Open Spaces as Return-Air Options - Code Notes

Stud cavities and floor joist spaces are often used to return air to the HVAC system's air-handler and are specifically allowed in the I-codes. Field testing shows that these return systems are often extremely leaky. Leaks within areas that include combustion appliances do not meet the code, and they present potential health risks. Open spaces in the building are often effective and inexpensive (e.g., incorporating hallways as part of a return-air system).

Homes with basements often use wall stud and floor joist spaces as return-air cavities. Extensive testing indicates that duct leakage in these homes is very high unless ducts have been pressure tested and sealed under some beyond-code program (utility, state or local) that tests for duct tightness. In one random sample of 40 homes during 2000, over 60% of the leaks were located in the return-air ducts. In one-third of those homes, return-air leaks connected to the basement could create enough negative pressure that exhaust gases were at risk of being back-drafted down water heater flues.

Some jurisdictions want every bedroom to have a return-air duct directly back to the HVAC cabinet. Yet field measurements in typical homes indicate that second-floor return-air ducts relying on building cavities for air transport are often so leaky that they returned little air to the HVAC blower. By code, building cavities used for air return can only convey air from one floor level back to the HVAC blower (2000 and 2003 IRC M1601.1.1 #7).

As an inexpensive and effective alternative to sealing ducts, the code specifically allows air return by connecting rooms by permanent openings. For example, hallways can be part of the return-air path. Two generic approaches are identified that fit the code.

Strategy #1, for Single-Story and Multi-Story Homes

1. Use either hard ducts or flex ducts for short, centralized returns that only pull air from central hallways and living zones. (Flex ducts are easy to seal tightly but are also vulnerable to flow restrictions.)
2. Any of the following is acceptable for pressure relief in bedrooms and dens with operable doors:

In a hallway ceiling that has already been finished with drywall, ductwork and under-framing are installed to create a long dropped ceiling, typically providing a 7-foot ceiling height the length of the hallway.

- A pair of offset transfer-air grilles in room walls that connect to hallways or other open spaces directly linked to the central return.
- Short "jump ducts" (typically located in ceilings) that allow room air to flow back to hallways.
- Any method of pressure balancing that, during operation of the HVAC blower, creates no more than a 2.5-pascal pressure difference across closed doors (amendment to the Florida code in 2003). This may require a pressure test.

Strategy #2, More Suitable for Ranches

One HVAC ductwork concept incorporates a dropped ceiling. In a hallway ceiling that has already been finished with drywall, ductwork and under-framing are installed to create a long dropped ceiling, typically providing a 7-foot ceiling height the length of the hallway. The supply plenum and mini-runs are suspended within the cavity; the rest of the dropped ceiling cavity carries return air from individual rooms back to the HVAC air-handler. (For more details, see "Additional Information.")

Plan Review

The plan review guidance for Strategy #1 assumes that mechanical plans have been submitted for permit. If no mechanical plan is submitted, compliance will need to be determined in the field.

1. Verify that the mechanical plan shows the location of the return and supply duct system and the proposed cfm for each register.
2. Verify that the location of the jump ducts, offset transfer grilles or pressure balancing strategy is shown on the plan.
3. Verify that the total unobstructed area for each transfer grille is specified on the plans. The grille area should be based on the total supply cfm for the room.
4. Verify that the return duct(s) back to the system is sized per manufacturer's specification. Verify that the return duct locations are in centralized hallways or living zones and not in a closet, bathroom, toilet room, kitchen, garage, mechanical room, furnace room, other dwelling unit, or a room containing a fuel burning appliance that draws its air from that exhausts air into that room. (IRC 2000 Section M1602.2 and 2003 Section M1602.3).
5. Require a construction detail to show the proposed jump ducts, offset transfer grilles or pressure balancing strategy.

Plan Review for Strategy #2 assumes that mechanical plans have been submitted for permit. If no mechanical plan is submitted, compliance will need to be determined in the field.

1. Verify that a mechanical plan has been submitted that shows the location of the return and supply duct system and the proposed cfm for each register.
2. Verify that the total unobstructed area for each transfer grille is specified on the plans. The grille area should be based on the total supply cfm for the room.
3. Require a construction detail to show the dropped ceiling detail and how the supply duct will be suspended and supported in the dropped ceiling space.

Field Inspection

1. If mechanical plans have been submitted, verify that the installed system matches the system shown on the approved building plans.
2. If mechanical plans have not been submitted, verify the following in the field:

- For Strategy #1, verify that a transfer grille or jump duct is installed for each sleeping room. Also, verify that centralized returns are located in a hallway or living space.
- For jump ducts, verify that the duct work is sealed.
- For Strategy #2, verify that the dropped ceiling space was framed after the sheetrock was installed and taped in the hallway. Also, verify that the sheetrock that forms the sides of the dropped, return-air cavity is sealed to the top plate.
- Verify that the supply duct is properly sealed and supported per IRC Section M1601.3.

Code Citations*

IRC 2003, Section M1601 Duct Construction, M1601.1.1

Above-Ground Duct Systems: Item #7 Stud wall cavities and the spaces between solid floor joists

to be utilized as air plenums shall comply with the following conditions: 7.3 Stud wall cavities shall not convey air from more than one floor level. 7.4 Stud wall cavities and joist space plenums shall be isolated from adjacent concealed spaces by tight-fitting fire blocking in accordance with Section R602.8.

IRC 2000 and 2003, Section M1601.3.1

Joints of duct systems shall be made substantially airtight by means of tapes, mastics, gasketing, or other approved closure system.

IRC 2000 Section M1602.3 and 2003, Section M1602.2 Prohibited Sources

The prohibited sources section allows for permanent openings between rooms in order to connect spaces together to meet a return-air location requirement: Item 4 prohibits return-air sources as follows: "A closet, bathroom, toilet room, kitchen, garage, mechanical room, furnace room or other dwelling unit." Item 5 prohibits "A room or space containing a fuel-burning appliance where such a room serves as the sole source of return air."

Additional Information

- "Builders Guide: Cold Climates" by Joe Lstiburek is available for purchase at the Energy and Environmental Building Association (EEBA) (html,) website.
- See the article "Design and Construction of Interior Duct Systems," on the Florida Solar Energy Center (FSEC) (html,) website.