TECH TIP # 14

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

DIRT STREAKING

----- Sources of Dirt
----- Practical Solutions

They all suffer from it --- everyone. Dirt streaking is common to every convection type of heating system -- hydronic, ducted air, gas, oil or electrically fueled, yes, even non-ducted baseboard heaters. In fact, high intensity electric baseboard can be very serious offenders.

How does dirt streaking occur? Is one type of system cleaner than another? Here are answers based on our present understanding of the problem.

Clean and dirty are relative terms. For most of us a dirty system connotes a hand-banked, coal fired gravity furnace with leaky seams, and with coal dust and ashes carried about the house -- both by moving air and walking people. In this case both the type of fuel and the condition of the system are factors affecting cleanliness. For our purposes, we rule out problems involving faulty or old equipment. We are going to talk about dirt streaking in modern heating systems installed, adjusted, vented, etc., in accordance with standard practices.

Many homeowners, storekeepers and landlords believe that the dirt accumulation on walls or ceilings adjacent to supply outlets comes from dirty supply air entering the room. This is certainly a possibility -- especially in new construction where ducts can fill up with dirt and debris before close-up. But streaking occurs even when high efficiency filters are used and supply air is 99 percent pure. Streaking also occurs around hot water radiators, convectors and electric baseboard heaters -- in which case no supply air, clean or dirty, is introduced, only room air is circulated by (gravity) convection.

Obviously then the dirt must already be in the room. It can be stated with certainty that regardless of the system, the major portion of dirt and dust particles found in a room are brought into the space on clothing, shoes, air infiltration through cracks around doors and windows (ever check your window sills?) and generated inside by normal household activities. (Smoking and cooking are prime “dirt” sources.) In other words, compared to the amounts generated by other sources, no properly designed and operated heating system “makes” dirt.

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Old free standing radiators used to be notorious for causing dirt streaking. But if you ever looked directly in back of one, the wall was clean. Or, after one or two winters in an old home you would usually see bars on the ceilings made up of rows of light and dark areas clearly outlining the wood lath behind the plaster. And who, during spring house cleaning, hasn't noticed how dirty inside windows become over the winter months.

All these things are examples of one form of dirt migration called **thermal precipitation**. Whenever a temperature gradient exists between air and a surface, suspended particles in the air are pushed by the hotter, faster moving air molecules toward the cooler wall surface. So, in the case of an old free-standing radiator, the wall area directly behind the unit was clean because the wall was hotter than the room air, hence, there was no thermal precipitation toward the wall. On the other hand, just above the radiator the wall surface was cooler than the hot rising column of air, and dirt streaking began in earnest.

The dirt bars appear on the ceiling of an old home because the surface temperature between the wood lath of what is typically an uninsulated wall is colder than the surface right in front of the lath. Thus, dirt will accumulate faster between the lath due to an increased rate of thermal precipitation brought on by a larger air to surface temperature gradient.

A similar situation exists for windows. The inside surface temperature of a window can often be 35 degrees colder than the wall, with the result that a larger gradient exists between the air and window surface, so a window gets dirtier faster.

Another vehicle by which dirt moves about is termed **diffusion**. There are particles so small they begin to act just like air molecules; even in still air they do not sink. These particles travel slowly and move in random, almost weightless manner. Diffusion deposits dirt uniformly, and it is independent of temperature. The action is only significant when particles are very close to wall and ceiling surfaces.

Probably the most significant action causing dirt migration is due to convection air currents. For instance; as primary supply air leaves a diffuser it entrains room air. (For every cfm of primary air about 15 cfm of room air is induced.) This large volume of secondary air carries dirt particles held in suspension and deposits them on wall and ceiling surfaces as the induced air is forced across the surface near the supply outlet. This convection action is also aided by thermal precipitation as well. Thus, the hotter the supply air the faster the dirt accumulates.

The same thing occurs in hydronic systems. The hotter the radiator or baseboard, the greater the mass of air moving over the heater and the greater the thermal gradient --- all of which causes faster dirt accumulation around the disseminator. The same thing applies to non-ducted electric heaters -- baseboard and recessed units alike. The higher the output (watts per foot) the more severe will be the dirt streaking -- all other things being equal.

A very familiar example of this combination convection/thermal action is a steam convector so often used in entrances to public buildings. Here we find all the "best" conditions for dirt streaking -- a high output device, hence large volumes of very hot air leaving the top of the unit, coupled to the fact that a lot of dust and dirt leaks into the lobby. Often, in less than a season, the wall above the convector is blackened.

Earlier we mentioned the bars of light and dark areas on the walls of older homes. One solution to this once important problem was to add insulation to the walls and ceiling. Streaking was eliminated because an insulated wall provides a warmer inside surface and a more uniform surface temperature. As an example: the typical inside surface temperature of an uninsulated wall on a zero day is about 65º F, but directly in front of the wall studs it's warmer -- about 69º F. (The studs offer more resistance to the flow of heat.) So, the surfaces between framing members will ordinarily dirty faster. With insulation added the wall surface temperature between the studs is higher -- about 71º F -- and more in agreement with the surface directly in front of the 2 x 4 studs. All things being equal then, an outlet placed against an uninsulated wall will begin showing signs of dirt streaking much sooner than if the wall is insulated.

Another factor entering the picture appears to be carpeting. Observations have indicated that perimeter outlets or hot water baseboard sections placed in rooms with carpeting -- especially wall to wall carpeting -- do not streak as badly as similar devices placed in rooms without carpeting. One explanation that has been given is that a carpet acts as a giant filter, and room air is cleaned as it moves across the floor toward the heating device. However, this is merely conjecture at the present time. It does not point to the fact that a particular heating system or fuel is not necessarily the basic factor affecting dirt streaking or overall house cleanliness in general.

Through the years both ducted air and hydronic heating systems have been designed using steadily lower and lower supply air and water temperatures. Old gravity hot air registers and hot water radiators were too hot even to touch, and both systems caused considerable streaking. Today, with lower design register and radiator temperatures, streaking is reduced. Another favorable influence is the fact that people redecorate more often today than in years past. And while grandmother may have worked harder, today's homemaker cleans cleaner simply because of the improvement in house cleaning and decorating aids. (Consider the benefits of an electronic air cleaner.)

While nothing can replace good housekeeping to reduce dirt streaking, there are some influencing factors that the contractor can do something about.

- Design --- several small outlets, each handling moderate air volumes, are better than using fewer and larger outlets. Again, the greater the concentration of heat emission the greater the streaking.

- Installation --- outlets should be fitted tightly. This will help to avoid streaking caused by air leaking out the corners of a register between the frame and wall. Smudge rings help sometimes too --- if properly installed.

- Adjustment --- set the blower speed to achieve modest register face velocities and minimum practical air temperature rise.

- Service --- clean filters and inside ducts at the outset in new construction and regularly thereafter. Never run a system without filters. Suggest or provide frequent cleaning of the outlets themselves.