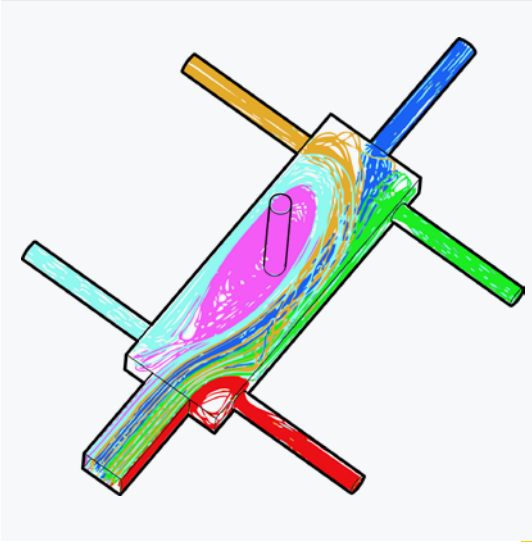


Building America Case Study

Technology Solutions for New and Existing Homes

New Insights for Improving the Designs of Flexible Duct Junction Boxes

PROJECT INFORMATION

IBACOS
www.ibacos.com

Construction: Fiberglass duct board or sheet metal junction boxes

Type: Flexible duct constant-volume HVAC systems

Builders: Those using ACCA Manual D process for sizing duct runs

Size: N/A

Price Range: N/A

Date completed: N/A

Climate Zone: All

PERFORMANCE DATA

Pressure losses are high for flexible duct junction boxes relative to other standard duct fittings; however, contractors prefer the boxes because they can be easily and quickly fabricated onsite and their materials are low cost.

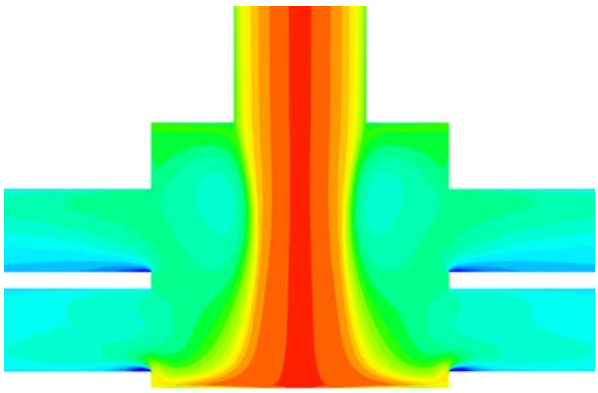
ACCA Manual D guidelines must be expanded for junction boxes so pressure drops are accurately—or at least conservatively—estimated. Current guidelines do not provide enough constraints to properly minimize pressure loss.

Building America SM U.S. Department of Energy

Advanced simulation technologies are defining new processes for measuring airflows in duct fittings. The U.S. Department of Energy Building America team IBACOS used computational fluid dynamics (CFD) software to explore and develop guidance to better control the airflow effects of changing design configurations.

The current Air Conditioning Contractors of America (ACCA) guidance (Rutkowski 2009) allows for unconstrained variations in the number of takeoffs, takeoff locations, and box sizes. The only variables currently used to select an equivalent length (EL) are the velocity of the air in the duct and the friction rate because the first takeoff is located at least twice its diameter away from the inlet. This condition does not account for other factors that may affect pressure loss across these types of fittings.

The CFD simulations confirmed that further limitations on junction box design will ensure lower pressure systems and better airflows to rooms. ACCA Manual D EL estimates need to be conservative; otherwise, blowers may be undersized and create inadequate airflow. Balancing dampers should be installed to increase the pressure of runs with higher-than-intended flows to force air into outlets that receive less air than they are designed for.

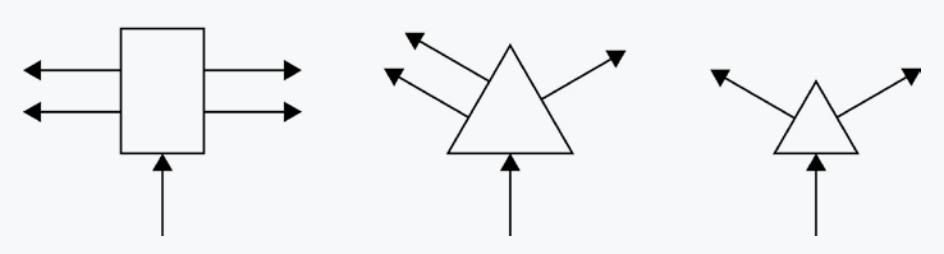


CFD technology allows for detailed analysis of air, which is difficult to measure and characterize. The image on the left illustrates the pressure gradient of a well-performing design. The airflow travels down through the box and deflects to the sides, and the outlets have near equal color (pressure). This image represents a four-outlet box.

Key Energy Efficiency Measures

HVAC

- Special efforts must be made when designing junction boxes to ensure that the EL values from ACCA Manual D are conservative.
- Ensure the lowest pressure drop by following the guidelines outlined in the Lessons Learned.

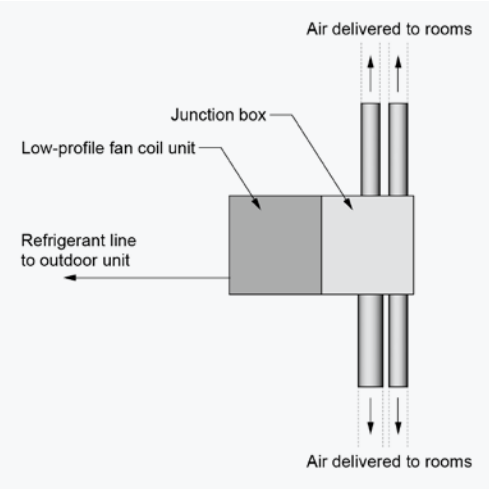


These configurations should be used, based on the number of takeoffs (four maximum). If you want more takeoffs, use two boxes, placing the branch attached to the second box at the back of the first box.

Lessons Learned

IBACOS used a series of CFD simulations to show that additional design constraints will ensure better alignment with ACCA Manual D EL values and thus better system performance.

- To minimize flow instabilities, the box width should be at least three times the inlet width or diameter.
- If splitting into two branches, consider using a metal wye fitting instead of a junction box because pressure drops are much lower for metal wye fittings.
- Balancing losses are increased in asymmetrical layouts, so ensure the flow splits in the outlet ducts are symmetrical.
- Place outlets only on the sides of the box, not directly opposite the inlet. Outlets directly opposite the inlet will require significantly more balancing pressure to match outlet flows to their targets.
- The space between the first outlet and the inlet should be at least one outlet diameter. Pressure losses decrease as this distance increases; however, considering material efficiency, limit this distance to about one outlet diameter.



Small, distributed fan coil units efficiently supply air in low-load homes. Their low profile allows them to be easily integrated into ceilings and wall cavities. The entire HVAC system will thus be more likely to fit inside conditioned space. These units can be ducted with small-diameter flexible ducts by a compact, materially efficient junction box that can be fabricated onsite. Current codes prevent the use of small-diameter plastic ductwork, which could be a low-friction solution to low-flow systems as opposed to current wire-helix designs with high friction rates.

Rutkowski, H. (2009). *ACCA Manual D—Residential Duct Systems,* 3rd ed., Version 1.00. Group 11 of Appendix 3. Arlington, VA: Air Conditioning Contractors of America.

For more Information, see the Building America report, *Computational Fluid Dynamics Analysis of Flexible Duct Junction Box Design,* at *www.buildingamerica.gov*

Image credit: All images were created by the IBACOS team.

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DOE/GO-102014-4298 • January 2014