Environmental Resources Group
Assessment • Remediation • Compliance • Risk Management

INDOOR AIR QUALITY EVALUATION REPORT

OKEMOS PUBLIC MONTESSORI AT CENTRAL
4406 OKEMOS ROAD
OKEMOS, MICHIGAN 48864

PREPARED FOR:

OKEMOS PUBLIC SCHOOLS
4406 OKEMOS ROAD
OKEMOS, MICHIGAN 48864
ATTENTION: MR. MARK FARGO

PREPARED BY:

ENVIRONMENTAL RESOURCES GROUP, LLC
3125 SOVEREIGN DRIVE, SUITE 9B
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ERG PROJECT NO.: 10281

PROJECT DATE: OCTOBER 17, 2023

FINAL REPORT DATE: NOVEMBER 8, 2023

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1.0 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Environmental Resources Group, LLC (ERG) was retained by Okemos Public Schools to conduct an Indoor Air Quality Evaluation within Rooms 120, 129 and 135 at the Okemos Public Montessori at Central, 4406 Okemos Road, Okemos, Michigan. The specific tasks of the evaluation were as follows:

- Conduct visual and olfactory observations in and around Rooms 120,129 and 135 of the school.
- Conduct sampling for carbon dioxide, oxygen, carbon monoxide, lower explosive limit (LEL) and hydrogen sulfide and conduct measurements of temperature and relative humidity in select locations in and around the school.
- Conduct moisture testing of select substrates.
- Conduct bioaerosol (air) and microvacuum (settled dust) sampling for mold, pollen and other particulate using Zefon Air-O-Cell cassettes in Rooms 120, 129, 135 and select control rooms and out-of-doors.
- Collect digital photographs of current conditions.

Kristin Peterson conducted the evaluation on October 17, 2023, to determine current indoor air quality conditions in Rooms 120, 129 and 135 following water intrusion events reported in each of the rooms. Other Rooms (Music Room, Library and Room 104) without reported water intrusion events were also tested as points of comparison to the other rooms.

1.2 BACKGROUND INFORMATION

The structure is a single-story building of steel and masonry construction with a flat, membrane roof. The age and the square footage of building was not provided at the time of the evaluation. Part of the building is a two-story building with a basement. The two-story part of the building is heated and cooled using ducted supply and return air ventilation system. The building also has supplemental radiant heat.

The school portion of the building is heated by unit ventilators. The daycare rooms and the offices are heated by radiant heaters and heated and cooled by a ducted supply and return forced air ventilation system.

There was reported water intrusion in Rooms 120, 129 and 135. There were complaints of odors in those rooms. The most recent water intrusion event was reported to have occurred this summer. Staff reported 2” of water on the floor in Room 129 and in the hallway outside the room from a broken drain pipe. The pipe was reported to have been repaired. The water had been reported to have been clean up by maintenance staff.

Staff have concerns that the water intrusion and odors in the Rooms are affecting air quality.

1.3 EVALUATION EQUIPMENT AND METHODS

Kristin Peterson, a trained investigator with over 24 years of environmental experience, made visual and olfactory observations and collected samples.

Carbon dioxide measurements were made using a TSI IAQ Calc Carbon Dioxide Meter. The meter was allowed to equilibrate for five minutes prior to the collection of data from the instrument. The instrument was used pursuant to the manufacturer's recommendations.

Oxygen, carbon monoxide, LEL and hydrogen sulfide concentrations were measured using an RKI Instruments Inc., Model GX2009 four gas meter. The instrument was allowed to equilibrate for five minutes prior to the collection of data from the instrument. The four-gas meter was used pursuant to the manufacturer's recommendations.

Temperature and relative humidity measurements were collected using a Protmex, Model MS6508, digital temperature humidity meter. This instrument was allowed to equilibrate for 5 minutes prior to the collection of data and was used pursuant to the manufacturer's recommendations.

Moisture measurements were collected using a Extech pin/pinless infrared moisture meter Model M0260. The meter requires no warmup period, its calibration was field verified prior to use and the instrument was used pursuant to the manufacturer's recommendations.

Bioaerosol (air) and microvacuum (settled dust) samples were collected using Zefon Air-O-Cell cassettes, tubing, and a high-volume vacuum pump. All bioaerosol samples were collected and analyzed in the ERG Indoor Air Quality Laboratory pursuant to the requirements of modified ASTM International Standard D7391-09.

Digital photographs were collected using a digital camera.

2.0 VISUAL AND OLFACTORY OBSERVATIONS

During the ERG evaluation, visual and olfactory observations were made by the inspector. A summary of observations in select areas of the building follows:

Room 120

- No unusual odors were observed upon entry to the area.
- Water-stained ceiling tiles were observed in the room. No mold growth was observed.
- The carpet was stained but overall the carpet was in fair to good condition.
- Floor tiles were observed under the carpet. The tile is assumed to be asbestos containing.
- The unit ventilator intake grill was slightly dirty.
- Plants, beehive, and a tree limb were observed in the room.
- Plants were observed in the room and were observed to be in good condition.
- Some of the lights were covered with fabric.
- The overall level of dust was low.

Room 129

- An odor of locker room/dirty socks was observed upon entry.
- The carpet was stained. A dirty sock odor was observed in the carpet.
- The floor was damp to the touch at the door to the exterior.
- Floor tile, assumed to be asbestos containing, were observed under the carpet.
- Rust marks were observed on the door frame of the exterior door.
- No odors were observed above the drop ceiling tile.
- The ceiling tile in the room were observed to be slightly bowed.
- The unit ventilator was observed to be clean.
- No mold stains were observed on the furniture.
- The overall level of dust was low.

Room 135

- A slight odor of dirty socks was observed upon entry.
- The carpet was stained. An odor of dirty socks was observed in the carpet.
- Rust marks were observed on the radiant heaters.
- The ceiling tiles were dirty. The dirt was near the supply air diffusers.
- Floor tiles were observed under the carpet. The floor tiles were assumed to be asbestos containing.
- No odors were observed above the drop ceiling tiles.
- The overall level of dust was low.

Music Room, Library and Room 104

- A deodorizer-like odor was observed in the Music Room. No odors were observed in the other two rooms.
- No water staining or mold growth were observed.
- The overall level of dust was low.

Out-of-doors

- Temperature was cool. The sun had just come up.
- The grounds appeared well maintained.
- Light vehicle traffic was observed.
- No pedestrian traffic was observed.
- No unusual odors were observed.

3.0 RESULTS OF TESTING

All samples were collected by Kristin Peterson. During sampling, the building was occupied by maintenance staff, a small number of instructional staff and the investigator.

A log with sample description information and the results of bioaerosol (air and settled dust) and other sample data appear in Appendix A and are summarized below.

Indoor carbon dioxide was measured between 415 and 494 parts per million (ppm) indoors. Carbon dioxide was measured at 357 ppm out-of-doors.

Oxygen was recorded at 20.9 percent at all indoor and out-of-doors locations.

Carbon monoxide was not detected indoors or out-of-doors.

LEL was not detected indoors or out-of-doors.

Hydrogen sulfide was not detected indoors or out-of-doors.

Indoor temperature was recorded between 68.5 and 72.6 degrees Fahrenheit. Out-of-doors temperature was recorded at 50.7 degrees Fahrenheit.

Indoor relative humidity was recorded between 44.0 and 52.7 percent. Out-of-doors relative humidity was measured at 71.5 percent.

The results of indoor bioaerosol sample analysis indicated total airborne spore concentrations between 0 and 120 structures per cubic meter of air (s/m^3). Pollen was not detected indoors and other particulate was recorded between 600 and 2,500 s/m^3. The out-of-doors sample had a spore concentration of 4,700 s/m^3, pollen was detected at 400 s/m^3, and other particulate was recorded at 4,960 s/m^3.

The microvacuum (settle dust) samples found 5% spores in the settled dust in the samples from the carpets in Rooms 120 and in 129 and 135.

Digital photographs appear in Appendix B.

4.0 CONCLUSIONS

Based upon reports by others, the visual and olfactory observations made by the investigator and the results of sample analysis, the following conclusions were drawn:

Test results were indicative of conditions at the time of the investigation and may not represent conditions at other times. No conclusions can be drawn regarding areas of the building which were not inspected.

4.1 DIRECT READ INSTRUMENT MEASUREMENTS

Carbon dioxide (CO_2, a colorless odorless gas that results from normal human respiration) concentrations were acceptable in the tested areas of the building and were below the limits established by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) in Voluntary Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. The ASHRAE carbon dioxide recommended limit is 700 parts per million (ppm) above the out-of-doors concentration. The out-of-doors carbon dioxide concentration was 357 ppm, making CO_2 concentrations of 1,057 ppm or less acceptable in this case. The data indicates that adequate fresh air ventilation was provided to the tested areas of the building. No students and limited staff were present in the inspected areas at the time of the evaluation.

Oxygen (0_2, a colorless, odorless gas necessary for human life that makes up approximately 20.9% of the atmosphere by volume) concentrations were within the acceptable range of 19.5 – 23.5% at all sampling locations.

Carbon monoxide (CO, a simple asphyxiant gas and possible source of headache) concentrations were acceptable in all indoor tested areas. In fact, carbon monoxide was not detected indoors or out-of-doors.

LEL (combustible gases and a possible upper respiratory irritant) concentrations were acceptable in all tested areas. In fact, LEL was not detected indoors or out-of-doors.

Hydrogen sulfide (H_2S, a flammable, colorless gas that smells like rotten eggs and which may cause upper respiratory irritation) concentrations were acceptable in all tested areas. In fact, hydrogen sulfide was not detected indoors or out-of-doors.

Indoor temperature readings were within the ASHRAE (Standard 55) recommended human comfort temperature range (68-74.5 degrees Fahrenheit) in all tested locations.

Indoor relative humidity recorded during the inspection was acceptable and was below the limit (65%) recommended by ASHRAE (in voluntary standard 62.1-2007) in all of the tested areas.

4.2 BIOAEROSOL SAMPLE RESULTS

Airborne mold concentrations in "clean" commercial buildings generally total 2,650 s/m^3 or less with spores of the genera *Aspergillus and/or Penicillium* making up not more than 750 s/m^3 and spores of the groups Ascospores and Basidiospores together making up not more than 1,000 s/m^3. The total of all other spores should not exceed 900 s/m^3 (Baxter, Journal of Occupational Environmental Hygiene, January 2005). Those limits are called the Baxter Criteria. Additionally, highly allergenic spores (i.e. – *Pithomyces, Stemphyllium, Stachybotrys*) should not be present in a statistically significant number (i.e. – a raw count of 10 or more spores). Airborne mold concentrations in the tested areas at the time of sampling were within the limits established as the Baxter Criteria and are indicative of "clean" conditions.

Indoor airborne pollen concentrations in "clean" air-conditioned buildings are generally below 30 s/m^3. Individuals with pollen allergy may exhibit symptoms when pollen concentrations exceed approximately 50 s/m^3, especially when grass or highly allergenic ragweed pollen are present. Pollen was not detected in the collected indoor air samples.

Organic fibers such as cellulose (paper fibers) may be present in "clean" buildings in the range of 0 to 10,000 s/m^3. These fibers are not known to cause illness or allergy at these levels, but might suggest inadequate housekeeping or poor ventilation, among other things. Cellulose concentrations were within the normal range (0 to 10,000 s/m^3) in the collected air samples.

Inorganic fibers such as mineral wool or fiberglass (fibrous glass) are not known to cause illness may create dermal irritation when present in concentrations exceeding 1,000 s/m^3. Fibrous glass was not detected in the collected air samples.

Synthetic fibers include polyester and Dacron and do not generally exceed 1,000 s/m^3. The presence of elevated synthetic fiber concentrations suggests degrading synthetic fiber surfaces (clothing, carpet, upholstered furniture) and/or the need for improved housekeeping. Synthetic fibers were detected in nearly all of the collected indoor air samples but at concentrations below the recommended 1,000 s/m^3 threshold.

Mineral fibers, such as gypsum, generally do not exceed 1,000 s/m^3 and may be indicative of uncontrolled renovation or demolition. Mineral fibers were not detected in the collected air samples.

Opaque particles, including soot, fly ash, binders, copy toner, etc., generally do not exceed 5,000 s/m^3. When indoor concentrations exceed 10,000 s/m^3, attempts to identify the source of the particles and reduce their number should be made. The opaque particle concentrations did not exceed the 5,000 s/m^3 threshold in any collected air sample.

Insect fragments, including antennae, legs, wings, etc., should not be observed in "clean" indoor environments. Detectable quantities of insect fragments, including excrement, may cause allergic

reactions in sensitive individuals and suggests the existence of current or past infestation or poor housekeeping. Insect fragments were not detected in the collected air samples.

The settled dust samples collected from the carpets in Rooms 120, 129 and 135 indicated 5% mold in the settled dust and were not indicative of clean conditions.

This analytical technique cannot differentiate spores of the genus *Aspergillus/Penicillium*, among others, due to their similar morphology. Additionally, some mold, pollen, yeast, bacteria, arthropods, and other airborne constituents may be present, but are not identifiable by this technique.

A dirty sock odor was observed in Rooms 129 and 135. The odors were also observed in the carpets in those rooms. The carpets were stained and were in fair to good condition.

Water-stained ceiling tiles were observed in the inspected areas. No visible mold was found in the inspected areas.

No elevated airborne spore concentrations were found in the collected air samples. Airborne mold concentrations in Rooms 120, 129 and 135 met the Baxter Criteria, are comparable to or lower than those in the control rooms and are indicative of normal or "clean" conditions.

Elevated mold in settled dust was found in the samples collected from carpets in Rooms 120, 129 and 135.

The above conclusions are based on the inspection results, observations made at the time of the inspection and information provided by others. Should new or revised information become available, ERG reserves the right to revise the report, modify or change the above conclusions and subsequent recommendations.

5.0 RECOMMENDATIONS

Based on the observations made by the investigator, the findings of this evaluation and the conclusions above, the following recommendation are offered:

1. Within the confines of an enclosure and as described in the large, isolated areas requirements in the New York City Department of Health and Mental Hygiene Guidelines on the Assessment and Remediation of Fungi in Indoor Environments conduct the following within the Rooms 120, 129 and 135:
   a. Clean and disinfect the carpet with a enzymatic carpet cleaner, such as Renu Systems All surface cleaner. Install fans to facilitate drying within 24-48 hours.
   b. HEPA vacuum the floor following the drying.
2. If the smell does not dissipate, remove, and dispose of the carpets in Room 129 and 135. Asbestos containing floor tiles is believed to exist under the carpets. Comply with all AHERA regulations.
3. Clean and disinfect the flooring under the carpet. Allow for the area to dry.
4. Remove and replace the water-stained ceiling tile.

This evaluation was conducted consistent with sound investigative principles and current industry standards. Information in this report was provided by other than ERG. The accuracy or correctness of that information was not confirmed or verified by ERG. For additional information, please review the attached data or call ERG.

Kristin Peterson
Senior Industrial Hygienist

Phillip A. Peterson
Senior Project Manager

APPENDIX A

Air Sample Data Sheet and Laboratory Data

PROJECT NUMBER 10281 DATE 10/17/2023

PROJECT Okemos Public Montessori at Central SAMPLED BY Kristin Peterson

CLIENT Okemos Public Schools ANALYZED BY ERG

AIR SAMPLE DATA SHEET

SAMPLE #	TYPE	DESCRIPTION	TIME ON / TIME OFF	SAMPLE TIME (MIN)	FLOW ON / FLOW OFF (L/MIN)	AVERAGE FLOW	VOLUME (LITERS)	RESULTS CO_2	O_2	LEL	CO	H_2S	T (° F)	RH (%)	Other
1	BA	Room 120 near center of Room	6:14 / 6:19	5	15.8 / 15.8	15.8	79								See attached data sheets
2	FB	Field Blank													See attached data sheets
3	V	Near center of Room 120	6:20					494	20.9	0	0	0	68.5	52.7	
4	V	Near unit ventilator Room 120	6:21					472	20.9	0	0	0	69.4	51.7	
5	MV	On carpet at unit ventilator in Room 120	6:22												See attached data sheets
6	V	Hallway between Rooms 120 and 129	6:30					417	20.9	0	0	0	69	52.7	
7	BA	Near center of Room 129	6:35 / 6:40	5	15.8 / 15.8	15.8	79								See attached data sheets
8	V	15' from entry to Room 129	6:37			15.8	79	415	20.9	0	0	0	71.2	49.7	
9	V	10' fron unit ventilator in Room 129	6:38					431	20.9	0	0	0	71.6	49	
10	MV	On carpet at exterior door of Room 129	6:42												See attached data sheets

SAMPLE TYPES:
CO - CARBON MONOXIDE
CO_2 - CARBON DIOXIDE
O_2 - OXYGEN
H_2S - HYDROGEN SULFIDE
LEL - LOWER EXPLOSIVE LIMIT
T - TEMPERATURE
RH - RELATIVE HUMIDITY
FB - FIELD BLANK
B - BULK
MV - MICROVACUUM
BA - BIOAEROSOL
V - VARIOUS

PROJECT NUMBER 10281 DATE 10/17/2023

PROJECT Okemos Public Montessori at Central SAMPLED BY Kristin Peterson

CLIENT Okemos Public Schools ANALYZED BY ERG

AIR SAMPLE DATA SHEET

SAMPLE #	TYPE	DESCRIPTION	TIME ON / TIME OFF	SAMPLE TIME (MIN)	FLOW ON / FLOW OFF (L/MIN)	AVERAGE FLOW	VOLUME (LITERS)	RESULTS CO_2	O_2	LEL	CO	H_2S	T (˚ F)	RH (%)	Other
11	BA	Out of doors outside Door 16	6:56 / 7:01	5	15.8 / 15.8	15.8	79								See attached data sheets
12	V	Out of doors outside Door 16	6:57					357	20.9	0	0	0	50.7	71.5	
13	BA	20' from entry to Room 135	7:11 / 7:16	5	15.8 / 15.8	15.8	79								See attached data sheets
14	V	10' from entry to Room 135	7:17					417	20.9	0	0	0	70.1	44	See attached data sheets
15	V	Near center of Room 135	7:18					429	20.9	0	0	0	70.6	44.5	
16	MV	On carpet near radiant heater Room 135	7:19												See attached data sheets
17	BA	Music Room 10' from entry	7:30 / 7:35	5	15.8 / 15.8	15.8	79								See attached data sheets
18	V	Music Room 10' from entry	7:31					474	20.9	0	0	0	72.6	46.5	
19	BA	10' from front desk Library	7:39 / 7:44	5	15.8 / 15.8	15.8	79								See attached data sheets
20	V	10' from entry to Library	7:40					459	20.9	0	0	0	71.6	46.7	

SAMPLE TYPES:
CO - CARBON MONOXIDE
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PROJECT NUMBER 10281 DATE 10/17/2023

PROJECT Okemos Public Montessori at Central SAMPLED BY Kristin Peterson

CLIENT Okemos Public Schools ANALYZED BY ERG

AIR SAMPLE DATA SHEET

SAMPLE #	TYPE	DESCRIPTION	TIME ON / TIME OFF	SAMPLE TIME (MIN)	FLOW ON / FLOW OFF (L/MIN)	AVERAGE FLOW	VOLUME (LITERS)	RESULTS CO_2	O_2	LEL	CO	H_2S	T (°F)	RH (%)	Other
21	BA	Room 104 near center	7:48 / 7:53	5	15.8 / 15.8	15.8	79								See attached data sheets
22	V	Room 104 10' from entry	7:50 /		/			451	20.9	0	0	0	71.6	45.2	
			/		/										
			/		/										
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			/		/										

SAMPLE TYPES:
CO - CARBON MONOXIDE
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IAQ Bioaerosol Analytical Report

ERG Project Number: 10281

Client Name: Okemos Public Schools

Project Name: Public Montessori at Central

Date of Sample Collection: 10/17/2023
Date of Submittal: 10/17/2023
Date of Analysis: 10/17/2023

Report Date: 10/17/2023
Analyst: Kaila Schwanitz
Minimum Reporting Limit: 60 s/m³

Sample #	1			2			7		
Sample Location	Room 120 Near Center of Room			Field Blank			Center of Room 129		
Spores	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned
Alternaria	ND			ND			ND		
Ascospore	ND			ND			ND		
Aspergillus/Penicillium	ND			ND			ND		
Basidiospore	ND			ND			ND		
Botrytis	ND			ND			ND		
Chaetomium	ND			ND			ND		
Cladosporium	ND			ND			ND		
Curvularia	ND			ND			ND		
Drechslera/Bipolaris	ND			ND			ND		
Epicoccum	ND			ND			ND		
Erysiphae/Oidium	ND			ND			ND		
Fusarium	ND			ND			ND		
Hyphal Fragments	ND			ND			ND		
Nigrospora	ND			ND			ND		
Periconia/ Myxomycete/Smut	ND			ND			ND		
Ulocladium/Pithomyces	ND			ND			ND		
Rhizopus	ND			ND			ND		
Stachybotrys	ND			ND			ND		
Stemphyllium	ND			ND			ND		
Torula	ND			ND			ND		
Miscellaneous/Unidentified Spores	ND			ND			ND		
Total	ND			ND			ND		
Pollen									
Grass	ND			ND			ND		
Tree	ND			ND			ND		
Other/Unknown Pollen	ND			ND			ND		
Total	ND			ND			ND		
Other Particulate									
Cellulose Fibers	20	300	20.3%	5		20.3%	20	300	20.3%
Fibrous Glass	ND			ND			ND		
Synthetic Fibers	5	60	20.3%	ND			10	100	20.3%
Mineral Fibers	ND			ND			ND		
Opaque Particles	20	300	20.3%	5		20.3%	15	200	20.3%
Insect Fragments	ND			ND			ND		
Total	45	660		10			45	600	
*Debris rating	1			0			1		

Notes:

All samples prepared and analyzed per the modified ASTM D7391-09.

IAQ Bioaerosol Analytical Report

ERG Project Number: 10281

Client Name: Okemos Public Schools

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Date of Sample Collection: 10/17/2023
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Report Date: 10/17/2023
Analyst: Kaila Schwanitz
Minimum Reporting Limit: 60 s/m³

Sample #	11			13			17		
Sample Location	Out-of-Doors Outside Door 16			20' From Entry to Room 135			Music Room Near Entry (130)		
Spores	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned
Alternaria	ND			ND			ND		
Ascospore	163	2100	20.3%	5	60	20.3%	ND		
Aspergillus/Penicillium	ND			ND			ND		
Basidiospore	30	400	20.3%	ND			ND		
Botrytis	ND			ND			ND		
Chaetomium	ND			ND			ND		
Cladosporium	ND			ND			5	70	20.3%
Curvularia	ND			ND			ND		
Drechslera/Bipolaris	ND			ND			ND		
Epicoccum	ND			ND			ND		
Erysiphae/Oidium	ND			ND			ND		
Fusarium	ND			ND			ND		
Hyphal Fragments	ND			ND			ND		
Nigrospora	ND			ND			ND		
Periconia/ Myxomycete/Smut	ND			ND			ND		
Ulocladium/Pithomyces	ND			ND			ND		
Rhizopus	ND			ND			ND		
Stachybotrys	ND			ND			ND		
Stemphyllium	ND			ND			ND		
Torula	ND			ND			ND		
Miscellaneous/Unidentified Spores	172	2200	20.3%	ND			ND		
Total	365	4700		5	60		5	70	
Pollen									
Grass	ND			ND			ND		
Tree	ND			ND			ND		
Other/Unknown Pollen	30	400	20.3%	ND			ND		
Total	30	400		ND			ND		
Other Particulate									
Cellulose Fibers	15	200	20.3%	34	400	20.3%	5	70	20.3%
Fibrous Glass	ND			ND			ND		
Synthetic Fibers	5	60	20.3%	30	400	20.3%	20	300	20.3%
Mineral Fibers	ND			ND			ND		
Opaque Particles	374	4700	20.3%	133	1700	20.3%	128	1700	20.3%
Insect Fragments	ND			ND			ND		
Total	394	4960		197	2500		153	2070	
*Debris rating	1			1			1		

Notes:

All samples prepared and analyzed per the modified ASTM D7391-09.

IAQ Bioaerosol Analytical Report

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Date of Sample Collection: 10/17/2023
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Date of Analysis: 10/17/2023

Report Date: 10/17/2023
Analyst: Kaila Schwanitz
Minimum Reporting Limit: 60 s/m³

Sample #	19			21					
Sample Location	10' From Entry Front Desk Library			Room 104 Near Center					
Spores	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned	structures/ sample	s/m³	% trace scanned
Alternaria	ND			ND					
Ascospore	5	60	20.3%	5	60	20.3%			
Aspergillus/Penicillium	ND			ND					
Basidiospore	ND			ND					
Botrytis	ND			ND					
Chaetomium	ND			ND					
Cladosporium	ND			5	60	20.3%			
Curvularia	ND			ND					
Drechslera/Bipolaris	ND			ND					
Epicoccum	ND			ND					
Erysiphae/Oidium	ND			ND					
Fusarium	ND			ND					
Hyphal Fragments	ND			ND					
Nigrospora	ND			ND					
Periconia/ Myxomycete/Smut	ND			ND					
Ulocladium/Pithomyces	ND			ND					
Rhizopus	ND			ND					
Stachybotrys	ND			ND					
Stemphyllium	ND			ND					
Torula	ND			ND					
Miscellaneous/Unidentified Spores	ND			ND					
Total	5	60		10	120				
Pollen									
Grass	ND			ND					
Tree	ND			ND					
Other/Unknown Pollen	ND			ND					
Total	ND			ND					
Other Particulate									
Cellulose Fibers	10	100	20.3%	ND					
Fibrous Glass	ND			ND					
Synthetic Fibers	ND			10	100	20.3%			
Mineral Fibers	ND			ND					
Opaque Particles	69	870	20.3%	44	600	20.3%			
Insect Fragments	ND			ND					
Total	79	970		54	700				
*Debris rating	1			1					

Comments

*Debris rating (% obstructed by particulate matter): 0= no particulate matter detected, 1= >0-5%, 2= 6%-25%, 3= 26%-76%, 4= 75%-90%, 5= >90%. Where debris rating =5, fungal/pollen/other particulate are reported as "present." For debris ratings 2-4, negative bias is expected. The degree of negative bias increases with the percent of the trace that is obstructed.

Samples were received in acceptable condition, unless otherwise indicated. Results relate only to items tested. Results are reported in units of structures per cubic meter of air (s/m³), except blank samples, where the actual number of observed particles are reported. Spore types listed without a count or other data indicate that the specific analyte was not detected during the course of sample analysis. Spores of the genera *Aspergillus* and *Penicillium* are categorized together due to their small size and spherical shape with few distinguishing characteristics. Other similar spores will be categorized as *Aspergillus*/*Penicillium* unless fruiting bodies allow more precise identifications.

ND= none detected (minimum of 20.3% trace scanned) unless otherwise reported .

Minimum Reporting Limit represents the lowest calculated limit in this report.

Flow Rate is in liters per minute. Time is reported in minutes.

The enclosed data from Environmental Resources Group, LLC (ERG) is for sample(s) collected by our client. The client bears all risk relative to the use of this data, including any course of action or inaction. Further, ERG asserts that the data pertains only to the submitted sample(s). ERG makes no representation or guarantee about the source of the material analyzed, the suitability of the sample size, sample frequency or sample distribution, or the relationship of the submitted sample(s) to the area sampled.

Approved Signatory: 

Date: 10/17/2023

ERG Environmental Resources Group
3125 Sovereign Drive • Suite B • Lansing, MI 48911
Phone: 517-999-6020 • Fax 248-924-3108

Client Name: Okemos Public Schools
Contact Person: K. Peterson
Project Name/ Number: 10291
Project Location: Okemos Public Montessori at Central, Okemos, MI 4406 Okemos Rd
Email Distribution List:
Phone No.:
Purchase Order No.:

Date	Time	Sample #	Client Sample Descriptor	MATRIX (SEE RIGHT CORNER FOR CODE)	# OF CONTAINERS	PARAMETERS: FAD	HOLD SAMPLE	Remarks:
10/17/23		-01	Room 120 Near center of room	A	1	X		BA-79L
		-02	F. blank	A	1	X		OL
		-05	on carpet at unit vent room 129	A	1	X		MV
		-07	center of room 129	A	1	X		BA-79L
		-10	on carpet near exterior door room 129	A	1	X		MV
		-11	out-of doors outside door 11	A	1	X		BA-79L
		-13	20' from entry to room 135	A	1	X		BA-79L
		-16	on carpet near radiant heater (135)	A	1	X		MV
		-17	Music Room (130) Near center	A	1	X		BA-79L
		-19	10' from entry front desk Library	A	1	X		BA-79L

Matrix Code: S Soil; A Air; O Oil; B Bulks; GW Ground Water; SW Surface Water; W Wastewater; X Other: Specify

Comments:

Samples received in acceptable condition: ✓

Sampled/Relinquished By:	Date/ Time 9:51 10/17/23	Received By:
Relinquished By:	Date/ Time	Received By:
Relinquished By:	Date/ Time	Received By Laboratory:

Turnaround Time ALL RESULTS WILL BE SENT BY THE END OF THE BUSINESS DAY

_____Same day ___X___ 1 bus. day _____ 2 bus. days _____ 3 bus. days _____ 4 bus. days

_____5-7 bus. days (standard) Other (specify time/date requirement): _____

LAB USE ONLY

ERG project number: 10231/O.P.S.

Temperature upon receipt at Lab (if applicable):

Please see back for terms and conditions

ERG Environmental Resources Group
3125 Sovereign Drive • Suite B • Lansing, MI 48911
Phone: 517-999-6020 • Fax 248-924-3108

Client Name: OPS
Contact Person: K. Peterson
Project Name/ Number: 10281
Project Location: Central
Email Distribution List:
Phone No.:
Purchase Order No.:

Date	Time	Sample #	Client Sample Descriptor	MATRIX (SEE RIGHT CORNER FOR CODE)	# OF CONTAINERS	PARAMETERS										HOLD SAMPLE	Remarks:
						T40											
10/17/23		21	Room 104 Near Center	A	1	X											BA-79L

Matrix Code

S	Soil	GW	Ground Water
A	Air	SW	Surface Water
O	Oil	W	Wastewater
B	Bulks	X	Other: Specify

Comments:

Samples received in acceptable condition ☐

Sampled/Relinquished By:	Date/ Time 10/17/23 9:51	Received By:
Relinquished By:	Date/ Time	Received By:
Relinquished By:	Date/ Time	Received By Laboratory:

Turnaround Time ALL RESULTS WILL BE SENT BY THE END OF THE BUSINESS DAY

_____Same day _X_ 1 bus. day _____ 2 bus. days _____ 3 bus. days _____ 4 bus. days

_____5-7 bus. days (standard) Other (specify time/date requirement): _____

LAB USE ONLY

ERG project number:

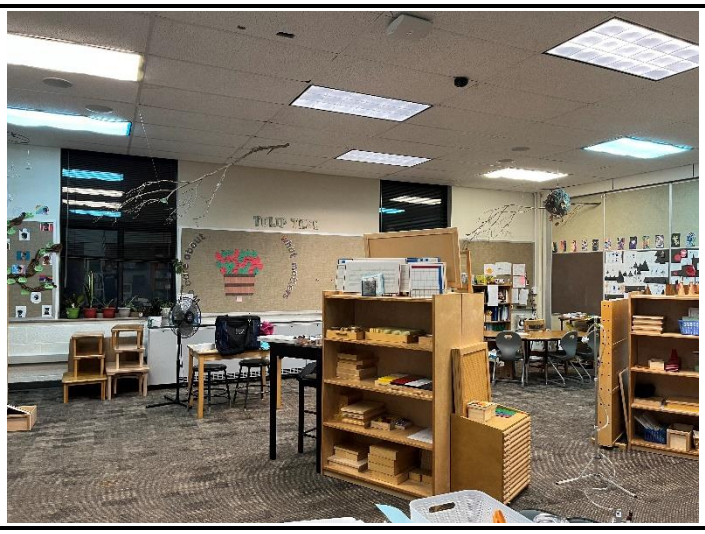
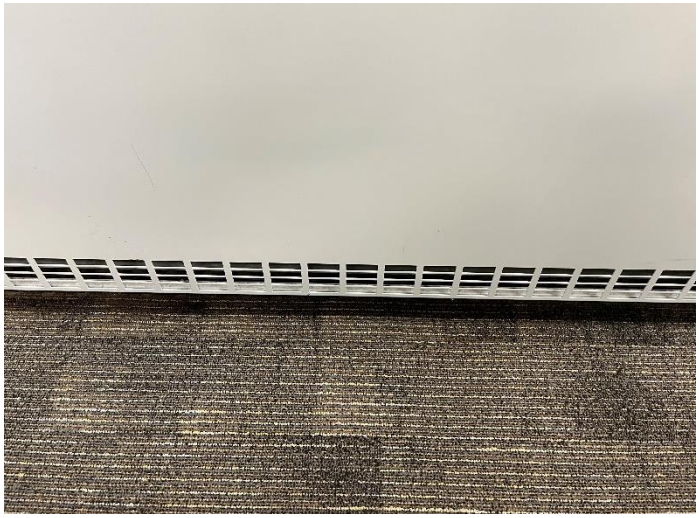
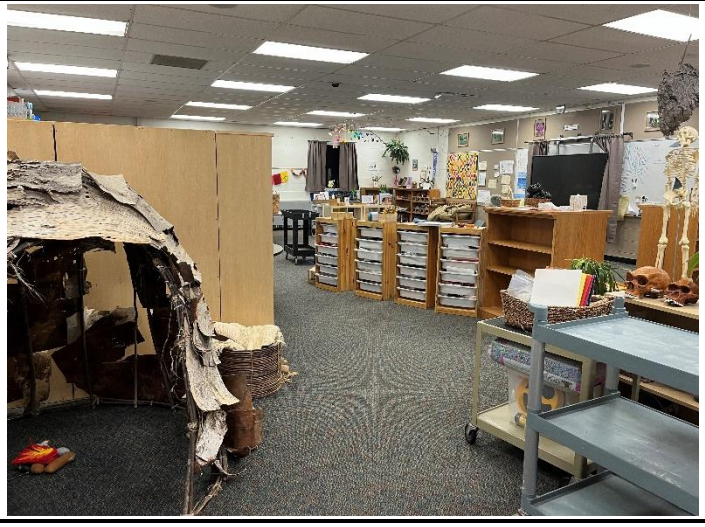
Temperature upon receipt at Lab (if applicable):

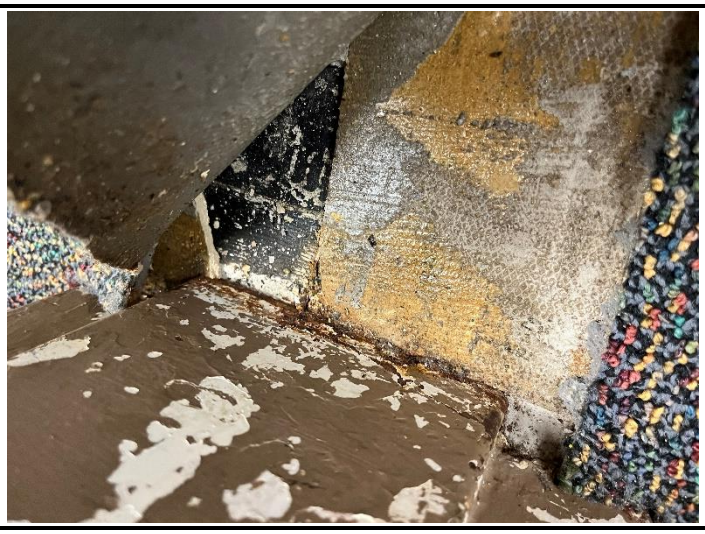
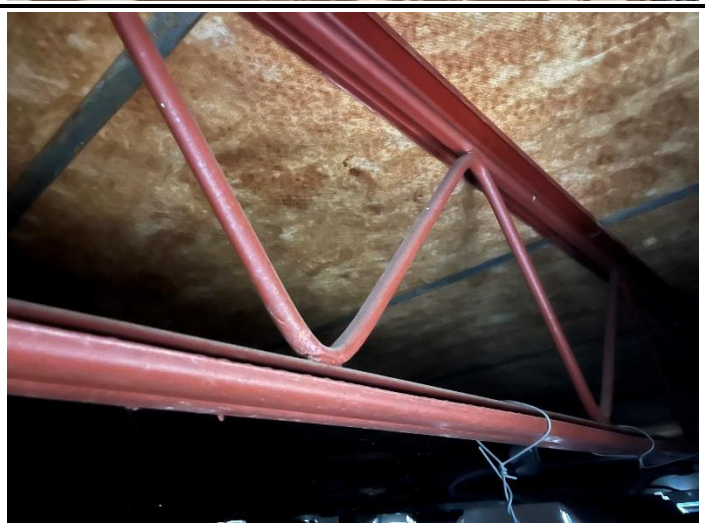
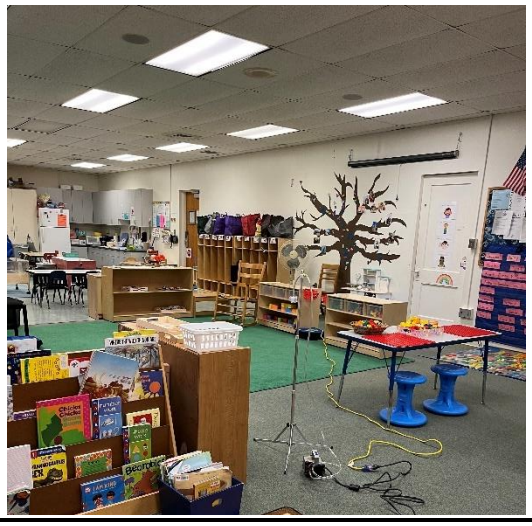
Please see back for terms and conditions

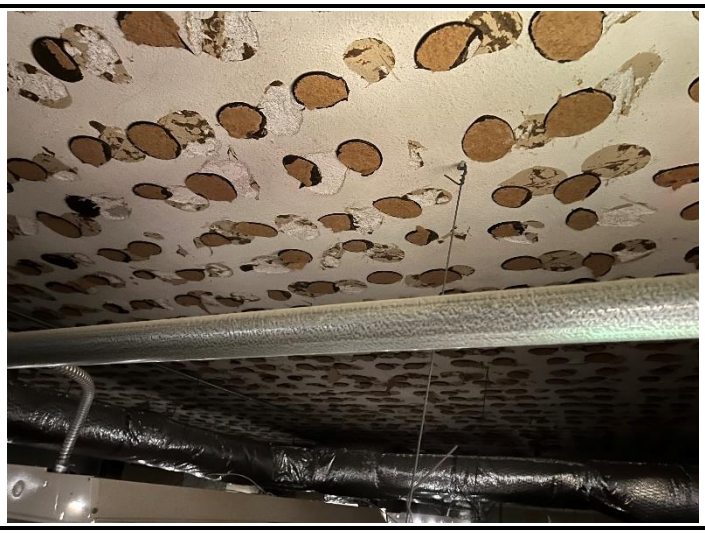
APPENDIX B

Digital Photograph Log

Photograph Date: October 17, 2023
Photo taken by: ERG
Site: Okemos Public Montessori at Central, Okemos
ERG Project #: 10281

	1. View of Room 120.
	2. Stained carpet was observed in Room 120 near the unit ventilator.
	3. View of Room 129.

	4. 9” x 9” assumed asbestos containing floor tile was observed under the carpet in Room 129.
	5. View above the ceiling in Room 129.
	6. View of Room 135.

	7. Above the ceiling in Room 135.

APPENDIX C

New York City Department of Health and Mental Hygiene Guidelines on the Assessment and Remediation of Fungi in Indoor Environments

Guidelines

on

Assessment and Remediation of Fungi in Indoor Environments

New York City Department of Health and Mental Hygiene

November 2008

Table of Contents

Preface

This 2008 document revises existing guidelines and supersedes all prior editions. It is based both on a review of the current literature regarding fungi (mold) and on comments from a review panel consisting of experts in the fields of mycology/microbiology, environmental health sciences, environmental/occupational medicine, industrial hygiene, and environmental remediation.

These guidelines are intended for use by building owners and managers, environmental contractors and environmental consultants. It is also available for general distribution to anyone concerned about indoor mold growth. The attached fact sheet, "*Mold Growth: Prevention and Cleanup for Building Owners and Managers*," is a simplified summary of these guidelines, which may be useful for building owners, managers and workers. It is strongly recommended that the complete guidelines be referred to before addressing the assessment or remediation of indoor mold growth.

In 1993, the New York City Department of Health and Mental Hygiene (DOHMH) first issued recommendations on addressing mold growth indoors. In 2000, DOHMH made major revisions to the initial guidance and made minor edits in 2002.

The terms *fungi* and *mold* are used interchangeably throughout this document.

This document should be used only as guidance. It is not a substitute for a site-specific assessment and remediation plan and is not intended for use in critical care facilities such as intensive care units, transplant units, or surgical suites. Currently there are no United States Federal, New York State, or New York City regulations for the assessment or remediation of mold growth.

 These guidelines are subject to change as more information regarding this topic becomes available.

The New York City Department of Health and Mental Hygiene would like to thank the following individuals and organizations for participating in the revision of these guidelines. Please note that these guidelines do not necessarily reflect the opinions of the participants or their organizations.

Donald Ahearn, PhD	**Georgia State University**
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John Tancredi	**Environmental Contractors Association of New York City – Pinnacle Environmental Corp.**
Donald Weekes, CIH, CSP	**InAIR Environmental Ltd.**
Chin Yang, Ph.D.	**Prestige EnviroMicrobiology Inc**

We would also like to thank the many others who offered opinions, comments, and assistance at various stages during the development of these guidelines.

These guidelines were prepared by the Environmental and Occupational Disease Epidemiology Unit of the New York City Department of Health and Mental Hygiene. This document, and any future revisions, is available online at nyc.gov/health. For further information please call 311 or (212) NEW-YORK (from outside the City).

Introduction

Fungi (mold) are present almost everywhere. In an indoor environment hundreds of different kinds of mold are able to grow wherever there is moisture and an organic substrate (food source). They can grow on building and other materials, including: the paper on gypsum wallboard (drywall); ceiling tiles; wood products; paint; wallpaper; carpeting; some furnishings; books/papers; clothes; and other fabrics. Mold can also grow on moist, dirty surfaces such as concrete, fiberglass insulation, and ceramic tiles. It is neither possible nor warranted to eliminate the presence of all indoor fungal spores and fragments; however, mold growth indoors can and should be prevented and removed if present.

The purpose of these guidelines is to provide an approach to address potential and observed mold growth on structural materials in commercial, school, and residential buildings. Mold growth in critical care areas of health-care facilities such as intensive care units or surgery suites may pose significant health concerns to patients. This document is not intended for such situations. Please visit the US Centers for Disease Control and Prevention (CDC) at www.cdc.gov for more information on dealing with mold growth and its cleanup in health-care facilities.[1] Mold on bathroom tile grout, in shower stalls, and on bathtubs is a common occurrence. Occupants can control this growth through frequent use of household cleaners.

Water accumulation in indoor environments can lead to mold growth (and other environmental problems), which has been associated with human health effects (see ***Appendix A***).[2-6] Indoor mold growth can be prevented or minimized, however, by actively maintaining, inspecting, and correcting buildings for moisture problems and immediately drying and managing water-damaged materials. In the event that mold growth does occur, this guide is intended to assist those responsible for maintaining facilities in evaluating and correcting this problem.

Removing mold growth and correcting the underlying cause of water accumulation can help to reduce mold exposures and related health symptoms.[7,8] Prompt remediation of mold-damaged materials and infrastructure repair should be the primary response to mold growth in buildings. The simplest, most expedient remediation that properly and safely removes mold growth from buildings should be used. Extensive mold growth poses more difficult problems that should be addressed on a case-by-case basis in consultation with an appropriate building or environmental health professional. In all situations, the source of water must be identified and corrected or the mold growth will recur.

Effective communication with building occupants is an important component of all remedial efforts. Individuals who believe they have mold-related health problems should see their physicians. Individuals who may have an occupationally related illness should be referred to an occupational/environmental physician for evaluation, following any needed initial care. Clinic contact information is available from the New York State Department of Health at www.health.state.ny.us/environmental/workplace/clinic_network.

Environmental Assessment

The presence of mold growth, water damage, or musty odors should be addressed quickly. In all instances, any sources of water must be identified and corrected and the extent of water damage and any mold growth determined. Water-damaged materials should be removed or cleaned and dried. For additional information on cleaning water-damaged materials and personal belongings, refer to the EPA document "Mold Remediation in Schools and Commercial Buildings."[9]

A trained building or environmental health professional may be helpful in assessing the extent of the moisture problem and mold growth and developing a site-specific work plan. The presence of a trained professional to provide oversight during remediation can also be helpful to ensure quality work and compliance with the work plan. According to the American Industrial Hygiene Association a trained professional should have, at a minimum, a relevant science or engineering degree and two years of full-time supervised experience in mold assessment.[10]

Visual Inspection

A visual inspection is the most important initial step in identifying a possible mold problem and in determining remedial strategies. The extent of any water damage and mold growth should be visually assessed and the affected building materials identified. A visual inspection should also include observations of hidden areas where damages may be present, such as crawl spaces, attics, and behind wallboard. Carpet backing and padding, wallpaper, moldings (*e.g.* baseboards), insulation and other materials that are suspected of hiding mold growth should also be assessed.

Ceiling tiles, paper-covered gypsum wallboard (drywall), structural wood, and other cellulose-containing surfaces should be given careful attention during a visual inspection. Ventilation systems should be visually checked for damp conditions and/or mold growth on system components such as filters, insulation, and coils/fins, as well as for overall cleanliness.

Equipment such as a moisture meter or infrared camera (to detect moisture in building materials) or a borescope (to view spaces in ductwork or behind walls) may be helpful in identifying hidden sources of mold growth, the extent of water damage, and in determining if the water source is active.

Using personal protective equipment such as gloves and respiratory protection (*e.g.* N-95 disposable respirator) should be considered if assessment work might disturb mold. Efforts should also be made to minimize the generation and migration of any dust and mold.

Environmental Sampling

Environmental sampling is **not** usually necessary to proceed with remediation of visually identified mold growth or water-damaged materials. Decisions about appropriate remediation strategies can generally be made on the basis of a thorough visual inspection. Environmental sampling may be helpful in some cases, such as, to confirm the presence of visually identified

mold or if the source of perceived indoor mold growth cannot be visually identified.

If environmental samples will be collected, a sampling plan should be developed that includes a clear purpose, sampling strategy, and addresses the interpretation of results. [11,12] Many types of sampling can be performed (*e.g.* air, surface, dust, and bulk materials) on a variety of fungal components and metabolites, using diverse sampling methodologies. Sampling methods for fungi are not well standardized, however, and may yield highly variable results that can be difficult to interpret.[11-17] Currently, there are no standards, or clear and widely accepted guidelines with which to compare results for health or environmental assessments.

Environmental sampling should be conducted by an individual who is trained in the appropriate sampling methods and is aware of the limitations of the methods used. Using a laboratory that specializes in environmental mycology is also recommended. The laboratory should be accredited in microbiology by an independent and reputable certifying organization.

For additional information on sampling, refer to the American Conference of Governmental Industrial Hygienists' publication, "Bioaerosols: Assessment and Control" and the American Industrial Hygiene Association's " Field Guide for the Determination of Biological Contaminants in Environmental Samples."[11,18]

Remediation

The goal of remediation is to remove or clean mold-damaged materials using work practices that protect occupants by controlling the dispersion of mold from the work area and protect remediation workers from exposures to mold. The listed remediation methods were designed to achieve this goal; however, they are not meant to exclude other similarly effective methods and are not a substitute for a site-specific work plan. Since little scientific information exists that evaluates the effectiveness and best practices for mold remediation, these guidelines are based on principles used to remediate common indoor environmental hazards. These guidelines are not intended for use in critical care facilities such as intensive care units, transplant units, or surgical suites.

Prior to any remediation, consideration must be given to the potential presence of other environmental hazards, such as asbestos and lead. These guidelines are based on possible health risks from mold exposure and may be superseded by standard procedures for the remediation of other indoor environmental hazards.

Moisture Control and Building Repair

In all situations, the underlying moisture problem must be corrected to prevent recurring mold growth. Indoor moisture can result from numerous causes, such as: façade and roof leaks; plumbing leaks; floods; condensation; and high relative humidity. An appropriate building expert may be needed to identify and repair building problems. An immediate response and

thorough cleaning, drying, and/or removal of water-damaged materials will prevent or limit microbial growth.

Relative humidity should generally be maintained at levels below 65% to inhibit mold growth.[19] Short-term periods of higher humidity would not be expected to result in mold growth.[20] However, condensation on cold surfaces could result in water accumulation at much lower relative humidity levels. Relative humidity should be kept low enough to prevent condensation on windows and other surfaces.

Emphasis should be placed on ensuring proper repairs of the building infrastructure so that water intrusion and moisture accumulation is stopped and does not recur.

Worker Training

Proper training of workers is critical in successfully and safely remediating mold growth.[21,22] Training topics that should be addressed include:

- Causes of moisture intrusion and mold growth
- Health concerns related to mold exposure
- The use of appropriate personal protective equipment
- Mold remediation work practices, procedures, and methods

For additional information, the National Institute of Environmental Health Sciences' publication, "Guidelines for the Protection and Training of Workers Engaged in Maintenance and Remediation Work Associated with Mold" lists minimum training criteria for building maintenance and mold remediation workers that should be completed before addressing indoor mold growth.[23]

Trained building maintenance staff can address limited and occasional mold growth. For larger jobs, more extensively trained mold remediation workers may be needed.

Cleaning Methods

Non-porous materials (*e.g.* metals, glass, and hard plastics) can almost always be cleaned. Semi-porous and porous structural materials, such as wood and concrete can be cleaned if they are structurally sound. Porous materials, such as ceiling tiles and insulation, and wallboards (with more than a small area of mold growth) should be removed and discarded. Wallboard should be cleaned or removed at least six inches beyond visually assessed mold growth (including hidden areas, see ***Visual Inspection***) or wet or water-damaged areas.[24] A professional restoration consultant should be contacted to restore valuable items that have been damaged.

Cleaning should be done using a soap or detergent solution. Use the gentlest cleaning method that effectively removes the mold to limit dust generation. All materials to be reused should be dry and visibly free from mold. Consideration should also be given to cleaning surfaces and

materials adjacent to areas of mold growth for settled spores and fungal fragments. A vacuum equipped with a High-Efficiency Particulate Air (HEPA) filter could also be used to clean these adjacent areas.

Disinfectants are seldom needed to perform an effective remediation because removal of fungal growth remains the most effective way to prevent exposure. Disinfectant use is recommended when addressing certain specific concerns such as mold growth resulting from sewage waters. If disinfectants are considered necessary, additional measures to protect workers and occupants may also be required. Disinfectants must be registered for use by the United States Environmental Protection Agency (EPA). Any antimicrobial products used in a HVAC system must be EPA-registered specifically for that use.

The use of gaseous, vapor-phase, or aerosolized (*e.g.* fogging) biocides for remedial purposes is **not** recommended. Using biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold.

Quality Assurance Indicators

Measures to ensure the quality and effectiveness of remediation should be undertaken regardless of the project size. Evaluations *during* as well as *after* remediation should be conducted to confirm the effectiveness of remedial work, particularly for large-scale remediation. At minimum, these quality assurance indicators should be followed and documented:

- The underlying moisture problem was identified and eliminated
- Isolation of the work area was appropriate and effective
- Mold removal and worksite cleanup was performed according to the site-specific plan
- Any additional moisture or mold damage discovered during remediation was properly addressed
- Upon completion of remediation, surfaces are free from visible dust and debris.
- If environmental sampling was performed, the results of such sampling were evaluated by a trained building or environmental health professional.[10]

Restoring Treated Spaces

After completing mold remediation and correcting moisture problems, building materials that were removed should be replaced and brought to an intact and finished condition. The use of new building materials that do not promote mold growth should be considered. Anti-microbial paints are usually unnecessary after proper mold remediation. They should not be used in lieu of mold removal and proper moisture control, but may be useful in areas that are reasonably expected to be subject to moisture.

Remediation Procedures

Three different sizes of remediation and the remediation of heating, ventilation, and air-conditioning (HVAC) systems are described below. Currently, existing research does not relate the amount of mold growth to the frequency or severity of health effects. However, as the presence of moldy materials increases, so does the potential for exposure[8] and the need to limit the spread of mold-containing dusts and worker exposures. As such, the size of the area impacted by mold growth as well as practical considerations were used to help define remedial procedures.

Since the following areas were arbitrarily selected, site-specific conditions must be considered in choosing adequate remediation procedures. For more information on the unique characteristics of building types and occupancies that may influence remediation procedures refer to the American Industrial Hygiene Association's publication, "Recognition, Evaluation, and Control of Indoor Mold."[25]

Small Isolated Areas (10 square feet or less) – *e.g.* ceiling tiles, small areas on walls

(a) Remediation can be conducted by trained building maintenance staff. Such persons should receive training on proper cleaning methods, personal protection, and potential health hazards associated with mold exposure. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

(b) Respiratory protection (e.g., N-95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection should also be worn.

(c) The work area should be unoccupied.

(d) If work may impact difficult-to-clean surfaces or items (e.g. carpeting, electronic equipment), the floor of the work area, egress pathways, and other identified materials/belongings should be removed or covered with plastic sheeting and sealed with tape before remediation.

(e) Efforts should be made to reduce dust generation. Dust suppression methods particularly during any cutting or resurfacing of materials are highly recommended. Methods to consider include: cleaning or gently misting surfaces with a dilute soap or detergent solution prior to removal; the use of High-Efficiency Particulate Air (HEPA) vacuum-shrouded tools; or using a vacuum equipped with a HEPA filter at the point of dust generation. Work practices that create excessive dust should be avoided.

(f) Moldy materials that can be cleaned should be cleaned using a soap or detergent solution. Materials that cannot be cleaned should be removed from the building in a sealed

plastic bag(s). Plastic sheeting should be discarded after use. There are no special requirements for the disposal of moldy materials.

(g) The work area and areas used by workers for egress should be HEPA-vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) or cleaned with a damp cloth and/or mop and a soap or detergent solution.

(h) All areas should be left dry and visibly free from mold, dust, and debris. Check that other quality assurance indicators (see ***Quality Insurance Indicators***) have also been met.

Medium-Sized Isolated Areas (10 – 100 square feet)

(a) Remediation can be conducted by trained building maintenance staff. Such persons should receive training on proper cleaning methods, personal protection, and potential health hazards associated with mold exposure. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

(b) Respiratory protection (e.g., N-95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection should also be worn.

(c) The work area should be unoccupied.

(d) Cover the floor, egress pathways, and items left in the work area with plastic sheeting and seal with tape before remediation.

(e) Seal ventilation ducts/grills and other openings in the work area with plastic sheeting. The HVAC system servicing this area may need to be shut down to properly seal vents.

(f) Efforts should be made to reduce dust generation. Dust suppression methods particularly during any cutting or resurfacing of materials are highly recommended. Methods to consider include: cleaning or gently misting surfaces with a dilute soap or detergent solution prior to removal; the use of High-Efficiency Particulate Air (HEPA) vacuum-shrouded tools; or using a vacuum equipped with a HEPA filter at the point of dust generation. Work practices that create excessive dust should be avoided.

(g) Moldy materials that can be cleaned should be cleaned using a soap or detergent solution. Materials that cannot be cleaned should be removed from the building in sealed plastic bags. Plastic sheeting should be discarded after use. There are no special requirements for disposal of moldy materials.

(h) The work area and areas used by workers for egress should be HEPA-vacuumed and cleaned with a damp cloth and/or mop and a soap or detergent solution.

(i) All areas should be left dry and visibly free from mold, dust, and debris. Check that other quality assurance indicators (see ***Quality Insurance Indicators***) have also been met.

Large Areas (greater than 100 square feet in a contiguous area) – *e.g.* on separate walls in a single room

Properly trained and equipped mold remediation workers should conduct the remediation. The presence of a trained building or environmental health professional (see ***Environmental Assessment***) to provide oversight during remediation may be helpful to ensure quality work and compliance with the work plan. The following procedures are recommended:

(a) Personnel trained in the handling of mold-damaged materials equipped with:

i. A minimum of half-face elastomeric respirators with P-100 filters used in accordance with the OSHA respiratory protection standard (29 CFR 1910.134)
ii. Full body coveralls with head and foot coverings
iii. Gloves and eye protection

(b) Containment of the affected area:

i. The HVAC system servicing this area should be shut down during remediation.
ii. Isolation of the work area using plastic sheeting sealed with duct tape. Furnishings should be removed from the area. Ventilation ducts/grills, any other openings, and remaining fixtures/furnishings should be covered with plastic sheeting sealed with duct tape.
iii. Consider using an exhaust fan equipped with a HEPA filter to generate negative pressurization.
iv. Consider using airlocks and a clean changing room.
v. Egress pathways should also be covered if a clean changing room is not used.

(c) The work area should be unoccupied.

(d) Efforts should be made to reduce dust generation. Dust suppression methods particularly during any cutting or resurfacing of materials are highly recommended. Methods to consider include: cleaning or gently misting surfaces with a dilute soap or detergent solution prior to removal; the use of High-Efficiency Particulate Air (HEPA) vacuum-shrouded tools; or using a vacuum equipped with a HEPA filter at the point of dust generation. Work practices that create excessive dust should be avoided.

(e) Moldy materials, that can be cleaned, should be cleaned using a soap or detergent solution. Materials that cannot be cleaned should be removed from the building in sealed plastic bags. The outside of the bags should be cleaned with a damp cloth and a soap or detergent

solution or HEPA-vacuumed in the work area (or clean changing room) prior to their transport to unaffected areas of the building. There are no special requirements for the disposal of moldy materials.

(f) Before leaving isolated areas, workers should remove disposable clothing to prevent the tracking of mold-containing dusts outside of the work area.

(g) The work area and egress pathways (and clean changing room if present) should be HEPA-vacuumed and cleaned with a damp cloth and/or mop with a soap or detergent solution and be visibly clean prior to the removal of isolation barriers. Plastic sheeting should be discarded after use.

(h) All areas should be left dry and visibly free from mold, dust, and debris. Check that other quality assurance indicators (see ***Quality Insurance Indicators***) have also been met.

Remediation of HVAC Systems

Mold growth in heating, ventilation, and air-conditioning (HVAC) systems can pose building-wide problems. Obtaining professional help should always be considered in addressing even small amounts of mold growth or moisture problems within an HVAC system. Recurring problems, regardless of size, may indicate a systemic problem and appropriate professional help should be sought.

Small Isolated Area of Mold Growth in the HVAC System (<10 square feet) – *e.g.* box filter, small area on insulation

(a) Remediation can be conducted by trained building maintenance staff that are familiar with the design and function of the impacted HVAC system. Such persons should receive training on proper cleaning methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

(b) Respiratory protection (*e.g.* N-95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection should be worn.

(c) The HVAC system should be shut down prior to any remedial activities.

(d) Efforts should be made to reduce dust generation. Dust suppression methods particularly during any cutting or resurfacing of materials are highly recommended. Methods to consider include: cleaning or gently misting surfaces with a dilute soap or detergent solution prior to removal; the use of High-Efficiency Particulate Air (HEPA) vacuum-shrouded tools; or using a vacuum equipped with a HEPA filter at the point of dust generation. Work practices that

create excessive dust should be avoided.

(e) The use of plastic sheeting to isolate other sections of the system should be considered.

(f) Moldy materials that can be cleaned should be cleaned using a soap or detergent solution. Growth-supporting materials that are moldy, such as the insulation of interior-lined ducts, flexible ducts, and filters, should be removed and sealed in plastic bags. There are no special requirements for the disposal of moldy materials.

(g) The work area and areas used for egress should be HEPA-vacuumed and cleaned with a damp cloth and/or mop and a soap or detergent solution. Any plastic sheeting should be discarded after use.

(h) All areas should be left dry and visibly free from mold, dust and debris. Check that other quality assurance indicators (see ***Quality Insurance Indicators***) have also been met.

Large Area of Mold Growth in the HVAC System (>10 square feet)

Properly trained and equipped mold remediation workers with specific training and experience in HVAC systems, should conduct the remediation. The presence of a trained building or environmental health professional (see ***Environmental Assessment***) with experience and specific knowledge of HVAC systems, to provide oversight during remediation can be helpful to ensure quality work and compliance with the work plan. The following procedures are recommended:

(a) Personnel trained in the handling of mold-damaged materials equipped with:

i. A minimum of half-face elastomeric respirators with P-100 filters used in accordance with the OSHA respiratory protection standard (29 CFR 1910.134)
ii. Full body coveralls with head and foot coverings
iii. Gloves and eye protection

(b) The HVAC system should be shut down prior to any remedial activities.

(c) Containment of the affected area:

i. Isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape
ii. The use of an exhaust fan equipped with a HEPA filter to generate negative pressurization should be considered
iii. Consider using airlocks and a clean changing room
iv. Egress pathways should also be covered if a clean changing room is not used

(d) Efforts should be made to reduce dust generation. Dust suppression methods

particularly during any cutting or resurfacing of materials are highly recommended. Methods to consider include: cleaning or gently misting surfaces with a dilute soap or detergent solution prior to removal; the use of High-Efficiency Particulate Air (HEPA) vacuum-shrouded tools; or using a vacuum equipped with a HEPA filter at the point of dust generation. Work practices that create excessive dust should be avoided.

(e) Moldy materials that can be cleaned should be cleaned using a soap or detergent solution. Growth-supporting materials that are moldy, such as the insulation of interior-lined ducts, flexible ducts, and filters, should be removed in sealed plastic bags. The outside of the bags should be cleaned with a damp cloth and a soap or detergent solution or HEPA-vacuumed prior to their removal from the isolated work area. There are no special requirements for the disposal of moldy materials.

(f) Before leaving isolated areas, workers should remove disposable clothing to prevent the tracking of mold-containing dust outside of the work area.

(g) The work area and egress pathways (and clean changing room if present) should be HEPA-vacuumed and cleaned with a damp cloth and/or mop and a soap or detergent solution prior to the removal of isolation barriers. Plastic sheeting should be discarded after use.

(h) All areas should be left dry and visibly free from mold, dust, and debris. Check that other quality assurance indicators (see ***Quality Insurance Indicators***) have also been met.

Communication with Building Occupants

Communication with occupants of affected spaces is important regardless of the size of the project but is especially important when mold growth requiring large-scale remediation is found. When large-scale remediation is performed, the building owner, management, and/or employer should notify occupants in the building. Notification should include a description of the remedial measures to be taken and a timetable for completion. Group meetings, held before and after remediation, with full disclosure of plans and results, can be an effective communication mechanism. Building occupants should be provided with a copy of all inspection reports upon request. For more detailed information on risk communication refer to the American Industrial Hygiene Association's publication, "Recognition, Evaluation, and Control of Indoor Mold."[26]

References

1. US Department of health and Human Services, Centers for Disease Control and Prevention (CDC), Guidelines for Environmental Infection Control in Health-Care Facilities, Atlanta, GA, 2003, www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf

2. Health Canada, Fungal Contamination in Public Buildings: Health Effects and Investigation Methods, 2004

3. Institute of Medicine. Damp indoor spaces and health. Washington, DC: National Academies Press, 2004.

4. Mazur L, Kim J. Spectrum of noninfectious health effects from molds. Committee on Environmental Health, American Academy of Pediatrics. *Pediatrics*, 2006; **118**(6): e1909-26.

5. Seltzer JM, Fedoruk MJ. Health effects of mold in children. *Pediatr Clin N Am*, 2007; **54**: 309-333.

6. Storey E, Dangman KH, Schenck P, et al. Guidance for clinicians on the recognition and management of health effects related to mold exposure and moisture indoors. Farmington, CT: University of Connecticut Health Center, Division of Occupational and Environmental Medicine, Center for Indoor Environments and Health, 2004. http://oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

7. Kercsmar C, Dearborn D, et al. Reduction in Asthma Morbidity in Children as a Result of Home Remediation Aimed at Moisture Sources. *Env Health Perspectives* 2006: **114**(8): 1574-1580.

8. Haas D, Habib J, et al. Assessment of indoor air in Austrian apartments with and without visible mold growth. *Atmospheric Env* 2007: **41**: 5192-5201.

9. US Environmental Protection Agency. Mold Remediation in Schools and Office Buildings. Washington DC, 2001. www.epa.gov/mold/table1.html

10. American Industrial Hygiene Association. Assessment, Remediation, and Post-Remediation Verification of Mold in Buildings. AIHA guideline #3. Fairfax, VA. 2004.

11. American Industrial Hygiene Association. "Total Fungi and Other Assessment Methods," Field Guide for the Determination of Biological Contaminants in Environmental Samples. Hung L, Miller JD, Dillon HK, ed. Fairfax, VA; AIHA 2005.

12. Morey P. "Microbiological sampling strategies in indoor environments," Sampling and analysis of indoor microorganisms. Yang CS, ed. Hoboken, NJ: John Wiley & Sons, Inc., 2007.

13. Park J, Schleiff P, et al. Building-related respiratory symptoms can be predicted with semi-quantitative indices of exposure to dampness and mold. *Indoor Air* 2004: **14**: 425-433.

14. Meklin T, Reponen T, et al. Comparison of mold concentrations quantified by MSQPRC in indoor and outdoor air sampled simultaneously. *Science of the Total Environment* 2007: **382**: 130-134.

15. Wieslander G, Norbäck D, Venge P. Changes of symptoms, tear film stability and eosinophilic cationic protein in nasal lavage fluid after re-exposure to a damp office building with a history of flooding. *Indoor Air* 2007: **17**: 19-27.

16. Hicks J, Lu E, et al. Fungal Types and Concentrations from Settled Dust in Normal Residences. *J Occ Env Hygiene* 2005: **2**: 481-492.

17. Hung L, Lindsey S, Kroehle K. A Fungal Abatement Project in an Office Located in Arid Southwestern Region of the United States. *Proceedings: Indoor Air 2002*: 733-738.

18. Burge H, Otten J. "Fungi," Bioaerosols Assessment and Control. J Macher, ed. Cincinnati, OH: American Conference of Industrial Hygienists, 1999.

19. American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc. Ventilation for acceptable indoor air quality – ASHRAE Standard (ANSI/ASHRAE 62.1-2007). Atlanta, GA, 2007.

20. American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc. 2007 ASHRAE Handbook – Heating Ventilating and Air-Conditioning Applications, Chapter 21, Inch-Pound Edition, Atlanta, GA, 2007

21. Cummings K, Sickle D, et al. Knowledge, Attitudes, and Practices Related to Mold Exposure Among Residents and Remediation Workers in Posthurricane New Orleans. *Arch Env Occ Health* 2006: **61**(3): 101-108.

22. Cummings K, Cox-Ganser J, et al. Respirator Donning in Post-Hurricane New Orleans. *Emerging Infectious Disease* 2007 **13**(5): 700-707.

23. National Clearinghouse for Worker Safety and Health Training. *Guidelines for the protection and training of workers engaged in maintenance and remediation work associated with mold*; May 20, 2005. http://tools.niehs.nih.gov/wetp/index.cfm?id=327

24. Krause M, Geer W, et al. Controlled Study of Mold Growth and Cleaning Procedure on Treated and Untreated Wet Gypsum Wallboard in an Indoor Environment. *J Occ Env Hyg* 2006: **3**: 435-441.

25. American Industrial Hygiene Association. "Advanced Perspectives in Mold Assessment and Control: Approaches to Varying Occupancies/Building Types," Recognition, Evaluation, and Control of Indoor Mold. Prezant B, Weekes D, Miller JD ed. Fairfax, VA; AIHA 2008.

26. American Industrial Hygiene Association. "Remediation: Scope, Roles, and Risk Communication," Recognition, Evaluation, and Control of Indoor Mold. Prezant B, Weekes D, Miller JD ed. Fairfax, VA; AIHA 2008.

Appendix A

Health Effects

Several comprehensive reviews of the scientific literature on the health effects of mold in indoor spaces have been published in recent years.[1-3] This appendix reflects these reviews but has also considered more recently published articles.

Potential for Exposure and Health Effects

Fungi are common in both indoor and outdoor environments and play a vital role in the earth's ecology by decomposing organic matter such as dead trees and leaves. As a result, all people have routine exposure to fungi, which may occur through inhalation, ingestion, and touching moldy surfaces. The main route of exposure to mold for people living or working in moldy indoor environments is inhalation of airborne fungal spores, fragments, or metabolites.[2] Ingestion and dermal exposures are less understood in these scenarios and can easily be minimized or prevented by workers through proper hygiene and work practices. Therefore, the remaining discussion will focus on the adverse health effects of mold due to inhalational exposure.

Adverse health effects may include: allergic reactions; toxic effects and irritation; and infections.[1-5] The mere presence of mold growth does not necessarily indicate that people present in the area will exhibit adverse health effects. However, as the amount of mold-impacted materials increases, so do potential exposures. Certain exposures may represent a significant risk such as occupational exposures to high concentrations of fungi and chronic (long-term) exposures, especially of individuals with underlying health conditions such as asthma, compromised immune systems, or allergies.

Evidence linking mold exposures to severe human health effects is documented in reports of occupational disease, particularly in forestry and agricultural settings where inhalation exposures were typically high and/or chronic.[2,6-11] The intensity of mold exposure and associated health effects experienced in undisturbed indoor environments is usually much less severe than that experienced by agricultural or forestry workers.[2,7,12-14] With the possible exception of exposures from mold remediation work, such high-level exposures are not expected indoors.[15-16] Although high-level exposures are unlikely to occur in undisturbed indoor settings, chronic exposures to lower levels may still raise health concerns.

Several factors influence the likelihood that individuals might experience health effects following exposure to mold in indoor environments. These include: the nature of the fungal material (e.g., allergenic, toxic/irritant, or infectious); the degree of exposure (amount and duration); and the susceptibility of exposed people. Susceptibility varies with genetic predisposition, age, state of health, concurrent exposures, and previous sensitization. It is not possible to determine "safe" or "unsafe" levels of exposure for the general public because of variation of individual susceptibility, lack of standardized and validated environmental exposure sampling methods, and lack of reliable biological markers. [17]

In addition to the adverse health effects associated with exposure to mold, in 2004, the Institute of Medicine (IOM) reported health risks associated with living in damp indoor environments. The IOM reported evidence suggesting an association between damp indoor environments and the development of asthma. Reported respiratory symptoms included, wheezing, coughing, and exacerbation of asthma.[2]

Allergic and Hypersensitivity Effects

It is well established that fungi can cause allergic reactions in humans. The most common symptoms associated with allergic reactions include runny nose, sneezing, post-nasal drip with sore throat, eye irritation, cough, wheeze, and other symptoms associated with the aggravation of asthma.[2,13,18-23] Immunological responses to mold include allergic rhinitis, hypersensitivity pneumonitis, and asthma exacerbations. These conditions require prior exposure for sensitization. These symptoms may persist for some time after removal from the source.

Allergic rhinitis is a group of symptoms that mostly affects the mucous membranes of nasal passages and may result from an allergic reaction to fungi. Symptoms often associated with "hay fever" such as congestion, runny nose, and sneezing may occur.[5,24]

Hypersensitivity pneumonitis (HP) is a rare lung disease with delayed onset (3-8 hours) of fever, shortness of breath, cough, chest tightness, chills, and general malaise. With continued exposure, HP can lead to permanent lung disease. The occurrence of HP, even among those that are highly exposed to fungi, is rare. HP has typically been associated with repeated heavy exposures in forestry and agricultural settings, which raises concerns for workers routinely performing mold remediation, but has also been reported in indoor settings with lower level chronic exposures.[3,11,18,25-27]

Allergic bronchopulmonary aspergillosis (ABPA) and allergic fungal sinusitis (AFS) are examples of rarely occurring allergic reactions to non-invasive fungal growth in the respiratory system. Most symptoms are non-specific resembling asthma or chronic sinusitis. In addition, ABPA and AFS usually occur in those with underlying medical problems. In the case of ABPA, this includes cystic fibrosis, asthma, and other predisposing medical conditions.[28,29]

Recent studies, which have suggested an association between the presence of indoor mold and the development of asthma or allergies, are limited and difficult to interpret. Stark *et al.* found higher concentrations of dust-borne mold in infants' homes were associated with development of allergic rhinitis, which is a known risk factor for childhood asthma.[24] However, other studies have shown higher concentrations of dust-borne fungi and other microorganisms in infants' homes were associated with a *decreased* risk for asthma and wheezing.[30,31] Jaakkola et al. reported an association between a moldy odor in the home and development of asthma, but no association with visible mold or water damage was found. Although the sample size for this subset was small, it suggests that active mold growth might be a stronger risk factor for certain health effects than presence of nonviable or inactive mold alone.[32] This also is supported by recent studies that have shown allergen production is significantly increased during active growth.[33,34]

Though available, allergy testing for molds is limited, subject to high rates of error, and can be difficult to interpret. Preparations for skin testing or the specific antigen in blood tests may be different from the mold to which an individual is sensitive. A positive test indicates an allergic response but does not definitively link a specific mold exposure to an individual's current health condition.[5]

Irritant and Toxic Effects

Irritant Effects

Indoor growth of mold can lead to the production of volatile organic compounds (VOCs), also referred to as microbial VOCs (MVOCs), and the presence of fungal glucans.[13,35-38] Glucans are components of many fungal cell walls. Some studies have reported an association with the inhalation of glucans and airway irritation and inflammation, but results have been mixed and may not be applicable to expected indoor concentrations. Observed effects may also be the result of exposure to or contact with other fungal components, metabolites, or synergistic effects with other microbial agents.[17,36,39] Resolution of irritant symptoms upon removal from the source can help distinguish irritant effects from allergic symptoms.[5]

MVOCs are responsible for the musty odor often associated with mold growth, which may be noticeable at very low concentrations. Many of the MVOCs are common to other sources in the home.[40] The very low levels usually found indoors have not been shown to cause health effects.[35,37]

Toxic Effects

Some symptoms and maladies have been attributed to the toxic effects of fungi in indoor environments. Certain fungi can produce toxins (mycotoxins) at varying levels that are dependent on many complex environmental and biological factors.[41] The reported symptoms from exposure to mycotoxins indoors include headaches, irritation, and nausea/loss of appetite, but are often non-specific (*e.g.* fatigue, inability to concentrate/remember), and may be caused by other environmental and non-environmental agents.[2,42-46] Although health effects from exposures to mycotoxins have been associated with certain occupational exposures or ingestion of mold-contaminated food, scientific support for the reported effects in indoor environments has not been established. This may be due to the lower levels of exposure and different routes of exposure.[2,5,13,21,27,46-49]

Stachybotrys is colloquially referred to as "black mold" or "toxic mold." It has been suggested that toxins produced by this mold are associated with specific health effects. Acute Idiopathic Pulmonary Hemorrhage (AIPH) in infants has been described in several reports suggesting a relationship with *Stachybotrys*. AIPH is an uncommon condition that results in bleeding in the lungs. The IOM reviewed the existing studies and concluded that there was insufficient evidence to determine if mold exposure was associated with AIPH.[2,3] The evidence is also insufficient for an association between inhalation of *Stachybotrys* toxins indoors and neurological damage.[2,26,49]

Although severe health effects from the inhalation exposures to *Stachybotrys* toxins indoors is plausible, it is not well-supported, and the issue remains controversial.[2,3,5,27,49,50]

Organic dust toxic syndrome (ODTS) describes the abrupt onset of fever, flu-like symptoms, and respiratory symptoms in the hours following a single, heavy exposure to dust-containing fungi and other microorganisms. Unlike HP, ODTS does not require repeated exposures to bioaerosols and can occur after the first exposure. ODTS has been documented in farm workers handling contaminated material, but may also affect workers performing remediation of building materials with widespread mold growth.[2,11,27] ODTS is a self-limited illness, which usually improves within 24 hours after the discontinuation of exposure. It may be underreported among workers exposed to fungi, but would not be expected in occupants of buildings with mold growth.[11,27]

Infectious Disease

Only a small number of fungi have been associated with infectious disease. Few of these fungi are typically found in the indoor environment.[51,52] Several species of *Aspergillus* are known to cause aspergillosis, most commonly *A. fumigatus*, *A. flavus*, and rarely, other species. Aspergillosis is a disease that generally affects severely immunosuppressed persons. Exposure to these molds, even in high concentrations, is unlikely to cause infection in healthy individuals.[21,53] Heavy exposure to fungi associated with bird and bat droppings (*e.g. Histoplasma capsulatum* and *Cryptococcus neoformans*) can lead to health effects, usually transient flu-like illnesses, in healthy individuals. More severe health effects are primarily encountered in immunocompromised persons.[18,54]

Appendix A References

1. Health Canada, Fungal Contamination in Public Buildings: Health Effects and Investigation Methods, 2004

2. Institute of Medicine. Damp indoor spaces and health. Washington, DC: National Academies Press, 2004.

3. Mazur L, Kim J. Spectrum of noninfectious health effects from molds. Committee on Environmental Health, American Academy of Pediatrics. *Pediatrics*, 2006; **118**(6): e1909-26.

4. Seltzer JM, Fedoruk MJ. Health effects of mold in children. *Pediatr Clin N Am*, 2007; **54**: 309-333.

5. Storey E, Dangman KH, Schenck P, et al. Guidance for clinicians on the recognition and management of health effects related to mold exposure and moisture indoors. Farmington, CT: University of Connecticut Health Center, Division of Occupational and Environmental Medicine, Center for Indoor Environments and Health, 2004.
http://oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

6. do Pico G, Hazardous Exposure and Lung Disease Among Farm Workers. *Clinics in Chest Medicine* 1992; **13(2)**: 311-28.

7. Cookingham C, Solomon W. "Bioaerosol-Induced Hypersensitivity Diseases," Bioaerosols. H Burge, ed. Boca Raton, FL: CRC Press, 1995.

8. Lee S, Adhikari A, Grinshpun S, et al. Personal Exposure to Airborne Dust and Microorganisms in Agricultural Environments. *Journal Of Occupational and Environmental Hygiene* 2006; **3**: 118-130.

9. Moore J, Convery R, Millar BC. Hypersensitivity Pneumonitis Associated with Mushroom Worker's Lung: An Update on the Clinical Significance of the Importation of Exotic Mushroom Varieties. *Int. Arch Allergy and Immunology*, 2005; **136**: 98-102.

10. Rose C. "Hypersensitivity Pneumonitis," Preventing Occupational Disease and Injury. Levy B., et al. ed. American Public Health Association, Washington DC, 2005

11. Seifert SA, Von Essen S, Jacobitz K, et al. Organic dust toxic syndrome: a review. *J Toxicol Clin Toxicol*, 2003; **41**(2): 185-193.

12. Weltermann BM, Hodgson M, Storey E, et al. Hypersensitivity pneumonitis: a sentinel event investigation in a wet building. *Am J Ind Med*, 1998; **34**(5): 499-505.

13. Bush RK, Portnoy JM, Saxon A, et al. The medical effects of mold exposure. *J Allergy Clin Immunol*, 2006; **117**(2): 326-333.

14. Hodgson MJ, Morey PR, Attfield M, et al. Pulmonary disease associated with cafeteria flooding. *Arch Environ Health*, 1985; **40**(2): 96-101.

15. Rautiala S, Reponen T, Nevalainen A, et al. Control of exposure to airborne viable microorganisms during remediation of moldy buildings; report of three case studies. *Am Ind Hyg Assoc J*, 1998; **59**(7): 455-60.

16. Morey P, Hunt S. Mold contamination in an earthquake damaged building, in *Proceedings of Healthy Buildings*, 1995; **95**:1377-80 in *Guidelines for the protection and training of workers engaged in maintenance and remediation work associated with mold, May 20, 2005*: National Clearinghouse for Worker Safety and Health Training.

17. Douwes J, Thorne P, Pearce N, Heederik D. Review – Bioaerosol Health Effects and Exposure Assessment: Progress and Prospects. *Annals of Occupational Hygiene*, 2003; **47**(3): 187-200.

18. Burge H, Otten J. "Fungi," Bioaerosols Assessment and Control. J Macher, ed. Cincinnati, OH: American Conference of Industrial Hygienists, 1999.

19. Committee on Environmental Health, American Academy of Pediatrics. Spectrum of noninfectious health effects from molds. *Pediatrics*, 2006;**118**(6): 2582-6.

20. Dales RE, Zwanenburg H, Burnett R, et al. Respiratory health effects of home dampness and molds among Canadian children. *Am J Epidemiol*, 1991; **134**(2): 196-203.

21. Levetin E. "Fungi," Bioaerosols. H Burge, ed. Boca Raton, FL: CRC Press, 1995.

22. Bush RK, Portnoy JM. The role and abatement of fungal allergens in allergic diseases. *J Allergy Clin Immunol* 2001; **107**(3 Suppl): S430-40.

23. Villette M, Cornier Y, et al. Hypersensitivity Pneumonitis in a Hardwood Processing Plant Related to Heavy Mold Exposure. *Journal Of Occupational and Environmental Hygiene* 2006; **3**: 301-307.

24. Stark P, Celedón J, et al. Fungal levels in the Home and Allergic Rhinitis by 5 Years of Age. *Environmental Health Perspectives* 2005; **113** (10): 1405-1409.

25. Cox-Ganser J, White S, et al. Respiratory Morbidity in Office Workers in a Water-Damaged Building. *Environmental Health Perspectives* 2005; **113**(4): 485-490.

26. Jarvis J, Morey P. Allergic Respiratory Disease and Fungal Remediation in a Building in a Subtropical Climate. *Applied Occupational and Environmental Hygiene* 2001; **16**(3): 380-388.

27. Kuhn D, Ghannoum M. Indoor Mold, Toxigenic Fungi, and *Stachybotrys chartarum*: Infectious Disease Perspective. *Clinical Microbiology Reviews* 2003; **16**(1): 144-172.

28. Ritz N, Ammann R, et al. Risk factors for allergic bronchopulmonary aspergillosis and sensitization to *Aspergillus fumigatus* in patients with cystic fibrosis. *European Journal of Pediatrics* 2005; **164**(9): 577-582.

29. Simon-Nobbe B, Denk U, et al. The Spectrum of Fungal Allergy. *Int. Ach Allergy Immunol* 2008; **145**:58-68.

30. Iossifova Y, Reponen T, et al. House dust (1-3)-ß-D-glucan and wheezing in infants. *Allergy* 2007: **62**:504-513.

31. Douwes J, van Strien R, et al. Does early indoor microbial exposure reduce the risk of asthma? The Prevention and Incidence of Asthma and Mite Allergy birth cohort study. *J Allergy Clin Immunol.* 2006 **117**(5): 1067-1073.

32. Jaakkola J, Hwang B, Jaakkola N. Home Dampness and Molds, Parental Atopy, and Asthma in Childhood: A Six-Year Population-Based Cohort Study. *Environmental Health Perspectives* 2005; **113**(3): 357-361.

33. Mitakakis T, Barnes C, et al. Spore germination increases allergen release from *Alternaria. J Allergy Clin Immunol.* 2001 **107**(2): 388-390.

34. Green B, Mitakakis T, Tovey E. Allergen detection from 11 fungal species before and after germination. *J Allergy Clin Immunol.* 2003 **111**(2): 285-289.

35. Schleibinger H, Laußmann D. Emission patterns and emission rates of MVOC and the possibility for predicting hidden mold damage? *Indoor Air* 2005; **15**(suppl 9): 98-104.

36. Rylander R, Lin R. (1-3)-ß-D-glucan – relationship to indoor air-related symptoms, allergy and asthma. *Toxicology* 2000; **152**: 47-52.

37. Horner W, Miller JD. Microbial volatile organic compounds with emphasis on those arising from filamentous fungal contaminants of buildings. ASHRAE Transactions: Research 4621 (RP-1072) 2003.

38. American Industrial Hygiene Association. "Total Fungi and Other Assessment Methods,"

Field Guide for the Determination of Biological Contaminants in Environmental Samples. Hung L, Miller JD, Dillon HK, ed. Fairfax, VA; AIHA 2005.

39. Douwes J. (1-3)-ß-D-glucans and respiratory health: a review of the scientific evidence. *Indoor Air* 2005: **15**: 160-169.

40. Wessen B., Strom G., et al. "Analysis of Microbial Volatile Organic Compounds," Microorganisms in Home and Indoor Work Environments. Flannigan B., Samson R., Miller J., ed. New York NY: Taylor and Francis, 2001.

41. Bennett J, Klich M. Mycotoxins. *Clin Microbiol Rev*; 2003; **16**(3): 497-516.

42. Hodgson MJ, Morey P, Leung WY, et al. Building-associated pulmonary disease from exposure to *Stachybotrys chartarum* and *Aspergillus versicolor*. *J Occup Environ Med*, 1998; **40**(3): 241-249.

43. Croft WA, Jarvis BB, Yatawara CS. Airborne Outbreak of Trichothecene Toxicosis. *Atmospheric Environment*, 1986; **20**(3): 549-552.

44. DeKoster J, Thorne P. Bioaerosol concentrations in noncompliant, complaint, and intervention homes in the Midwest. *Am Ind Hyg Assoc J*, 1995; **56**(6): 573-580.

45. Johanning E, Biagini R, Hull D, et al. Health and immunological study following exposure to toxigenic fungi (*Stachybotrys chartarum*) in a water-damaged office environment. *Int Arch Occup Environ Health*, 1996; **68**: 207-218.

46. Kelman BJ, Robbins CA, Swenson LJ, et al. Risk from inhaled mycotoxins in indoor office and residential environments. *Int J Toxicol*, 2004; **23**(1): 3-10.

47. Fischer G, Wolfgang D. Relevance of airborne fungi and their secondary metabolites for environmental, occupational and indoor hygiene. *Arch Microbiology* 2003; **179**: 75-82

48. Fung F, Hughson W. Health Effects of Indoor Fungal Bioaerosol Exposure. *Applied Occ and Env Hygiene* 2003; **18**: 535-544.

49. Miller J D, Rand T, Jarvis B. *Stachybotrys chartarum*: cause of human disease or media darling? *Medical Mycology* 2003; **41**: 271-291.

50. Etzel R. Mycotoxins. *JAMA* 2002; **287**(4): 425-27.

51. Horner W, Worthan P, Morey P. Air- and dust-borne mycoflora in houses free of water damage and fungal growth. *Appl Environ Microbiol* 2004; **70**(11): 6394-6400.

52. MacIntosh D, Brightman H, et al. Airborne Fungal Spores in a Cross-Sectional Study of Office Buildings. *J Occ Env Hyg* 2006; **3**: 379-389.

53. US Centers for Disease Control and Prevention. Division of Bacterial and Mycotic Diseases, US Department of Health and Human Services. Aspergillosis. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/aspergillosis_t.htm, 6 October 2005.

54. Lenhart S, Schafer M, et al. Histoplasmosis – Protecting Workers at Risk. Occupational Respiratory Diseases. Cincinnati, OH: US Department of Health and Human Services, 2004.

FACT SHEET

MOLD GROWTH – PREVENTION AND CLEANUP FOR BUILDING OWNERS AND MANAGERS

Mold can grow indoors on many wet or damp building materials. Mold may cause health problems in some people.

Mold needs water or moisture to grow. Stop indoor mold growth by fixing leaks, drying wet materials, and cleaning up the mold.

THINGS BUILDINGS OWNERS AND MANAGERS CAN DO TO PREVENT MOLD GROWTH

Fix Water Problems

- Correct water leaks immediately
- Dry any water-damaged items immediately

Control Moisture Sources

- Make sure that bathroom exhaust fans are working, if present
- Make sure that a bathroom window can be opened, if no exhaust vent is present
- Use a dehumidifier to keep humidity levels low in basements

HOW TRAINED BUILDING MAINTENANCE STAFF CAN CLEAN MOLD GROWTH

First, look to see how much damage there is, including any hidden mold growth. If the mold covers a large area (more than 100 square feet), is in the HVAC system, or is difficult to get to, you may need professional help. If the there is less than 100 square feet of mold growth then you should be able to handle the cleanup job yourself:

- Inform affected building occupants about the plan to clean
- Occupants should be removed from the work area before cleaning
- Cover or remove difficult-to-clean surfaces or items (e.g. carpeting, electronics) from the work area before cleaning
- Maintenance staff should use safety goggles, gloves, and a disposable respirator when removing mold growth
- Cleaning should be done using soap or detergent, and water
- Most porous materials (e.g. ceiling tiles, insulation) that are moldy should be removed and thrown away
- If more than a small area (10 square feet) of mold growth is present:
    - ✓ Cover the floor in the work area with plastic sheeting
    - ✓ Cover entry and exit pathways with plastic sheeting
    - ✓ Seal any ventilation ducts with plastic sheeting
    - ✓ Mop and/or HEPA-vacuum the work area and pathways
- Dispose of any plastic sheeting, moldy materials, and used sponges or rags in sealed heavy-duty plastic bags.
- If the mold returns quickly or spreads, you may have an ongoing water problem. Fix water problems immediately.
- For complete recommendations on the assessment and remediation of mold, visit our web site at nyc.gov/health

SUGGESTED SUPPLIES TO CLEAN MOLD GROWTH

- Soap or detergent
- Disposable rags/sponges and scrub brush
- Buckets
- Heavy-duty plastic garbage bags
- Protective gear (goggles, rubber gloves, N95 respirator)

FOR MORE INFORMATION

Visit our web site at **nyc.gov/health** for complete recommendations on mold removal or call the New York City Department of Health and Mental Hygiene. In NYC, **call 311**.