Minimizing Indoor Mold Problems through Management of Moisture in Building Systems

Position Document
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COMMITTEE ROSTER

The ASHRAE Position Document on minimizing indoor mold problems through management of moisture in building systems was developed by the Society's Minimizing Indoor Mold Problems through Management of Moisture in Building Systems Position Document Committee.

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Purpose

To inform ASHRAE members, policymakers and regulators of the position that ASHRAE maintains as to measures that can be taken to minimize indoor mold problems through moisture management.

Scope

This document discusses ASHRAE's position on the management of moisture in buildings by providing an overview of an extremely complex topic and highlighting resources available through ASHRAE regarding the management of moisture and thus mold in buildings.

Executive Summary

ASHRAE has a long history of researching, developing and publishing information and guidance that addresses moisture / mold management within buildings. We emphasize that problems can generally be avoided by proper design, construction and operation. Comprehensive moisture / mold management requires multi-disciplinary input from professionals with various areas of expertise. Any potential conflict between moisture management and energy conservation goals can be significantly mitigated through proper design and operation.

Policymakers are urged to account for the multi-disciplinary aspects and seek the most accurate scientific and technical information available on moisture / mold management to avoid developing policies that unintentionally exacerbate or fail to address the issue properly. ASHRAE's technical expertise should be utilized in the development of any policies addressing moisture / mold management. Some of the resources that address these issues are included in Table 1.

Comprehensive moisture management should address the complexity of the interaction of building systems, operation, and maintenance and occupant activities. The concepts described in this document represent ASHRAE's basic recommendations to address moisture in buildings. Buildings / systems/ operations satisfying these key concepts are more likely to comprehensively manage moisture / mold.

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1.0 INTRODUCTION

ASHRAE is the primary organization for the technical aspects of design, construction and operation of HVAC systems and building envelopes, and has a long history of developing standards, guidelines, design guides and special publications, which provide design criteria that help minimize mold proliferation within buildings. In addition, ASHRAE, through its conferences and network of chapters, provides seminars and programs focused on technical information and disseminates information on good design practices to prevent mold proliferation. Failure to address the impact of moisture in buildings is a frequent cause of mold proliferation in buildings. While no cognizant authority has established threshold limit values for mold spore exposure, mold growth is frequently associated with indoor air quality (IAQ) complaints. It is important to note that comprehensive moisture / mold management requires a three-phase approach: prevention, mitigation and remediation. ASHRAE's primary focus has been on prevention through moisture management - specifically the design of systems that will prevent and manage moisture accumulation within buildings. An integrated approach is required and specific technical information cannot be taken out of context. ASHRAE's technical expertise should be utilized in the development of any standards or guidelines addressing moisture / mold management.

Policymakers are urged to account for the multi-disciplinary aspects and seek the most accurate scientific and technical information available on moisture / mold management to avoid developing policies that unintentionally exacerbate or fail to address the issue properly. Individuals involved in the design, construction, operation, maintenance or regulation of buildings should recognize that current legislation, codes, standards and guidelines may be based on limited scientific information and have conflicting requirements. In-appropriate application or interpretation of conflicting requirements can result in conditions that will exacerbate mold proliferation in buildings. ASHRAE members should strive to educate and inform their clients and the entire design team of the potential impact of these conflicting requirements.

Another area of potential conflict involves energy management. Both energy conservation and moisture management goals must be considered in the design, construction, operation and maintenance of HVAC systems. The impact of mold proliferation suggests that energy and equipment investment are sometimes necessary to achieve sound moisture management in a building. However, it is also possible to achieve effective dehumidification and moisture management while using less energy than many traditional designs. Any potential conflict between moisture management and energy conservation goals can be significantly mitigated through proper design and operation.

This paper is not a comprehensive treatment of the topic of moisture management as it relates to mold in buildings, but generally discusses ASHRAE's position and highlights its resources addressing key building design and maintenance criteria regarding humidity control, surface condensation, adequate thermal insulation, building pressurization, infiltration, proper water management in HVAC and plumbing systems, proper equipment design, climatic conditions and occupant activities. New technologies and information regularly become available on moisture / mold management. Additional research and the development of additional technically sound guidance is encouraged.

2.0 BACKGROUND: BASICS OF MOLD

Fungi are ubiquitous in nature and they perform an active role in the decomposition of organic material and the natural recycling of nutrients from wood, wood-products and vegetation in the environment. Fungi are also used in industrial (biodegradation), pharmaceutical (antibiotics) and food production (cheese, alcoholic beverages). Fungi are microscopic organisms that form visible colonies or other structures when growing under favorable environmental conditions on a suitable substrate with adequate moisture. Mold is a term used to describe a broad range of filamentous fungi. Mold reproduces through the production of microscopic spores that are dispersed by wind, rainfall, and physical disturbance. A mixture of fungal genera that are mostly derived from botanical sources is generally present in the outdoor air and in the air in well maintained dry buildings. However, mold can colonize and grow in indoor

environments that are affected by excess moisture. Water / moisture accumulation is the primary limiting factor for mold growth in buildings. Ineffective water management can result in elevated concentrations or the predominance of some species that have been associated with IAQ concerns.

HVAC systems, of prime concern for ASHRAE, play a key role in moisture management in buildings. The conditioning of air often includes the addition or removal of moisture. As a result, portions of HVAC equipment and components are often wet. The HVAC system provides a method of moisture control and is a critical building system that requires diligent moisture management.

Table 1 lists selected ASHRAE resources addressing sources of moisture and practices that minimize moisture / mold in buildings.

3.0 RECOMMENDATIONS FOR MOISTURE MANAGEMENT

Comprehensive moisture management should address the complexity of the interaction of building systems, operation, maintenance and occupant activities. The following represent ASHRAE's basic recommendations to address moisture in buildings. Buildings / systems / operations satisfying the factors listed below are more likely to comprehensively manage moisture / mold.

1.# Building envelopes, penetrations, and building systems are designed and built to achieve protection of the indoor environment and the building materials from water, including both liquid and vapor, infiltration or accumulation. Design and construction accounts for the changes in material hygrothermal properties as a function of both time and moisture load.

2.# Building and system design takes into consideration moisture that will be created internally as well as influences from the exterior that could cause moisture accumulation (condensation) on surfaces or within materials.

3.# Building and system design, operation and maintenance provide for drying of surfaces and materials that might be prone to moisture accumulation under the normal operating conditions of the building, e.g., entryway floors and exterior wall construction assemblies.

4.# Building and system design, operation and maintenance provide for water management of surfaces and materials that are expected to have moisture present, e.g., HVAC evaporator coils and bathroom fixtures.

5.# Mechanical system design properly addresses ventilation air. Mechanically introduced ventilation air is filtered and conditioned (temperature and humidity) before it is introduced into the conditioned spaces. Exhaust and ventilation air systems are designed and controlled so that neutral or positive pressure differential is maintained between the indoor and outdoor conditions. For humid climate zones, provide for a positive pressure differential between indoor and outdoor conditions during mechanical cooling system operation.

6.# Building and system design, construction and operation take into account current and intended occupant uses of the building.

7.# Each building has an O&M plan used by operating personnel to properly manage the systems in the building. Appropriate O&M is essential to long-term performance and moisture / mold management of the building and its systems and to the satisfaction of the occupants. Changes in the operation of the building from the intended design could result in increased moisture and/or mold proliferation.

8.# The sequence of operation for the HVAC system contains appropriate provisions to:
   a.# dehumidify or humidify as required, without overcooling or overheating
   b.# manage humidity during both occupied and unoccupied periods
   c.# control pressurization throughout the various operational conditions of the building
   d.# provide monitoring of critical conditions and have alarms to notify operating personnel of conditions that are outside of proper performance.

9.# Moisture accumulation is investigated in a timely manner and steps are taken to identify and control the source of the water, and assure that any mitigation and remediation is performed in a way that protects the occupants. Effective communication between building

management and occupants occurs during this process. Preventive maintenance and inspection procedures that allow for the rapid identification of moisture accumulation, removal of the moisture, assessment of any resulting damage, and evaluation of the potential for mold growth in the area are used to minimize the growth of mold within buildings and systems. Appropriate procedures for the removal or cleaning of mold growth are used to minimize the opportunity for dissemination of mold within the building.

Table 1. Sources of Moisture and Practices that Minimize Moisture / Mold Problems in Buildings[1]

Sources of Moisture	Practices that minimize moisture/mold	ASHRAE references
High indoor humidity	•# Proper dehumidification design conditions •# Proper selection of coil sections	2001 Handbook, *Fundamentals*, chapters 24.5, 27 Standard 55-2004 Standard 62.1-2004 2004 Handbook, *HVAC Systems and Equipment*, chapters 21, 22
	•# Positive humidity control with humidity monitoring and control devices used in the facility •# Design based on dew-point rather than wet-bulb	*Humidity Control Design Guide* 2001 Handbook, *Fundamentals*, chapters 17, 23, 24, 26, 27 Standard 62.1-2004 2004 Handbook, *HVAC Systems and Equipment*, chapter 20
Condensation	•# Adequate insulation	2001 Handbook, *Fundamentals*, chapters 23, 24 2002 Handbook, *Refrigeration*, chapter 32 2004 Handbook, *HVAC Systems and Equipment*, chapter 43
	•# Temperature control of surfaces to be above dewpoint	2001 Handbook, *Fundamentals*, chapters 23, 24 *Humidity Control Design Guide*, 2:10
	•# Properly placed vapor retarders	2001 Handbook, *Fundamentals*, chapters 23, 24 *Humidity Control Design Guide*, 2:10 Standard 62.1-2004
Poor or non-existent maintenance	•# Design allows proper inspection and maintenance activities	2001 Handbook, *Fundamentals*, chapter 26 Guideline 1-1996 Guideline 12-2000, 3.3 Standard 62.1-2004, 5.14 2004 Handbook, *HVAC Systems and Equipment*, chapter 16 2003 Handbook, *HVAC Applications*, chapters 26, 27, 38 See footnote 2
	•# Regular documented observation	Guideline 1-1996, 7.1.2 Standard 62.1-2004, 4.3 Guideline 12-2000, 7.6 2003 Handbook, *HVAC Applications*, chapter 38
	•# Qualified and trained personnel	2003 Handbook, *HVAC Applications*, chapters 2, 38, 42
	•# Appropriate resources- materials and funds	2003 Handbook, *HVAC Applications*, chapters 2, 36, 38 2004 Handbook, *HVAC Systems and Equipment*, 1.3
	•# Maintenance manuals and schedules	*Humidity Control Design Guide*, 2:32 Standard 62.1-2004, 7.2.6, 8.1.2, 8.2 Standard 1-1996 Guideline 4-1993, 1 2003 Handbook, *HVAC Applications*, chapters 36, 38, 42
	•# Cleanliness of building and building systems, including housekeeping	Guideline 12-2000, 5.6.1.6, 6.6.2, 7.6.1 2003 Handbook, *HVAC Applications*, chapters 37, 38
Improper operation	•# Appropriate sequence of operation	2003 Handbook, *HVAC Applications*, chapter 37
	•# Adherence to the building sequence of operation •# Annual review of building operation for compliance with original design intent	Standard 62-2004, 7.2.6 Guideline 1-1996 Guideline 4-1993

Sources of Moisture	Practices that minimize moisture/mold	ASHRAE references
Poor building stewardship	•# Appropriate selection of building materials	2001 Handbook, *Fundamentals*, chapters 23, 25
	•# Appropriate design of construction details considering regional limitations of materials, workmanship, building operations and maintenance	2003 Handbook, *HVAC Applications*, chapters 2, 36, 37, 38, 42
	•# Protecting building and building materials during construction	*Humidity Control Design Guide*, 2:28 Standard 62.1-2004, 4 2003 Handbook, *HVAC Applications*, chapter 43.4
	•# Supervision of workforce: quality workmanship	2001 Handbook, *Fundamentals*, chapters 25, 34 2003 Handbook, *HVAC Applications*
	•# Verification of building system operation	1999 Handbook, *HVAC Applications*, 41.4 Guideline 1-1996
	•# Proper and timely drying and repair of wetted materials following moisture accumulation or water damage	*Humidity Control Design Guide*, 2:28 2001 Handbook, *Fundamentals*, chapter 23 2003 Handbook, *HVAC Applications*, chapter 43
Leaky building envelope	•# Minimizing water and air infiltration	2001 Handbook, *Fundamentals*, chapters 23, 24, 30, 43 2003 Handbook, *HVAC Applications*, chapter 43 Standard 119-1988, 1
	seal penetrations	
	proper penetration flashing	2003 Handbook, *HVAC Applications*, chapter 43
	minimize water entrainment at openings	2003 Handbook, *HVAC Applications*, chapter 43
	•# Appropriate drainage planes in walls	2001 Handbook, *Fundamentals*, chapter 24 2003 Handbook, *HVAC Applications*, chapter 43
	•# Appropriate control of site drainage away from the building envelope and materials	2001 Handbook, *Fundamentals*, chapter 24 2003 Handbook, *HVAC Applications*, chapter 43
Improper pressurization	•# Pressurization appropriate to climate and facility requirements	*Humidity Control Design Guide*, chapters 2, 16 2003 Handbook, *HVAC Applications*, chapters 1, 5, 31
Uncontrolled ventilation	•# Appropriate humidification / dehumidification of outside air	*Humidity Control Design Guide*, chapters 11, 12
	•# Appropriate control and monitoring of outside air intake and exhaust systems	2001 Handbook, *Fundamentals*, chapter 24 2003 Handbook, *HVAC Applications*, chapters 31, 44 Standard 62.1-2004, 5.2, 5.6
Inadequate water management of HVAC systems	•# Properly sloped and sized drain pans and lines •# Appropriate use of anti-microbials	Standard 62.1-2004, 5.11, 7.2.3 *Humidity Control Design Guide*, 2:29, 7:116
	•# Minimize moisture carryover	2004 Handbook, *HVAC Systems and Equipment*, chapters 21.2, 45.7
	•# Adequate equipment insulation (non-condensing)	2001 Handbook, *Fundamentals*, chapters 23, 24 2004 Handbook, *HVAC Systems and Equipment*, chapter 16.6
	•# Minimize equipment air leakage (seals)	*Humidity Control Design Guide*, chapters 2:28-29, 16:257
	•# Appropriate equipment location (conditioned or non-conditioned)	2004 Handbook, *HVAC Systems and Equipment*, chapter 45.2
	•# Properly located, installed and controlled humidifiers	*Humidity Control Design Guide*, chapter 14 2004 Handbook, *HVAC Systems and Equipment*, chapters 19, 20

Sources of Moisture	Practices that minimize moisture / mold	ASHRAE references
Plumbing – leaks, overflow, storm drainage	•# Appropriate installation of plumbing system	
	•# Minimize water leaks including those attributable to other trades (Nail through pipes, etc.)	
	•# Adequate insulation for dewpoint control	2001 Handbook, *Fundamentals*, chapters 23, 24
	•# Prevent and address sewage backflow	
Occupant activity	•# Properly account for moisture producing activities	2001 Handbook, *Fundamentals*, chapters 8, 28, 29 *Humidity Control Design Guide*, chapter 11:164-178 Standard 154-2003
	•# Proper combustion air and venting of appliances	2004 Handbook, *HVAC Systems and Equipment*, 28, 29, 30, 31 2001 Handbook, *Fundamentals*, chapters 18, 26 Standard 62.1-2004, 5.8
	•# Properly address changes in area usage or equipment	Standard 62.1-2004, 8.1.3
Weather	•# Design of building envelope for climate conditions	2001 Handbook, *Fundamentals*, chapters 24, 25, 26, 28, 29 2003 Handbook, *HVAC Applications*, chapter 43 *Humidity Control Design Guide*, chapter 2:10-11
	•# Proper and timely drying and repair of wetted materials following catastrophic events	

[1] This table is not an exhaustive list – there are other documents that could be instructive.

[2] A new standards committee, 180P, *Standard Practice for Inspection and Maintenance of HVAC Systems*, has been formed and is beginning work in 2005.