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Learning from Forensics: Moisture Management of Shower Assemblies or Mold

Proper moisture management is necessary in the design, installation and performance and reconstruction of shower assemblies, or resultant damage includes mold, fungi and/or bacteria growth:

The sensitive topic of mold and mold damage is directly related to the management of moisture. Mismanagement of moisture results in mold and mold damage including: deterioration of building structures and the components of the building structure; property damage; and could cause health and respiratory illness which results in loss of productivity of the individual or group of individuals; and can escalate into higher cost related to litigation.

Claims awarded for mismanagement of mold were highlighted by the Ballard lawsuit in Texas in which the remediation and restoration following a flood loss was not fully remediated by the company performing the remediation and the failure of the insurance company to properly investigate the failed remediation. A recent award for mold growth on improperly stored lumber and resultant mold damage resulted in a 22.6 million dollar award in Manhattan Beach California. Due to the results of many lawsuits, insurance companies are declining to cover for mold damage and/or charging higher premiums for the mold exposure coverage.

Mold spores can be inhales, ingested, or absorbed through the skin. Asthma, nausea, coughing, elevated body temperatures and symptoms associated with Candida, Immune Deficiency Syndrome, Lupus, Lymphoma, are also symptoms of mold exposure. The first symptoms of exposure to mold growth include when occupants in a building with mold growth report health concerns such as headaches, breathing difficulties, skin irritation, allergic reactions, and aggravation of asthma symptoms. Many doctors are not trained in identification of mold symptoms and have difficulty in identifying the differences based on the symptoms of the individual or group of individuals. Patients that relate potential mold exposure have a better chance of proper diagnosis by the doctors.

Water leaking through exterior wall assemblies, windows and window flashing, and roof assemblies, have been investigated in forensics and many articles and books have been written on the moisture intrusion and related failures and solutions to prevent and correct the existing moisture and related damage. Joe Lstiburek can give full day or longer courses on the subject of moisture control with basic concepts of wet moves toward dry, hot moves toward cold, high pressure moves toward low pressure, gravity, capillary migration, and surface tension with solutions on the management of moisture in roofs, walls, concrete slabs and the building envelop for control of moisture.

Wet areas as defined in ANSI A108 AN-4.15 and the Handbook for Ceramic Tile Installation published by the Tile Council of North America, Inc. include:
"Tile surfaces that are/either soaked, saturated, or regularly and frequently subjected to moisture or liquids (usually water), such as gang showers, tub enclosures, showers, laundries, saunas, steam rooms, swimming pools, hot tubs, and exterior areas."

The role of the consultant, and when designated is an expert witness, when investigating moisture failures in shower areas is to work with facts, analyze the design, installation, and performance of the related assemblies for moisture management. The process of the forensic evaluation, which with repetition, leads us to: analysis of products which fail or are successful; identifying of common causes of moisture mismanagement including assemblies which retain moisture or support the concept of all water getting to the drain assembly of the shower; and solutions to resolve the mismanagement of moisture which results in mold (also called BOG bio-organic growth and may include fungi and/or bacteria growth).

Products used in construction that repeatedly support microbial growth with the introduction of moisture include: drywall and greenboard, oriented strand board (also called OSB), particle board, composite wood assemblies, paper including moisture resistive barrier papers, mastic, carpet and carpet pads.

Tile is not suitable for direct bond to greenboard in showers and has been removed from the 2006 International Residential Code, the ANSI A108-99 and the Annual Tile Council of America Handbook for Ceramic Tile Installation. Drywall and water resistant gypsum backing board (also called greenboard) are manufactured with 100% recycled paper with the paper bound to the gypsum core with adhesives including sugar and starch. Add any persistent moisture and the wetting/drying process will support underlying mycelial and/or sporulating structures including Stachybotrys species and Penicillium/Aspergillus species both of which are the center of most mold litigation and media attention. Water resistant gypsum board is not suitable for any horizontal assembly in wet areas unless covered and protected 100% by a waterproof membrane. The exception to this may be shower ceiling assembly where the maximum spacing of stud support is 12 inches apart. Water resistant gypsum board will retain moisture and support bio-organic growth and loose structural integrity at locations where the water resistant gypsum board is installed over a non-breathable backing surface. Water resistant gypsum board and drywall should never be in contact with Portland cement mortar bed of the shower assembly. Water resistant gypsum board may be used at intermittent water areas such as a bathtub surround where no shower head occurs. A survey performed by the Tile Contractors Association of San Diego was taken on the average lifetime expectancy of tile installed over water resistant gypsum board in showers. The result of the survey is the expected lifetime of properly installed water resistant gypsum board with usage of the shower is 3 to 7 years. The "most stupid design" goes to the builders that assign tile to be installed over double greenboard with tile bonded with mastic on shower wall assemblies and uses full bullnose tile to make the wall assembly look like tile over a mortar setting bed. With double greenboard, there are 4 layers-surfaces to support mold growth and worse if insulation is in the wall assembly behind the base layer of greenboard. The professional tile and stone contractors must decline to perform the work for installation of tile or stone directly bonded over water resistant gypsum board in showers and wet areas.

Oriented strand board has been used extensively in the home building industry. Industry groups such as the APA-Engineered Wood Association publish data that the engineered wood products meet or exceed national voluntary performance standards for strength, stiffness, dimensional stability, and bond durability. The oriented strand board has economic and environmental benefits through the use of lower quality and more easily farmed trees, but the risks for replacement and supporting fungal growth are much greater than plywood, especially in wet area construction. The rates for wetting and drying of oriented strand board and plywood are different. Moisture migration and structural deterioration and fungal growth in oriented strand board are significantly greater than the same amount of wetting and drying in plywood. Water saturated oriented strand board will swell 3 times more than similar saturated plywood. Many manufacturers of waterproof membranes will not guarantee the installation of the waterproof membrane when directly bonded to oriented strand board due to out gassing which may occur from the chemicals within the oriented strand board. The following is published in ANSI and in the Annual Handbook for Ceramic Tile Installation on page 12: **"Caution:** wood-based panels such as particle board, composite panels (veneer faces bonded to reconstituted wood cores), non-veneer panels (wafer board, oriented strand board, and other similar boards), lauan plywood, and softwood plywood expand and contract with changes in moisture content and are not recommended as backing materials for direct bonding of ceramic tile. Plywood, however, manufactured with fully waterproof adhesive and with an exposure durability rating of Exposure 1 or Exterior may be used on residential horizontal surfaces when installed in accordance to ANSI Specifications for the Installation of Ceramic Tile Section AN-3.4."

Paper products including moisture resistive barrier papers will shed moisture in a vertical application to a limit. Moisture trapped in a mortar setting bed with the moisture resistive barrier paper on the backside of the assembly, the moisture resistive barrier paper will support underlying mycelial and/or sporulating structures including Stachybotrys species, Penicillium/Aspergillus species. The moisture resistive barrier papers will decay and be eaten by organisms when trapped in a constant water condition such as between a bathtub flange or prefabricated shower pan flange where no drainage channels exist to drain the moisture in the shower wall assembly back to the drain assembly of the bathtub or prefabricated shower pan, or where weep holes are plugged in a tile lined shower receptor assembly. One layer of moisture resistive barrier paper behind a backer board installation or mortar setting bed is not sufficient for usage in a gang shower or multiple occupant usage showers. Minimum 2 layers are required for installations installed over shear wall panels. In wall assemblies subject to constant or prolonged usage, waterproof membranes are necessary to prevent the moisture intrusion into the wall cavity, including at windowsills.

Paper products including moisture resistive barrier papers, scribing felts, were not designed for horizontal application to prevent moisture intrusion or reduce moisture migration. Examples of failures would include installation over slab on grade construction where excess moisture can enter the assembly through the concrete slab. The installation failure of the slip sheet type of assembly is exacerbated by the use of mastic between the slip sheet or paper product and the concrete slab. The mastic can support underlying mycelial and/or sporulating structures including Stachybotrys species, Penicillium/Aspergillus species and insect population.

Carpet and pad installations adjacent to wet areas are subject to support of underlying mycelial and/or sporulating structures including Stachybotrys species, Penicillium/Aspergillus species when subjected to moisture from: leaking showers; leaking shower enclosures; moisture flowing over bathtub rims and ledges or prefabricated shower pan rims and ledges; or flowing over the bathtub or prefabricated shower pan rim between the shower pan flange and the tile. This author specifically cautions against using absorptive floor coverings adjacent to shower assemblies. Excess moisture through concrete slabs is another source which will support fungal or mold growth in carpet especially adjacent or near commercial kitchens where the commercial kitchens are not designed and installed similar to gang shower construction with waterproof membranes to egress water that gets into the assemblies and out through the drain assemblies in the kitchen floor.

Moisture management issues related to the design, build and sustain industry in this article are specifically directed to showers including multiple occupant showers, gang showers, and steam rooms;

Shower Assemblies:

The purpose of the shower assembly is to facilitate the cleaning of the human body with water and egress of all water with any chemicals into the drain assembly. The Uniform Plumbing Code covers the code requirements and approvals for shower receptors including Section 412 and Installation Standards 2 and 4 and the International Building Code Section 807 and International Residential Code cover the code requirements and approvals for shower wall and ceiling assemblies. These code publications are published every three years and in force when adopted and/or amended by the governing building department. Publications in our tile industry for reference include ANSI A108 – American National Standard Specifications for the Installation of Ceramic Tile, ANSI A137.1 American National Standard Specifications for Ceramic Tile, and the Annual Handbook for Ceramic Tile Installation published by the Tile Council of North America, Inc.

A major source of moisture to support mold in wall and floor assemblies and adjacent floors is from the usage of showers. Cecil Hunt, President of the Tile Contractors Association in San Diego placed a 6 inch glass in a shower and turned on the shower head filling the glass up in 3 minutes. Cecil Hunt calculated a shower used once a day for 12 minutes is equal to 8760 inches of rain per year in a shower. Don Halvorson did further calculations and published Technical Report 11-29-02 “Rainfall Inside My House” The Shower Environment, which included the conclusion the moisture inside a shower can be from 5.5 to 414 times more “rain” than on the roof no matter where you live on Earth. Don Halvorson and Gregory Mowat performed a conservative estimate that more than 25,000,000 showers are in a state of failure with excess moisture trapped in walls and in floors from shower usage in just the United States are supporting mold growth. Dave Gobis, when he was with the Ceramic Tile Education Foundation, stated at Coverings in 2005 that he estimated over 90% of showers in the United States were failing.

Gregory Mowat continued performing inspections in forensics as a consultant evaluating shower assemblies in 1990. Gregory Mowat wrote in 1991 to the Ceramic Tile Institute on shower failures, which were distributed to tile industry associations across the United States. April 1995 Gregory Mowat authored “Standard Shower Issues”. The

Standard Shower Issues article was distributed to tile industry associations across the United States. Beginning in February 2001, Gregory Mowat and Don Halvorson assembled photographs based on performing moisture surveys and sound testing of showers and correlated the moisture surveys and sound testing of showers to the destructive testing. The shower presentations have been given to over 3500 persons in the design, specification, build and sustain, and inspection industry, including construction defects, in 2002 into 2011. Don Halvorson authored "Shower Construction 101" August 10, 2002 based on inspections of showers. Gregory Mowat authored "Successful Showers" July 8, 2003 which has been published and distributed within the industry to combine the code references, industry standards and notes from learning from forensics. Gregory Mowat has authored and tailored to each presentation "Performing Moisture Surveys and Sound Testing in Showers". Don Halvorson and Gregory Mowat have inspected over 9000 homes including an estimated over 25,000 showers up through 2006. Don Halvorson and Gregory Mowat have performed or directing destructive testing in 2000 homes on over 3000 showers up through 2006. The analysis of moisture management failures and the components in showers starts with identifying the failure and then supplying or specifying the solution. Analyses of moisture management failures are the key to specifying or installing the next project with all of the proper moisture management solutions to reduce and prevent the mold, fungi and bacteria growth.

The Most Common Shower failures include:

1. Lack of waterproof membranes to protect all horizontal assemblies within the shower and splash area of the shower. Where no waterproof membrane is included, moisture migrates into the substrate causing decay, structural damage, and supporting mold, fungi and/or bacteria growth. Repair requires complete removal and replacement of the assembly with new installation to include the waterproof membranes with both the waterproof membranes and the finished tile surface sloped to drain minimum ¼-inch per foot.

Solution: Waterproof membranes are specified by the architect, assigned by contract from the builder or general contractor, or by the tile contractor with the waterproof membrane installed over a minimum pre-slope of ¼ inch per foot toward drain or outfall in order to protect all horizontal assemblies within the splash area of the shower head. This includes shampoo ledges, even if the shampoo ledge is above the 6-foot height requirement in the shower. The waterproof membrane is required to be 3 layers of hot mopping or equal as approved by the International Association of Plumbing & Mechanical Officials. Shower receptors, curbs, pony walls, seats, shelves, soap dishes, shampoo ledges, and windowsills are horizontal assemblies. There should be no standing or ponding water in the shower, when the shower is finished being used. All finished tile and stone surfaces should have the same minimum ¼ inch per foot slope toward drain.

2. The failures in a tile lined shower receptor start with plugged weep holes in the drain assembly. The back up of trapped water in the receptor supports: bacteria growth; contributes to the deterioration of the mortar bed; and supports water damp rising in the wall assemblies and over the dam assembly by capillary action. The trapped water will support bacteria growth due to the stagnant condition of the moisture in the mortar bed. Leaching of materials coming up through grout joints between the tiles or at the perimeter wall assembly of the tile lined shower receptor is the result of trapped moisture and the moisture is hindered from egressing to the weep holes at the drain assembly. Correction

to plugged weep holes at the drain assembly and trapped moisture in the tile lined shower receptor includes removal and replacement of the mortar bed and opening of the weep holes in the drain assembly with replacement of all damaged wall and floor assemblies.
Solution: Specify the tile lined shower receptor is to be water tested as required by the Uniform Plumbing Code. Following water testing, weep holes are to be opened and protected at shower drains in tile lined shower receptors prior to placing of the dry pack mortar. Use Anti-Hydro mixed with water in a 1 to 10 ratio with the water in mixing of the dry pack mortar which assists in moisture getting to the weep holes at the drain assembly faster.

3. Improper scratch coat installation contributes to the fracturing of the mortar bed and resultant damage of fracturing of the tiles. Resultant damages of improper scratch coat installation are indent fracturing of the tiles or stone and/or loss of bond of the tile or stone. The lack of a waterproof membrane instead of weather resistive barrier paper contributes to excess moisture/humidity entering the wall cavity of gang showers and multiple occupant usage showers contributing to mold and substrate swelling.
The improper scratch coat installation requires the wall assembly to be removed and replaced to stop the progressive fracturing of the tiles. Repair includes removal and replacement of the wall assemblies.
Solution: Lapping of paper-to-paper and wire-to-wire on vertical walls for the scratch and brown coat of the mortar bed. Proper wire is: 3.4 pounds per square yard expanded metal lath attached directly to studs; 2.5 pounds per square yard expanded metal lath installed over solid backing and mechanically fastened to the studs; and 2 by 2 16/16 gage reinforcing wire for horizontal installations. Mortar bed (scratch coat and brown coat) is to be uniform in thickness. Specifying a one coat float method following assembly method W222 is a good alternative as long as the wire reinforcing is mechanically fastened to the stud framing. Note there is not a requirement for the wire horizontally to be mechanically fastened. ANSI A108-99 accepts 2.5 pounds per square yard expanded metal lath attached directly to studs. Coordination of these requirements is mandatory by the builder or general contractor when the scratch coat and/or the scratch and brown coat are assigned to be installed with lath and plastering contractors.

4. Bathtubs and prefabricated shower receptors with negative sloped rims and ledges promote: water egressing into the wall assembly; inhibit moisture draining from the wall assembly to get to the drain assembly of the receptor; support the build up of moisture behind the tile with flowing over the bathtub rim and prefabricated shower pan rim into the adjacent tile leg assembly with damage to the tile leg assembly, floor and adjacent wall assembly; and support mold growth at the tile to receptor especially when caulking is present. Repair includes removal and replacement of the bathtub with an assembly with positive slope and replacement of the prefabricated shower pan with a tile lined shower receptor. The repair must include replacement of all damaged moisture absorptive flooring, sub floor, any damaged ceiling assembly, framing, and adjacent wall damage.
Solution: Bathtub are to inspected and accepted with positive slope from all ledges, and rims, to drain water to the drain of the bathtub including moisture that collects in front of the bathtub flange behind the tile or stone installation. Bathtub with negative slopes should be rejected and replaced prior to the tile assembly installation. Bathtubs with built in drainage channels are preferred over using existing bathtubs and designing and

coordinating weep holes to drain moisture from the wall assembly to the drain of the bathtub. Specify tile lined shower receptors instead of prefabricated shower pans.

5. Improper support of the bathtub or prefabricated shower pan contributes to cracking of grout or caulking at the tile intersection. Improper support can cause ponding in the receptor and can support moisture egressing over the bathtub or prefabricated shower pan rim into the tile leg assembly outside of the shower. Improper support can prevent the bathtub or prefabricated shower pan from being installed properly with proper drainage from all surfaces to the drain assembly.

Repair includes removal and replacement or reinstallation of the bathtub.

Solution: AN-3.6.4 Bathtubs require a secure and adequate support because of the combined weight of the tub, plus person plus the water. Specify as follows: "Secure bathtubs on metal hangers or on end grain wood blocks secured to wall structure. Set tubs close enough to wall so that ceramic tile covers the lip of the tub." AN-3.6.5 prefabricated shower receptors must be solidly set in mortar to prevent any movement or flexing of the unit from the weight of a person using the shower. Specify as follows: "Install prefabricated shower receptors in such a manner that they will not move or flex from the weight of persons using the shower unit." This author recommends specifying a tile lined shower receptor instead of using a prefabricated shower pan.

6. Bathtubs and prefabricated shower pans with inadequate flanges which promote moisture flowing into the wall and sub floor assembly. Repair includes removal and replacement of the receptor and replacement of all damaged building materials.

Solution: Bathtubs and prefabricated shower pans with an integral 1-inch flange are required to make a watertight wall intersection in shower assemblies. For bathtubs without integral flanges, a tile bead kit is installed. The tile bead kit must supply the equivalent of an integral 1-inch flange surrounding the bathtub. The purpose of the 1-inch flange is to be able to make a watertight intersection from the bathtub or prefabricated shower pan with the wall assembly. The Uniform Plumbing Code was changed in 1992 requiring all shower receptors shall have a minimum 1-inch flange. The architect, builder or contractor is encouraged to specify or install tile lined shower receptors instead of the prefabricated shower pan. Many times the builders are choosing the prefabricated shower pan instead of the approved tile lined shower receptor because the installation is cheaper. With the choice by the builder or architect, the builder or architect then has the responsibility to coordinate with the plumber, prefabricated shower pan manufacturer or manufacturer's, the tile contractor, and any other trade participating in the floor or wall assembly as to how to use the prefabricated shower receptor and water absorbing into the shower wall and how to drain the moisture from the wall assembly to the drain of the prefabricated shower receptor. This same coordination is necessary by the builder or architect for bathtubs in showers.

7. Lack of drainage channels in the bathtub or prefabricated receptor, or fourth sided flange or some way to drain moisture entering the wall assembly to the drain of the receptor. The lack of drainage channels leads to trapped moisture in the wall assembly, promotes the moisture flowing over the bathtub rim or prefabricated shower pan rim into the adjacent tile leg assembly, and promotes moisture damp rising up the wall assembly. The moisture trapped in the wall assembly contributes to corrosion of the wire reinforcing and excess moisture in the weather resistive barrier paper which will support mold growth, or moisture egressing through the backer board, or loss of structural

integrity of the greenboard and supporting mold growth. Repair is removal and replacement of the bathtub or prefabricated shower receptor and replacement of all damaged wall assemblies and floor assemblies.

Solution: Bathtubs and prefabricated shower pan manufacturers are changing the design of the manufactured appliance defect to include drainage channels or weep holes that will promote the egress from shower wall assemblies back to the drain assembly of the receptor. For bathtubs without drainage channels to prevent water flowing directly to the adjacent flooring, installation of a splashguard at both ends of the bathtub should be installed with curtain/drapery and rod installation when no shower enclosure is installed.

8. Shower door assemblies with leaks to the outside of the shower through the horizontal to vertical frame intersections. These voids and spaces in the shower enclosure frames allow vapor drive condensation with moisture collecting in the frame, which then leaks through the unsealed frame intersections. Shower doors with deteriorated or inadequate sweeps and/or water diverters on the shower doors allow for moisture to splash or drip to surfaces outside of the shower. Mineral and calcium deposits outside of the shower on or adjacent to the shower enclosure indicate moisture has and/or is leaking. Repair is for replacement with a new shower enclosure and repair all damaged flooring. Reinstallation of the shower enclosure assembly may occur only if parts are available and the shower enclosure has manufacturers or installers name and telephone number listed for where to purchase the parts following installation.

Solution: Shower door assemblies should be installed following manufacturer's installation instructions. The installation instructions should include the sealing of all horizontal to vertical frame intersections directly above the bathtub or prefabricated receptor. A mold resistant silicone sealant should be installed at frame intersections at the wall to the receptor. The shower door assembly should not allow moisture to flow through the frame or splash underneath the shower door. Shower door opening must be at least 22 inches. Void spaces in side of the frames should have a way to drain the moisture collecting out of the frame assembly. Stickers or identifying telephone number of the manufacturer should be installed on shower door assemblies for ease to purchase and replace parts as needed.

9. Unsealed finish plumbing fixtures including bathtub spouts, mixer valves and shower heads and escutcheon plates. Unsealed finish plumbing fixtures are a major problem with solid surface wall panels where the solid surface wall panels progressively loosing bond at the mastic to solid backing of the wall panel. The loss of bond of the wall panel causes movement of the wall panel and breaks the seal to become unsealed to the solid surface. The unsealed penetration allows moisture migration through the plumbing penetrations to the area behind the wall panel. Unsealed finish plumbing fixtures including bathtub spouts, mixer valves and shower heads and escutcheon plates are a major problem with prefabricated shower inserts when the shower head wall is not firmly supported to the stud framing. The problem occurs with both one piece molded insert and multi-panel prefabricated shower inserts. The movement of the shower head wall will break the bond of any sealant used to secure the plumbing penetration and allow moisture migration into and under the wall assembly through the plumbing penetration. Unsealed finish plumbing fixtures including bathtub spouts, mixer valves and shower heads and escutcheon plates may be a problem with single step backer boards without a secondary membrane for allowing the water to penetrate through the plumbing penetrations behind

the back board. The unsealed penetrations are not a problem if a mortar setting bed is installed with the membrane or waterproof membrane behind the wall assembly and water is able to drain to the shower receptor drain assembly. Repair for the solid surface wall panel assembly is removal and reinstallation if all damages can be replaced and adhesives such as epoxy can be used that will not break bond over other than greenboard as a solid surface backing to the solid surface wall panel. The prefabricated insert damages must be repaired with the addition of solid support at the shower head wall or replace the insert.

Solution: Prefabricated shower inserts and solid surface wall panels should be supported at the shower head wall and not allow for movement of the shower head wall assembly. Plumbing fixtures including shower head escutcheon plates, mixer valves and bathtub spouts adequately sealed to the wall assembly. Note there should be a hole on the downside of the mixer valve escutcheon plate to drain moisture that condensates between the escutcheon plate and the tile. The inside of the cylinder ring of the escutcheon plate at the mixer valve should be adequately protected to prevent moisture intrusion into the wall assembly. Solid surface wall systems must be installed over the backing with more solid support than spot mounting mastic by using an adhesive like epoxy that will maintain bond better than spots of mastic. Follow manufacturer's installation instructions for proper sealing of the plumbing penetrations of the single step backer board where the penetrations are made in the backer board.

10. Moisture absorptive floor coverings like carpet will support moisture damage, promote rust and corrosion at tack strips, support mold growth at carpet pad and carpet and allow moisture to penetrate into the sub floor. Repair is to solve the source of the moisture and replace the damaged floor assembly and sub floor where damaged. If materials are not match able, the entire bathroom floor will require replacement. Replace stained vinyl and resilient floor coverings and damaged sub floor.

Solution: Recommended not to use moisture absorptive floor coverings adjacent to showers. Best solution is to use a waterproof membrane assembly such as ANSI A118.10 and tile assembly for the entire bathroom floor.

11. Inadequate air ventilation supports mold growth on the soap and skin cell residue in the grout joints and other wall and ceiling surfaces within the shower. Repair is to increase air ventilation and use neutral soaps for cleaning the mold affected areas. Windows designed and used for air ventilation must be reachable by the user of the shower with notice posted to use the window for air ventilation. Hot and cold climates hinder the usage of the window for air ventilation. Air exhaust from bathrooms must be ventilated to the outside of the building and not to the attic. This author recommends to use a neutral soap and not to use any cleaner with bleach in the shower area.

Solution: Have adequate air ventilation to remove the moisture in the air during and following shower usage. Gang showers must have adequate air make up in the room to accommodate the air exhaust.

12. Showers changed to steam rooms after original installation are not designed nor installed with full waterproof membranes within all wall floor and ceiling assemblies. Moisture intrusion will occur and contribute to mold growth and deterioration of the wall and ceiling assembly. Repair is complete removal of the shower assembly and rebuild as a steam room with integral waterproofing for all horizontal and vertical assemblies.

Solution: When a shower is changed to a steam room, then all wall, ceiling and floor components of the shower are required to be equivalent to the steam room details in the Handbook for Ceramic Tile Installation. Waterproof membranes are used to wrap the entire structure to prevent moisture intrusion into the floor, ceiling and wall assemblies including seats. Adding steam to a shower changes the shower usage from a shower to a steam room. Tile and grout are not a waterproof assembly. The wall assembly must be installed to accommodate the moisture and thermal variations between usage and non usage of the steam room.

Tile contractors should find out in advance if the shower will be used as a steam room, or issue a waiver of liability or direction the shower not built as a steam room cannot be changed into a steam room without reconstruction of the shower assembly.

13. Backer boards which do not have an integral membrane as part of the backer board may not deteriorate with moisture penetration into the backer board, but the moisture penetrating, if unable to return to the drain assembly in the shower, will contribute to moisture damage in the wall and floor assembly including supporting mold growth, fungi and deterioration of underneath ceiling assemblies. Repair is complete removal and replacement with addition of the waterproof membrane or weather resistive barrier paper.

Solution: Follow backer board installation instructions of the manufacturer.

Backer boards installed in showers, which due not have integral membrane, are in lieu of a wire reinforced mortar bed. The installation still requires a weather resistive barrier paper on all vertical wall assemblies and waterproof membranes over all horizontal wood framing. Waterproof membranes may be required when installation is in gang showers, steam rooms or multiple occupant usage. Installation of backer board in showers directly to water resistant gypsum board without a weather resistive barrier paper is not an approved assembly and will contribute to water damage of the water resistant gypsum board backing in the shower assembly.

Where tile is directly bonded to the waterproof membrane the waterproof membrane must meet the ANSI A118.10 requirements.

The 2006 International Residential Code no longer permits greenboard as a suitable backing for direct bond of tile or other solid surface materials in a shower assembly.

Distributors selling the backer board should sell the tape and give manufacturers installation requirements or verify the contractor and employees have the manufacturer's recommendations. Contractors should inspect the backer board before installation of stone over the backer board. If you are a contractor installing backer board, follow manufacturer's installation directions explicitly. If you are following another contractor's installation of the backer board, accept or reject the assembly and verify the backer board installation complies with the manufacturer's installation instruction. Verify the proper waterproof membrane or weather resistive barrier paper has been properly installed. The backer board is not approved to be installed over greenboard without a waterproof membrane or weather resistive barrier paper. Remember the Marble Institute of America recommends L/720 for suitable substrate to receive stone installation on horizontal surfaces.

The Ceramic Tile and Stone Institute of Northern California is currently cautioning against exterior veneer installations utilizing backer board due to investigation of many

exterior veneer failures where installations were promoted and specified by the backer board sales representative.

14. Access for the handicapped is required for showers related to public swimming pools. Repair is to modify the assembly for proper access. See Installation Standard 4 in the Uniform Plumbing Code, Tile Council of American Handbook for Installation and the ANSI A108 requirements.

Solution: Design and specify accessible showers in public swimming pools. See Installation Standard 4 of the Uniform Plumbing Code and the Annual Handbook for Ceramic Tile Installation.

15. Walls not built with adequate support will contribute to excess deflection in the wall assembly. Repair is to remove the shower wall and add additional structural support.

Solution: Using studs on a 24-inch center in lieu of 16 inch maximum spacing in the walls is not a recognized backing for tile and stone installations unless sufficient cross bracing or shear panels are included as part of the wall assembly.

16. Wrong tiles installed on the floor assembly in tile lined shower receptor or on steps adjacent to the shower or bathtub, with the tile surface being slippery contributing to occupant slippage and accidents. Repair is to remove the tiles and replace with ceramic unglazed ceramic mosaic tiles or other approved tiles recommended by the tile manufacturer as suitable for walking surface with wet feet.

Solution: Specify ceramic mosaic tiles or tiles recommended by the tile manufacturer as suitable for wet walking surface in a shower.

17. Poor workmanship of tile installation resulting in tiles or soap dishes falling off of the wall assembly, cracking of grout joints, and excess moisture entering the wall assembly due to vapor drive condensation with moisture condensations in the void spaces between the tile and the substrate. Repair is to remove and replace all tiles not achieving the minimum 95% bond adhesion as required in ANSI A108.1, ANSI A108.4 and ANSI A108.5.

Solution: Assure the tiles are installed with minimum 95% bond adhesion to the substrate.

18. Reconstruction of the shower assembly following moisture damage repair and mold growth remediation and not following these guidelines for solutions or keys to successful installations will lead to reconstruction lawsuits. Builders replacing showers and not understanding the causes will reinstall an assembly which will continue to fail.

Solution: Know the causes of the failures before reconstruction. Use a consultant if unsure of the causes of the mismanagement of moisture leading to the failures and mold growth.

When mold is present, mold remediation should be left for trained, experienced professional as the recommended Personal Protective Equipment (PPE) and containment practices vary depending on the amount and type of mold contamination. PPE can include anything from an N-95 respirator, gloves, and goggles, to the use of mold-impervious body suits and a full-face powered air-purifying respirator (PAPR), which requires specialized training and medical clearance. Containment recommendations also depend upon the degree of mold contamination. Containment must be completed under negative pressure and sufficient layers of specific polyethylene sheeting. For severe cases of mold contamination, a decontamination chamber must be used for the entry into and exit out of the containment area. Most insurance companies will not insure

subcontractors or the reimbursement of expenses of mold exposure to occupants in the building or residence when exposed to mold spores caused by unprotected remediation of mold.

Solution to mold in showers is preparation in design, coordination of trades performing the work, and attention to the details of moisture management.

Challenge is issued to the plumbing manufacturers and installers to design receptors including bathtubs and prefabricated shower pans with drainage channels to egress moisture from the tile assembly on the shower walls, integrate with the wall assembly to prevent moisture intrusion, and manufacture the receptors with positive slope to drain all moisture to the drain of the receptor and to reduce moisture intrusion into wall assemblies through the plumbing penetrations.

Sources:

American Indoor Air Quality Council Post Office Box 11599 Glendale, Arizona 85318-1599 Web Site www.iaqcouncil.org

Ceramic Tile Distributors Association (800) 938-CTDA Web Site www.ctdahome.org

The Ceramic Tile Institute of America, Inc. 12061 Jefferson Boulevard, Culver City, California, 90230-6219 (310) 574-7800 Fax (310) 821-4655 E-mail ctioa@earthlink.net Web Site www.ctioa.org

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International Association of Plumbing and Mechanical Officials 5001 East Philadelphia Street Ontario California 91761-2816 (909) 472-4100, Fax (909) 472-4150 E-mail iapmo@iapmo.org Web Site http://www.iapmo.org

International Code Council 5360 Workman Mill Road Whittier California 90601 (800) 786-4452, Fax (866) 891-1695 Website www.iccsafe.org

Marble Institute of America, Inc. 30 Eden Alley Suite 301, Columbus Ohio 43215 (614) 228-6194 Fax (614) 461-1497 E-mail marbleinstitute@hotmail.com, Web Site: www.marble-institute.com

Mold & Moisture Management 385 Garrison Road Suite 116, Stafford Virginia 22554 (540) 720-5584, Web Site www.moldmag.com

National Kitchen And Bath Association Web Site www.nkba.org

National Tile Contractors Association Post Office Box 13629 Jackson Mississippi 39236 (601) 939-2071 Web Sites www.tile-assn.com and www.tileletter.com

Tile Council of North America, Inc. 100 Clemson Research Boulevard, Anderson, SC 29625 (864) 646-8453 Fax (864) 646-2821 E-mail literature@tileusa.com Web Site www.tileusa

Joe Lstiburek http://www.buildingscience.com

Environmental Protection Agency www.epa.gov/iaq/molds/index.html

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Gregory Mowat Graduated from San Diego State University with a Bachelors Degree. He has been active in the construction industry for 35 years. He has worked for contractors, tile brick and stone distributor, the Ceramic Tile & Marble Institute of San Diego and worked in Forensics the past 15 years. He has dedicated to educating members and students in the construction industry through articulate lectures and publications on tile and stone issues including showers, paving and veneer, and stone failures. His work specializes in failure analysis analyzing the design, installation and performance of these assemblies. He has received over 60 awards with the most notable being advanced to Fellow in the Construction Specifications Institute in 2002.

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