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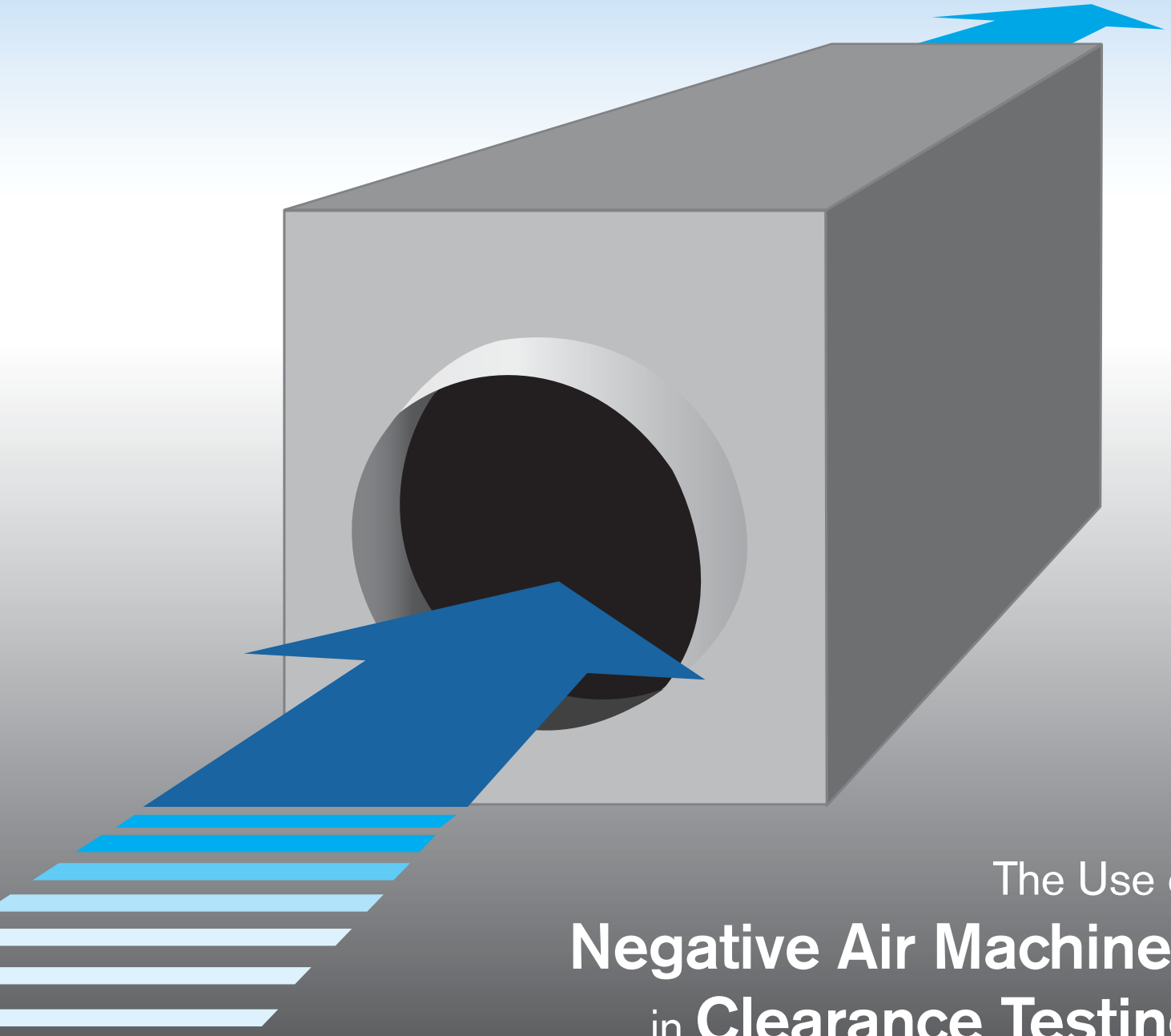

The Use of **Negative Air Machines** in **Clearance Testing** for **Mold Remediation** Projects

An IAQA White Paper

Indoor Air Quality Association (IAQA)
1791 Tullie Circle, NE
Atlanta, GA 30329
www.iaqa.org

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1. Introduction, Overview, and Acknowledgments

The mold remediation industry has produced a variety of different approaches and voluntary guidelines. However, there are no accepted U.S. federal governmental standards that define the processes and procedures necessary to control or eliminate uncontrolled indoor fungal growth or fungal hazards. Many authoritative but nonbinding documents provide various degrees of direction for mold remediation. The most commonly cited references include the following:

- *Bioaerosols: Assessment and Control* (ACGIH 1999)
- *Assessment, Remediation and Post-Remediation Verification of Mold in Buildings* (AIHA 2004)
- *Mould Guidelines for the Canadian Construction Industry* (CCA 2004)
- *Mold Remediation in Schools and Commercial Buildings* (EPA 2008)
- *Fungal Contamination in Public Buildings* (Health Canada 1995)
- *Standard and Reference Guide for Professional Mold Remediation* (IICRC 2008)
- *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* (NYCDOH 2008)

With regard to state regulation, Texas is currently the only state with specific rules for the remediation process. It is clear that both mold assessment and remediation are guided by a standard of care rather than a clear set of authoritative rules.

A standard of care can be effective in guiding professionals toward appropriate work practices. Its success and acceptance usually relies on broad consensus among experienced practitioners; but if there is no clear agreement regarding a particular work practice, then work practices and methods will vary greatly, even when the projects are very similar.

One of the remediation procedures applied inconsistently is the use of blowers and fans to create a pressure differential between the work area and surrounding areas. The purpose is to create a space that is negatively pressurized compared to the uncontaminated or less-contaminated areas, and therefore these machines used are often referred to as “negative air machines (NAMs).” In some instances, however, NAMs have been turned off before clearance or post-remediation verification (PRV) air sampling. This practice could be considered by some to be inconsistent with other remediation practices designed to protect the nonwork areas from contamination from airborne or settled mold spores.

As a result, IAQA formed an ad hoc committee on the use of NAMs in the mold remediation industry to define the issue and to identify gaps in current knowledge and industry practice. The particular focal point of the committee was to decide if the NAMs creating a negative pressure containment should be powered on or off for the PRV process and, if deemed appropriate, clearance air sampling. Efforts were made to create a committee whose members’ viewpoints represented a balance between the two positions. After reviewing the currently available literature, the committee developed this white paper on the issue.

Acknowledgments

Experts representing a balance of opinions on the NAM-On/NAM-Off position were solicited to serve on the ad hoc committee, with committee members divided between voting (IAQA member), nonvoting advisor/advisor, and peer reviewer. The ad hoc committee was co-chaired by Larry Robertson and Jack Springston. The information and recommendations presented in this paper would not have been possible without the dedicated efforts of the IAQA staff and the volunteer committee members. In addition to Mr. Robertson and Mr. Springston, the participants who have contributed so selflessly to this process include the following:

Voting members: J. Scott Armour
Graham Dick
Dan Greenblatt
Bill Kerbel
Michael Pinto
Don Weekes

Advisors: Michael Murdzia
Jim Pearson

Observer: Wei Tang

Peer reviewers: Michael Andrew
Elliott Horner

Participant: Davidge Warfield

IAQA staff: Glenn Fellman
Patti Harman

Future Efforts

With the completion of this white paper, the mandate of the ad hoc committee has been accomplished with modification. In other words, the result is not a clear, singular recommendation. Rather, it is now clear that site-specific circumstances drive the choice of either *ON* or *OFF* for NAMs during the PRV air-sampling process. Specific information and recommendations regarding the use of NAMs in the mold remediation industry have been provided in this paper. To that end, there was unanimous support by the members of the ad hoc committee for the recommendation that other industry groups involved in the development of guidance documents use the information provided in this paper, and that these industry groups specifically consider these findings regarding the operation of NAMs during PRV air sampling when developing revisions to guidance documents.

Interested parties who would like additional information on the topic or have comments to offer should feel free to contact IAQA so that their opinions can be conveyed to the principals involved in developing this white paper.

2. Acronyms and Definitions

ACGIH	American Conference of Governmental Industrial Hygienists
AFD	air filtration device. A mechanical filtration system generally comprising a fan or blower and a series of filters of varying efficiencies. Typically, an AFD used in hazardous material remediation work uses a combination of a HEPA-rated filter, one or more prefilters, and gaskets (seals) to achieve the maximum possible filtration with the minimum possible leaks of contaminated air. *See also* **HEPA**.
AIHA	American Industrial Hygiene Association
air mover	*See also* **air scrubber**, **NAM**, **blower**
air scrubber	an AFD that is set up to recirculate the air within a work area to remove airborne contaminants. *See also* **AFD**.
assessment	a process performed by an indoor environmental professional (**IEP**) that includes the evaluation of data obtained from a review of the building's history and an inspection of the subject site to formulate an initial hypothesis about the origin, identity, location, and extent of amplification of mold contamination
blower	a mechanical device for producing a current of air
CDC	Centers for Disease Control and Prevention
clearance testing	*See* **PRV**.
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate arrestance. Being, using, or containing a filter that is designed and certified to remove 99.97% of airborne particles measuring 0.3 µm in diameter from air passing through it (0.3 µm is considered the most penetrating particle size and therefore is used to classify the efficiency of the filter).
HVAC	heating, ventilation, and air conditioning
IAQA	Indoor Air Quality Association
IEP	indoor environmental professional. An individual qualified by knowledge, skill, education, training, certification, and/or experience to assess the fungal ecology of structures, systems, and contents at the job site, create a sampling strategy, sample the indoor environment, and interpret laboratory data.
IESO	Indoor Environmental Standards Organization
IICRC	Institute of Inspection, Cleaning and Restoration Certification
NAM	negative air machine. A fan or blower, often filtered, that exhausts air from a contained work area while creating an intentional negative pressure differential between the work area and adjacent areas. Note: a filter is not a necessary requirement to create a negatively pressurized

	space unless exhausting to either the indoor environment or a normally occupied outdoor space (e.g., building entrance, playground, smoking area).
NAU	negative air unit. *See* **NAM**.
PPE	personal protective equipment
PRV	post-remediation verification. The inspection and testing of areas in a building that have undergone remediation work to ensure that the remediation was successful. Also referred to as **clearance testing**.
OSHA	Occupational Safety and Health Administration, U.S. Department of Labor
RIA	Restoration Industry Association

3. Historical Aspects of Industrial Uses of NAMs—Implications for Mold Remediation

Today, the use of the terms *containment* and *NAM* in the mold industry are routine. These terms have become components of various recommendations, guidelines, and regulations regarding mold abatement throughout the industry. The industry has ample guidelines on when and how to set up containment systems; however, the industry in general has never questioned whether such guidelines are appropriate with regard to the work being performed, nor have they been evaluated to determine if modifications or exceptions to these guidelines are warranted.

Before the 1990s, many, if not most, mold remediation projects occurred without any regard to containment systems or NAMs. The first widely referenced publication that recommended the use of asbestos-like abatement practices in the mold remediation industry was the American Conference of Governmental Industrial Hygienists publication, *Guidelines for the Assessment of Bioaerosols in the Indoor Environment* (ACGIH 1989). A conference paper by one of the authors of that book recommended negative air pressure for the enclosed work area, airflow criteria consistent with OSHA asbestos standards, and post-remediation air sampling in the cleaned work area before removal of the containment barrier (Morey 1994). In 1999, ACGIH updated and renamed the book *Bioaerosols: Assessment and Control* (ACGIH 1999). The authors stated that “a full-scale containment commensurate with an asbestos abatement program is recommended for removing materials that are extensively contaminated.”

In 1993, the New York City Department of Health (DOH) convened an expert panel on "*Stachybotrys atra* in Indoor Environments." The purpose was to develop policies for medical and environmental evaluation and intervention to address *S. atra* contamination. The result of the panel discussion was publication of *Guidelines on Assessment and Remediation of* Stachybotrys atra *in Indoor Environments* (NYCDOH 1993). Those recommendations included the requirement that, for large-scale remediation projects, (1) the area be isolated using plastic sheeting, (2) a high-efficiency particle arrestance (HEPA) air filter exhausted negative air unit be used, and (3) airlocks and a decontamination unit be used when exiting the work area. In 2000, NYCDOH revised and expanded their guidelines to include the remediation of all fungi, not just *S. atra*. The revised guideline also specified that, for remediation of mold-contaminated heating, ventilation, and air-conditioning (HVAC) systems, use of an exhaust fan with HEPA filtration to generate negative pressurization was required (NYCDOH 2000).

Since the development of the NYC guidelines, a number of other agencies and organizations, including OSHA, EPA, and IICRC, have developed their own mold remediation guidelines in which they also recommend the use of negatively pressurized containment structures for remediation of “large” amounts of mold contamination and imply the need for continuous negative pressure differential throughout the remediation process. Refer to the Appendix for a listing of the various relevant industry guidelines and details regarding their stance on NAM usage and PRV.

4. Uses of Negative Air Machines

Remediation contractors typically use portable air filtration systems combined with containment barriers during mold remediation activities, to help isolate the remediation zone from adjacent areas as well as to control airborne particulate levels within the work area. These devices and/or systems are often called NAMs, negative air units (NAUs), air filtration devices (AFDs), or air scrubbers.

The units generally comprise a high-pressure fan and a series of filters of varying efficiencies. Most units are equipped with HEPA filters capable of removing 99.97% of particles measuring 0.3 µm in diameter from air passing through the filters. The devices are used to facilitate the following engineering controls:

- **Pressure differential**: the generation of relative pressure differences between work areas and adjoining nonwork areas. In most instances, the remediation zone should be negatively pressurized relative to adjacent areas. Pressure differentials are used in both construction and remediation projects to help control the airflow to and from the work area. This is accomplished through the use of various types of air moving devices, such as fans, pumps, or even vacuum cleaners.
- **Air exchange**: the replacement of air within the remediation zone with "clean" air from adjacent areas and/or outdoors. The exchange of air allows for the removal and dilution of airborne particulates. This can be accomplished by either mechanically exhausting air from the work space and pulling "fresh" air back in, or by mechanically supplying air into the work area. "Fresh" is a relative term that depends on the quality of the source. It should be established that incoming air quality is as good or better than the air quality goal established for the project. If this cannot be verified, then the replacement air should be conditioned (filtered or otherwise treated) before being introduced into the work area. When air is being pumped or drawn into the remediation zone, it is important that other contaminants not be introduced to the work area. Filtration of the exhaust air is usually required when the devices and/or systems exhaust indoors or near outdoor receptors such as outdoor air intakes or operable windows.
- **Air scrubbing** (or **air washing** or **air cleaning**): typically performed to make the remediation zone safer for workers and not put as great a burden on personal protective equipment (PPE). Air scrubbing filters the air within the remediation zone to reduce concentrations of potentially harmful airborne contaminants. Air scrubbing is accomplished by a series of filters, typically including a HEPA filter, and recirculating the air back into the work area with no effect on room pressurization. The process helps to reduce airborne concentrations of various particulates, including fungal spores. However, air scrubbers only filter out airborne particulates that are within the capture zone of the units.

Air Exchange and Negative Pressure

According to the EPA (EPA 2008), the purpose of containment during remediation activities is "to limit release of mold into the air and surroundings, in order to minimize the exposure of remediators and building occupants to mold." The EPA states that the contained area should always

be maintained under negative pressure to ensure that contaminated air does not flow into adjacent areas. EPA states that, for small-scale operations involving less than 10 ft^2 of affected surfaces, an exhaust fan ducted to the outdoors can be used. For larger-scale operations, however, EPA recommends that HEPA-filtered fan units be used to establish negative pressure within the work area.

As previously stated, pressure differentials and air exchange rates are not the same. Significant pressure differential can be established and maintained with little or no air exchange. Conversely, high air exchange rates may not necessarily result in significant pressure differentials. To maintain a particular pressure differential, a balance between the supply and exhaust volumes must be established. To limit the inflow of outside contaminants, the containment must be sealed off as much as possible from adjacent spaces such as cavities, chases, ducts, plenums, and outdoors. This will also reduce the volume of supply air. A low supply volume means a low exhaust volume is required to maintain the desired pressurization. A well-sealed area will also reduce the air exchange rate, because there is both low supply and low exhaust.

Establishing containment under negative pressure will limit the migration of particulate matter into surrounding areas. A less-than-well-sealed area with a higher air exchange rate may be preferable for mold remediation. Care must be used to prevent breaches through the penetrations when pressurization shifts and becomes neutral or positive. Flow of air inside the containment can cause localized reverses in the airflow, and containment can be breached even if negative pressurization is continuously maintained.

Filters

Industry practice has developed to specify that only devices using HEPA filtration are acceptable for use on mold remediation projects. In some cases, the AFD cabinet and filter are certified and/or tested together as HEPA. Contaminated air can bypass the filters and/or pass through poor seals and cross-contaminate the surrounding space. Filters become loaded with debris over time and may decrease in airflow even though they may pass initial testing. This may result in premature fan failure or inadequate air exchange.

5. Review of Current Issues with Negative Air Machines

NAM OFF

The NAM Off argument is generally based on creating realistic occupancy conditions when the NAM is not operating, regardless of whether it is exhausting outside the containment or it is functioning as an air scrubber. Although there is some anecdotal evidence supporting this contention, there are currently no peer-reviewed published scientific studies or documents that support this premise. Negative pressure within a work area can potentially bring in unfiltered air from outdoors and other portions of the building proper, including interstitial spaces, which could represent undetected or un-remediated fungal reservoirs. This is a confounding problem when trying to measure contamination of the cleaned space inside the containment. Spore trap sampling is currently one of the most prominent methods used by IEPs for the detection of intact airborne fungal spores in PRV sampling, and it is common for the spores from these various sources to be detected by this method of sampling within a negatively pressurized work area. Under most situations, the recovery of these spores may not represent any specific concern. However, in PRV testing, these spores from outside the clean work area have the potential to exceed the thresholds of individually designated PRV criteria, and the area may fail clearance testing as result.

Similarly, negative pressure may introduce makeup air that contains significantly fewer fungal spores than are present within the work area. Such a scenario would result in an artificial reduction, or dilution, of the actual airborne spore concentrations being measured by the IEP. In such instances, PRV testing could indicate that the work area meets the thresholds of individually designated PRV criteria when, in fact, field conditions actually warrant that additional abatement work be performed.

It should be noted that many industry authorities, including EPA, do not recommend air sampling for mold for PRV (clearance) purposes, citing inaccurate and imprecise data, and the lack of generally accepted PRV concentration limits. These authorities suggest that the quality of a remediation project can be determined by visual inspection alone (EPA 2008; NYCDOH 2008; NYSDOH 2010). Despite the fact that individualized PRV criteria may not be supported by any peer reviewed or industry reference, they are routinely utilized across the U.S. to determine the efficacy of remediation. Additionally, many of these individualized PRV criteria use data from spore trap samples, although spore trap sampling may not be a reliable method by which the efficacy of a remediation project can be judged (Robertson and Brandys 2011). Regardless, some IEPs continue to rely on the results of spore trap data to “pass” or “fail” remediation projects, and often direct additional unwarranted remediation based on that data. This results in both tangible and intangible costs to the contractor and client/owner, as well as unnecessary delays in reconstruction, impacting both the building owner and occupants.

NAM ON

The NAM On argument appears to be based on the belief that continuous negative pressure of the work area represents the most appropriate means to protect the health and safety of the occupants and workers, and to minimize migration of mold contamination from the work area to adjacent occupied spaces, because the quality of the remediation and concentration of fungal material in the work areas is unknown or, at least, untested. However, no scientific evidence currently exists to support this premise. As previously noted, negative pressure in a work area can potentially bring in air from other areas of the building that may be contaminated. This could potentially increase the concentrations of spores in the work area and create a greater exposure potential for the workers.

Such a configuration could actually increase potential exposures for workers and recontaminate the work area during the final stages of the remediation event. The potential for such a condition becomes even more evident when the outdoors or adjacent areas contain undesirable contaminants or harsh environmental conditions. For example, an undesirable indoor condition may be created if the outdoor air is below freezing and continuous negative pressure pulls extremely cold air into the work area and/or indoor environment. Conversely, in hot and humid climates, damp outdoor air can be pulled into wall voids and other interstitial spaces where condensation may become an issue. Additionally, continuous negative pressure may create undesirable exposure issues when outdoor contaminants such as ozone, smog, particulates, or smoke are drawn into the work areas.

The majority of current mold remediation guidelines appear to offer no guidance on how NAMs should be configured and operated in negative-pressure mode during PRV.

The IEP or remediation contractor has the ability to exercise professional judgment when configuring the work area to ensure that outside contaminants are not brought in or undesirable environmental conditions are not created in the indoor environment. Most current industry guidelines identify the need for such professional judgment, but then include prescriptive statements directing that the work area be maintained under negative pressure until the remediation work is completed.

However, it is not clear in many of these guidelines whether the remediation work includes post-remediation verification air sampling.

Lack of Industry Standards

The mold assessment and remediation industry is largely operating with a lack of generally accepted industry standards or guidance with regards to NAM usage during the PRV process, and that lack of guidance has resulted in the current conflicts regarding both. Clearly, most industry standards and guidelines call for the establishment of some sort of negative pressure differential within the work area, but for the most part they do not indicate at which point the NAMs can be turned off. With regard to PRV sampling, many guidelines recommend that only a visual inspection be performed, while several others recommend that some sort of testing (typically spore trap sampling) also be performed. Refer to Section 6 for additional information.

The City of Los Angeles issued guidelines on the assessment and remediation of mold in which they recommended that the NAM units run in negative pressure mode for a minimum of 12 hours after completion of the removal, and then be turned off a minimum of 30 minutes before performing PRV air sampling (City of Los Angeles 2005). Although many on the committee reject many of the specifics found in the Los Angeles Mold Remediation Guidelines, the committee agrees with the city's attempt to standardize the amount of time in which the unit is turned off. In doing so, the city has provided a standard by which IEPs and mold remediators must operate in Los Angeles. However, for the industry at large, that is not the case. The amount of time that a NAM is turned off appears to vary tremendously in the industry (IAQA 2013). One committee member indicated that, as an example, his company may have several different remediation projects ongoing. On one project, the IEP may require that the NAMs be turned off 24 hours before sampling, whereas on another it might be 12 hours, and on yet another site the instructions are to keep the NAM on.

OSHA does not have any specific regulation to maintain the work area under negative pressure during the entire remediation period, including post-remediation verification. However, specific inquiries to OSHA indicated that they could cite the General Duty Clause (29 U.S.C. § 654, 5(a)1) in instances where workplace concerns about worker safety arise. Additionally, recent information indicates that specific physical damage or health issues do not necessarily need to be identified in a case to support a claim against an employer. Attorneys may use aspects of professional liability to assert claims against a mold assessor or remediator for simply not following industry guidelines and accepted practice (Wilcox 2013).

6. Current Industry Standards and Guidelines

A review of the various industry standards and guidelines listed in the Appendix indicates that, for large-scale remediation projects, there is near-unanimous agreement on the need to physically contain the work area and isolate it from adjacent nonwork areas to help prevent the spread of mold to those areas. A majority of the guidelines also recommend the use of HEPA-filtered NAMs to establish a negative pressure differential between the work area and adjacent spaces. One consistent theme on the reasoning for containment is the need for effective removal of mold contamination while maintaining the safety and health both of the remediation workers and of the other building occupants. Additionally, the use of NAMs helps to prevent cross-contamination of previously unaffected adjacent spaces.

The 2000 New York City guidelines (NYCDOH 2000) specifically state, “The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.” They also note that the “listed remediation methods are not meant to exclude other similarly effective methods.” The Canadian Construction Association’s (CCA) guideline (CCA 2004) similarly states that “each remediation project has its own unique challenges that may require deviations from these guidelines” that should only be made by an experienced and qualified professional. Even the U.S. EPA notes that “professional judgment and experience” should be used to adapt their guidelines to particular situations (EPA 2008).

It is important to note that, with the exception of the Los Angeles assessment and remediation guidelines, none of the referenced standards or guidelines address whether NAMs should remain running during PRV and, if required, the subsequent clearance sampling and the receipt of laboratory results. The Los Angeles guidelines indicate that NAMs should be left running until the area passes a visual examination, and then be shut off during clearance air sampling (City of Los Angeles 2005). The *Texas Mold Assessment and Remediation Rules* state that no person may dismantle containment until clearance has been achieved, but the rules do not specifically address the requirement for negative air pressure to remain in operation during PRV sampling (Texas DSHS 2007).

There appears to be considerable disagreement between the various guidelines as to what PRV should specifically entail. All of the guidelines either imply or explicitly call for a visual assessment of the work area following remediation. Three—City of Los Angeles (2005), Texas DSHS (2007), and CSA (2012)—specifically require some type of clearance sampling, while several others only recommend it. Only the *Unified Facilities Guide Specification—Mold Remediation*, a joint publication of the U.S. Army Corps of Engineers (USACE), the Naval Facilities Engineering Command (NAVFAC), the Air Force Civil Engineer Center (AFCEC) and the National Aeronautics and Space Administration (NASA), makes no mention of PRV sampling and states that clearance is based solely on a visual assessment (USACE/NAVFAC/AFCESA/NASA 2011).

7. Conclusions and Recommendations

It is the consensus of the committee that mold remediation work, particularly for large areas (greater than 100 ft^2 within the same specific area), be conducted where the work area is isolated and maintained under negative pressure. This is supported by the various guidelines described in this document. The pressure differential should be maintained throughout the entire remediation process until a final visual inspection has been performed by a competent person. This inspection should confirm that the scope of work has been completed and the area is suitably clean and dry. Upon successful completion of this inspection, the work should be considered substantially complete. Then, if required, verification that airborne fungal spore concentrations meet a predetermined acceptance level can proceed, with the NAMs either on or off.

The determination of whether a NAM is in operation during the collection of PRV samples should be evaluated on a case-by-case basis by the competent person and they should document their decision and the rationale behind it. The documentation must be site specific and address the unique conditions influencing the decision. In all cases, the accuracy and precision of any analytical procedure used must be taken into account. Research and industry documents repeatedly conclude that caution must be applied when interpreting environmental sample results, particularly when only a limited amount of samples are collected.

For air sampling, there is no published evidence that supports the contention that turning a NAM off at the end of the removal process will result in more realistic occupancy conditions. The committee does not believe that the addition of unfounded and unsupported complexities in remedial practices improves the quality of a remediation project in general, and contends that such practices generally undermine the industry's ability to define an appropriate and standardized best practice.

The committee concludes that current industry guidelines and recommendations do offer the latitude for the coexistence of each position within the industry. However, the committee also believes that further action is necessary to clarify the specifics regarding NAM use as well as PRV and clearance sampling criteria. Both the "NAM on" safety/health premise and the "NAM off" more-accurate PRV-sampling premise lack scientific data supporting them and require further research. Based on these needs, the committee recommends the following:

1. That IAQA share this document with IAQ industry partners as well as others with a material interest in mold remediation, to foster further discussions regarding this matter. IAQA should encourage those groups to use the information in this white paper to better understand the latitude of professional judgment in the use of NAMs on mold remediation projects and, until additional scientific evidence becomes available, to adjust their own guidance documents accordingly to be consistent with these findings.
2. That IAQA supports the need for research and development towards a scientifically valid and industry-accepted means by which PRV sampling is performed and evaluated.
3. That IAQA supports the need for research on particle profiling and potential exposures, both inside and outside the work area, while NAMs are running, to improve the overall

understanding of particle dynamics, the specifics of exposure, and the potential for cross-contamination.

4. That IAQA supports the need for research into whether post-remediation clearance sampling, particularly spore trap sampling, has any measurable merit in determining the efficacy of the remediation process.

Appendix: Industry Standards and Guidelines

Reference	NAM Required? Y/N	NAM Usage Details	PRV Testing? Y/N	PRV Details
NYCDOH (1993)	Y	HEPA-exhausted negative air unit required for large-scale remediation (>30 ft^2) and remediation of HVAC systems.	N	Conduct air monitoring after large-scale remediation, to determine its effectiveness and whether area is safe for symptomatic persons to reoccupy. If post-remediation air samples indicate presence of *Stachybotrys*, even in minor amounts, further investigation of possible sources is required.
Health Canada (1995)	N	Removal of porous contaminated materials may result in the creation of hazardous aerosols; thus, it may be necessary to isolate area with plastic sheeting and carry out remediation under negative pressure.	N	PRV not discussed.
ACGIH (1989)	Y	Negative air pressure differential between work area and surrounding space must be created to prevent contaminants from leaving work zone. Air filtration device with HEPA filter should be used.	N	Success of remediation judged in part by visible degree of contaminant removal. Ultimate criterion is ability of people to occupy or reoccupy space without health complaints or physical discomfort.
NYSDOH (2010)	Y	HEPA-exhausted negative air unit required for large-scale remediation (>100 ft^2) and remediation of HVAC systems with >10 ft^2 of contamination.	N	Conduct air monitoring before occupancy to determine if area is fit to reoccupy.
NYCDOH (2008)	Y	Containment area must be maintained under negative pressure relative to surrounding areas, to ensure contaminated air does not flow into adjacent areas. Can be done with HEPA-filtered fan unit exhausted to outside of building. For small, easily contained areas, exhaust fan ducted to outdoors can also be used.	N	Use professional judgment to determine if cleanup is sufficient. Visible mold, mold-damaged materials, and moldy odors should not be present.
OSHA (2003)	N	For extensive contamination (>100 contiguous ft^2), exhaust fan with HEPA filter to generate negative pressure may be used depending on severity of contamination.	N	All areas should be left dry and visibly free from contamination and debris.

Reference	NAM Required? Y/N	NAM Usage Details	PRV Testing? Y/N	PRV Details
IICRC (2008)	Y	Negatively pressurize contaminated areas relative to unaffected or clean areas to prevent cross-contamination. Generally, when pressure differentials are used, they should be created using HEPA-filtered AFDs used as NAMs.	N	Post-remediation verification can include subjective or objective criteria. Subjective criteria can include but are not limited to visual inspection and odor detection and characterization. Objective criteria can include but are not limited to analytical testing (e.g., moisture monitoring, temperature, and relative humidity) and environmental sampling.
CCA (2004)	Y	For areas with >10 ft^2 of contamination, provide negative pressure in enclosure by drawing air from work area and exhausting it using an exhaust fan to outdoors, a HEPA vacuum, or a HEPA air-filtration device (NAM). Provide minimum negative pressure of 5 Pa (0.02 in. of water). Where possible, discharge filtered air outside building and away from people.	N	Generally, air samples are collected from work area and compared to samples taken in reference areas. Acceptable condition is indicated when concentrations of airborne fungal particles in work area are not significantly elevated when compared to concentrations in reference samples, and types of fungal particulate in work area do not differ significantly from those in reference samples. Samples may so be compared to any similar measurements taken in work area before remediation. Sample results should be interpreted by qualified professional.
AIHA (2004)	N	Defers to NYC DOH 2002 guidelines, but also states that alternative control measures may be considered by competent person in lieu of full containment including “maintaining only a slight negative or neutral pressure.”	N	Conduct detailed visual inspection when remediation complete to determine that all identified mold contaminated materials have been removed or treated and that adjacent surfaces are free of visible dust and debris. Use qualitative or quantitative testing (such as air sampling or surface sampling for mold) as needed as nonvisual evaluation tool in determining whether conditions are acceptable for reoccupancy.

Reference	NAM Required? Y/N	NAM Usage Details	PRV Testing? Y/N	PRV Details
City of Los Angeles (2005)	Y	Maintain work area under negative pressure with HEPA-filtered fan unit. Block supply and return air vents within containment area.	Y	Final air sampling required on remediation projects over 100 ft^2. Upon passing thorough visual inspection, do air sampling for documentation to support conclusive removal has occurred. Do air sampling before removal of containment; HEPA NAMs shall run in negative pressure mode for minimum of 12 hours after completion of removal before beginning sampling. NAMs shall be turned off for minimum of 30 minutes before start of sampling and shall remain off for duration of sampling. After sampling, NAMs can be turned back on until final results in and clearance given.
Umbach and Davis (2006) (California Research Bureau)	N	It may be necessary to establish negative air pressure to ensure that particles do not escape from contaminated rooms into adjacent rooms or ducts. The larger the affected area and the heavier the contamination, the more appropriate negative air pressure and more elaborate containment procedures become.	N	After remediation of identified mold (removal, repairs, and cleaning), air and surface sampling may be appropriate to verify that the problem has been fully corrected.
Texas DSHS (2007)	Y/N?	Containment must be specified in mold remediation protocol when mold contamination affects a total contiguous surface area of 25 ft^2 or more for project. If walk-in containment used, supply and return air vents must be blocked, and air pressure within walk-in containment must be lower than pressure in building areas adjacent to containment.	Y	No person shall remove or dismantle any walk-in containment structures or materials from project site before receipt by licensed mold remediation contractor or remediation company overseeing project of written notice from licensed mold assessment consultant that project has achieved clearance. Assessment consultant shall perform visual, procedural, and analytical evaluation in each remediated area to determine whether mold contamination identified for project has been remediated as outlined in remediation protocol.
AIHA (2008)	Y	Induce minimum negative pressure within the enclosure of 5 Pa (0.02 in. of water) by drawing air from enclosure using (1) exhaust fan directing air from within enclosure to outdoors (away from people) or (b) HEPA air filtration device exhausting air to outside of enclosure.	N	100% of areas affected by mold growth should be physically re-inspected. Value added by surface microbial testing over and above thorough visual inspection for absence of mold growth is uncertain.

Reference	NAM Required? Y/N	NAM Usage Details	PRV Testing? Y/N	PRV Details
USACE/ NAVFAC/ AFCESA/ NASA (2011)	Y	Install AFUs with HEPA filters in the containment. Configure AFUs to allow some of air to recirculate within containment. Discharge remainder of air directly to outside to maintain overall negative pressure in containment of 5 Pa minimum to 10 Pa maximum relative to outside and other adjacent spaces not undergoing remediation. AFUs shall filter minimum of four air changes per hour and maximum of six air changes per hour.	N	Clearance based on visual assessment (all visible mold removed, all visible dust removed, based on "white glove" test) by contracting officer. Maintain containments in place until spaces are inspected and accepted by government as being fully remediated. Government will determine whether contractor shall conduct additional cleaning and repeat clearance process.
CSA (2012)	Y	Ductwork, diffusers, and all openings in construction area shall be sealed or capped dust tight. All work areas within enclosure shall have negative air pressure provided by construction air-handling units. Ventilation systems shall be configured to create negative pressure in contaminated area.	Y	Clearance air samples shall be taken in Level 4 and 5 mould-affected areas (extensive contamination of area greater than 10 m^2 or numerous areas or HVAC or domestic water systems contamination in any affected area). This testing shall be performed and interpreted by environmental consultant or company qualified to do environmental testing.

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