Preventing Mold in New Construction

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The following is a guide intended for building contractors looking to improve the way they build and maintain their jobs. If you haven't already had a mold issue on one of your projects, you probably will. As most new-construction mold issues take place under-floor, they are often going un-noticed. This is until the customer, or you, go to sell the house. Unlike many building inspectors, a competent home or pest inspector will crawl into attics and crawlspaces. If they see obvious mold damage, they will call it out in their inspection report. We are in business to fix costly issues like this, though need to do our part to stop them before they happen. This is why I have put together the following checklist that if followed, should prevent most mold and rot issues.

<u>This is not a guarantee! Tahoe Mold and Water assumes no liability regarding the following information. We are available for confidential consultations if you have questions about a particular project.</u>

"An ounce of prevention is worth a pound of cure"

- ☐ **French Drain-** Provide a drain tile system on the uphill side of the home. This is set to, or below the footing depth. Geological/Soil specialists can often determine the depth of any underground water drainage. With this information to consider, the depth of the drain system is of utmost importance. If the drain is deep enough, water will flow under the system and find its way to the crawlspace. The system should be discharged in an approved manner that is consistent with local building codes. It must also be effective at keeping the water from flowing back to the structure. A drain system is only a temporary fix <u>unless</u> a clean-out is available to flush settled sand and debris that will inevitably get deposited in the line. Multiple riser clean outs should be provided if the system has a number of turns. Keep the perforations in the drain pipe facing upward unless it is supposed to leach out. Landscaping cloth can be provided to prevent dirt from entering the line though can also get caked with silt and reduce the amount of water entering the system. Systems intended to remove large amounts of water may need to be installed without cloth and be flushed annually. Laying gravel around the drain will increase the effectiveness of the system. A continuous bed of gravel above the drain may also help with surface water management. Just make sure you allow for adequate slope of your line, and upsize if there is any chance your system can become overwhelmed.

- ☐ **Sump Pump-** If standing water persists inside the foundation walls, a sump pump system will likely be the solution. You may have an opportunity to drain the crawlspace if the home is on a hill. Whenever possible, design a system that requires little maintenance and relies on gravity. If the home is on a flat lot or at

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the bottom of a hill; you will need to mechanically remove the water. Pumps should be set in a basin. The basin upper walls should be slightly above the surrounding grade (no more than 4"). A five gallon bucket can be effective. A perforate basin designed for this purpose is more effective, and is much larger. So large that they don't fit through a 16" OC and are often taller than the height of the crawlspace. This is why this should be installed before the floor framing. All areas of standing water will need to drain to one of the sump pumps. The number of sump pumps should be figured based on the needs of the area and the ability to drain all areas to a basin. Low points must have drainage trenches connecting them to a sump basin. Pumps should be high quality, be protected from debris entering the basin, and have adequate gravel around and below to allow good permeability. A drain stop needs to be installed on the pipe riser to relieve head pressure on the pump seals. Pumps must be discharged away from the home and typically to a dry well to contain water on the property. In some areas it may be allowable to discharge ground water to a septic or sewage system. If the discharge is not run below grade and under the freeze line, consideration must be given to heating the discharge plumbing to prevent ice obstructions in winter.

- ☐ **Interior French Drain-** Interior drain systems can be built of perforated pipe buried in a bed of gravel. Sloped to a pump basin or drain, the system is best run along the interior of the perimeter foundation. This can be very effective in evacuating water that makes it under the foundation before it has a chance to turn to water vapor. This is much easier to install prior to rolling of the first floor joists. Systems can be simplified by removing soil and replacing with gravel instead of using drain line. This can allow for less excavation, as a properly sloped drain line can require over 16" of excavation depth. It is important that mounds of dirt are not left underfloor.

- ☐ **Moisture Barrier-** It is now common in many jurisdictions to install a moisture barrier of no less than 6 mill plastic over the **entire** earth surface in an exposed earth crawlspace. If not required where you are building, this fairly inexpensive installation can greatly improve the performance of a house by reducing the need to ventilate unconditioned areas. Consider using something better than plastic that can last the life of the home. A moisture barrier is also important under a slab and often required per code. Concrete can transmit moisture from the surrounding earth. A moisture barrier is intended to isolate the homes envelope from that moisture. An effective moisture barrier will reduce the amount of water vapor throughout a home. Even dry soil can contribute to elevated levels of moisture in the air. Wet soil is not an issue as long as it is unable to impact organic based construction materials, like wood framing. Moisture barriers not only minimize water vapor, but can also block soil smell and even reduce levels of radon gas in a home. To improve the performance of your moisture barrier it can be sealed at the seams, to perimeter walls, and interior footings. Sealed barrier systems can be so effective at reducing water vapor that they can eliminate the need to ventilate your crawlspace. Unventilated attics and crawlspaces can prevent mold propagation as long as they are insulated in a manner to prevent dew points. Barriers should be

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installed prior to the floor sheeting, and makes it easier to work underfloor. Some damage should be expected during the construction process. Patch material and seam tape can be used to fix the system after all the tradesmen are complete.

☐ **Oriented Strand Board Plywood (OSB),** can become soft and structurally compromised with prolonged exposure to water. It has a lower Permeability Rating (perm) then its cousin, laminated plywood (CDX). OSB subfloors will typically trap more moisture in the crawlspace than comparable laminated plywood. When providing layers of your exterior wall that significantly reduce moisture transmission. Low permeability sheeting materials can essentially create a second vapor barrier in a home's wall and/or roof cavities. You then run the risk of trapping water vapor in your wall. This trapped vapor will condense, wetting your wall cavity. At a minimum this can create conditions for mold to grow. At worse this can lead to a complete failure of the wall system. There are high performance sheathing materials designed to provide an integrated moisture barrier and subfloor materials on the market that withstand exposure to weather. If constructing in winter, it may be wise to pay a little extra and safeguard your frame.

☐ **Reducing Moisture Impact-** It is likely that some rain will fall on your frame during construction. Of course it is a priority to get the frame up as quickly as possible to minimize exposure to rain and snow. If the home has large door/window systems, they should be protected if possible from blown in rain and snow. When moisture falls on the subfloor decks it should be removed before the water can be absorbed into the substrate. Keep a squeegee with a broom handle at every job. The crawlspace should be regularly inspected, especially after periods of precipitation. If standing water is discovered it will need to be removed immediately. This can be done with a shop vac or small pump for larger puddles. If gravel is above the barrier it may be necessary to pull back the gravel to uncover standing water, and then extract. This is one of the reasons that gravel above the moisture barrier can be problematic and trap moisture.

☐ **Heating During Construction-** In winter months your frame won't dry if it remains below 40*f. Providing heat to the crawlspace and living space will help to dry the frame prior to insulation, drywall, and flooring installation. Trapped moisture is a common problem with constructing in the winter, as the frame has little time at a suitable temperature to dry. It is common for much of the natural framing material to be delivered to the job with elevated moisture content. Measuring over 30% moisture in a 2x6 is not uncommon. This will require time and the proper conditions to dry. You may want to consider buying laminated wall framing and TJI joist systems that should come to the job dry. Of course if they get wet during the course of framing, they are no better than traditional lumber. Getting the frame to temperature requires the most amount of energy with less needed to maintain that temperature. Homes with no insulation or missing

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windows will take more energy than a home after wall board. Homes with Gypcrete slabs or interior concrete walls will also require more than an exclusively wood structure. We have found that it will take approximately 100 Kbtu per 2,000 square feet of floor space with additional heat needed for structures with a lot of concrete. You should expect that it takes 2-3 days before the frame will get to temperature (+60*F). Once at temperature it should be maintained for one to two weeks. Regular moisture readings of framing will determine the needed drying time. Indirect fired heaters are the most effective for this task, and have ductwork that can be distributed to areas where it is needed. These are expensive (+$2,200 to buy or +$180/day to rent). A more cost effective approach is to use electric heaters. We prefer the oil filled ones that present fewer fire risks. Due to limited amperage available in many temp panels, it may not be feasible to provide the needed heat using electricity. Direct flamed heater don't have their combustion gas managed, and can lead to elevated levels of CO, CO2, and unburnt fuel in the home. Extreme caution should be taken when providing heat to a project under construction.

- ☐ **Fans-** Air movement along a wet framing member will accelerate the rate at which the water evaporates from the material. This speeds the drying process though also introduces large amounts of water vapor into the air. If a plan is not in place to remove that water vapor, it will just move to another region of the home. It can then return to liquid form as condensation. If mold is present, the use of air movement is discouraged. If the airs temperature is low and/or relative humidity is high, air movement will have little effect.

- ☐ **Ventilation/Dehumidification During Construction-** In summer months, venting a wet frame can be effective in removing moisture. Under floor ventilation systems should be operable and run non-stop until the frame is dry. Additional fans may be needed to push humid crawlspace air out of the structure. The frame can only dry if the air is capable of holding additional moisture. This means humid air is less effective at drying. In winter months, ventilation can be inefficient, as heat loss will also slow drying. This is where dehumidifiers can be used to remove the moisture from the air while keeping a closed system. If using a refrigerant type dehumidifier (most common portable), consideration should be given to running these at lower temperatures where their capacity will be limited. Refrigerant dehumidifier's capacity is measured in pints per day. Most units will be at peak capacity when the temperature is at 80*F (Otherwise known as AHAM). This unit can be at 50% capacity when temperatures are below 50*F. In winter months, a desiccant dehumidifier is much more effective at lower temperatures and provides very hot and dry air. (Desiccants-320 CFM unit= $230/day, 700 CFM Unit=$501/day)

- ☐ **Monitoring Conditions-** it is smart for every general contractor and flooring installer to have a Psychrometer. This is a device that measures humidity and temperature. Relative humidity indicates the amount of moisture the air can hold in relation to temperature. Warm air can hold more moisture then cold air. At

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100% relative humidity, the air is saturated and can hold no more water. If temperatures are decreased, and the water vapor has nowhere to go, then dew or condensation will form. Ideally the living space and unconditioned spaces (attics, crawlspaces, and garages) should all remain under 60% relative humidity in the Tahoe Area. At certain points in the construction process you can expect ambient moisture to spike. This includes the installation of concrete, drywall mud, and interior masonry. As the materials dry, their moisture is evaporated into the surrounding air. If that air can't hold additional moisture, you will likely get condensation. Condensation is most commonly found on the coldest surface(s) in the room. As additional moisture is introduced into the air, this dew will spread to warmer surfaces. Without water vapor removal, you can essentially move moisture from one area of the house to an area previously dry. This is called secondary damage and the most common problem that results from improperly drying the house. When encountering high levels of relative humidity, a plan should be implemented for removing that moisture immediately.

- ☐ **Heating System Ductwork-** If the under floor heating was installed before dry-in, it should be hard piped unless it is protected from moisture. Fiberglass insulation should not be present in any form until the structure is protected from rain and snow. Wet soft ducting can present indoor air quality issues as well as provide little R-value. The weight of the water often causes the ductwork to sag and become detached. Wet soft ducting needs to be removed and disposed of immediately after it is discovered. In addition to water, workers crawling under the home can cause significant damage to heating distribution systems. Inspect heating runs after most of the specialty contractors have done their work. Easy to fix, a tear or detached return air can pull crawlspace air into the living space. A compromised supply run can pump warm air into a cold crawlspace introducing moisture. Having the largest impact on the air the occupant's breathe, the forced air heating system is of utmost importance though often overlooked. Consider the use of an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) to bring fresh air in.

- ☐ **Sub Area Ventilation-** Perimeter foundation vents should be provided for unconditioned crawlspaces. Approximately one square feet of vent for every 150-250 sq ft of crawlspace is typically recommended for unconditioned areas of the home. The size and number of vents should be based on a number of factors. The presence of ground moisture will likely increase water vapor and require more ventilation. Low clearance crawlspaces and interior cripple walls will restrict the airflow and require more ventilation to keep dry. Vents located on one side of a home do little to exhaust water vapor. Cross ventilation is the objective, with vents located within 3' of each side of the corners. If adequate natural ventilation is unachievable, or code dictates, you may use a mechanical ventilation system. It is preferable to have one that will activate when humidity in the underfloor area is elevated. Consideration should be given to the system activating in winter months, and potential pipe freezing. If relying on a mechanical ventilation system, it should be operable before the floor gets sheeted. It is preferable to pull air out

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of the crawlspace instead of pushing air in. A system that has both a fan pulling air in and out of a crawlspace should be balanced or create some negative pressure inside the crawlspace. This will reduce the amount of crawlspace air that finds its way to the living space. Studies show that many issues associated with ambient moisture and mold can be prevented by conditioning the crawlspace. To be effective, a sealed moisture barrier must be provided to cover the entire earth surface and attached to perimeter and interior foundations. An adequate thermal barrier may also be provided on perimeter walls and under the barrier as climate dictates. A well designed conditioned crawlspace should be sealed off from the outside air, with temperature maintained as you would the living space. The use of perimeter wall insulations that allow high vapor transmission (fiberglass, open cell foam, etc.) are discouraged and should be replaced with dense foam or other similar performing materials.

- ☐ **Attic Roof System Ventilation-** Becoming less common, roof system ventilation needs to be provided unless the roof is designed to be unvented. Ventilated roofs should have ventilation provided at the peak (ridge vent, gable vent, turtle vent) and at the bottom (freeze blocks, soffit). Having freeze block venting and ridge venting will prevent most mold issues in an attic. Of course there needs to be a clear channel, under the roof sheathing, from the lower to the upper vents for the system to function properly. Interior blocking must be drilled or notched, and insulation must be kept a minimum of 1" from the roof sheathing. It is best to use high density fiberglass batts and insulation baffles to achieve this. In a rafter roof there must be ventilation provided to every cavity. In an attic it can be effective and less costly to drill alternating freeze blocks. With fire concerns, it is now common to construct unventilated systems. For this to function properly there must be an adequate thermal barrier over the inside or outside of the exterior sheathing. This is usually done using closed cell spray foam or Poly-Iso foam board (R-Max). It is important to minimize the amount of moisture entering the roof cavity from the living space. Having a continuous vapor barrier can achieve this goal only if penetrations like recessed lighting are sealed.

- ☐ **Vapor Retarder-** Often called a vapor barrier; it is designed in our climate to prevent water vapor in the living space from diffusing into the insulation envelope. If installed prior to the frame becoming dry, a vapor retarder can trap the moisture it's intended to block. It is more effective to install underfloor barriers over the lower floor joists before subfloor sheeting. This will maintain a continuous barrier, which is the objective. Be cautioned, this process can lead to issues unless the floor system is kept dry. It is common to use plastic over loose fill or batt insulation in exterior walls and below insulated roof systems. You can also buy insulation with a craft paper barrier attached. When stapled to the stud framing, this can provide an approved vapor retarder. Better performing barriers are available on the market with seam tapes. With proper air sealing and taping, a vapor retarder can become an air barrier. Without eliminating air movement into the wall/ceiling cavity, the vapor retarder will have low effectiveness. In spite of this information, it is uncommon to find an effectively sealed vapor barrier system

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in area homes. It is however common to find more than one vapor barrier in a wall system. This can have destructive consequences by trapping moisture. You may be unknowingly doing this in your homes when using OSB sheathing materials.

- ☐ **Insulation-** Batt and blown-in insulation should never be installed prior to the home being dried in. Of course it is much easier to insulate a floor prior to sheeting it, though not if it needs to be re-insulated afterwards. Most of these insulations will not resist water and will keep the surrounding framing wet much longer than uninsulated cavities. Foam insulations can be much more resistant to water, though may have issue with adhesion if the surface they are sprayed onto is wet or dirty.

- ☐ **Moisture Readings-** A penetrating moisture meter is a tool every contractor should have. It allows you to measure the moisture content of wood materials and relative moisture of gypsum board and other materials. It is common to find new framing lumber coming off the truck with elevated moisture content. Ideally, wood framing should be no more than 8%-12% moisture content. Anything over 18% should be considered wet. If drywall and flooring is installed over the wet framing, it could potentially create a mold issue. This is why it is important to confirm framing is dry prior to insulation, vapor retarder, and flooring installation

- ☐ **Routine Inspection-** It is often tough to reach areas under a house or in the attic where many mold issues occur. You will need to make it a point to inspect the crawlspace and attic of your jobs. It is important to ensure your systems are operable and that there is no obvious damage. You'll want to make sure your specialty contractors have treated the under floor with the same care as the rest of the home.

- ☐ **Lumber Mold-** Not all mold is an issue. You will get new lumber with mold growth. This lumber mold is normal and doesn't present issues with air quality after construction. However cutting wood can aerosolize allergens/carcinogens like lumber mold that would otherwise be contained. It is difficult at times to tell the difference between lumber mold and atypical mold. The dark, and at times thick growth that forms on the sap wood is usually lumber mold. If the lumber has a spotted growth, green color, or haze over the surface you may be dealing with atypical mold. If you receive lumber that has excessive amounts of lumber mold there is a good chance you will also have some problem molds mixed in. Using the cleanest lumber available should reduce the likelihood that you are building mold issues into your home.

- ☐ **Mold Issues-**If you are unfortunate to have a project develop mold issues; you will probably want to consult a professional. First, most contractors don't have pollution coverage on their liability insurance policy. Second, unless you have your crew fit tested for respirators, pass a pulmonary test, and be properly trained for using and adorning safety equipment, you could be in violation of multiple

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OSHA regulations. Lastly, unless you have the proper equipment and training it is unlikely you will be successful on your first attempt. Spraying bleach over your customer's home can present far worse problems then mold damage. Chemicals are no substitute for abrasive structural cleaning. This can be done with a wire brush, sander, or a blasting media like baking soda or dry ice. It should only be done with engineering controls (containment) in place. This requires having HEPA Filtered Air Scrubbers. After the cleaning is done, all the particulate needs to be HEPA vacuumed, no shop vacs, and surfaces damp wiped. It is customary to have an Independent Environmental Professional (IEP) inspect the work and take samples to either confirm the work is complete, or recommend additional work. To pass this inspection one must do the procedure and be able to show that all surfaces that had mold growth are now clean. They commonly perform air sampling to determine if airborne levels of mold are normal. This can be difficult to achieve for some professionals in the industry, and near impossible for those that are unfamiliar with the process. Painting with Kills or other coatings and treatments are not considered proper remediation and will typically allow mold to propagate once again. The pesticide "Timbor" is typically used by pest companies to "treat the fungal damage". This is not the solution and will just add chemicals to a bad situation. This solution won't remove the mold and will again get called out on future inspections. If there was an easy process to get rid of mold issues we would all be doing it. Unfortunately, costly remediation is the only long term solution. If you need to hire a remediation contractor, it may be wise to first get an initial mold inspection and work scope. Make sure the remediation contractor has all the needed work scope in their estimate, and that their process is consistent with industry standards.

The following are Red Flags, to be aware of when selecting a remediation contractor.

1. **If they provide a remediation estimate that is significantly less than other estimates for the same work.**
2. **If they do not inspect the entire work area before giving an estimate.**
3. **If the work scope including treating, painting, fumigating, or the application of chemicals.**
4. **If the contractor does not have mention of engineering controls or negative pressure.**
5. **If the contractor is to do a large area (over 1,000 sq ft) and intends to do it by hand with a wire brush.**
6. **If the contractor or someone working for him is also the person doing the clearance inspection. This should always be an independent professional so the work is not in question.**

In an effort to continually improve the services and information we provide, your comments and feedback are welcomed. Let us know if you think we are missing anything. Thanks! Ned Riley

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