~~804.4.2~~ **5.504.4.3 Paints and coatings.** Architectural paints and coatings shall comply with VOC limits in Table 1 of the ARB Architectural Coatings Suggested Control Measure, as shown in Table 804.4.2 5.504.4.3, unless more stringent local limits apply or comply with the VOC-emission limits defined in the 2009 Collaborative for High Performance Schools (CHPS) critera and listed on its Low-emitting Materials List or certified under the GREENGUARD Environmental Institute's Children & Schools Certification.[MSOffice1] The VOC content limit for coatings that do not meet the definitions for the specialty coatings categories listed in Table 5.504.4.3, shall be determined by classifying the coating as a Flat, Nonflat, or Nonflat-High Gloss coating, based on its gloss, as defined in subsections 4.21, 4.36, and 4.37 of the 2007 California Air Resources Board, Suggested Control Measure, and the corresponding Flat, Nonflat, or Nonflat-High Gloss VOC limit in Table 5.504.4.3 shall apply.

5.504.4.6 Resilient flooring systems. For 50% of floor area receiving resilient flooring, install resilient flooring complying with the VOC-emission limits defined in the 2009 Collaborative for High Performance Schools (CHPS) criteria and listed on its Low-emitting Materials List, certified under the Resilient Floor Covering Institute (RFCI) FloorScore program, or certified under the GREENGUARD Environmental Institute's Children & Schools Certification[MSOffice2]. Documentation shall be provided that verifies that finish materials are certified to meet the pollutant emission limits.

Note: Products certified under the FloorScore program may be found at: http://www.rfci.com/int_FS-ProdCert.htm and those certified under the GREENGUARD Environmental Institute's Children & Schools Certificatoin may be found at: http://www.greenguard.org/Default.aspx?tabid=135~~.~~

~~804.4.5~~ **A5.504.4.7 Resilient flooring systems, Tier 1.** For 80% of floor area receiving resilient flooring, install resilient flooring c~~C~~omplying with the VOC-emission limits defined in the 2009 Collaborative for High Performance Schools (CHPS) criteria and listed on its Low-emitting Materials List, ~~www.chps.net/manual/lem_table.htm,~~ certified under the FloorScore program of the Resilient Floor Covering Institute, or certified under the GREENGUARD Environmental Institute's Children & Schools Certification.[MSOffice3]

A5.504.4.7.1 Resilient flooring systems, Tier 2. For 90% of floor area receiving resilient flooring, install resilient flooring cComplying with the VOC-emission limits defined in the 2009 Collaborative for High Performance Schools (CHPS) criteria and listed on its Low-emitting Materials List, certified under the FloorScore program of the Resilient Floor Covering Institute, or certified under the GREENGUARD Environmental Institute's Children & Schools Certification.[MSOffice4]

Note: Products certified under the FloorScore program may be found at: http://www.rfci.com/int_FS-ProdCert.htm and those certified under the GREENGUARD Environmental Institute's Children & Schools Certificatoin may be found at: http://www.greenguard.org/Default.aspx?tabid=135.

~~804.4.6~~ **A5.504.4.8 Thermal insulation, Tier 1.** Comply with Chapter 12-13 in Title 24, Part 12, the California Referenced Standards Code, and with the VOC-emission limits defined in 2009 CHPS criteria and listed on its Low-emitting Materials List~~, www.chps.net/manual/lem_table.htm~~. or certified under the GREENGUARD Environmental Institute's Children & Schools Certification.

A5.504.4.8.1 Thermal insulation, Tier 2. Install No-Added Formaldehyde thermal insulation in addition to meeting the 2009 CHPS criteria and listed on its Low-Emitting Materials List or certified under the GREENGUARD Environmental Institute's Children & Schools Certification.[MSOffice5]

~~804.4.7~~ **A5.504.4.9 Acoustical ceilings and wall panels.** Comply with Chapter 8 in Title 24, Part 2, the California Building Code, and with the VOC-emission limits defined in the 2009 CHPS criteria and listed on its Low-emitting Materials List or certified under the GREENGUARD Environmental Institute's Children & Schools Certification,[MSOffice6] ~~www.chps.net/manual/lem_table.htm~~.

Documentation shall be provided that verifies that finish materials are certified to meet the pollutant emission limits.

collaborative for high performance schools

Agreement to Adopt

GREENGUARD Children & Schools Certification as an Acceptable Alternative for CHPS EQ2.2 Low-emitting Materials Credit between Collaborative for High Performance Schools (CHPS) and Greenguard Environmental Institute (GEI)

Adopted: March 8th, 2007

The Collaborative for High Performance Schools (CHPS) rating program criteria scoring includes points for Low-emitting Materials under Credit EQ 2.2. This credit requires products to be tested in accordance with the California Department of Health Services (*CDHS) Standard Practice*[A], as referenced below, and meet its allowable emission limits. Section 6 of the *CDHS Standard Practice* defines the provisions required for "Acceptable Alternatives to its Practice".

As an acceptable alternative, products certified under *GREENGUARD Children & Schools Program (C&S)* are eligible for CHPS EQ2.2 points provided that all of the following terms and conditions agreed to by CHPS and Greenguard Environmental Institute (GEI) have been met and verified per the product certification documents:

Chamber Testing

1. **Product testing is conducted by the *GREENGUARD Test Method*[B] only in a small scale chamber following the guidance of ASTM D5116[C].** Products or processes requiring full scale chamber testing are not currently eligible to receive CHPS credits at this time, but may become eligible at a future date.
2. **The emission factors for each time point used in classroom modeling are calculated from directly measured chamber concentrations.** Concentrations calculated by extrapolation, such as described in the *GREENGUARD Method* Sections 3.12.3.4 and 3.12.3.5, are not currently eligible for CHPS EQ 2.2 credits.

Room Modeling

3. **Classroom emission concentrations calculated from product chamber emissions are calculated using all of the following:**
   - The equation listed in the *GREENGUARD Method* Section 3.12.3.4 with a ventilated volume fraction of 0.9 as described in the *CDHS Standard Practice* Section 3.10.2.4 and 4.2.4.
   - The classroom modeling ventilation parameters and the product material area defined in the *CDHS Standard Practice* in Section 4.2.4 and tabulated in Table 7.4.

Approval criteria

4. **Product compliance will be determined at a time point no sooner than 168 hours, and product classroom emission concentrations must be less than the maximum acceptable limits for all individual Volatile Organic Compounds (VOCs) listed in the *CDHS Standard Practice* described in Section 4.3 and in Section 6.11 and Section 9 (for carpets).** Data for time points less than 336 hours must demonstrate that the emissions have peaked before the compliance time point.

5. **Products must be in a product category listed under CHPS EQ 2.2 except for cabinetry and teacher desks or others as approved by CHPS.** Cabinetry and teacher desks may be added as a product category in the future when CHPS has developed applicable test provisions and modeled room parameters.

6. **Testing and approval for pupil desks and teacher/pupil chairs are defined herein:**
   - Classroom desks and chairs will be tested in whole using the small chamber option of the *GREENGUARD Method* following the guidance of ASTM D5116, or until other testing options are determined and approved by CDHS, CHPS, and GEI. Testing units will be 1 desk per chamber or 1 chair per chamber or 1 combo desk-chair per chamber.
   - Classroom emission concentrations for pupil desks and chairs will be calculated using the *GREENGUARD Method* Section 3.12.3.3 equation and classroom modeling parameters defined in *CDHS Standard Practice* Section 4.2.4 and listed in its Table 7.4. The classroom model product loading of 27 pupil desks, 27 pupil chairs and 1 teacher chair will be used with the emission factor using units of mg/hour (per unit not per area).

Reporting requirements

7. **Electronic copies of the laboratory test reports for individual products will be sent to CHPS upon request to verify and audit compliance.** The reports will include all information required by the *CDHS Standard Practice* Section 5.1 and *GREENGUARD Method* Section 5, including chamber concentrations and documentation showing the equations used to calculate the classroom concentrations from the chamber data. Product specific reports and data shall be kept in a confidential CHPS data space and may be reviewed only by CHPS Staff and DHS Staff.

8. **GEI will provide to CHPS an annual report including the following information:** (a) product types from the GREENGUARD certification program; (b) list of CRELs with ranges and levels; (c) list of CA Prop 65 Chemicals with ranges and levels; (d) list of CA Toxic Air Contaminants (TACs) Class I and II Carcinogens with ranges and levels; and (e) 10 most abundant chemicals per product type.

9. **Products will be tested at least once per year; re-testing is required following any significant manufacturing change to the products materials or processes.**

Additional Provisions

10. GEI agrees to formally adopt the required programmatic changes to the *GREENGUARD Children & Schools* Certification program to meet the requirements of this agreement.

11. Upon approval of this agreement by the CHPS Board, CHPS will recognize this approval by both electronic and written communication on the CHPS website and formally to GEI.

12. All GEI press releases on this agreement will be reviewed and approved by CHPS staff prior to publication.

13. Any public claims regarding this agreement will include a disclaimer to address the following:

    CHPS credits are offered for the GEI certified products that meet the testing method requirements and emission limits defined in the Agreement between CHPS and GEI [reference agreement posted on CHPS website]. GREENGUARD *testing methods and criteria outside of the scope of this Agreement, including testing for total VOCs, phthalates, total particles, and criteria for iVOCs with no CRELs, have not been evaluated and are not endorsed by CHPS or CDHS.*

14. GEI agrees to work with CHPS staff to incorporate the *GREENGUARD Children & Schools* certified products into the Low-Emitting Material Table on the CHPS website and via a weblink from the GREENGUARD Product Guide with the disclaimer below. Products listed on the GREENGUARD website may be listed on the CHPS website.

15. This agreement will be reviewed by CHPS and GEI annually. Either party may terminate this agreement by providing written notice to the other party at any time.

References

A. California Department of Health Services, 2004. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers. 850 Marina Bay Pkwy (EHLB), Richmond, CA 94804. Available on-line at: *http://www.cal-iaq.org/VOC/Section01350_7_15_2004_FINAL_PLUS_ADDENDUM-2004-01.pdf*

B. GREENGUARD Environmental Institute, 2007. Method for Measuring Chemical Emissions from Various Sources Using Dynamic Environmental Chambers. 1341 Capital Circle, Suite A, Atlanta, GA 30067. Available on-line at:http://www.greenguard.org/Default.aspx?tabid=134

C. ASTM International, 2006. Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products. Committee D22.05 on Indoor Air. Standard D 5116-06. PO Box C700, West Conshohocken, PA, 19428-2959.
Available on-line at:
http://www.astm.com/DATABASE.CART/REDLINE_PAGES/D5116.htm

This Agreement will be posted at http://www.chps.net/manual/lem_table.htm

GREENGUARD Environmental Institute
2211 Newmarket Parkway, Suite 110
Marietta, GA 30067
1.800.427.9681
www.greenguard.org

ANSI/GREENGUARD ENVIRONMENTAL INSTITUTE MOLD AND MOISTURE MANAGEMENT STANDARD FOR NEW CONSTRUCTION (ANSI/GEI – MMS1001)

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ANSI/GREENGUARD ENVIRONMENTAL INSTITUTE
MOLD AND MOISTURE MANAGEMENT STANDARD
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This foreword is not part of the standard. It is intended for informational purposes only and does not contain requirements necessary for conformance to the standard. This standard has not been completely processed according to ANSI requirements and may contain material that has not yet been subject to a consensus process.

FOREWORD

The intent of this standard is to reduce the risk of losses to lenders, insurers and building developers due to mold growth by providing best practices guidelines for safeguarding against moisture and mold damage. This standard applies to new construction of commercial and multi-unit residential buildings of four stories or more. Moisture intrusion is increasingly problematic for building developers, contractors, owners and occupants resulting in adverse consequences. Adherence to proactive moisture management principles as detailed in this standard can reduce the risk of mold growth.

This standard includes both mandatory and non-mandatory language. Mandatory language has been used for those practices or procedures that must be followed to reduce the risk of moisture intrusion and mold growth. Non-mandatory language has been used in those elements of the standard where procedures should be more flexible to account for different building types, locations, construction practices, etc. Designers, builders and third-party consultants should exercise judgment in creating and implementing an effective moisture management program. In total, this document is intended to serve as guidance for achieving "best practices" in design, construction and operations, and may not be appropriate for use in building codes.

GEI understands that due to the nature and complexity of design, construction, and building operations and maintenance practices, conformance to this draft standard alone cannot guarantee that mold growth or moisture problems will not occur in a given building; however, conformance to the standard is intended to reduce the likelihood of experiencing such problems.

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Consensus Board for the Mold and Moisture Management Standard for New Construction

At the time of ANSI approval, the Consensus Board was populated by the following members:

Chair – Tony Worthan, Air Quality Sciences Inc.
Consensus Board Staff – Ethleen Howell, GREENGUARD Environmental Institute

Representative	Organization	Interest Category
Alan Bender	Bovis Lend Lease, Inc	Producer
James Kavanagh	BioPure Construction Services	Producer
Patrick Lazzari	W.G. Yates & Sons Construction	Producer
David O'Haren	Holder Construction	Producer
Larry Speck	University of Texas	Producer
John Adams	Georgia Tech Enterprise Innovation Inst.	User
Stuart Alston	Carter & Associates	User
Craig Drumheller	NAHB Research Center	User
Charlie Perry	Environmental Assurance Group	User
Richard Standing	Delta Intermediaries, Inc	User
Brad Wainmann	Peoples United Financial	User
Terry Brennan	Camroden Associates	General Interest
Doug Henderson	Troutman Sanders LLP	General Interest
Elliott Horner, PhD	Air Quality Sciences, Inc	General Interest
Dave Jacobs, PhD	National Center for Healthy Housing	General Interest
Sam Rashkin	U.S. Environmental Protection Agency	General Interest
Jed Waldman, PhD	California Department of Public Health	General Interest

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MOLD AND MOISTURE MANAGEMENT STANDARD FOR NEW CONSTRUCTION

1.0 Introduction

This standard is intended to help building designers, constructors, owners, and maintenance staff prevent moisture problems and associated mold growth during design, construction, acceptance, and operations & maintenance of commercial buildings. Moisture intrusion and subsequent mold growth in buildings may affect the health and comfort of occupants, negatively impact rental income, and threaten asset resale. To avoid these issues, moisture and moisture-sensitive building materials should be managed throughout the life cycle of the building, including design, construction, acceptance, and operations & maintenance. To this end, this standard requires that all of the parties involved participate in the moisture management efforts to reduce the risk of moisture-related problems and consequential mold growth. This is necessary because design flaws, construction defects, improper sequencing of installations, and poor maintenance can all contribute to moisture/water damage, either singly or in combination. Many of the principles and practices discussed in this standard also apply to water release or intrusion incidents that may occur during construction and/or occupancy, such as domestic water leaks/overflows or inclement weather that overcomes temporary waterproofing measures. However, this guidance does not address problems that result from sewage spills or flood water from streams, rivers, lake or oceans. For responding to these conditions see ANSI S500.

An understanding of basic moisture management principles and adherence to this standard are essential for preventing water or moisture damage and their consequences. The ultimate goal is to reduce risk by preventing mold growth, damage to building components, and occupant complaints of poor health or discomfort. The purpose of this standard is to outline procedures to achieve this goal.

The full purpose of this standard is stated in the following section (see section 1.1). Pertinent definitions are provided in a glossary of terms (see section 2.0). The elements of this standard apply to the various aspects of the construction process, including design and planning (see section 3.0); material selection and storage; sequencing of work; construction methods and practices (see section 4.0); verification testing at substantial completion / acceptance phase (see section 5.0); as well as building operations and maintenance once the building is operational and/or occupied (see section 6.0). This standard also includes review by a qualified third party to be conducted at various points during all four of the project phases, including document review and physical inspection to verify conformance with the standard. Required submittals for verifying compliance with the standard are described in section 7.0. Pertinent references are provided in section 8.0. This standard applies to commercial buildings, multi-family residential buildings that are four stories or more in height, and hospitality facilities (hotels and motels); the scope of this standard does not include single-family or duplex residential buildings (R-3 occupancy classification).The standard provides procedures for buildings evaluated under the standard. This standard is not intended to provide a comprehensive listing of the criteria necessary for the successful design, installation and operation of the multitude of building components, geometries, and wall systems in various climates. In addition, specialty occupancies, such as natatoriums and water theme parks, will require additional attention to critical areas that might not be present in less demanding environments, such as office buildings.

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1.1 Purpose

This standard provides guidance and information on minimizing moisture damage and subsequent mold growth in buildings as it relates to the four general phases of a construction project: (1) building design; (2) construction; (3) acceptance / substantial completion; and (4) occupancy / operations and maintenance (O&M). The primary purposes for minimizing the chances of mold growth are:

1. To minimize remediation and material replacement expenses
2. To minimize litigation opportunities and expense
3. To increase the likelihood of obtaining financing and insurance with mold coverage

2.0 Glossary

Acceptance phase – pertaining to construction projects, the time of substantial completion, immediately prior to occupancy

Building envelope - those elements of a structure that separate the interior areas from the outdoor environment (includes any and all portions of roofs, walls, and floors).

Colonization – pertaining to mold, the process of mold (fungi) growing or developing on or in a substrate (material) – mold colonization results in the digestion and deterioration of the substrate – colonized surfaces or materials usually shed particles (mycelial fragments, spores, spore fragments and substrate particles) that contain mold metabolites (e.g., allergens, enzymes, glucans, mycotoxins, etc.)

Controlled phase of construction - the period of time beyond the completion of the building envelope. All elements of the building envelope are in place, including exterior walls, windows, doors, and roof. Water repelling features such as flashing, caulking, drip edges, etc. must be in place. Ideally, air-conditioning and pressurization systems will also be in place to provide humidity control

Construction - the process of assembling material and building a structure according to a design

Damp (moist) - slightly or moderately wet - containing elevated amounts of water (in a material), usually at least some as capillary water (see moisture content)

Design - the systematic planning of a structure; this planning is most often carried out by skilled professionals who document their plans with drawings and equipment specifications

Dry - essentially free of water; at or near the moisture content expected in service

Exposed phase of construction – the period of time from the beginning of construction until the roof of a structure is complete. During this time the building envelope is unfinished and provides the interior areas with little or no protection from the outside environment.

Fungi - a Kingdom of eukaryotic organisms distinct from bacteria, plants and animals – fungi have chromosomes in a nucleus, are multicellular (except yeasts) and absorb nutrients from externally digested sources – mushrooms, puffballs, yeasts, mildew and molds are fungi

Mildew (cf mold) – vernacular term for discoloration of surfaces by fungal colonization – also used to refer specifically to two groups of plant diseases

Moisture - water in either bound, vapor or liquid form in air or in building materials

Moisture content (bulk moisture content, MC%) – the amount of water (as vapor and liquid) in a material; moisture in porous materials may be either bound water (held by molecular attraction) which typically cannot be removed under typical use

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conditions, or capillary water (held by capillary forces) which can mostly be removed if the material is protected from water. Moisture content is typically expressed as a percentage of the oven dry weight of the material.

Moisture damage – a loss or harm to a building material caused by excess water in either vapor or liquid form (see also moisture intrusion) that may render the material unfit for its intended use or service

Moisture intrusion – entry of moisture into a building from water leakage, vapor migration, capillary movement, air infiltration, and/or bypass of dehumidification cooling coils; may be from sources either external or internal to the building

Moisture and mold management plan (MMMP)- a written document developed prior to initiation of construction activities as an on-site resource to be implemented throughout the construction process - describes the practices, procedures, materials, and components that may impact moisture management; and outlines preventive measures, incident response actions, communications channels, and quality control / recordkeeping provisions

Moisture resistant – pertaining to materials, a material that absorbs and/or retains only minimal amounts of moisture and/or that is largely not biodegradable. This determination can be made based on the nature of the material (non-porous), or the results of pertinent testing, such as ASTM D 6329.

Moisture sensitive – pertaining to materials, a material that readily absorbs and/or retains moisture and that is at least partly biodegradable, thus permitting mold colonization when wet or sufficiently damp. This determination can be made based on the nature of the material (porous or semi-porous), or the results of pertinent testing, such as ASTM D 6329.

Mold (mildew) – vernacular term for various fungi – these fungi are microscopic to barely visible, but colonies are usually clearly visible (colonies of mold(s) on material). Several dozen species occur commonly on damp or water-damaged building materials; the term mold is used collectively for any of these

Mold growth – see *Colonization*

Partially enclosed phase of construction – the phase during which a building will typically have completed roof and floors and a partially completed wall system, but not yet operable permanent cooling and heating systems

Qualified party – One who, by a combination of training, education, knowledge, skills and experience, has the ability to solve or resolve problems related to the subject matter that the qualified party is addressing.

Qualified third party – a qualified individual or entity (as defined above) who is independent / separate from the building developer / owner, designer and contractor, and who provides impartial inspection, assessment and monitoring services to the developer / owner, designer and/or contractor pursuant to the requirements of this standard

Relative moisture content – pertaining to material moisture readings, a measurement reported on a unitless 0 to 100 reference scale. As this is not an absolute measurement, such readings are usually performed on several samples or against a baseline so that any differences can be noted.

Submittal - the documents provided by a contractor to the owner, designers or reviewers to demonstrate compliance of material or equipment selections with the contract specifications. Such documents

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may also include requests by the contractor to purchase and install equivalent products

Third party – see *qualified third party*

Value engineering - a formal or informal process of reducing estimated "first costs" by using alternate materials, equipment, methods or design approaches in a construction project. The proposed changes may reduce building performance or functionality to provide cost savings.

Visible Mold Growth – see *Colonization*

Water activity (a_w) – the decimal equivalent of the relative humidity in a small enclosed space in equilibrium with a material sample – a_w is a measure of the availability of water in a material for biological processes, and thus is the measure of moisture that is relevant to mold growth – at the same a_w value the moisture content of different materials will vary according to the hygroscopic properties of those materials

Water loss incident – a water or moisture intrusion event, usually unexpected, such as a leak or spill of liquid water that may result in damage to affected building materials (see also moisture damage)

Wet - containing appreciable amounts of water; containing an amount of water well in excess of the amount of bound water (see moisture content) typical for the material, in extreme cases even containing bulk liquid water in addition to capillary water

3.0 Design (Pre-construction)

3.1 Overview. This section discusses key moisture prevention issues to address in the design stage of a building project. Sections 3.2 through 3.8 establish the requirements for the design and development stage of a new construction or major renovation project that pertain to moisture management and prevention of mold growth. Table 3-1 summarizes key design factors to address for control of potential moisture problems in buildings. The advantage of addressing these factors early on (i.e., as early as possible during the design phase, and well before completion of drawings) is that it will be less costly and less disruptive than trying to correct problems once drawings are completed, or construction begins, or certainly after completion and occupancy. The qualified third party will review these aspects of the design (see section 3.8). Further, to support the moisture / mold prevention effort, the design specifications shall also include a requirement that a moisture and mold management plan be part of the contract documents (see section 4.0, particularly section 4.2).

Table 7.1 in section 7 provides a summary of the required documentation that should be produced during the design phase to comply with this standard. Resources to support this section can be found in section 8.0.

3.2 Site Features. The design team shall consider the site features in relation to the proposed building location. A licensed professional on the design team shall design the rain and groundwater control systems for the building and site. The design should include changes to the site to direct water away from the building. The design team shall also review other factors, including the soil composition, elevation of the water table, and other pertinent factors in designing the ground level barriers, foundation and below-grade damp-proofing. The design team shall produce a written statement that these factors have been considered. To prevent or minimize mold growth and resultant degradation of building materials, the building site or suitable documents shall be visually examined.

3.3 Architectural Systems (Envelope). Building envelopes must be designed to control moisture intrusion and unwanted accumulation and subsequent mold growth. Therefore, in addition to building code requirements, the design team shall

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consider the features listed in Table 3-1 in the design of the building envelope. The architect shall incorporate the necessary components into the envelope design so that an effective weather-resistive barrier is created for the facility. The design team shall anticipate the need for moisture control presented by these features and accommodate those needs in the envelope design process.

The design team must use local climatic data and identify indoor temperature and humidity design conditions for each building zone and design the enclosure and in some cases partitions, floors and ceilings that separate zones with different indoor requirements so that condensation and rain water problems are avoided. To complete this task, the designers must often rely on program information provided by the owner. The designs for the wall and roof must not allow condensation to occur in locations within those assemblies that are not intended to divert water or allow water to accumulate without damage to building materials. The assemblies shall be designed with consideration for the physical properties of the materials and climate to determine if (and where) condensation will occur. The design team must avoid the creation of misplaced or unintended vapor barriers.

3.4 HVAC Systems. The heating, ventilating and air-conditioning (HVAC) systems shall be designed to provide thermal comfort (heating and cooling), humidification and/or dehumidification, without causing moisture problems or mold growth, in addition to meeting building code requirements. The design team shall anticipate any moisture and/or humidity-generating construction activities as well as occupant and/or operating activities, and accommodate such activities in design of the HVAC systems. Similar to section 3.3, the HVAC system designer must use climatic data and program information provided by the owner to design systems that will not foster condensation that could damage building materials. The design team shall also address the factors listed in Table 3-1, which can affect moisture control both during construction and in the built environment.

3.5 Plumbing Systems. Moisture intrusion problems and resultant mold growth can occur in even the driest of climates due to failures in building plumbing systems. As such, in addition to building code requirements, the design team shall address the plumbing system design factors listed in Table 3-1.

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Table 3-1. Design Intent: Factors to address for control of moisture in buildings.

Design Factor	Items to Address	Goals
Site features (section 3.2)	-topography (grading / surface water), soil type (e.g., expansive clays), hydrology characteristics (ground water control); and flood plain location -landscaping drainage and irrigation -building orientation -site drainage system components and their placement / location -intended building use -use(s) of adjacent sites	-anticipate water intrusion -control water runoff -Preventing surface and groundwater intrusion - avoid spraying building with irrigation water
Architectural systems (envelope) (section 3.3)	-seasonal climatic conditions in relation to indoor temperature and humidity requirements -roofing (including drainage / guttering) -façade -wall systems (below- and above-grade) -foundation and base floor systems -windows and doors -insulation -damp-proofing -material selection -selection, placement, and location of air barriers, vapor barriers, drainage planes, flashing, caulking / sealants, sheathing, cladding, and wall coverings	-prevent formation and/or accumulation of condensation -prevent rainwater intrusion - control water that may enter the wall systems -prevent water from ponding (e.g., on roof)
HVAC systems (section 3.4)	- seasonal climatic conditions in relation to part-load cooling and dehumidification -temperature, humidity and other operational controls -pressurization -filtration -ventilation rates -material selection (e.g., insulation) -equipment sizing and system capacities -installation requirements -testing and balancing specifications -points of access -provide access for emergency shutoff and maintenance	-maintain heating, cooling, and dehumidification -anticipate moisture and/or humidity-generating construction activities as well as occupant and/or operating activities -control condensation -allow for ongoing operational monitoring and inspection
Plumbing systems (section 3.5)	-placement / location of system components -location and routing of piping -pressurization -insulation -overflow protections -provide access for emergency shutoff and maintenance -leak detection (optional consideration)	-control condensation -protect from freezing -protect from leaking

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3.6 Materials Selection. Building materials vary greatly in their response to moisture. Material composition can directly affect the possible development of mold growth. For example, mold will develop more readily on materials such as those containing amorphous cellulose (paper), than on solid wood products under comparable conditions.

3.6.1 Specifying Appropriate Materials. The design team shall specify appropriate materials and equipment for areas with expected exposure to moisture (both water and prolonged high humidity). This shall include consideration of the anticipated construction schedule and reasonable expectations of climate and weather that will prevail during construction when selecting materials. The design team should also specify that measures shall be taken to protect materials from exposure to moisture, with additional, more stringent measures specified for moisture-sensitive materials. The contractor and material suppliers should comply with these specified measures. Moisture resistant building materials should be selected based on verified test results and specified wherever possible, such as in areas prone to moisture (for example, shafts and chases, which are typically installed during the exposed phase of construction [see also section 4.2.5.1]). The design team should request from the materials manufacturers any available information regarding mold resistance of products and should retain any such information or responses received from manufacturers. The preferred method for microbial resistance testing of moisture sensitive materials is as described in ASTM D 6329-98 (2003) – *Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers*. Examples of moisture sensitive materials and components / equipment that will require consideration include the following, at a minimum:

- Paper-faced gypsum wallboard
- Forest products (wood framing, OSB, plywood, etc.)
- Air handling units
- Energy recovery units (Air-to-air heat exchangers)
- Fan coil units
- Dehumidification units
- Pipe insulation
- Duct insulation
- Wall insulation
- Roofing components
- Water resistant gypsum wallboard
- Exterior gypsum sheathing
- Wall covering
- Textiles
- Flooring underlayment

The design team should provide a final listing of areas that are prone to elevated moisture and an accounting of all mold resistant building materials to be used in those locations. This listing should be reviewed by the contractor and qualified third party prior to the beginning of construction (and during construction, as applicable, to assure that the specified materials are being used).

3.7 Quality Assurance. The quality assurance program should list the minimum performance requirements for the envelope, HVAC systems and plumbing systems. As with any quality assurance plan, the goal should be to achieve satisfactory performance of the building systems in accordance with the overall design. Combined with a third-party review of the design, an effective construction quality assurance program will minimize the potential for water intrusion prior to occupancy. The design team should specify the acceptable measures and minimum performance requirements for verifying the effectiveness of the installed systems. The contractor should devise plans to meet the requirements. For example, for the façade, one acceptable method is to perform spray

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testing at representative sections of the building envelope or of *in situ* installations of any penetrations, such as windows and doors, in accordance with ASTM E 1105 – *Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference*. The design team should also specify equivalent quality assurance requirements for concrete slabs (such as ASTM F1869-9803), roofing systems, air barriers and drainage plane. For HVAC systems, one acceptable method is to set stringent tolerances for test and balance operations and detailing requirements for moisture control within the functional performance testing phase of building commissioning.

3.8 Qualified Third Party Review. A qualified third party shall conduct a design review with regard to the potential for moisture issues (see also section 7.0). The goal is to verify that the building design addresses moisture control effectively. In addition to the specific features of the building, the review should consider the previous success or failure of comparable designs in a given locality for buildings of similar size and use.

The qualified third party shall operate as an Owner's representative. The review of the design, construction and operation practices is generally intended to provide the Owner and future occupants with a building that has a reduced possibility of suffering from moisture and mold problems. However, the third party may be contracted to the contractor or designer for convenience, with the understanding by all parties that the third party review activities are completed on behalf of the Owner and occupants.

The third party review should be conducted at various stages and should include schematic design documents, design development documents and construction documents. The third party should also review the quality assurance plan (see section 3.7) and any value engineering items suggested by the owner and/or contractor (see also section 3.9). Third party findings shall be documented and classified based on the severity of the finding. For example, the third party might devise classifications to differentiate between serious conceptual flaws, systems that will be difficult to install and/or suggestions for improvement. Any serious flaws, as determined by the third party reviewer, shall be addressed by the design team, as these pose the greatest risk for moisture problems in the building. Measures to address any installation critical items identified may require modifications to the Quality Assurance requirements (see section 3.7) specified by the design team.

3.9 Value Engineering. The design team shall review proposed value engineering changes (such as substitute products submitted by the contractor) to assure that they meet design specifications. In addition, a qualified third party shall review any value engineering changes made to the design. The purpose of this review is to assure that any such changes will not adversely affect moisture control in the building, either by direct impact or indirect effect, and still will perform as intended to minimize moisture problems and subsequent mold growth.

4.0 During Construction

4.1 Overview. The success of a construction project in general requires collaboration and coordination among numerous parties. This is particularly true when it comes to management of moisture issues and preventing mold growth. There are several key administrative, technical and procedural elements that must be implemented during building construction to prevent or minimize moisture problems and consequent mold growth. This section establishes the requirements to be followed during the construction phase for new construction. These include development and implementation of a moisture and mold

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management plan, periodic inspections of the job site, and review of contractor change orders as they affect moisture management.

Table 7.2 in section 7 provides a summary of the required documentation that should be produced during the construction phase to comply with this standard.

4.2 Moisture and Mold Management Plan (MMMP). A critical administrative control for preventing mold growth during the construction process is the development and implementation of a written MMMP, which can serve as a useful resource for on-site personnel. The MMMP shall be developed by the contractor with input from the designers, owner/developer and the third party reviewer. This plan shall be ready for use prior to beginning construction and shall be diligently implemented throughout the construction process. The MMMP shall be devised with specific regard to the facility type (office building, condominium, hospital, etc.), construction methods, and local climate. The plan shall be reviewed by a qualified third party (see section 4.3). The MMMP shall focus on those processes, materials and components that may impact management of moisture and consequential mold growth during construction and shall address the key requirements as described below in sections 4.2.1 through 4.2.8.

The listing of moisture sensitive materials prepared by the design team (see section 3.6.1) shall be included in the MMMP.

4.2.1 Roles and Responsibilities. As part of the MMMP, the Owner or Contractor shall designate roles and responsibilities of key personnel involved in moisture management.

4.2.1.1 Moisture Manager. One individual on the jobsite shall be designated as the moisture manager (this individual may be the construction project manager). The moisture manager shall be qualified to serve in this role, by virtue of his or her training, education, knowledge, skills and experience. The moisture manager shall serve as the primary point of contact for the third party reviewer / inspector. The moisture manager shall be responsible for assuring that construction activities and practices conform to the MMMP and shall have the authority to enforce the MMMP. In addition, the moisture manager shall be responsible for documentation of all actions that pertain to moisture management including periodic review of such documentation per section 4.2.2 below.

The moisture manager may also carry other job titles for a project. While some time must be devoted to moisture management on a weekly basis, it is anticipated that this person will have other duties at the site. It is not required that the moisture manager perform all of the tasks listed in this standard for the construction phase, but carries the responsibility to ensure that they do occur, by delegating and checking progress as appropriate based on the size of the construction project.

4.2.2 Recordkeeping / Documentation. A recordkeeping/documentation mechanism is an important quality control element of the MMMP. This should include training records; logs of the condition of delivered materials, equipment and components; forms, checklists and logs for documenting deficiencies, water and moisture damage incidents and/or discovery of mold growth; periodic inspections and testing; and any associated protective and/or mitigative actions. Documentation should be maintained for all such activities. The designated moisture manager should review all such documentation periodically (at a minimum, quarterly; monthly review is preferred) for any trends or recurring patterns of moisture-related incidents or concerns, to facilitate updates and/or improvements to the MMMP.

4.2.3 Worker Training / Orientation. All workers shall be informed of the practices and procedures established in the MMMP

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for effective management of moisture and/or water intrusion on the jobsite, and the importance of following those requirements. Training shall be conducted by a qualified party. At a minimum, the foreman or supervisor for each trade (on each shift) working on the jobsite, as well as project engineers and/or project managers of the general contractor and owner shall attend moisture and mold related training sessions. These individuals shall in turn provide information via training and/or orientation sessions to other staff in their organizations. Training records shall be maintained per section 4.2.2.

4.2.4 Transport, Delivery, and Storage. Both the materials suppliers and the construction contractor have the responsibility to comply with this section, as applicable. These requirements, as described in sections 4.2.4.1 through 4.2.4.3 are intended to assure that all materials and components (particularly those listed in section 3.6) are adequately dry prior to shipment, are protected from moisture damage during shipment to the site and that their condition upon delivery is acceptable. Additionally, all materials shall be stored properly to prevent moisture and/or water damage and mold growth during all phases of construction activity. A quality control system shall be established to include inspection and rejection processes, monitoring criteria, and documentation of results.

4.2.4.1 Transport. Materials suppliers / subcontractors who transport materials and equipment to the construction site should physically protect moisture sensitive materials and equipment from water damage or moisture exposure during transport. The protective measures used should be documented.

4.2.4.2 Delivery. Deliveries of moisture sensitive materials or components should be scheduled so that prolonged storage is avoided (thereby minimizing risk of moisture damage to materials once on site); climate attributes and weather conditions should also be considered when scheduling such deliveries. The following criteria shall be used for acceptance upon delivery: first, moisture sensitive materials and mechanical equipment components delivered shall be the same as those specified (or per section 3.7, substituted products as approved by the design team); second, these materials shall be free of obvious water or moisture damage and/or visible mold (as determined by a qualified party, e.g., moisture manager or designee). Moisture content of moisture sensitive materials should be measured upon delivery using acceptable instrumentation, and moisture content should be less than levels that would support mold growth on or in that material (refer to section 4.2.6.2 for equipment requirements). Wet materials, mechanical equipment or components shall be rejected if irreparable damage has occurred. Results of inspection and monitoring should be documented as well as any rejection of materials or equipment / components. Chain of custody of these building materials and components should also be documented.

4.2.4.3 Storage. All materials and equipment intended for use indoors shall be stored in a manner to protect them from moisture intrusion or water damage. These items shall be periodically inspected for moisture damage and/or mold growth, and the moisture levels and environmental conditions of the storage areas monitored. Criteria for acceptability of storage conditions are similar to those stated in section 4.2.4.2. For any materials exceeding moisture level criteria (moisture level criteria listed in 4.2.6 and 4.2.6.1), moisture levels should be reduced and additional protection from moisture should be provided. Any materials showing signs of water damage and/or visible mold shall be removed from the site (water damaged and/or moldy materials shall not be installed). Measures for protection and/or drying of materials should be documented.

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4.2.5 Scheduling and Sequencing. The construction schedule requires coordination and collaboration among all parties, including the owner, design team and contractor. As the construction process progresses through its three phases ("exposed" phase, "partially enclosed" phase, and "controlled" phase), attention to moisture control increases. Certain activities should only be conducted during certain phases of construction in order to avoid water damage and consequential mold growth. Generally, all indoor materials should not be delivered, stored or installed before the partially enclosed phase of construction. Additionally, moisture sensitive materials or components shall not be installed before the partially enclosed phase of construction. Careful attention shall be paid to protecting all materials and components delivered, stored, installed or already present during the partially enclosed phase. Routine management of water and moisture shall persist through the controlled phase of construction. Protective measures shall be taken throughout the construction process. If any exceptions to the practices described herein are deemed necessary by the construction team, alternate protective measures shall be reviewed and approved by the moisture manager and documented.

4.2.5.1 Exposed Phase. All work in the building is exposed to the elements during this first phase of construction. Thus, the exposed phase presents the greatest risk of water intrusion and accumulation. Therefore, delivery, storage, and installation of moisture sensitive materials should be avoided to the degree possible during the exposed phase of the construction project. Moisture sensitive materials or components that must be installed during this phase (for example, elevator shaft components) should be scheduled for delivery so that prolonged storage is avoided. Such items should be inspected upon delivery as described in section 4.2.4.2, and shall be protected and monitored during storage as described in section 4.2.4.3. Moisture sensitive materials and components shall not be installed until they can be protected nor shall they be installed wet. Protection of moisture sensitive materials and components shall be maintained until the building is completely closed in (controlled phase).

4.2.5.2 Partially Enclosed Phase. This second phase of construction presents similar concerns as the exposed phase, since only partial protection from the elements is in place during this phase. Some areas of the building may have more protection than other areas. As the degree of protection increases in an area, more moisture sensitive activities may proceed in that area if monitoring indicates adequate moisture control. The moisture manager shall continue to maintain protective measures as described in section 4.2.5.1, including inspection, monitoring, and documentation. The moisture manager shall inspect and monitor moisture sensitive materials and components prior to installation for the presence of moisture damage and/or mold growth, and to monitor environmental conditions of storage. The moisture manager shall maintain any needed protective or corrective measures.

4.2.5.3 Controlled Phase. At this phase of construction the building envelope is completed and sealed. As such, the controlled phase shall be used to the degree possible for the storage and installation of moisture sensitive materials. The moisture manager shall continue to maintain protective measures as described in sections 4.2.5.1 and 4.2.5.2, including inspection, monitoring, and documentation. In addition, the moisture manager shall inspect and monitor any moisture sensitive materials or components that were installed prior to the controlled phase for the presence of moisture damage and/or mold growth, and take corrective actions as needed. Note that at this phase ambient sources of moisture remain and new concerns are introduced. These concerns must be addressed, including elevated humidity, condensation, wet processes, and water loss incidents.

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4.2.5.4 Wet Materials. Materials that become wet during construction must be addressed. Moisture-sensitive materials must be dried within 48 hours to minimize the potential for mold growth. Materials remaining wet for longer than this must be evaluated for possible mold growth. Material surfaces that are not visible (such as the interior face of gypsum board wall cavities) may require destructive inspection. Note that the absence of visible mold growth is not an indicator that materials are acceptable to remain in service, as factors other than possible mold growth may require the removal of previously wet materials (swelling, discoloration, warranty issues). Those decisions are the responsibility of the design team, contractors and owner.

Moisture-resistant materials that become wet during construction must also be evaluated. Any surface mold growth must be removed without damaging the material. Further, these materials must be returned to acceptable moisture levels before the materials are installed or work continues that may trap moisture within wall assemblies. As with moisture sensitive materials, there may be conditions beyond mold growth that require replacement or condemnation of the materials.

4.2.6 Monitoring. The moisture manager (or designee) or the qualified third party should monitor environmental conditions (e.g., temperature, relative humidity) during the partially enclosed and/or controlled phase in all areas where moisture sensitive materials are stored and installed in the building. The conditions in these areas should be observed weekly for signs of water intrusion and mold growth. Visual observations and measurements of environmental conditions (temperature and relative humidity) should be performed and documented. These measures should also be recorded when a water loss incident occurs (see section 4.2.7).

Building interior. Interior areas of the building shall be maintained below 70% relative humidity with a dewpoint temperature not to exceed 68 °F. Should conditions exceed this value for longer than 12 consecutive hours, the affected areas shall be monitored daily (rather than only weekly) for signs of mold growth on stored or installed materials. If elevated relative humidity conditions continue to occur, acceptable corrective actions may include one or more of the following:

- Close inspection of moisture sensitive materials for evidence of mold growth (and possible testing), and removal (or rejection) of any mold-colonized materials
- Removal (or rejection) of the wet material(s)
- Installation of temporary dehumidification systems
- Removal of standing water, if present
- Relocation of building materials to other areas, as long as the materials are not mold-colonized and will not introduce moisture to otherwise dry areas
- For any materials that are visibly moldy, removal / remediation by a qualified party

Wood framing. The moisture content of representative portions of the wood framing, both stored and installed, shall be evaluated on a weekly basis, with additional evaluations performed during water events that may have compromised these materials. Wood framing members shall be maintained at a moisture content no greater than 19% (or other material-specific control points for the project as determined by the qualified third party and the design team). Products that exceed this level shall require corrective actions as outlined above. Modifications (but not exclusions) to this criteria based on varying types of wood may be evaluated by the qualified third party.

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Millwork, finishes, trim. Millwork, finishes and trim components shall be maintained within the moisture content range advised by the manufacturers.

Flooring. Floor coverings shall not be installed over poured slabs until the concrete has cured sufficiently. The manufacturers' requirements shall be met before flooring is installed. Testing shall adhere to *ASTM F2120-02 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes* or other method approved by the project design team (see section 8 for additional references).

4.2.6.1 Gypsum Wallboard That Is Not Mold-Resistant. Moisture damage to wallboard that has not been specifically engineered to be mold-resistant can be extremely costly and disruptive during the construction process. As such, gypsum wallboard that is not mold-resistant shall be installed only during the controlled phase (with ambient sources of water and moisture addressed as described in section 4.2.5.3), unless prior approval has been obtained (and documented) from the moisture manager to install gypsum wallboard that is not mold-resistant during the partially enclosed phase. If so approved, adherence to protections as described in section 4.2.5.2 is required. Gypsum wallboard that is not mold-resistant shall not be installed during the exposed phase. Wherever possible, the designer should consider using gypsum wallboard that is resistant to the growth of mold.

At any point (delivery, storage, installation) the moisture content of gypsum wallboard should not exceed 0.9% (weight of contained water compared to the combined weight of the gypsum product and contained water), or other limit established for the project. Any measurement of gypsum wallboard that is found to exceed this value shall require immediate attention from the moisture manager. Further, the qualified third party shall be informed so that a plan to address the situation can be devised.

In addition, it is essential to eliminate the cause of the elevated moisture condition to prevent recurrence. The moisture manager shall complete a Water Incident Report (see section 4.2.7) and take corrective actions.

4.2.6.2 Quality and Accuracy of Monitoring Equipment. All monitoring equipment shall be of sufficient quality and accuracy to test the materials and environmental conditions. The equipment shall meet the following minimum requirements:

- Temperature sensors shall have an accuracy of ± 1°F and a certified calibration within the past year.
- Humidity sensors shall have an accuracy of ±3% (within the measurement range of 30% and 90%) and a certified calibration within the past year.
- Moisture meters shall be checked for accuracy before each day's use and shall have an accuracy of ±1% over the typical operating range according to the manufacturer. In addition, this equipment shall comply with *ASTM D4444-92 Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters*.
- Infrared cameras used for envelope evaluations shall have a minimum detector size of 320 X 240 in the focal plane array and a minimum thermal sensitivity of 50 milli-Kelvin (mK) at 30 °C. The device shall also be fully radiometric to allow for more accurate field interpretation and investigation of anomalies. Infrared cameras used for investigation of localized water intrusion shall have a resolution not lower than 160 x 120 and a minimum thermal sensitivity of 100 MK at 30 °C.
- All equipment shall be calibrated at the intervals recommended by the

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manufacturer and any time the equipment becomes damaged and requires repair.

4.2.7 Water Loss Incidents. A written incident response plan shall be required as part of the MMMP to address mitigation of unexpected water intrusion that may occur during construction. While the goal of the MMMP is to prevent moisture damage to the degree possible, when unexpected water intrusion does occur, the goal is to minimize resultant damage including mold colonization (growth). A water loss incident is defined as follows for each phase of construction:

- Exposed phase: An event of such magnitude that it overcomes the protective measures taken to protect moisture sensitive materials stored at the construction site.
- Partially enclosed phase: A water event that exceeds 10 gallons.
- Controlled phase: A water event that exceeds 1 gallon.

The moisture manager shall investigate and document the cause(s) and effect(s) of water loss incidents. The source of any such incidents shall be corrected. The effects of any such incidents shall be remediated, including drying, cleaning, and removing damaged materials or components / equipment. Remediation of water losses shall be executed by, qualified parties. Such remediation shall use proper control measures in accordance with current accepted industry practice (refer to the appendix for remediation guides from IICRC, USEPA, and NYC-DOH). The application of chemicals intended to inhibit mold growth is not allowed if such an application is the sole measure taken to address a moisture problem and/or mold growth. A qualified party shall perform removal of damaged building materials, e.g. a qualified water damage restorer and/or mold remediation contractor. Upon completion of such remedial actions, the moisture manager or designee (and/or other qualified third party independent of the restorer / remediator) shall conduct a clearance inspection to verify that all affected materials or components have been successfully dried, cleaned, and/or removed so that construction activities may resume. Clearance criteria shall be established in advance by the moisture manager and/or qualified third party. The results of the clearance inspection shall be documented, including visual observations, moisture measurements (e.g., comparing results to non-affected, representative materials), and any other criteria as deemed appropriate by the moisture manager and/or qualified third party. Acceptable repairs do NOT include painting over mold growth.

4.2.8 Periodic Inspections. The construction moisture manager shall regularly inspect the jobsite for moisture issues during each of the three construction phases, and through project completion. This shall include physical inspection and moisture measurements. The requirements of the inspection shall be listed in the design documents. All findings should be documented in writing, and the moisture manager shall review such documentation periodically to track results, deficiencies and remediation measures.

4.3 Periodic Third Party Inspections. A qualified third party shall conduct an adequate number of site visits during each of the three construction phases and at substantial completion / acceptance phase (pre-occupancy). These site visits shall include physical inspection of the building, testing, and a review of the documentation associated with the MMMP, focusing on the moisture status of the building at the time of the inspection. The requirements of the inspection should be listed in the design documents. The overall purpose of these inspections is to assure that no moisture damage or visible mold growth are present, and where it is present, that mitigation measures are established, implemented, and documented. Inspection requirements during the three construction phases and at

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substantial completion / acceptance phase (pre-occupancy) are described below in sections 4.3.1 and 4.3.2 (see also section 7.0).

4.3.1 Periodic Qualified Third Party Inspection During Construction. Periodic third party inspections during construction shall minimally include visual observations, measurements of moisture levels in representative building materials, and review of pertinent documentation. Findings of all periodic inspections shall be documented. Particular attention shall be paid to any areas where documented moisture problems and/or mold growth occurred, as well as areas representative of general building conditions. Any problem area (e.g., where corrective measures are required) shall be re-inspected during subsequent inspections to verify effectiveness of corrective actions taken. Representative areas requiring inspection shall minimally include: perimeter of below-grade walls; insulated piping that will carry liquids below expected dew points temperatures; areas adjacent to window and door openings; areas directly beneath roof(s); and plumbed areas. To facilitate the third party inspection and review process, prior to the site visit, the moisture manager shall make available the MMMP and representative examples of the records maintained as required by the plan to the third party inspector.

Any deficiencies reported by the third party reviewer that are not corrected by the construction team shall be tracked through to the completion of construction. A list of these deficiencies shall be provided to the owner and facility manager immediately prior to occupancy. This will allow the people responsible for operation and maintenance to include these items in the ongoing preventive maintenance activities.

The total number of site inspections will vary based on project size/duration. Inspections shall occur no less frequently than at the following intervals, unless the third party inspector and contractor establish other quality control procedures that provide reasonable assurance that the design elements are accurately followed and moisture control measures are well-established and strictly adhered to:

- Exposed phase: Once per quarter
- Partially Enclosed phase: Once per month
- Controlled phase: Twice per month

It is likely that for projects of sufficient size, different portions of the construction may be at different phases at a given point in time. In such cases, the inspection frequency may differ by the separate portions. For projects comprised of multiple, similar, smaller buildings, the third party inspections shall span the term of the project, not the individual timeframe for each building.

Third party inspections should also include observation or performance of the testing elements of the quality assurance program (see section 3.7). Any failures in these systems that are observed during the inspections shall be corrected and a plan should be devised to prevent future failures.

In addition, the third party reviewer shall review submittals and shop drawings provided by the contractor for the building envelope components and critical mechanical systems. The reviewer shall verify the capabilities and features of the submitted products and advise the design team if the potential exists for these products to create a moisture problem. As with the design reviews, the submittal review is not intended to relieve other parties of their responsibilities, but to provide additional checks of possible problems.

4.4 Contractor Change Orders During Construction. In addition to review by the design team (e.g., review of change orders submitted by the contractor, to assure they meet design specifications), the third party reviewer shall also review any change

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orders submitted to ensure that any such changes will not adversely affect moisture concerns in the building, either by direct impact or indirect effect. Further, any changes initiated by the owner or design team shall be reviewed by the third party reviewer prior to issuance to the contractor for action.

5.0 Acceptance Phase.

5.1 Overview. This phase occurs at the end of construction (substantial completion) and immediately prior to occupancy. The requirements for this phase of construction are designed to verify that the building has no elevated moisture or mold growth and that the building is ready for occupancy.

Table 7.3 in section 7 provides a summary of the required documentation that should be produced during the acceptance phase to comply with this standard.

5.2 Third Party Inspection and Verification Testing. Requirements for qualified third party inspection and testing at the acceptance phase, immediately prior to occupancy, shall minimally include those addressed during the three construction phase inspections (see section 4.3.1). In addition, inspection at substantial completion / acceptance phase shall include items that are expected to be completed prior to occupancy to assure that the building is acceptable for occupancy. These additional items shall minimally include HVAC system operations and general cleanliness, and evidence that the interior finishes and furnishings are free of elevated moisture and visible mold growth. To demonstrate this, the following shall be completed and documented:

- *A moisture survey of the interior of the building, with identification of possibly wet areas*. Acceptable methods are: 1) infrared thermography with confirmation of any suspect areas with direct measurement of moisture content; or 2) a thorough survey of all walls within the building using moisture meters. This testing shall include all interior spaces with particular emphasis on those areas more prone to mold growth (e.g., underneath plumbing fixtures, door thresholds, window openings, immediately beneath the roof, kitchen areas, etc.) The moisture meters shall meet the requirements of section 4.2.6.2.
- *Operation of HVAC equipment and plumbing fixtures*. Verification of the function of a representative selection of this equipment under all anticipated modes of operation, including any appliances that use water, shall be conducted to affirm that no deficiencies exist that would introduce water to the interior spaces. Results of verification testing shall be conducted.
- *Measurement of the relative air pressure inside the building with respect to outdoors at representative locations*. Such testing shall be conducted during various operational modes of the HVAC systems. The objective shall be to identify the possible infiltration of unconditioned air that might lead to the indoor condensation of water vapor.

Additional means of determining that no uncontrolled moisture is present in the building, and that the building is acceptable for occupancy may be identified and used by the designers, contractor and or qualified third party. These may include one or more of the following, or other procedures not listed here:

- *An infrared survey of the exterior of the building once the climate control systems are in operation*. The goal should be to identify possible areas of water intrusion or condensation within the exterior wall assemblies. For high-rise buildings where access

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to exterior elevated sections of the envelope would be difficult, surveys of the lower floors should be used as representative locations for the entire building, assuming that the construction of these areas is similar. In addition, for such inaccessible areas, some information on deficiencies within exterior wall assemblies should be obtained from the interior infrared survey.

- *An infrared survey of the roof once the installation is complete*. Any areas of suspect moisture intrusion identified by infrared thermography should be examined further, possibly using destructive means, to identify the source and extent of moisture intrusion. Corrective measures shall be taken and documented.
- *Baseline testing for airborne fungi*. See section 5.2.1 below.

For the testing listed above, any infrared cameras used shall have a minimum accuracy and resolution as listed in section 4.2.6.2.

5.2.1 Test for Airborne Fungi to Establish a Baseline for the Building (optional). An appropriate number of samples, as indicated by the qualified third party, should be taken to accurately characterize the building, including a sufficient number of samples collected from the outdoor air. Due to the variability of air sampling results based on the type, timing (diurnal / seasonal) and location of the testing, a qualified professional with experience in the routine practice of such work should perform the collection and analysis. This testing can be useful as part of an overall plan to demonstrate whether or not the indoor conditions are typical of a dry, well-maintained building. The results can also be used in future diagnostic efforts.

In creating a sampling strategy, the qualified party should rely on appropriate guides, such as:

- *Assessment, Remediation, and Post-Remediation Verification of Mold in Buildings*, AIHA, 2008
- *Bioaerosols: Assessment and Control*. Edited by Janet Macher. ACGIH. 1999.
- *Field Guide for the Determination of Biological Contaminants in Environmental Samples, Second Edition*. Edited by Ling-Ling Hung, J. David Miller, and H. Kenneth Dillon, AIHA, 2005.
- *Recognition, Evaluation, and Control of Indoor Mold*. Edited by Bradley Prezant, Donald M. Weekes, and J. David Miller, AIHA, 2005.

6.0 Occupancy: Mold / Moisture Operations and Maintenance (O&M).

6.1 Overview. The need for moisture management and prevention of mold growth continues after substantial completion of construction and into occupancy. The operation of building systems and the activities of occupants can contribute to moisture problems. Therefore, a moisture / mold operations and maintenance (O&M) plan is required to minimize moisture problems after the building is operational and occupied.

It is appropriate for the O&M plan for a building to include some of the elements of the MMMP developed for that specific project. The designers, contractor, and qualified third party should provide preventive maintenance information for the facility managers based on the quality assurance testing and other verification testing performed during the construction and acceptance phases.

Table 7.4 in section 7 provides a summary of the required documentation that should be produced during the O&M phase to comply with this standard.

6.2 Written O&M Manual. A written, site-specific O&M manual shall be prepared

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that documents and outlines the necessary practices and procedures for managing moisture during building operations and occupancy. This manual shall be associated with and/or a part of an overall building operations and maintenance plan. The written manual shall minimally include all of the elements of the mold / moisture O&M plan, as described below in sections 6.2.1 through 6.8. The O&M manual shall be reviewed at least annually to ensure it accurately reflects any changes in building conditions, use or occupancy. Changes to the O&M manual and the date(s) such changes are implemented shall be documented. All parties involved in the construction may have input to the creation of the O&M manual, but the Contractor is responsible for delivering the manual.

6.2.1 Communications Channels. Communications channels should be established and documented (with contact information reviewed and verified at least annually). This information should be made available to facility staff. A contact number for the appropriate facility staff should be provided to building occupants.

6.3 Roles / Responsibilities. In general, the building operator shall carefully maintain the building systems in accordance with manufacturers' guidelines, current accepted industry practice and O&M procedures established for the property. Facility staff and building occupants shall follow the guidance provided in the O&M plan.

6.3.2 O&M Manager. One individual shall be designated as O&M manager. The O&M manager shall assure that building operations personnel are trained in the practices and procedures for moisture management and prevention of mold growth, and that occupants are informed of the components of the O&M plan as they pertain to occupant activity. The O&M manager shall review the written O&M plan periodically (at least annually) and update it as necessary, e.g., as the building ages, and/or when a change of building use occurs (remodeling, redesign, or change in the nature of occupant activity).

6.4 Worker / Building Operations Personnel Training. During or prior to the first quarterly inspection by the qualified third party, building operations personnel (facility staff) shall be informed of the concerns caused by atypical (elevated and unintended) moisture in the building. The facility staff shall be trained in early recognition of signs of atypical moisture and mold growth and preventive and corrective actions to be taken. Within 90 days of start of employment, all building operations personnel shall be trained in the elements of the O&M plan and their responsibilities for helping minimize the risk of moisture damage and consequential mold growth in the building. O&M worker training shall be documented. O&M training program materials shall be reviewed and updated at least annually, with any changes and date(s) of implementation documented. Refresher training shall be provided on at least an annual basis and all such training shall be documented.

6.5 Occupant Awareness. Building occupants (e.g., tenants, vendors, subcontractors) should be informed of the elements of the O&M plan and their responsibilities for helping minimize the risk of moisture damage in the building. A Moisture Intrusion Guide for Building Occupants should be developed by the Owner (or designee) or the General Contractor and qualified third party as part of the overall O&M Plan to help make occupants aware of the importance of early recognition of signs of moisture damage or mold growth and the need and means to promptly notify the O&M manager (or designee). The O&M manager should retain copies of (or otherwise document) occupant notifications and/or other communications regarding the moisture / mold O&M plan and any other associated activities. The Moisture Intrusion Guide for Building Occupants should be reviewed and updated

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annually (with any updates and date[s] of implementation documented), and any updates distributed to building occupants.

6.6 Periodic Surveillance / Inspection and Monitoring. The O&M manager (or designee) or a qualified third party shall conduct periodic physical inspections and monitoring once occupancy begins. The O&M manager (or designee) or qualified third party shall look for signs of elevated humidity, water intrusion and mold growth. Areas requiring inspection shall minimally include: HVAC systems and components; plumbed areas; penetrations (e.g., below roofs, windows); and building material surfaces and finishes; plus locations where moisture-generating activities by occupants and/or building staff occur, and humidity problems associated with air conditioning systems. In addition, the building exterior shall be inspected (e.g., roof, site exterior, grounds) for potential moisture sources. Frequency of inspections and monitoring is described below in sections 6.6.1 and 6.6.2.

6.6.1 In-house Inspection and Monitoring. At a minimum, the O&M manager or designee shall conduct inspection and monitoring as described above on a quarterly basis for as long as the building remains operational. Inspection and monitoring findings and any resultant corrective and/or preventive actions shall be documented.

6.6.2 Qualified Third Party Inspection and Monitoring. At a minimum, during the first year of building operations, a qualified third party should physically inspect and monitor the building on a quarterly basis, with annual inspection and monitoring thereafter for as long as the building is operational. The third party inspector should also review records of in-house inspections and monitoring as part of its periodic surveillance. Any recommendations resulting from third party surveillance should be documented and subsequent visits should follow up to assess whether such recommendations were addressed.

6.7 Water Loss Incidents. A written incident response plan should be a part of the O&M plan, to address mitigation of unexpected water intrusion that may occur. This plan should be similar to that described in section 4.2.7, with the addition of conditions related to building operations and occupancy.

6.8 Recordkeeping / Documentation. The designated O&M manager should ensure that records (e.g., forms, checklists) are maintained pertaining to preventive maintenance activities, moisture or water loss incidents, mold growth, occupant complaints and all associated response actions. The O&M manager should review such records periodically (at least annually) for trends or recurring patterns of complaints or incidents, or other persistent issues. The review should include written recommendations to the owner / operator for correcting the causes of recurring or persistent issues or any other moisture-related problems. In addition, the forms / checklists used to record O&M activities should be reviewed at least annually, and for any changes made to these forms / checklists the date(s) of implementation shall be documented.

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7.0 Required Documentation for Verification of Compliance With Standard.

Various documentation is required by this standard during building design, construction, at acceptance, and during operation / occupancy in order to verify compliance with the standard and to meet the goal of preventing moisture problems and mold growth in buildings. Responsibility for developing and maintaining such documentation lies with various involved parties, as described below in Tables 7-1 through 7-4.

Table 7-1. Required documentation for design phase for verification of compliance with standard.

Design Factor	Required Documentation
Site features	-Verification of soils and hydrology assessment completed by a qualified civil engineer or professional geologist registered in the state where construction will occur -Signed landscape architecture review completed by a qualified party identifying any design issues, mitigating measures recommended, design team responses, and a statement of final disposition of the identified items
Architectural systems (building envelope)	Signed review completed by a qualified third party identifying any design issues, mitigating measures recommended, design team responses, and a statement of final disposition of the identified items
HVAC systems	Signed review completed by a qualified third party identifying any design issues, mitigating measures recommended, design team responses, and a statement of final disposition of the identified items
Plumbing systems	Signed review completed by a qualified third party identifying any design issues, mitigating measures recommended, design team responses, and a statement of final disposition of the identified items
Materials selection	-Listing of product names and characteristics of moisture sensitive materials -List of locations of moisture sensitive and / or mold resistant building materials - Signed review completed by a qualified third party identifying any design issues, mitigating measures recommended, design team responses, and a statement of final disposition of the identified items
Value engineering	Signed review by a qualified third party verifying that changes predicted to affect the resilience of the facility to moisture have been approved by the design team

Table 7-2. Required documentation for construction phase for verification of compliance with the standard.

Construction Practice	Required Documentation
Moisture and mold management plan	-Verification that the written moisture management plan includes: -designated roles and responsibilities -provisions for worker training -schedule of periodic monitoring activities -criteria for acceptance / rejection of moisture sensitive materials delivered on site -protective measures for moisture sensitive materials stored on site -incident response plan, including communication hierarchy -provisions for periodic inspection
Worker training / orientation	-Copy of employee training syllabus -Signed and dated verification by each employee attending orientation and training

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Construction Practice (cont'd)	Required Documentation
Material and Equipment Submittals	-Listing of submitted materials that are moisture-sensitive with approvals from the design team and third party reviewer -Listing of alternate or substituted products that affect the moisture resistant features of the building
Transport of moisture sensitive materials	-Listing of protection measures for moisture sensitive materials used by contractors, suppliers, or sub-contractors - Photo documentation of representative measures (time stamped)
Delivery of moisture sensitive materials	-Signed logs of visual inspection of all moisture sensitive materials -Signed logs of moisture content measurements from representative selections of moisture sensitive materials -Signed logs of disposal or return of any moisture sensitive materials rejected for moisture related reasons
Storage of moisture sensitive materials	- List of storage criteria for each material - Logs of monitoring of moisture content measurement of sensitive materials - Logs of monitoring of environmental conditions of storage areas (temperature, RH, etc.)
Scheduling and sequencing of installation of moisture sensitive materials	- General: list, with signed approval by moisture manager, of any exceptions to moisture control practices and alternate protective measures used
- Exposed phase	-List of locations of all moisture sensitive materials installed in exposed phase (list must be made available to inspectors) -Signed and dated logs of visual inspection and moisture content measurement of moisture sensitive materials -Listing of protection measures used for installed moisture sensitive materials -Photo documentation of representative measures (time- and date-stamped)
- Partially enclosed phase	-Signed and dated logs of visual inspection and moisture content measurement of representative moisture sensitive materials
- Controlled phase	- Logs of visual inspection of moisture sensitive materials
Gypsum wallboard (GWB) that is not mold-resistant	-Signed verification that installation of GWB prior to controlled phase was approved by the moisture manager. -
Monitoring of environmental conditions	- Signed and dated logs of monitoring of environmental conditions (temperature, RH, etc.) once moisture sensitive materials are installed
Water loss incidents	- All reports of water loss incident investigations and associated remedial actions and clearance inspections (per section 4.2.7)
Third party inspections	-Reports of qualified third party inspections and monitoring during each phase (the exposed phase, the partially enclosed phase, the controlled phase) (minimum of three reports).
Change orders	- Signed and dated verification that change orders affecting moisture control were approved by the design team and third party reviewer

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Table 7-3. Required documentation for acceptance phase for verification of compliance with the standard.

Required Element	Required Documentation
Third-party inspections	-Reports of qualified third party inspections and verification testing during acceptance phase (substantial completion)

Table 7-4. Required documentation for building operations / occupancy for verification of compliance with the standard.

Operations & Maintenance (O&M) Element	Required Documentation
Written O&M plan	-Verification that written O&M plan includes: -water incident response plan -any updates made as a result of periodic program review and date(s) implemented -any associated records
Communications plan	-Copy of written communications plan -Verification that date of last review is present on plan and that contact information is current
Worker / building operations personnel training	-O&M worker training syllabus -Signed and dated verification by each employee attending orientation and training -A training module shall be added to the new employee orientation; signed statements must be submitted by trainees indicating an understanding of the materials presented
Occupant awareness	-Awareness Program outline -Signed verification by each occupant attending awareness program -Documentation of effort(s) made to get non-attendees to attend
Quarterly surveillance (in-house)	-Written reports of periodic (quarterly) surveillance through in-house inspection and monitoring, including any resultant corrective and/or preventive actions, and associated follow-up actions
Third party surveillance	-Written reports of periodic (quarterly during first year of occupancy and annually thereafter) surveillance by third party inspection and monitoring including verification and approval of records reviewed, any resultant recommendations, and associated follow-up actions
Water loss incidents	-Statement of clearance criteria for remedial actions and verification that clearance criteria were established in advance. -Reports of all water loss incidents and investigations, and associated remedial actions and clearance inspections (per section 6.7)
Annual records review	-Report of periodic (annual) records review by the O&M manager to evaluate any trends or patterns, resultant recommendations made to the owner / operator, and any associated follow-up actions

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A5.505 Indoor Moisture Control. **Follow the guidance of ANSI/GEI-MMS 1001 Mold and Moisture Management Standard for New Construction to ensure that moisture concerns have been addressed from Design through Building Acceptance.** [MD7]