Environmental Health Technical Brief

Dirt Streaking & Ghosting

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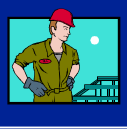
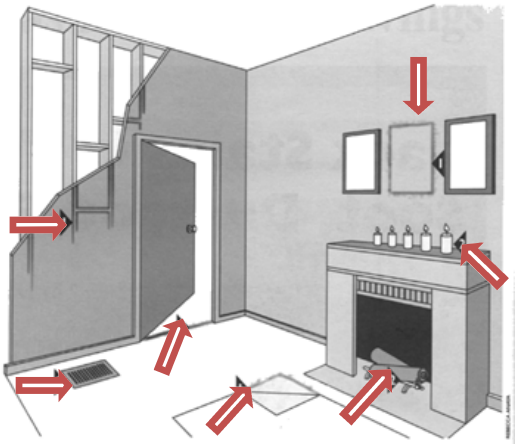


What Are Those Black Stripes On The Walls?

Indoor air contains many different types of particles from both indoor and outdoor sources. These particles will eventually land on interior surfaces. When enough build up, they can cause a visible discoloration, staining, or striping. Consider this phone call from a town resident.

"*I moved into a brand new home about 2 months ago, and I have black mold on the walls, on the outside of my garbage pails, coffee maker, and even inside the refrigerator. Can you help me?*"



Many of us have received similar calls from the public over the years. A call like the one above is more suggestive of some other type of particle, not mold. Asking about moisture problems and odor may rule out mold. Next, ask if anyone in the home is a smoker. When the answer to both of those questions is no, it's time to dig deeper and consider other things that might be causing the stains. These stains are sometimes called ghost stains, or ghosting, because they often appear on framing members (studs), sheetrock nail heads, underneath doors, on carpets, plastic, and around picture frames on walls.

There are a variety of things that can cause particle deposition on surfaces inside homes. They are usually related to defects in the building envelope, combined with driving forces and sources generated by building occupant activities or building mechanical systems. After looking for obvious sources, taking a building science approach can often lead to diagnosis and successful treatment.

Indoor and Outdoor Sources	
Combustion Byproducts	Non-Combustion Sources
Candles	Dirt , clay, & house dust
Cigarette, cigar, pipe smoke	Cooking byproducts
Standing pilot lights on furnaces, gas stoves & dryers	Rubber particles form worn truck/ car tires
Gas log fireplaces	Pollen
Oil lamps	Cellulose (paper dust), cotton
Automobile exhaust	Solvents in household products

Common Indoor Locations	
Wall-ceiling junctures	Ceilings near recessed lights
Wall & ceiling studs and joists	Sheetrock nail heads
Walls above/ behind radiators	Walls around picture frames
Plastic like garbage pails, ice cube trays, inside refrigerator	Carpets– under doors, along edges near walls
Around outlet covers	

Building Science – It's All About The Building Envelope

In order for a house to heat and cool evenly and be comfortable for occupants, there are three barriers that must surround the building in a continuous fashion to protect the home. They are an air barrier, thermal barrier, and moisture barrier. Together, these are known as the building envelope. There should be no gaps, penetrations, or voids in the building envelope, or problems will ensue. A point to remember is that heat and moisture can both be carried by air currents. Air and moisture need a penetration to flow through. Heat may also be conducted through a solid surface.

Penetrations in the air barrier allow outside unconditioned air (or inside conditioned air) to move through and around insulation in the walls. This is called thermal bypass. In the winter, when cold outside air hits a poorly insulated wall, condensation will usually form on the back side of the wall. This can lead to mold growth in the wall cavity. Thermal bypass can also result in particles in warm room air sticking to walls with cold spots. If you see dirt streaking in striped or other geometric patterns on walls or ceilings, think thermal bypass, and think about adding insulation.

Differences in indoor vs. outdoor air temperatures also affect relative pressure in a house, which cause air currents to flow. Pressurization problems are compounded when the HVAC system has leaky ducts and/or exhaust fans. Leaky ducts on both the supply and return side can cost a homeowner more than higher utility bills. Pressurization also causes stack effect – warm air rising. Consider the following pressurization scenario.

Inspectors found auto exhaust from warming up a car inside the garage being sucked into house return duct. Soot then leaked out of supply ducts into the space between the first and second floors in the house. This space became pressurized and forced air and particulates up through the seams in the plywood subfloor. Particles were then impacted onto the carpet, which served as a filter. The result was black marks on the carpet that looked like stripes, following the plywood seams.

Driving Forces

In order for dirt streaking/ghosting to occur, there must be a driving force to push particles against a surface. Driving forces include electrostatic forces and moisture (attraction), forced air (impaction), and gravity. The location of the particle deposition will often give a hint as to which of the three forces may be causing the problem.

<u>Attraction</u>

Particles in air coming from a ventilation system can pick up an electrical charge if they are passing through lined ducts at high speed. In some homes with soot deposition problems, air velocity measurements were taken at trunk ducts (before the branches) and found to be up to three times higher than they should be.

These homes were relatively dry, with humidity measurements at or below 55% RH. In cases like these, the end result is that the charged particles will naturally stick to surfaces in the home with an opposite charge. Also, the particles caught in turbulence can form both positive and negative charges. This allows them to stick to each other and form larger particles which can either stick to vertical and horizontal surfaces, settle out onto flat surfaces, or be impacted onto things like fan blades and filter media.

Impaction

If you have seen dark stains on a carpet at the threshold (underneath a door), you are most likely looking at a door that is kept closed most of the time in a home with a forced air heating/cooling system. Let's say this is a bedroom. Here's what is happening. Forced air coming from the supply ducts in the bed room is positively pressurizing the room (when the door is closed). In this case, the hall or main part of the house has lower pressure. Physics teaches us that pressure always flows from high to low. High pressure air in the bed room flows through the undercut below the door into the hall or main part of the house. Dirt/dust particles in the bedroom air are impacted onto the carpet underneath the door. Over time, enough particles build up, causing a dark stripe on the carpet at the threshold.

Gravity

Particles fall out of the air and eventually settle on surfaces. Gravitational pull causes heavier particles to fall out of the airstream faster. You can often see these particles on desk and counter tops and other horizontal surfaces.

Combined Forces

Dark stains where ceiling and walls meet usually mean a combination of attraction, impaction, and gravity are occurring. The first signs are usually seen on exterior walls, especially along ceiling joists, studs in walls, and especially around nail heads, which have cooler surfaces than surrounding material.

Sources: Occupant Activities

Candle Burning

Candle burning is the most common cause of indoor soot besides tobacco use. Even when an occupant denies burning candles, finding them inside of drawers and cabinets often tells a different story. The length, width, and strength of the wick greatly affect the flame and how the candle burns. So does the composition of the wax, like adding fragrances. The worst candles can produce a lot of soot. These are typically made of soft wax and may have fragrance added. If you can't get an occupant to give up candle burning entirely, have them switch to those made with a hard wax. Tell them to keep the wicks trimmed short - no more than 1/4 inch in length. It is also best to avoid burning candles in jars.

A simple test to do at home:

Burn a new candle for several hours near a TV that is turned on. Wipe the TV screen with a white tissue. If the tissue picks up soot from the TV screen, stop using these candles immediately. This test can be repeated periodically.

Gas Log Fireplaces

Using gas log fireplaces is another common source of indoor soot. Soot can form on the cool surface of a log when the pilot light touches the log. The soot can then be spread throughout the house via an air handler, or by hot air rising causing a temperature differential (stack effect).

Kerosene Heaters & Cooking Activities

Some people use kerosene heaters indoors for warmth. They are notorious for producing particles that are unhealthy to breathe in. Cooking without using an exhaust fan can also send particles into the air. They have to eventually land somewhere. Think about how grease spatters when pan-frying. Depending upon the integrity of the building envelop, the particles can deposit in different ways.

Sources: Building Mechanical Systems

Faulty Heating and Air Distribution Systems

Poorly tuned furnaces can cause a "puffback" explosion that can blow soot throughout a building. Often, the furnace will make strange noises. This is very dangerous. In severe cases, it can cause a fire. Call a furnace repair service immediately if you suspect this.

Furnaces, heat exchangers, and fan housings are almost always insulated. Ducts may also be lined with insulation, although this is seldom seen in new construction in the Northeast. When this insulation deteriorates, it can flake off and be blown through ductwork, sending oily, black particles into room air. They will eventually either fall onto surfaces via gravity, stick to walls via attraction, or end up on floors or other surfaces via impaction. All of these sources can contribute to ghosting problems.

For More Information, Contact:

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