Ducted Returns

Last Updated: 03/13/2018

Scope

A ducted central return brings air from central return registers back to the air handler through insulated, air-sealed ducts

Provide for pressure balancing between bedrooms and the rest of the house.

- Install ducted returns or a combination of ducted returns, transfer grilles, jump ducts, and/or door undercuts in bedrooms to allow pressure balancing between bedrooms and the rest of the house in homes with ducted heating and cooling systems by providing a path for room air to return to the central air handler, thereby increasing the volume of conditioned air circulating in the room.
- Do not use building cavities alone for return air pathways. Return pathways should be ducted from the return grille to the return plenum of the central air handler. The return ducts should be sealed with mastic or metal tape at all seams and joints.
- ENERGY STAR Certified Homes requires that the dedicated return ducts, transfer grilles, jump ducts, and/or door undercuts together achieve a rater-measured pressure differential of ?3 Pascals (0.012 inch water column) with respect to the main body of the house when bedroom doors are closed and the air handler is operating on the highest design fan speed. A rater-measured pressure differential of ?5 Pascals (0.020 inch water column) is acceptable for rooms with a design airflow ?150 cfm.
- Refer to the balancing report provided by the HVAC contractor for the bedroom air flows to size the return ducts. If a balancing report was not provided, the flow of the supply register when the air handler is on high speed may need to be measured using a flow hood, anemometer, or other flow measurement tool.
- Test the pressure differential with the bedroom doors closed.

See the **Compliance Tab** for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.

Description

For central “forced air” furnace and air conditioning systems to operate properly, the HVAC distribution system should be designed with adequate supply and return registers to provide conditioned air to all parts of the house and return stale air to the furnace for reconditioning. Inadequate return air pathways can cause pressure imbalances from room to room, which can cause drafts and temperature differences between rooms or floors, leading to comfort complaints. Pressure imbalances can also cause the furnace and air conditioning equipment to work harder than necessary. A well-designed return air strategy is critical for the performance of the HVAC system in an energy-efficient house, which may have lower airflow requirements to meet the lower heating and cooling loads (**Burdick 2011**). The return air must have a clear path back to the air handler from every room that has a supply outlet, with the exception of bathrooms or kitchens due to the potential for spreading odors through the house (**Burdick 2011**).

Each room can be individually ducted to the return side of the air handler; however, installing that much ducting is costly and there may be space constraints that limit the feasibility of this approach. Utilizing a central return strategy is a simple and effective way to return stale air to the air handler (Figure 1). When utilizing a central return strategy, one or more return registers should be installed in central hallways or stairwells adjacent to the main living spaces of the house, with at least one return per floor. These central returns should be ducted to the return side of the HVAC air handler with air-sealed ducts that are insulated if located in unconditioned space (Figure 2). Building cavities (the space between wall studs or “panned” floor joists) should not be used as return air pathways; if unducted, these spaces are very difficult to air seal. Return air pathways that leak will draw air from unintended places in the house and can lead to undesirable pressure differences. A fully ducted return system will be easier to air seal and will have better airflow characteristics than building cavities used as return air pathways.

To ensure that “stale” air is able to return to these central returns from rooms that have closeable doors such as bedrooms or offices, builders will often rely on door undercuts. Typical door undercuts (1/2 to 3/4 inch) alone do not allow adequate return volume, especially when carpet is installed, and are not appropriate for an energy-efficient house. Door undercuts are not approved in ACCA Manual D (**Rutkowski 2009**). Other methods for providing an air pathway from closed rooms to central return registers are **jump ducts** and **transfer grilles**.

Return ducts are installed by the HVAC contractor. Return duct locations should be indicated on the HVAC design plans. Tasks associated with this installation should be included in the contract for the appropriate trade, depending on the workflow at a specific job site.

How to Install Return Ducts

1. Calculate the amount of return air needed. A target value for return capacity is two times the volume of the total supply air with an airflow velocity within the return of less than 500 feet per minute and the net free area of the grille sized 1.5 times the cross-sectional area of the return duct (Burdick 2011). ENERGY STAR requires that returns achieve a rater-measured pressure differential ? 3 Pascals (0.012 inch water column) with respect to the main body of the house when bedroom doors are closed and the air handler is operating on the highest design fan speed. A Rater-measured pressure differential of ? 5 Pascals (0.020 inch water column) is acceptable for rooms with a design airflow ?150 cfm. The bedrooms can be pressure-balanced using any combination of transfer grilles, jump ducts, dedicated return ducts, and/or undercut doors.
2. Determine whether you will use individual return ducts to each bedroom, one or more central ducts, or central ducts in combination with transfer grills, jump ducts, and/or undercut doors. Consider filter placement when making this decision. With individually ducted returns, the filter will need to be located at the equipment return air inlet. With a centrally located return, the filter can be located at the return grille. This configuration may make it easier for the homeowner to change or clean the furnace filter, if plans called for locating the furnace in a hard to reach location, such as an attic or crawlspace.
    1. Consider noise when determining placement of returns. A return duct that has a direct connection to the blower motor could transfer that blower noise to the living room.
    2. Consider size when locating central returns. Central return grilles are much larger than most supply grilles.
3. Install return ducts as you would supply ducts.
    1. Seal all seams, gaps, and holes of the return duct system with mastic (Figure 3).
    2. Seal the return box to the floor, wall, or ceiling with mastic, caulk, and/or foam.
    3. Do not use building cavities as return air pathways.

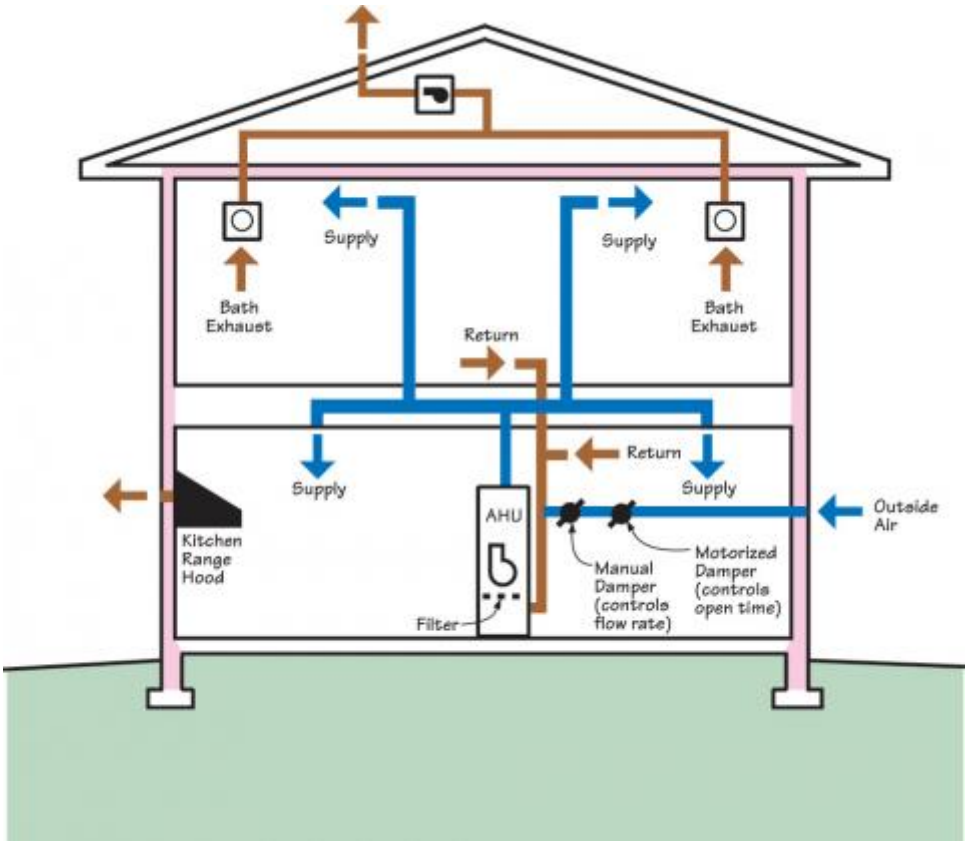

Figure 1. A complete HVAC system includes ducted returns

Figure 2. A ducted central return brings air from central return registers back to the air handler through insulated, air-sealed ducts. (Image courtesy of Steven Winter Associates).

Figure 3. Return ducts are air sealed with mastic, just like supply ducts

Ensuring Success

To determine if an adequate pathway exists for air to return to centrally located returns, the following room-to-room pressure measurement can be used:

1. Turn on the air handler to high.
2. Close all interior doors.
3. Using a manometer, connect tubing to the input port. The reference port for the differential pressure measurement can remain open.
4. While standing in the center of the house or hallway, place the tubing from the manometer under each door and record the pressure difference from each room with respect to the main body of the house (note the presence of a negative or positive sign). The bedroom will typically be pressurized (positive) when the doors are closed.
5. ENERGY STAR requires that rooms should not be pressurized or depressurized by more than 3 Pascals for any room being supplied with less than 150 cfm of conditioned air. If the supplied airflow to a room exceeds 150 cfm, a threshold of ?5 Pascals is required. These are good metrics to strive for regardless of whether or not pursuing ENERGY STAR certification.

Climate

No climate specific information applies.

Training

Right and Wrong Images

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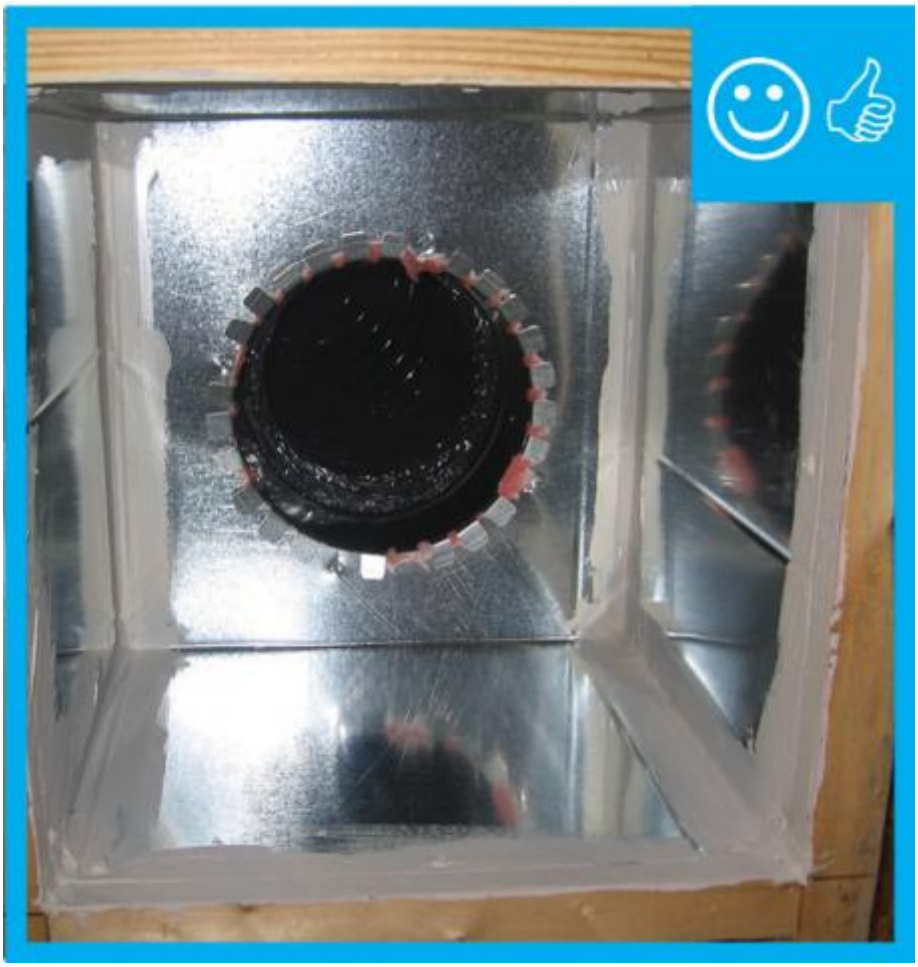

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CAD

None Available

Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

ENERGY STAR Certified Homes (Version 3, Rev. 08)

ENERGY STAR Certified Homes (Version 3/3.1, Revision 08), Rater Field Checklist

6. Duct Quality Installation

6.2 Bedrooms pressure-balanced using any combination of transfer grills, jump ducts, dedicated return ducts, and / or undercut doors to achieve a Rater-measured pressure differential ? 3 Pa with respect to the main body of the house when all bedroom doors are closed and all air handlers are operating. See Footnote 34 for alternative.[34]

Footnotes:

(34) Item 6.2 does not apply to ventilation or exhaust ducts. For an HVAC system with a multi-speed fan, the highest design fan speed shall be used when verifying this requirement. As an alternative to the 3 Pa limit, a Rater-measured pressure differential ? 5 Pa is permitted to be used for bedrooms with a design airflow ? 150 CFM. The Rater-measured pressure shall be rounded to the nearest whole number to assess compliance.

ENERGY STAR Revision 08 requirements are required for homes permitted starting 07/01/2016.

Associated Air Barrier Council

Associated Air Barrier Council 2002. AABC National Standards for Total System Balance 2002. The manual details the minimum standards for total system balance.

National Environmental Balancing Bureau

National Environmental Balancing Bureau (NEBB) Section 15990 – Testing, Adjusting, and Balancing. NEBB is a certification association whose members perform testing, adjusting and balancing (TAB) of heating, ventilating, and air-conditioning systems and commission and retro-commission building systems. This document is the TAB procedural standards.

2009 IECC, /2009 IRC

R403.2.1/N1103.2.1 Supply be insulated to ? R-8, all other ducts insulated to ? R-6, unless the ducts are within conditioned space.

R403.2.2/N1103.2.2 Ducts air handlers, filter boxes, and building cavities used as ducts shall be sealed.

R403.2.3/N1103.2.3 Building framing cavities shall not be used as supply ducts.

2012 IECC / 2012 IRC

R403.2.1/N1103.2.1 Supply be insulated to ? R-8, all other ducts insulated to ? R-6, unless the ducts are within conditioned space.

R403.2.2/N1103.2.2 Ducts shall be sealed.

R403.2.3/N1103.2.3 Building framing cavities shall not be used as ducts or plenums.

2015 and 2018 IECC / 2015 and 2018 IRC

R403.3.1/N1103.3.1 Supply and return ducts shall be insulated to ? R-8 for ducts ? 3-inch diameter, and ? R-6 for ducts < 3 inches unless the ducts are within conditioned space.

R403.3.2/N1103.3.2 Ducts shall be sealed.

R403.5/N1103.3.5 Building framing cavities shall not be used as ducts or plenums.

Retrofit: 2009, 2012, 2015, and 2018 IECC

Section R101.4.3 (Section R501.1.1 in 2015 and 2018 IECC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Retrofit: 2009, 2012, 2015, and 2018 IRC

Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their

continued safe use.

More Info.

Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

Case Studies

1. **New Whole-House Solutions Case Study: Nelson Construction: Hamilton Way, Farmington, CT**
   (662KB)
   Author(s): PNNL
   Organization(s): PNNL
   Publication Date: April, 2012
   Case study about design and testing 10 high-performance homes in Farmington, Connecticut.

References and Resources*

1. **AABC National Standards for Total System Balance 2002**
   Author(s): Associated Air Barrier Council
   Organization(s): Associated Air Barrier Council
   Publication Date: January, 2002
   Standards book discussing changes, additions and enhancements over the 5th edition of the AABC National Standards for Total System Balance.
2. **ACCA Manual D - Residential Duct Systems**
   Author(s): Air Conditioning Contractors of America
   Organization(s): Air Conditioning Contractors of America
   Publication Date: December, 2013
   Standard outlining industry procedure for sizing residential duct systems.
3. **Advanced Strategy Guideline: Air Distribution Basics and Duct Design**
   Author(s): Burdick
   Organization(s): IBACOS, National Renewable Energy Laboratory
   Publication Date: December, 2011
   Document providing guideance and considerations for duct design in an energy efficient house.
4. **Building America Best Practices Series Volume 11: 40% Whole-House Energy Savings in the Marine Climate**
   Author(s): Baechler, Gilbride, Hefty, Cole, Williamson, Love
   Organization(s): Pacific Northwest National Laboratory, Oak Ridge National Laboratory
   Publication Date: September, 2010
   Report providing builders in marine climates with guidance for building homes that have whole-house energy savings of 40% over the Building America benchmark with no added overall costs for consumers.
5. **DOE Zero Energy Ready Home National Program Requirements**
   Author(s): Department of Energy
   Organization(s): DOE
   Publication Date: April, 2017
   Standard requirements for DOE's Zero Energy Ready Home national program certification.
6. **ENERGY STAR Certified Homes, Version 3 (Rev. 08) National Program Requirements**
   Author(s): U.S. Environmental Protection Agency
   Organization(s): EPA
   Publication Date: December, 2015
   Webpage with links to Document outlining the program requirements for ENERGY STAR Certified Homes, Version 3 and 3.1 (Rev. 08).
7. **HVAC System Pressure Relief**
   Author(s): Raymer, Moyer
   Organization(s): Tamarack Technologies, Florida Solar Energy Center
   Publication Date: July, 2006
   Correcting pressure imbalances in your HVAC system can result in a healthier, more efficient home.
8.

Measure Guideline: Sealing and Insulating Ducts in Existing Homes
Author(s): Aldrich, Puttagunta
Organization(s): CARB, National Renewable Energy Laboratory, Steven Winter Associates, SWA
Publication Date: December, 2011
Report descibing the sealing and insulating of HVAC duct systems in new and existing homes.

9. **NEBB Section 15990 - Testing, Adjusting, and Balancing**
Author(s): National Environmental Balancing Bureau
Organization(s): National Environmental Balancing Bureau
Publication Date: January, 2005
Standard that includes testing, adjusting and balancing (TAB) to produce design flows for air and hydronic systems.
10. **READ THIS: Before You Design, Build or Renovate**
Author(s): Lstiburek, Brennan
Organization(s): Building Science Corporation
Publication Date: December, 2006
Document with important building science considerations, designed for members of the residential construction and remodeling industries, as well as owners and managers who work in affordable housing.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

Contributors to this Guide

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