Water Intrusion

Almost all buildings will experience some kind of water intrusion, in the form of leaks, flooding or other excessive indoor dampness at some point in their life cycle. According to *Damp Indoor Spaces and Health,* excessive dampness is not only a problem by itself, but also a contributor to several potentially problematic exposures, such as mold, dust mites and bacteria. In addition, dampness can cause chemicals and particles, such as lead and formaldehyde to be released from building materials. Scientific evidence reviewed in the report links mold and other factors related to damp conditions in homes and buildings to asthma symptoms in some people with the chronic disorder, as well as to coughing, wheezing and upper respiratory tract symptoms in otherwise healthy people.

Some degree of moisture is necessary in an indoor environment. The appropriate amount of relative humidity to have in a building is 30 to 50 percent. Less than 30 percent relative humidity can lead increased health symptoms. Over 50 percent relative humidity can encourage microbiological growth which can lead to health symptoms. With too much moisture, the structural integrity of the building may also be compromised.

There are four basic categories of identified effects of mold on human health: allergy, infection, irritation and toxicity.

Mold is a very common allergen. Approximately 10 percent of the population is allergic to molds. The most common response to mold exposure may be allergy. People who are atopic, that is, who are genetically capable of producing an allergic response, may develop symptoms of allergy when their respiratory system or skin is exposed to mold to which they have become sensitized. Sensitization can occur in atopic individuals with sufficient exposure.

People vary widely in sensitivity to mold and other microbiological growth. Allergic reactions can range from mild, transitory responses, to severe, chronic illnesses. The Institute of Medicine (IOM, 1993) estimates that one in five Americans suffers from allergic rhinitis, the single most common chronic disease experienced by humans. Additionally, about 14 percent of the population suffers from allergy-related sinusitis, while ten to 12 percent of Americans have allergy-related asthma. About nine percent experience allergic dermatitis. A smaller number, less than 1 percent, suffers serious chronic allergic diseases such as allergic broncho-pulmonary aspergillosis and hypersensitivity pneumonitis (IOM, 1993).

Mold can have two major effects to a person with asthma, as an irritant or as an allergen. An irritant reaction to fungal exposure causes inflammation and can happen without previous hypersensitivity. Substances produced by fungi that are suspected to cause irritant reactions include microbially derived volatile organic compounds (MVOCs), ergosterols and glucans. MVOCs are produced by fungi as a byproduct of their metabolism and their health effects are undetermined. They may cause nontoxic adverse effects as irritants or trigger psychological effects because of their odor. Toxic reactions do not likely occur as a result of MVOC exposure due to the low concentrations present in even the most contaminated environments. Common indoor fungi grow near room temperature and do not easily grow inside the human body.

Most toxic reactions to fungi occur as a result of eating mold-contaminated foods. A toxic reaction is unlikely to occur from inhalation of fungi because the amount of exposure generally is too low to cause health effects. These reactions occur in extreme conditions not ordinarily encountered in the indoor home, school or office environment.

Irritation from mold can be caused by volatile organic compounds (VOCs) produced through primary or secondary metabolism and released into the air. The most common symptoms include irritation of the mucus membranes and irritation of the respiratory system. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school or office environments.

In addition to mold, a number of allergic asthma triggers are associated with excess moisture, including house dust mites and cockroaches. Lead paint failure is often caused by moisture problems. It results in loose and flaking paint that contaminates household dust on the interior and soil on the exterior. The offgassing of VOCs found in building products, such formaldehyde, is also increased by higher building relative humidity.

An indoor moisture problem always has four facets:

1. The source - where did the moisture come from?

2. The path - how did the moisture get to where it caused the problem?

3. The form - a vapor or mist, free water or a condensate?

4. The force - gravity, air pressure, capillarity or diffusion that carried the moisture from one place to another?

In most circumstances, the location of the problem, the source of the moisture and the path of the moisture are all close together and easily identifiable. For example, water leaking into the corner of a basement (form: free water) is likely coming in through openings in the basement wall (path), the water is coming from the downspout that is spilling water in this corner of the building (source) and gravity is carrying the water in (driving/pulling force). Other water intrusion problems are less obvious. The moisture source and path are not apparent at all and significant investigation may be required. Some common moisture problems are listed below.

Exterior Walls

A common water-intrusion problem is moisture on exterior walls. During the heating season, the interior surface of an exterior wall may have a temperature below the dew point, leading to beads of moisture condensing on the surface. Other sources can be ice backup in winter, a blocked rain gutter spilling water, wind driven rain, leaking pipes or waste lines or blocked weep holes leaking around windows or doors.

There are many paths this moisture can take to enter the building, such as leaking through openings in walls or through floors, moisture vapor convected through wall openings, moisture

extrusion through wall surfaces and condensate from humid inside air. All leaks bringing free water into the structure must be blocked or corrected.

In foundation walls, possible moisture sources include backed up city storm or sewer systems, storm water spillage from gutters that are clogged or broken, storm drains, wind driven rain, storm water grading toward the building, a rising water table or unvented showers or bathrooms.

Possible moisture paths include leaks through wood, window and door framing, leaking through holes or cracks in foundation walls, moisture wicking through mortar joints and masonry materials, moisture carried in heating ductwork under a slab, moisture vapor from showers, clothes dryers or moisture vapor from soils in a crawlspace.

Diverting the water source can be done by securing and properly pitching gutters and downspouts; when possible and code permits, disconnecting downspouts from storm systems and running water on ground away from the building, redesigning gutter systems so less of the underground storm system is required and grading soils away from the building. Some techniques to block moisture source include filling holes and cracks in surfaces, applying waterproofing materials and closing up subslab heating/cooling ductwork.

Techniques to ventilate the moisture source include using a dehumidifier to reduce relative humidity, venting clothes dryers directly to the exterior and venting showers and bathrooms directly to the exterior. In addition, controlling surface temperature/room temperature with heating or insulation can keep condensate from forming on walls.

Possible paths for water to take when entering through the roof include ice backing up, leaking in along eave edge, wind-driven rain and snow coming in through roof vents, free water leaking in through holes in roof, water leaking in around flashings and exterior vapor entering through roof vent openings.

In order to correct the problem, remove or correct the moisture source. The moisture source can be blocked by installing ice guards on the edge of roofs, caulking joints between roof sheathing and fascia board and repairing flashings.

Mechanical Systems

Mechanical systems can be a source of moisture, a path for moisture problems and a solution to other moisture problems.

Plumbing can contribute with leaking waste stacks and pipes, leaking water service lines, frozen pipes in winter or corroded pipes. Overflowing can be caused by broken fixtures, carelessness or improper connection through tubs, sinks, toilets, water heaters, clothes washers, garbage disposals or dishwashers. The HVAC system can contribute leaking radiators, leaking or corroded pipes and leaking heat ducts.

With forced-air heating, heat ducts under a slab with water leaking into them can act as a humidifier driving moisture vapor into the building. This is significant because heat ducts

traveling through a crawlspace can pick up mold spores or open cold air returns into basement can carry mold spores and moisture from basement to upper floors.

Air conditioning units can provide sources of water when units are oversized and do not dehumidify effectively or units are oversized and space gets too cold leading to the forming of condensation.

As with exterior walls, too low a setting on the thermostat can cause dewpoint temperatures to be reached on walls and windows, causing a condensate to be formed.

Plumbing concerns can be addressed by keeping all water and waste lines inside the conditioned space, fully insulating any water or wastes line that must pass through unconditioned space and addressing leaking plumbing fixtures immediately.

For HVAC, addressing leaking pipes that may be carrying hot water or steam for heating is important. A failed sub-slab ductwork, forced-air system can be sealed off and replaced with an above grade heating system. All accessible duct joints on a forced air system can be sealed with mastic to keep moisture and mold spores from entering the system or being carried somewhere else by the system. Cold-air returns for forced-air systems must be connected directly to the furnace and the air should not travel through any area not regularly used for living space. When installing any new piping or ductwork, it should always be within the conditioned space and not in the walls or other unconditioned spaces. Bath and kitchen ventilation fans must vent directly to the exterior. To encourage fan usage, it is important to connect the fan to the light switch in the bathrooms. This means it will be on whenever someone has turned on the light to use the bathroom. Keeping wire screens on top of chimney flues to keep debris and animals out is also useful.

Whenever new heating equipment is installed it must be sized properly, properly vented and, whenever possible, be a unit that gets its combustion air from outside the residence and ventilates the flue gases directly to the exterior. Whenever new air conditioning units are installed, they must be properly sized and positioned so the condensate formed is properly drained away.

Interior Framing and Surfaces

How the building is put together on the inside and how many holes are put into the surfaces that are exposed to the exterior can create moisture paths in the building. Some paths can be very difficult to find. Examples of this in the ceiling between the interior and the unconditioned attic spaces include the fan venting directly into the attic (moisture can condense on the cold roof sheathing), recessed light fixtures into the attic and mechanical system holes. The best remedial measure with moisture paths is to block or close them off so no moisture can move through them and do damage. Non-heat generating openings, such as recessed and other light fixtures and chimney collars can be blocked or closed off in the attic and openings can be sealed with plastic sheeting, caulk or foams. Around chimney collars, metal flashing from coil stock can be secured to the chimney and framing with adhesive caulk. Openings in framing in the basement can be blocked or closed off with Styrofoam insulation cut to fit the openings and sealed around the perimeter with caulk or foams compatible with Styrofoam.