GRILLES & REGISTERS:

WARM-AIR LAYOUT TIPS

How to lay out warm-air heating systems for comfort, quiet, and customer satisfaction.

Many builders of energy efficient homes place great emphasis on "comfort" in their marketing. And many install forced-air heating because it allows them to integrate air cleaning, ventilation, and circulation along with the heating.

But forced-air heating does not equate with comfort in the minds of many homeowners—particularly in the Northeast where hydronic heating is king. Many associate forced-air heating with drafts, noise, and discomfort—which is what a badly-designed forced-air system is likely to produce.

But air systems can produce first-class comfort if the installer understands the basic principles. In this article, "Bud" Konzo, who helped develop many of the guidelines now widely used for forced-air heating layout, answers some of the most common questions he's been asked over the years about how to lay out forced-air heating systems.

BY SEICHI "BUD" KONZO

Return-Air Grilles

Q: What factors govern the location of return-air grilles?

A: First of all, return-air grilles have only a slight effect on the way air circulates in a room. The "suction effect" is local. The room air slowly drifts toward the grille opening; it is only at a point about six inches in front of the grille that the room air speeds up before it disappears.

Therefore, return-air grilles will be almost equally effective at the floor, in the baseboard, above the baseboard, or high on the wall. You don't choose a grille location because it will "draw room air" strongly to that opening.

Q: Should return-air grilles be placed in bedrooms?

A: In general, yes. Most bedroom doors will be closed for some time during the night. Unless a l-inch air space exists at the bottom of the door (above the carpeting) a return outlet is needed or warm air cannot enter the room.

Q: Where can return-air grilles be omitted?

A: Return-air grilles are usually omitted from bathrooms, and kitchens. Warm air that enters such spaces can leave them through the open doorway, under a closed door, or through a bathroom- or kitchen-vent opening.

Q: Where is the best location for a return-air grille in the living room?

A: Usually, we try to find a location in an adjoining hall, near the living room. You want to avoid locating a return-air grille near a favorite chair in the living room. Air motion within a foot or two of the opening might be noticeable. Also, since there might be a straight run between the return-air grille opening and the circulating fan in the furnace, the fan noise might be transmitted through the opening.

Q: Would two or more return-air grilles for the living room give better results than one large opening for the same room?

A: The *number* of openings is not important. One large return in a hallway, for example, might serve not only the hallway, but also the nearby living room, dining room, or any other space that connects to the hallway.

Q: Wouldn't such a large return-air grille in the hallway be drafty?

A: It might be drafty if one lived in the space. Normally, however, a hallway serves as a connecting link between lived-in spaces and is occupied only for a few seconds at a time.

Q: Should rooms on the second-story have enough return-air capacity to handle the second-story air supply?

A: This is rarely possible. Return-air grilles should be located in second-story bedrooms and maybe a hallway. But as stated before, cold-air currents will make their own path and that may be down the nearest stairway to a return-air grille on the first story. This interchange of air between rooms occurs with any heating system—warm air or hydronic—and the strength of the interchange depends upon the tightness of the house construction.

Q: If you don't need as many return-air grilles as you do warm-air supply outlets, does that mean the return-air openings and ducts can be smaller?

A: Definitely not. In general the return and supply sides of the system should have equal total duct area and air-opening area. For example, if we have fifteen 6-inch supply ducts totalling 420 square-inches in duct area, I would expect to have at least 420 square-inches in total for the return-air ducts. These are crude figures, but the point is that just four return air ducts could handle all fifteen supply ducts.

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Q: You mentioned that a straight run from the return-air grille to the furnace might transmit fan noise. How could you prevent this noise transfer?

A: One way would be to prevent a direct chute, and include a change in direction. A better way would be to use sound-absorbing duct-liner in the return-air duct.

Q: We have a strong flow of cold air coming down our stairway and leaping through the stair banisters into the living room. Could we locate a return-air grille at the base of the stairway and capture all of this air before it enters the lower floor room?

A: We've tried it, but as stated earlier, we cannot "pull" cold air currents from their natural path. We have found, however, that we can supply a strong counter-current of heated air up the stairways and break up the natural flow of cold return air. This works, however, only when the fan is running.

Q: We have two large French doors that open to an outdoor porch. The cold air leaks around the door and cold air flows down the exposed glass surface into the dining room. We've tried weatherstripping and plastic film coverings, but the dining room is still unusable in cold weather when the wind blows from that direction. Would return-air floor grilles at the base of the doors help?

A: In general, the "suction" effect of a return-air grille in the floor is not effective. We suggest two positive steps:

1) *Install storm doors* so that a second barrier is placed between the inside and the outdoors. This second barrier should be tightly weatherstripped and may make the dining room a habitable space.

2) *Shoot a counter-acting warm-air supply* upwards at the door from two floor registers placed near the threshold. Again, this requires continuous air flow in severely cold weather.

Q: Should we go to the extreme of having a double-header return-air duct in our main room on the first floor? This would remove heated air near the ceiling for summer cooling, and remove cool air near the floor for winter heating.

A: This is a refinement that is soon neglected by the homeowner. It sounds good in theory, and would work, but after a few years, the homeowner will not remember which should be open and which closed. In time, the return-air ducts could be throttled, and the total air-flow be restricted.

Q: We have a large return-air grille in the floor in the main hallway. Could we replace it with a low wall return-air grille?

A: It might require two smaller return-air grilles in the low wall but it can be done, and would be as effective.

Q: I don't like floor grilles because dirt can fall into them, especially if placed at a threshold of an outside door. Is there a simple way of cleaning them?

A: Install a drop-in grille that fits snugly into the sheet-metal box. The grille can be lifted out and the flat pan below can be easily vacuum-cleaned. Make sure the grille does not move when stepped on or it can become a hazard. Also make sure that a flat pan exists so that the dirt does not fall downwards through the return duct.

Q: Can the adjustable vanes on a return-air grille be closed tight?

A: Some can be, but this type should not be installed. If any ducts need dampering, a separate adjustable damper should be used that works behind the adjustable vanes.

Supply-Air Registers and Diffusers

Q: Are warm-air supply registers as important as return-air grilles?

A: Even more so. Warm-air supply registers and diffusers *control* not only the velocity, but also the direction that the supply air takes when it leaves the outlet. That is, we have a great deal of control over how the air is introduced into a space, and this might extend all the way across a living space.

Q: Homeowner A lives in an area where heating is most important. Homeowner B experiences just the opposite. Homeowner C lives in an area that requires both winter heating and summer cooling. Each homeowner asks: "Is there a best location for a supply register (or diffuser) for my climate?"

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A: Theoretically, we could specify a separate layout for these three cases, and for large commercial or institutional buildings we might spend the time making those distinctions.

In small buildings and in small residences, however, extensive testing indicates that a simple compromise is best.

For year-round air conditioning, namely winter heating and summer cooling, we recommend the following location and type of air outlets:

1) *Location:* At the perimeter of the building. This is the outside exposed wall.

2) *Type:* Either floor-type or baseboard-type outlets. Both would discharge air towards the ceiling and close to the wall so that the air does not spread out into the living space until it gets above head level.

Q: What's the difference between a *register* and *diffuser?*

A: A register is similar in appearance to the old-fashioned outlets developed for the old gravity furnaces. Modern floor registers consist of two basic types:

1) *Fixed bars:* Can deflect the air outwards or upwards.

2) *Adjustable bars:* Can deflect the air outwards and can be adjusted on the spot.

The diffuser was developed mainly for baseboard or low-wall locations and was originally wider than one stud space. The outlet air could be directed upwards or be deflected sideways to cover a larger part of the exposed wall. In this discussion we shall use the terms interchangeably. In some ways, the baseboard diffuser bears a strong resemblance to the baseboard radiator in a forced hot-water system.

Q: Why is the perimeter location good for winter heat?

A: The heat supply, when introduced at the perimeter, does the best job in overcoming the downdrafts from the cold window surfaces. This holds true for hot-water heating as well.

Q: Why is the same perimeter location good for summer cooling?

A: Hundreds of laboratory tests, plus several field tests confirm the good performance of the perimeter location combined with upward discharge of cooled air. The cool air is gradually diluted as it reaches the ceiling, then spreads outward and gradually falls into the living zone by gravity action. The air is distributed with fewer drafts, and when adjusted properly provides an atmosphere of gently stirring room air.

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Q: What about supply registers in a crowded kitchen?

A: In small kitchens, very little space is available for a supply register and ingenuity is required. In some kitchens an outlet can be placed on a ledge above the sink and in front of the window that is commonly located there. The upward discharge overcomes the downdrafts from the window glass.

Q: In small bathrooms, a floor or baseboard register may not be possible on a perimeter wall. Could we use a high sidewall register?

A: A high sidewall register on an inside wall may be the only available space. Be sure to use registers that have adjustable vanes that can spread the air both up and down as well as from side to side. The trick is to avoid a high-velocity jet that hits the opposite wall and causes excess air motion below.

Q: In a basement with a large activity room, the air diffusers are at the ceiling, and the lower part of the room is cold. There's wall-to-wall carpeting to insulate against the cold concrete floor, but the warm air never penetrates below head level. Can we fix it?

A: Trying to heat a room from ceiling diffusers or high wall registers goes contrary to the force of gravity, which makes warm air want to rise. In my former home I ran the supply duct down an inside wall in the basement and left the duct open about a foot above the floor. The warm air "splashes" on the floor and distributes itself in a fan-like pattern. The warm air does have excess air motion within a foot or two of the "splash point," but the remainder of the room benefits from the slowly moving air stream from the central point.

Q: How can you avoid excess air motion?

A: The best solution is to install registers or diffusers that can be adjusted in the field. I defy any engineer to predict exactly what air patterns will occur in the field. To do so, he would have to predict the flow in the duct leading to the register and know how wind leakage around windows and doors affects the indoor air circulation.

Q: This leads to the matter of "balancing" the system. How should it be done and by whom?

A: A correct balancing adjustment cannot be done in one session. The installer should explain how he proposes to go about it.

Step 1. The installer should *open all dampers*, both in the duct system and at register and grille faces.

Step 2. *Adjust room thermostat and fan-switch settings* to recommended position.

Step 3. *Leave six or more desk-type thermometers* at table height in various rooms, and ask homeowners to observe them during typical winter weather.

Step 4. *Instruct homeowner* how to close dampers, preferably in the duct system. The homeowner should partially close dampers leading to overheated rooms. Usually these will be small rooms and rooms near the furnace.

Q: Why can't the installer do this?

A: He could, but it would cost a bundle to include this service in the installation cost. This balancing is part of the "breaking-in" process of any heating system for which the homeowner is responsible. The wise installer will report back several days after the system has been under close observation and will listen to the owner's experience in balancing the system. He should make sure that the owner has not been "fiddling" excessively with the thermostat setting. He should mark with a felt marking pen the "winter setting of the damper" with a large "W". He should explain to the owner that a similar balancing will be necessary when the cooling season comes. The damper position for summer will be marked with an "S". Unfortunately, this simple process is rarely explained to the owner and poor results are created from the beginning.

Q: Can you have too many supply outlets?

A: No. The more outlets the better chances of distributing warm air where it is needed. In a large living room, for example, two or more registers may be desirable. Also, with more supply outlets, the flow volume at each outlet is likely to be decreased, and that usually means lower air velocity, which means less air noise. In general, we see two few supply outlets rather than too many.

Furnace Location

All too frequently the furnace installer has little input into the size and location of a furnace room. The builder or developer says, "I want you to install a furnace, and here is where I've allowed some space for the furnace and chimney." If the furnace room is at the far end of a large building and inside the garage, the furnace installer may be licked before he starts.

Q: We have a long wing of rooms attached to another long wing in an L-shaped arrangement. One installer is recommending two furnaces. Does this make sense?

A: When the straight run of a trunk duct extends 40 feet or more from the furnace, we know that the heat loss from the ducts can be large and that air will cool considerably as it reaches the end. This means more air flow is needed at distant runs. In an L-shaped building, it makes a lot of sense to provide two units, one to supply one wing and a second to supply the other wing.

If the builder wants a comfortable house with least energy expense, a heating contractor's advice should be sought as early as possible.

Although two smaller units will cost more than a larger unit; two units have several advantages. This is an easy way to get zone control—if one unit fails, the second unit will keep the house from freezing—and main trunk ducts for two furnaces will be smaller than that for a single large furnace.

Q: We have a choice between installing a furnace in the attic space or placing it in a crawlspace. Which is better?

A: I'd recommend the crawlspace, as long as space is provided around the furnace for easy access for servicing. The vagrant heat loss from the furnace casing, the trunk ducts, and the branch take-offs will warm the crawlspace and can be helpful in heating the floor overhead, whereas heat lost in the attic space is mostly wasted. This does require some insulation of the crawlspace's exposed walls (instead of floor insulation), and a vapor-barrier cover placed over the crawlspace ground.

Q: When should the heating contractor provide input in the house design?

A: If the builder or developer wants a comfortable house with least energy expense, he should seek advice from the heating contractor as early as possible. This includes input on house orientation, location of windows, insulation levels, vapor retarders, location of chimney (or vents), location of compressors for summer cooling, tree shading, as well as headroom in basement, and furnace-room location. ■

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