Understanding EPA Document 402-F-13053

“Moisture Control Guidance for Building Design, Construction and Maintenance”

Presented at:

Florida Healthcare Engineering Association
30TH Spring Meeting – May 9, 2014

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Gobbell Hays Partners, Inc.
Architecture ● Engineering ● Environment ● Health ● Safety
Introduction: Objectives

• Review the Science – Moisture Impacts on Buildings

• Review the new EPA Moisture Control Guidance Document
  • New Construction – Design & Cx
  • Operations and Maintenance – Monitoring & Inspecting
“In the 21st century, architecture isn’t truly excellent unless it deeply engages the natural world and promotes health and resilience.”

William Leddy, FAIA; quoted from an Opinion Piece Repositioning the AIA Institute Honor Awards: There Is No Separation Between Sustainability and Design Excellence
Part I

Building Envelope Science
Material Properties related to Moisture Transfer

Design and Construction Issues
Means and Methods for Controlling Moisture Intrusion
Capillary Properties of Building Materials

• Moisture Capacity of Materials is directly related to Capillary Properties of Materials

  ▶ Small Capillary Materials: Absorb moisture more slowly with higher pressure, but also dry more slowly

  ▶ Large Capillary Materials: Absorb moisture more quickly with lower pressure, but dry more quickly
Capillary Properties of Materials and Permeability of Building Materials

- Permeability of Materials is directly related to the Capillary Properties of Material
  - Capillary Properties establish Porosity of Materials
  - Porosity allows for movement of moisture through the Materials
Capillary Properties of Materials and Permeability of Building Materials

- Moisture movement through Materials is directly related to Moisture Capacity of the Capillaries

- High Volume of Moisture movement causes High Capillary Pressure, which tends to begin the breakdown of Materials over time
Permeability of Building Materials

- What is the Permeance of Some Standard Building Materials?

  - 4” Brick: 0.8 Perm
  - Stucco: 1.6 Perm*
  - 1” of concrete: 3.2 Perm
  - 3/8” Gypsum Board: 50.0 Perm
  - 6 mil. Polyethylene: 0.06 Perm
  - 2 Costs of Exterior Paint: 0.9 Perm

*Stucco Permeance Today – Old Stucco can be as high as 18.9 Perm

Permeability of Building Materials

- The Permeance of Some Standard Building Sheathing and Building Wrap Materials

  - 3/8” OSB: 2.0 Perm
  - Fiberboard – asphalt impregnated: 15.0 Perm
  - DensGlass: 23.0 Perm
  - XPS rigid insulation: 1.0 Perm
  - No. 15 asphalt saturated felt: 6.0 Perm*
  - Tyvek: 58.0 Perm*

*No. 15 asphalt impregnated felt has an Air Permeance of 0.4 Perm while Tyvek is 0.0045 Perm (@ wind pressure 30 mph)
Design Issues to Control Moisture Infiltration

• Air Barriers versus Vapor Barriers
  - Air Barrier – An element that controls the movement of air and/or water across a building envelope system (horizontal and vertical), but may be permeable to moisture vapor.
  - Vapor Barrier – Impermeable to moisture vapor movement.
Design Issues to Control Moisture Infiltration

• Air Barriers versus Vapor Barriers
  - Air Retarder – An element that effectively resists or slows the rate of airflow across a building envelope system or assembly.
  - Vapor Retarder – Limits the flow of moisture vapor across a building envelope system or assembly.
Design Issues to Control Moisture Infiltration

• Traditional Construction Techniques
  - Most all Exterior Building Cladding Materials Allow for Moisture Infiltration!
  - Design Exterior Envelopes to Drain the Moisture that is Allowed into the System.
  - Eliminate potential for moisture collecting in the Building Envelope System.
Design Issues to Control Moisture Infiltration

- Traditional Construction Techniques
  - Create a Diaphragm
    - “Drain Plane – A Plane for Rain to Drain”
      - Thomas “Willie” Adams, Envirotest, Inc.
  - Diaphragm Drained to Daylight
Design Issues to Control Moisture Infiltration

Moisture Management System

Building Envelope Design Guide - Wall Systems
by Daniel J. Lemieux, AIA and Paul E. Totten, PE
Wiss, Janney, Elstner Associates, Inc.
http://www.wbdg.org/design/env_wall.php
Construction Means and Methods

• Appropriate Means, Methods, Techniques, Sequences, and Procedures to Eliminate Moisture Saturation of Building Materials During Construction and beyond.

• Standard Specifications are being written to define Limitations for Moisture Saturation of Materials

• Important to monitor construction process step-by-step, including third-party review.
Construction Means and Methods

• Sequencing of Construction Issues
  
  ‣ Installing Gypsum Materials Prior to having Building Envelope Dried-in
  
  ‣ Installing Water Based Materials Against Highly Permeable Materials
  
  ‣ Installing Materials over Substrates that are not Sufficiently Dry or Conditioned.
Summary – Part I

• Prevention of Inappropriate Water and Moisture Vapor Infiltration into Buildings and the Building Materials during Design and Construction is “Step One” to the Prevention of Mold Growth in Building Systems
Part II


• General Guidance for Implementation of Moisture Control Measures
  
  ▶ New Construction – Design & Cx
  
  ▶ Operations & Maintenance – Monitoring & Inspecting
Introduction: What is it?

- It was developed by the Indoor Environments Division of the EPA

- It is a guidance document intended for use by people who work in the design, construction and maintenance of buildings.
Introduction: What it is not!

- It’s not a code, standard or even a textbook.
- It does not deal directly with flooding, just moisture/water intrusion/rainwater.
Introduction: What is it made of?

- Chapter 1: Moisture Control Principles
- Chapter 2 & 3: Design and Construction
- Chapter 4: Operations & Maintenance
- Appendix A - G: Provides useful tests, checklists and procedures for specific evaluations.
Introduction: What is it made of?

• Following Chapter 1, the remainder of the Document addresses Design, Construction and Operations as it relates to each of the following:

  - Site Drainage
  - Foundations
  - Walls
  - Roof and Ceiling Assemblies
  - Plumbing Systems
  - HVAC Systems
Chapter 1: Moisture Control in Buildings

• Un-controlled Moisture results in adverse health conditions and expensive repairs.

• Lawrence Berkley Nat’l Lab found that building dampness and mold raise the risk of respiratory illness by 30 to 50%.

• Also, 21% of people in the U.S. with Asthma can be attributed to dampness and mold in homes.
Chapter 1: Moisture Control in Buildings

- Not only is it unhealthy, it's expensive!
- The Berkley Lab estimates the annual asthma related medical costs attributable to damp buildings totals approximately $3.5 Billion. So where's the rest of the money?
  - Absenteeism
  - Reduced Productivity
  - Increased Insurance Risk
  - Repair and Replacement
  - Interruption to Business Operation
Chapter 1: Moisture Control in Buildings

- Understanding the air dew-point temperature is critical in determining condensation issues and how to avoid them.

- The wall surfaces in this photo have similar near condensation conditions. The mold growth is uniform and evenly distributed rather than a single concentrated area of dampness.
Chapter 1: Moisture Control in Buildings

• The dew point is the temperature of the air at which condensation occurs.

• The higher the dew point, the greater the chance for condensation to form.

• Very humid air has a high dew point. Condensation can occur on surfaces only a few degrees cooler than the Air.
Chapter 1: Moisture Control in Buildings

A Simplified Psychrometric Chart Relates Air Temperature, RH and Dew Point.
- The Blue Line traces the elements of the capillary break in the rainwater control system for a section through a building.

- Known as the “Pen Test.” It is also utilized to trace the continuity of the insulation layer and the air barrier – see Appendix 3.
Chapter 2: Designing for Moisture Control

The International Energy Code Climate Zone Map
Developed by the U.S. Department of Energy
While simplistic, negative drainage is a common deficiency.
Chapter 2: Designing for Moisture Control

- Components of an Unvented Crawl Space Foundation.
Chapter 2: Designing for Moisture Control

- Concrete Block with Interior Rigid Insulation and Stucco.
Chapter 2: Designing for Moisture Control

- Moisture Control in an Unvented Low-Slope Roof Assembly with Structural CMU Walls.
Chapter 2: Designing for Moisture Control

- Plumbing Systems: Three Goals of Design:
  - Design supply, waste and fixtures to prevent leaks and ease in detect leaks and make repairs.
  - Design should address prevention of condensation issues on pipes and fixtures.
  - Select materials to minimize mold growth in areas that are unavoidably wet.
Chapter 2: Designing for Moisture Control

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Chapter 2: Designing for Moisture Control

- HVAC Systems: 4 goals of design:
  - Keep the indoor air dew point temperature low enough to reduce the risk of condensation and moisture absorption by organic materials.
  - Design against negative pressure conditions by properly addressing all connections on the supply and return sides.
  - Design to control water from coil condensation.
  - Limit indoor humidity loads. Provide for the proper balance of exhaust air with dry makeup air.
Chapter 3: Constructing to prevent Moisture Problems:

- Controlling the uncontrollable: Construction companies have always had to deal with the usual suspects when erecting buildings!
  - Rain – the Weather!
  - Water used in materials that are installed wet.
  - Leaks in temporary or permanently installed plumbing.
  - Poor humidity control following dry in but prior to the HVAC systems being operational.
Chapter 3: Constructing to prevent Moisture Problems:

- Pre-Construction Planning: Should address each of our six sections:
  - Site Drainage
  - Foundations
  - Walls
  - Roof and Ceiling Assemblies
  - Plumbing Systems
  - HVAC Systems

- When constructing, keep it dry! If you see a design problem – Get it Resolved! Address, O & M issues that will change due to the “as built construction.”
Chapter 3: Constructing to prevent Moisture Problems:

• Pre-Construction Planning: Consists of the two following goals:

  ▶ Develop a Moisture Control Plan to be used during Construction.

  ▶ Review the Moisture Control Plan details with the Design Team, Construction Management, and Subcontractors.
Chapter 3:
Constructing to prevent Moisture Problems:

• Three Guidance Items for Developing the Moisture Control Plan
  
  ▸ The owner and design team will determine the level of concern for moisture control.
  
  ▸ Make the construction schedule, sequencing of work and delivery of materials to meet the objectives of the Plan.
  
  ▸ Identify the those responsible for each part of the plan.
Chapter 3: Constructing to prevent Moisture Problems:

• Three Guidance Items for *Reviewing* the Moisture Control Plan
  
  - Address rainwater and subsurface water control, seasonal conditions and changes, commissioning & testing.
  
  - Make sure that any changes are reflected in the contract documents, shop drawings and submittals.
  
  - Schedule required inspections & testing while moisture control details are exposed.
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

“The people who keep buildings working—the HVAC mechanics, carpenters, plumbers, electricians, engineers, custodians and managers—inherit the good points and the bad points of the design and construction.”
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

• Site Drainage Maintenance: GOALS

  Facility maintenance and preventative maintenance plans include site drainage.

  All runoff from parking lots, sidewalks, etc. is diverted to a designed, designated drainage system.

  Future site development or building modifications, additions do not interfere with existing site drainage conditions.
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

- **Foundation Maintenance: GOALS**
  
  - Foundation drainage systems divert water away from structures.
  
  - Do you even have a foundation drainage system???
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

• Wall Maintenance: GOALS

  ▶ Create and operate verification and inspection systems to detect potential moisture problems before harm is done

  ▶ Effectively maintain walls to prevent moisture problems, as intended by the design.
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

• Roof & Ceiling Maintenance: GOALS

  - Facility maintenance and preventative maintenance plans include moisture control issues for roof and ceiling assemblies.

  - Moisture does not penetrate roof or ceilings or collect in exterior elements, except as intended by design.
Chapter 4: Operating and Maintaining Moisture-Controlled Environments:

• Plumbing Maintenance: GOAL
  ▶ Plumbing systems are inspected and maintained to prevent flooding and condensation.

• HVAC Maintenance: GOAL
  ▶ Facility maintenance and preventative maintenance plans include moisture control in HVAC Systems.
The Appendices:

Appendix A: “The Pen Test”
Appendix B: Roof Inspection Checklist
Appendix C: Testing Moisture During Construction
Appendix D: Air Pressure Mapping
Appendix E: HVAC Inspection Checklist
Appendix F: Site Drainage & Maintenance
Appendix G: Dampness and Mold Evaluation Glossary