor to test their hypothesis. Direct microscopic examination of any fungal structures found on the swab normally provides the fungi genus, but not speciation, and therefore has limited value to the assessor.

Method: Follow the sampling protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the Chain of Custody (COC) form and specify the method of analysis.

F3. Settled Dust

Settled dust samples can be collected from porous, semi-porous, and non-porous substrates to evaluate the presence and prevalence of fungi in a facility. Settled dust samples can be analyzed by a variety of laboratory procedures (direct microscopic examination, culturable fungi, QPCR) depending on the assessors data needs. Settled dust sampling may be used to test the assessor's hypothesis.

Direct microscopic examination allows rapid determination of fungal structures identification. Direct microscopic examination of any fungal structures found on the settled dust sample normally provides the assessor with the fungi genus but not necessarily the species.

Method: Follow the sampling protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the Chain of Custody (COC) form and specify the method of analysis.

F4. Fungal Allergen/Vacuum Method

This method utilizes a cassette which fits on the suction hose end of a standard vacuum with HEPA exhaust filtration. Check with your lab to obtain the minimum sampling quantity and be sure to sample ONLY from areas where visible dust has accumulated. Mark the sampling area and record that data.

Method: Follow the sampling protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the Chain of Custody (COC) form and specify the method of analysis

F5. Bulk Sampling

Bulk samples can be collected from *porous* and semi-porous substrates to evaluate the presence and *concentration* of *fungi* in a facility. Bulk samples can be analyzed by a variety of laboratory procedures (direct

microscopic examination, culturable *fungi*, QPCR) depending on the assessor's data needs. *Bulk sampling* may be used to test the assessor's *hypothesis*.

Direct microscopic examination allows rapid determination of fungal structure identification. Direct microscopic examination of any fungal structures found on the sample normally provides the assessor with the genus but not necessarily the species.

Method: Follow the *sampling* protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the *Chain of Custody (COC)* form and specify the method of analysis.

F6. Surface Contact Plates

Surface contact plate samples can be collected from *porous*, semi-porous, and *non-porous* substrates to evaluate the presence and *concentration* of *fungi* in a facility. Surface contact plate samples can be analyzed by a variety of laboratory procedures (direct microscopic examination, viable *fungi* which when cultured create colony forming units, QPCR) depending on the assessor's data needs. Surface contact plate *sampling* may be used to test the assessor's *hypothesis*.

Direct microscopic examination allows rapid determination of fungal structures identification. Direct microscopic examination of any fungal structures found on the sample normally provides the assessor the genus, but not necessarily the species.

Method: Follow the *sampling* protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the *Chain of Custody (COC)* form and specify the method of analysis.

F7. Tape Lift Surface

Tape lift surface samples can be collected from porous, semi-porous, and non-porous substrates to evaluate the presence and prevalence of fungi in a facility. Tape lift surface samples can be analyzed by direct microscopic examination. Tape lift surface sampling may be used to test the assessor's hypothesis. Direct microscopic examination allows rapid determination of fungal structures identification. Direct microscopic examination of any fungal structures found on the sample normally provides the assessor the genus but not necessarily the species.

Method: Follow the *sampling* protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the *Chain of Custody (COC)* form and specify the method of analysis.

F8. Airborne Fungi Sampling

Airborne *fungi* samples can be collected from areas to evaluate the presence and prevalence of *fungi* in a facility. Airborne *fungi* samples can be analyzed by a variety of laboratory procedures (direct microscopic examination, viable *fungi* which when cultured create colony forming units, QPCR) depending on the assessors data needs. Agar impact *sampling* may be used to test the assessor's *hypothesis*, especially evaluating IICRC *Condition 1* or *2*.

Direct microscopic examination allows rapid determination of fungal structures identification. Direct microscopic examination of any fungal structures found on the sample normally provides the assessor the genus, but not necessarily the species.

Method: Follow the *sampling* protocol of the laboratory used for the analysis. Label the sample with your sample identifier. Complete the *Chain of Custody (COC)* form and specify the method of analysis(es).

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INFORMATIVE APPENDIX G - QUALIFICATIONS OF THOSE CONDUCTING AN ASSESSMENT

The application and use of this standard as covered in Sections 4.2 through 4.4 and the development of the written report as covered in Section 7 shall be by one individual assessor or a team of assessors based upon the size and complexity of the facility and the anticipated effort to identify and assess all areas of the building for *moisture affected areas* and fungal contamination.

Assessor

In order to render a professional opinion under this standard, assessors shall have the skill set and knowledge base for the design and management of a fungal *assessment*, and familiarity with protocols for fungal remediation and conducting *post remediation verification* as determined by the authority having jurisdiction.

Assessors shall recognize the limitations of their professional ability and provide services only when qualified. Professionals need to understand and determine the limits of their professional abilities based on education, knowledge, skills, practice experience, and other relevant considerations.

Microbiological Assessment and Remediation

Assessors shall be competent in assessing facilities where fungal growth is obvious or fungal exposure is alleged. Experience with *assessment* strategies and evaluation of the results of visual *assessments*, *invasive fungal assessments*, airborne monitoring, and *bulk sampling* is essential.

Microbiology/Mycology

Assessors shall have a general knowledge of the classification and analytical techniques associated with the identification of fungi to the genus and species level.

Heating, Ventilating and Air Conditioning (HVAC)

Assessors shall have the ability to recognize problems and conditions leading to fungal growth in HVAC systems and be able to determine the impact of fungal growth in facilities. In addition, assessors shall have experience in controlling fungal growth in HVAC systems.

Building Science

In order to assess extent of potential damage, knowledge of how buildings operate, applicable building codes, and common sources of water intrusion from failures of building envelopes and systems is recommended. Assessors shall be able to recognize other factors that contribute to fungal problems including failures of plumbing, HVAC systems, and other unplanned sources of water and *moisture*.

Regulatory Contracts and Communication

Assessors shall have knowledge of current applicable guidelines and regulations for fungal *assessment* and remediation. They should also be proficient in communicating risk to the facility occupants and have ability to respond to occupant complaints. Assessors shall know the legal obligations for disclosure of exposure conditions and the legal purpose and application of professional services as determined by the authority having jurisdiction. The ability to resolve situations where contract terms and legal disclosure obligations conflict, especially confidentiality agreements, is recommended. In addition, they shall have knowledge of any applicable local, state, and federal standards, regulations, and guidance that needs to be followed.

Indoor Environmental Quality (IEQ)

Assessors shall be able to identify and assess environmental conditions and recognize factors affecting the indoor environment including but not limited to *indoor air quality*, contaminants, temperature, *humidity*, sound, light and *ventilation*.

Building Science and Fungal Ecology

Assessors shall have knowledge of the type and size of the system(s) being evaluated, and shall include but is not limited to: Air distribution design; air distribution operation; pollutant pathways; HVAC/Mechanical components; duct construction materials; have the ability to access and close HVAC components in accordance with all federal, state and local regulations; surface *sampling* principles and procedures of this standard and the ability to interpret laboratory data and visual observations for fungal/*moisture* conditions on similar projects.

An assessor may contact relevant professionals in the areas above for additional expertise.

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INFORMATIVE APPENDIX H - INFORMATIVE REFERENCES

This appendix provides a list of key industry references, standards, and guidance documents that may be helpful to the assessors and their clients these include but are not limited to:

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