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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY GUIDELINES FOR MOLD REMEDIATION IN SCHOOLS AND COMMERCIAL BUILDINGS

Summary

On April 2, 2001 the United States Environmental Protection Agency published guidelines for "Mold Remediation in Schools and Commercial Buildings."[1] The EPA document includes background information on mold along with suggestions for prevention, investigation, evaluation, and remediation of mold contaminated areas. This technical data bulletin focuses mainly on the EPA's recommendations for respiratory protection used to help reduce exposure to mold during remediation work. The reader is encouraged to consult the EPA guidelines in their entirety for a more complete discussion of mold remediation.

Background

The term "fungi" includes organisms such as yeasts, molds, mildews, and mushrooms. Fungi can exist as single cells or as threadlike strands which may branch extensively. Fungi normally reproduce as spores. Spores can contain one or many cells, are between less than 2 μm to more than 100 μm in size, and are adapted for airborne dispersal.[2] Conditions which promote growth include high relative humidity, moisture, standing water, heat, and a food source for the organism such as wood or paper.

Building materials which have been damaged due to flooding or continuous moisture damage are susceptible environments for the growth of fungus. Spores may be released into the air as part of the mold's natural reproduction process or if the mold is disturbed. This may be of specific importance for those performing construction, maintenance (e.g. HVAC systems), investigative or remediation work.

Molds are known to cause a variety of health effects via ingestion, inhalation, and skin contact. These may include allergenic affects, asthma, runny nose, hypersensitivity pneumonitis, organic dust toxic

3M Occupational Health and Environmental Safety Division

3M Center, Building 235-2W-70
P.O. Box 33275
St. Paul, MN 55133

syndrome, irritation of the eyes, skin, nose, throat and lungs; as well as infection of immune-compromised or immune-suppressed individuals. Health effects only occur when persons are directly exposed to the molds—no person to person transmission has been documented.

Some molds such as *Aspergillus*, *Fusarium, Penicillium, Trichoderma, Memnoniella* and *Stachybotrys chartum* are known to produce toxic substances known as mycotoxins.[3] These may cause mucous membrane irritation, skin rash, nausea, immune suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects, and cancer. The toxins are typically contained in or on the spores, but a few have been shown to be volatilized (exist as a vapor).

Fungi can also produce volatile organic compounds (VOC) that are thought to be the source of odors associated with mold and mildew. Inhalation of the VOCs may cause symptoms such as headaches, nasal irritation, dizziness, fatigue and nausea, which are typically not life-threatening.

Prevention and Remediation of Mold-Contaminated Areas

The best approach for preventing mold contamination is to prevent conditions which foster mold growth from occurring. Immediate clean-up of water damage to building materials, fixing of leaks, maintenance of a moderate level of relative humidity (50%), and preventing dirt build-up in HVAC systems are important steps. During the remediation work, proper containment should be used to keep the spores from spreading. Use of biocides, such as chlorine bleach, is not necessarily recommended and dead mold may still cause allergenic or toxic effects. A thorough discussion of investigation, evaluation and cleaning is given in the EPA guidelines. It is recommended that all persons with asthma, hypersensitivity pneumonitis, severe allergies, immune suppression, or other chronic inflammatory lung diseases be removed from the contaminated area until remediation is complete. [3]

Personal Protective Equipment (PPE)

Currently, there are no published exposure limits for biological organisms from the EPA or the Occupational Safety and Health Administration (OSHA). Sampling may be done, but the results are often left up to interpretation as there are no published US Federal standards for comparison. EPA's selection of clean-up methods, personal protective equipment (PPE) and containment are determined based upon the size of the contaminated area. Larger areas require more stringent measures. Professional judgement should also be used depending on the toxicity of the mold (if known), possibility of hidden mold, the potential for aerosolizing the mold, or if persons with asthma, allergy or immune suppressive disorders are present near the remediation work.

Use of PPE does not eliminate the risk of exposure or illness. However, use of appropriate PPE including gloves, goggles, disposable coveralls, full body clothing, head gear, foot coverings, and respiratory protection may help reduce exposure. Training for remediation workers by qualified individuals is recommended before performing any remediation activity.

EPA recommended levels of respiratory protection are given in Table 1. There is some confusion as the descriptions of these levels do not match exactly with descriptions presented later in their guidelines. Also, the National Institute for Occupational Safety and Health (NIOSH) no longer approves HEPA filters with negative pressure respirators. Under 42 CFR 84, HEPA filters are only approved with powered air purifying respirators (PAPRs). For negative pressure respirators, 100 level filters (N100, R100, or P100) may be used in place of HEPA filters. However, a less efficient

filter may be acceptable for certain remediation work. No respirator removes all contaminants and the actual reduction of exposure to the user will depend upon many factors besides filter.

Table 1. EPA recommended levels of respiratory protection

Size of remediation area	PPE level	Description
< 10 ft^2	Minimum	N95 respirator
10 - 100 ft^2	Limited OR Full	N95 respirator or half-face respirator with HEPA filters OR Full-face respirator with HEPA filters
> 100 ft^2	Full	Full-face respirator with HEPA filters

These PPE levels are defined later in the EPA document as follows:

Minimum: When cleaning up a small area affected by mold, you should use an N-95 respirator. This device covers the nose and mouth, will filter out 95% of the particulates in the air, and is available in most hardware stores. In situations where a full-face respirator is in use, additional eye protection is not required.

{3M comment: N95 filters are tested by NIOSH to be at least 95% efficient against particles in the most penetrating size range. Filtration efficiency may be greater for particles that are either smaller or larger. The actual reduction of exposure to the user will depend upon many factors besides filter efficiency including, but not limited to proper donning, maintenance, face to facepiece seal, whether it is a half mask or a full facepiece respirator, etc.}

Limited: Limited PPE includes use of a half-face or full-face air purifying respirator (APR) equipped with a HEPA filter cartridge. These respirators contain both inhalation and exhalation valves that filter the air and ensure that it is free of mold particles. Note that half-face APRs do not provide eye protection. In addition, the HEPA filters do not remove vapors or gases.

{3M comment: Please see the above statement regarding HEPA filters. Table 1 also includes N95 respirators in this category. Workplace protection factor studies have shown that both filtering facepieces and elastomeric facepieces with replaceable filters meet or exceed the ANSI assigned protection factor of 10 for half mask respirators.[4, 5]}

Full: In situations in which high levels of airborne dust or mold spores are likely or when intense or long-term exposures are expected (e.g., the cleanup of large areas of contamination), a full-face, powered air purifying respirator (PAPR) is recommended. Full-face PAPRs use a blower to force air through a HEPA filter. The HEPA-filtered air is supplied to a mask that covers the entire face or a hood that covers the entire head. The positive pressure within the hood prevents unfiltered air from entering through penetrations or gaps.

{3M comment: Table 1 does not mention PAPRs. It is unclear if EPA is recommending a negative pressure full facepiece respirator, a PAPR with a full facepiece, a PAPR with a hood, or all of the above. Other types of respirators that offer equivalent or higher levels of protection, such as a supplied air respirator or a self-contained breathing apparatus (SCBA), may also be appropriate.}
Note: The VOCs or volatile toxins produced by the mold may include alcohols, aldehydes, ketones, aromatics, amines, terpenes, chlorinated hydrocarbons, and sulfur-containing compounds. These are thought to be at orders of magnitude lower than what is typical in industry.[6] A particulate filter designed for nuisance level organic vapors may be appropriate for exposures to some of these chemicals at levels that are well below the exposure limits. Gases and vapors associated with

disinfectants (e.g. chlorine) may also warrant the use of an appropriate chemical cartridge in conjunction with the particulate filter.

Table 2 lists some examples of 3M negative pressure respirators, but is by no means exhaustive. Particulate filters approved for use with negative pressure respirators are divided into N-series (not for use in environments containing oily mists), R-series (use for a single shift in environments containing oily mists) and P-series (oil-proof, change out per manufacturer's instructions). Biohazards are typically not considered to be oily mists. However, if oily mists are present in the environment from other sources (e.g. pneumatic tools), R-series or P-series filters must be used. If no oily mists are present, either a N, R or P-series filter may be used. Nuisance level relief means relief from concentrations that are below published exposure limits. Certain biocides (e.g. formaldehyde) may require a different cartridge other than one that is approved for acid gases. Table 3 lists some examples of 3M PAPRs, but again this list is not exhaustive. PAPRs are approved with HEPA (High Efficiency Particulate Air) filters. Please see product literature and NIOSH approvals for further information.

Table 2. Examples of 3M™ Negative Pressure Respirators

Type of air purifying element	**Filtering facepiece**	**Filters or cartridges to be used with Half mask (6100, 6200 or 6300) or Full facepiece (6700, 6800, 6900)**
95 level filter	8210 (N95) 8511 (N95) 9210 (N95) 9211 (N95)	2071 (P95)
95 level filter (with nuisance level acid gas relief)	8246 (R95) 8516 (N95) 8576 (P95)	2078 (P95)
95 level filter (with nuisance level organic vapor relief)	8247 (R95) 8577 (P95)	2078 (P95)
95 level filter, organic vapor and acid gases	-	6003 + 5N11 (N95) or 5P71 (P95) + 501 retainer 6003 + 502 adapter + 2071 (P95)
100 level filter	8233 (N100) 8293 (P100)	2091 (P100) 7093 (P100)
100 level filter (with nuisance level acid gas relief)	-	2096 (P100)
100 level filter (with nuisance level organic vapor relief)	-	2097 (P100)
100 level filter, organic vapor and acid gases	-	6003 + 502 adapter + 2091 (P100) 6003 + 502 adapter + 7093 (P100)

Table 3. Examples of 3M™ Powered Air Purifying Respirators (PAPRs)

Type of air purifying element	Filters or cartridges to be used with 6800PF or 6900PF Power Flow Face-Mounted PAPR	Filters or cartridges to be used with GVP-1 Belt Mounted PAPR Assembly + GVP-123 Breathing Tube + 6700DIN, 6800DIN or 6900DIN Full Facepiece
HEPA filter	450-01-01R20	GVP-440
HEPA filter and organic vapor	-	GVP-441
HEPA filter and acid gases	-	GVP-442
HEPA filter, organic vapor and acid gases	-	GVP-443

The use of NIOSH-certified respirators must be accompanied by a full respiratory protection program as specified in OSHA 29 CFR 1910.134.[7] The American National Standard for Respiratory Protection, ANSI Z88.2-1992 also provides information on establishing and administering a respiratory protection program.[5] Important components of a respiratory protection program include written standard operating procedures, user training, respirator maintenance procedures and properly fitting the respirator to the user. In addition, respirators with tight-fitting facepieces (including positive-pressure types) are not considered protective if facial hair interferes with the face seal, since proper fit cannot be assured.

For More Information

An extensive list of resources and references is given at the end of the guidelines. Two in particular that may be helpful are the New York City Department of Health (NYCDH) "Guidelines for Assessment and Remediation of Fungi in Indoor Environments" [3] and the NIOSH "Martin County Courthouse and Constitutional Office Building, Stuart Florida. HETA 93-1110-2575." [8]

For complete copies of these documents please contact either the US EPA (800-438-4318), NIOSH publications (800-356-4674), the New York City Department of Health (212-442-3372) or see the references below.

In addition, the reader is advised to contact their local health department and be alert to supplements, modifications, or additional recommendations in the future.

References

[1] United States Environmental Protection Agency. *Mold Remediation in Schools and Commercial Buildings.* 2001. http://www.epa.gov/iaq/molds/index.html

[2] Levetin, E. Fungi in *Bioaerosols*, H.A. Burge editor. Lewis Publishers, Ann Arbor, MI. 1995.

[3] New York City Department of Health, Bureau of Environmental & Occupational Disease Epidemiology. *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*. 2000. http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html

[4] Myers, W. R. and Zhuang, Z.: Field Performance Measurements of Half-Facepiece Respirators: Developing Probability Estimates to Evaluate the Adequacy of an APF of 10. *Am. Ind. Hyg. Assoc. J 59(11)*: 796-801 (1998).

[5] American National Standards Institute: American National Standard for Respiratory Protection, Z88.2. New York: American National Standards Institute, Inc. 1992.

[6] Batterman, S.A. Sampling and Analysis of Biological Volatile Organic Compounds in *Bioaerosols*, H.A. Burge editor. Lewis Publishers, Ann Arbor, MI. 1995.

[7] Occupational Safety and Health Administration. *Respiratory Protection Standard, 29 CFR 1910.134.* 63 FR 1152. January 8, 1998.

[8] National Institute for Occupational Safety and Health. Weber, A.M, Martinez, K.F. *Martin County Courthouse and Constitutional Office Building, Stuart Florida. HETA 93-1110-2575*. NIOSH Publications Office, Cincinnati, OH. 1993.