

TOOLBASESM TECHSPECS

Ducts in Conditioned Space

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TECH @ A GLANCE

BENEFITS (+) / DRAWBACKS (-)

- + **ENERGY EFFICIENCY:** Allows for better performing HVAC system
- + **ENVIRONMENTAL PERFORMANCE:** Better indoor air quality control
- + **DURABILITY:** Reduced likelihood of condensation that could lead to moisture-related problems
- + **MARKETABILITY:** Increased occupant comfort/satisfaction
- **AFFORDABILITY:** Requires added attention to design; additional construction costs
- **SPACE:** Interior space may be required to install bulkheads, chases, or plenums

INITIAL COST

Incorporating ducts in conditioned space may cost slightly more than ducts in unconditioned space, especially if chases are created to accommodate ductwork. Costs can potentially be offset by reducing the size of mechanical equipment, eliminating duct insulation, minimizing duct length, and reducing material cost.

OPERATIONAL COST

The practice reduces heating and cooling energy costs by eliminating air leakage from ducts to the exterior and by preventing ducts from exposure to the temperature extremes of unconditioned spaces.



CODE ACCEPTANCE

Section M1601 of the 2003 International Residential Code (IRC) addresses ductwork. However, it does not specifically address any issues related to having ducts in conditioned space.

Section 503.3.3.3, Duct and Plenum Insulation, of the 2003 International Energy Conservation Code (IECC), outlines minimum supply and return duct insulation requirements for ducts in unconditioned space. No insulation is required for ducts in conditioned space.

In some areas of the country, conditioned crawlspaces and attics may need to meet specific code requirements.

RESULTS FROM THE FIELD

Several PATH Field Evaluations and other projects evaluated the cost and effect on trades of bringing ductwork into conditioned space.

WARRANTY

Using ducts in conditioned space will not affect manufacturer's warranty for HVAC equipment.

MAKING THE SWITCH

- Careful consideration is needed at the design phase to determine duct placement.
- Trade contractors may need to follow plans rather than the common practice of determining duct placement "on the fly."
- If your contractor is unwilling to make the necessary changes, you may need to seek another HVAC contractor who is willing to perform industry sizing calculations and follow best practices.
- Practice may affect the scheduling of trades if ductwork is routed through bulkheads or other architectural features that are subsequently covered with drywall.

THE BASICS

In many homes, ducts are run through attics, garages, crawlspaces, and basements for convenience and practical reasons. However, ducts in unconditioned areas are a big source of energy loss because of large temperature differences between air in ducts and the surrounding space, and duct leakage. According to the U.S. Department of Energy's publication, *Better Duct Systems for Home Heating and Cooling*, energy loss in ductwork can account for over 25 percent of heating and cooling energy needs of a house.

The practice of bringing ductwork into the conditioned space improves energy efficiency and reduces the likelihood of condensation and moisture problems. It can also reduce dust and other indoor air quality concerns. To place ducts in conditioned space, builders use a variety of methods including constructing bulkheads, dropped soffits, tray ceilings, running ducts through open-web floor joists, and placing ducts in closets, conditioned crawlspaces and attics. Transfer grilles from bedrooms, combined with central returns, simplify the process of bringing ducts into conditioned space.

Placing ducts in conditioned space eliminates the need to insulate ductwork, but it does not eliminate the need for good duct sealing practices. Properly sealed ducts deliver air where it is supposed to go and help maintain air quality by not drawing air from dusty areas (e.g., unconditioned crawlspaces, floor joist cavities). With ducts in conditioned space, leaked air remains in the house to provide useful heating and cooling.

DOLLARS AND SENSE

Initial Cost: Additional cost is minimal, up to a few hundred dollars, depending on design. Cost will depend on the ability to downsize equipment and reduce ductwork. For the Warren Builders PATH Field Evaluation added costs were \$278, and for the Habitat for Humanity project they were \$200.

Operational Cost: Savings on heating and air conditioning costs can be 25 percent or more. In the Warren Builders' case, it was estimated at 8% as shown.

	Ducts in Unconditioned Attic	Ducts in Conditioned Space
HVAC Materials*	\$252	\$201
HVAC Labor	\$103	\$100
Incremental Framing Cost	---	\$50
Incremental Drywall Cost	---	\$282
Total	\$355	\$633
Estimated Annual Energy Cost Savings	---	\$20 (approximately 8% savings)

*Material cost savings include shorter duct runs and smaller diameter duct line.

MAKING THE SWITCH

What is required to transition from your current building practices to using this technology?

Review the Practice With Your HVAC Contractor - Using a knowledgeable HVAC contractor who is willing to perform duct design calculations (e.g., Air Conditioning Contractor's Association Manual D) is the first step towards implementation.

Review Your Home Designs – Review standard home designs with your HVAC Contractor to plan the duct layout. Develop standard approaches for custom homes.

Develop an Installation Plan – Coordinate with contractors regarding duct layout and framing of duct chases to avoid schedule conflicts during construction. For example, carpenters and drywallers may need to return to the job to frame the bulkhead and cover it with drywall.



RESULTS FROM THE FIELD

This technology has been used by other builders in real-world building situations – learn from their experiences.

Albertville, Alabama, Warren Builders (PATH Field Evaluation)

- Side-by-side comparison of two identical single-story homes where ductwork was installed after drywall was complete using a bulkhead dropped down from the ceiling, which ran along the long axis of the house; Supply branches, perpendicular to the supply line, were fitted with high-throw diffusers placed at room interior walls
- Practice added \$230 to construction costs
- Discovered the need for additional trade contractor coordination with the system, since the drywall contractor and carpenter needed to return to the site to enclose ducts

Annapolis, Maryland, Arundel Habitat for Humanity (PATH Field Evaluation)

- In the affordable home with simple floor plan, ducts were created with trunk line spanning length of home in constructed bulkhead along first-floor ceiling; Registers off the trunk line serve both floors. A central return was provided at the landing of an open stairway
- Practice added \$200 to construction, or \$0.20 per square foot
- No significant barriers reported

Austin, Texas, Casa Verde Builders (2005 EnergyValue Housing Award winner)

- Affordable homes built by student laborers where the builders constructed tightly sealed, furred-down plenum in central hallway to supply air to most of the rooms in the house
- Unique practice reduced cost of duct construction

Bowie, Maryland, MADE Homes (2003 PATH Field Evaluation)

- Marketable, Affordable, Durable, Entry-level (MADE) Homes incorporated as much of the ductwork as possible in conditioned space; however, for practical considerations, HVAC contractor installed 2nd story attic returns
- All supply ducts were run through open-web floor joists
- No significant barriers reported

Tucson, Arizona, John Wesley Miller Companies

- Move-up/luxury homes featuring universal design, high ceilings, and architectural features used to bring ducts inside
- Ducts enclosed in soffits below the insulation along the central core of the house plan; a central return and transfer grilles across interior doorways equalize pressure throughout the house without need for numerous returns

FOOD FOR THOUGHT

This section provides some things to think about before switching to this building technology – make sure it's the right choice for you.

- Placing ducts in conditioned is most beneficial in extreme climates, but is suitable and effective for all climates. The potential for condensation is reduced in humid climates.
- The practice is easier to implement in single-story homes and in multi-story homes with open-webbed floor joists. It is appropriate for retrofitting, but it might be challenging to find areas to run ducts in existing homes.
- When used in conjunction with HVAC equipment in conditioned space, ducts in conditioned space can be an integral part of a universal design because owners have easy access for changing filters.
- If you build crawlspace foundations, investigate the possibility of building a “short basement” rather than a ventilated crawlspace. This technique simplifies the practice of bringing ductwork and equipment into conditioned space.
- In a well-insulated and sealed house with energy-efficient windows, supply registers can usually be located on interior walls, thereby reducing duct length. Keeping duct runs short not only reduces material use, but also improves efficiency of the duct system.
- In a carefully designed duct system in which duct length is minimized, duct diameter can often be reduced, thereby reducing costs and making it easier and less obtrusive to run ducts through interior spaces.
- Material savings from efficient duct design can help offset additional costs associated with bringing ducts into conditioned space.
- When transfer grilles are used, homeowners may be concerned about noise transmission through walls.
- If ducts are routed through open-web floor joists, it is essential that rim joists be sealed and insulated.
- If ducts are perpendicular to floor joists, and open web trusses are not used, it may be necessary to construct bulkheads for duct runs.
- Trade contractor schedules (e.g., carpenters, HVAC installers) may need to be reworked to accommodate the practice.

- Practical considerations may necessitate running some ductwork in unconditioned space. Keep in mind that there is an energy benefit whenever ducts are run in conditioned space.



DEFINITIONS

Duct System

A system for delivering conditioned or ventilating air which includes ducts, fittings, dampers, plenums, fans and other air handling equipment and appliances.

Manual D

Manual D is published by the Air Conditioning Contractors of America (ACCA) as a method for designing residential duct systems. This procedure can be applied to constant volume systems and zoned, variable air volume systems for all duct construction materials.

www.acca.org/

Manual J

Manual J is also published by ACCA as a guide for estimating residential heating and cooling loads. This manual is the accepted industry standard for the proper sizing and selection of HVAC equipment in residential homes. The eighth edition (published in 2004) is the most recent revision as of the creation of this document which incorporates a new comprehensive approach to ensuring that indoor environmental systems are as efficient as possible.

Manual S

Manual S is also published by ACCA to aid in the selection and sizing of heating and cooling equipment to meet Manual J loads based on local climate and ambient conditions at the building site. It contains sizing strategies for many types of cooling and heating equipment, as well as how to use comprehensive manufacturer's performance data on sensible, latent conditions at the building site or heating capacity for various operating conditions.

TECH CHECK

Below is a checklist of steps to follow if you decide to implement this technology in your next building project.

- Work with an HVAC contractor (and the architect) to identify interior space for ducts in new homes designs
- Ask your HVAC contractor to perform ACCA Manual J, S, and D calculations for each home design
- Carefully install and seal ducts during construction
- Test ductwork for leakage before encapsulating it behind drywall
- Educate the homeowner on the locations of primary ducts, and the location and change out interval for filters to maintain efficient operation.



The Partnership for Advancing Technology in Housing (PATH) is dedicated to accelerating the development and use of technologies that radically improve the quality, durability, energy efficiency, and affordability of America's housing. Managed by HUD, the PATH partnership includes the homebuilding, manufacturing, insurance and financial industries, and Federal agencies concerned with housing.

PATH addresses barriers to innovation, provides information on advanced building technologies, and advances housing technology research; making affordable, quality American homes a reality.

For more information on PATH, visit www.pathnet.org.

Tech Specs are prepared for PATH by the NAHB Research Center.

RESOURCES

ToolBase Services

Information on this building technology and many others brought to you by PATH and the building scientists at the NAHB Research Center.

www.toolbase.org

Air Distribution System Design (2003). Six-page U.S. Department of Energy fact sheet which discusses options and offers design recommendations for residential duct systems. http://www.eere.energy.gov/buildings/info/documents/pdfs/air_dist_sys_design-0782.pdf

Better Duct Systems for Home Heating and Cooling, 12-page fact sheet from the Building America program which discusses how to design and create an efficient duct system, duct testing, and repair.

http://www.eere.energy.gov/buildings/building_america/pdfs/30506_better_ducts.pdf

A Builder's Guide to Placement of Ducts in Conditioned Space (2000), a 44-page book published by the NAHB Research Center, available from <http://www.nahbrc.org>.

Air Conditioning Contractor's Association (ACCA) - Manual for residential load calculation (Manual J), heating and cooling equipment selection (Manual S), and duct sizing (Manual D). <http://www.acca.org>