
Why It's So Important (and Troubling) to Keep Ducts and Equipment in Conditioned Space

Perhaps the single most challenging BSC performance requirement for our Building America production homebuilders is that **all** ducts and HVAC equipment must be within the conditioned space (This means no ducts in outside walls and no ducts or air handlers in garages, vented attics and vented crawlspaces). It's an important and even driving element for each of the four case studies in this report. So, why all the heartache over this single design element?

There are really two sources of the heartache—how important it is to locate all ducts and equipment in conditioned space and how hard it can be for homebuilders to achieve this.

- **High performance virtually requires ducts and air handlers within conditioned space:**

Energy - It's possible to insulate ducts and air handlers to a level for which their heat loss and gain when located outside the conditioned space is as low as their heat loss and gain when located inside the conditioned space. But it is rarely practical, particularly for production builders. So, ducts and air handlers located outside the conditioned space are typically far less energy efficient than ducts and air handlers located inside the conditioned space.

Indoor Environmental Quality - It's possible to air seal ducts and air handlers so that all the air that is supplied by the delivery or distribution system is returned by the distribution system. But it is really difficult and, for most production builders, far from practical. When ducts leak outside the conditioned space, interior spaces can become pressurized or depressurized. These pressure imbalances can lead to the introduction of moisture in both the interior space (with human health implications) and building enclosure (with building durability implications). The pressure imbalances can also lead to the introduction of soil gases and combustion by-products to the living space (see **Figures SC-1** through **SC-5**).

Comfort - Thermal losses/gains and pressure imbalances created by ducts outside conditioned space result in reduced delivery and lack of comfort. This drives system oversizing and loops back to drive even greater energy inefficiency.

- **HVAC Design as a **part** of Home Design** – We end up sticking air handlers and ducts in outside walls, garages, vented attics and vented crawlspaces not by design, but lack thereof. Particularly in homes without full basements, bulky ducts and air handlers take up precious volume or even worse, floor space. Designing in floor space, dropped soffits, stacked columns, open-web floor trusses or floor framing layout with duct runs in mind can be expensive and gut-wrenching for the builder and the home designer/architect. So, as a runner-up, we condition the attic or crawlspace (see **Figure SC-7**), creating material choices and construction details that often challenge the builder and the building inspector.



Figure SC-7: Conditioned crawlspace

It is clear that we need an air distribution system that is as high performance as the rest of a Building America home. We don't **design** a home for wiring and plumbing runs because they are small enough to go in most any interior interstitial space, except for maybe one, by design, two-by-six plumb wall (and the sales and marketing folks seem to be OK with this loss of floor space). If we can get the efficiency of the air distribution system high enough to match the efficiency of our high performance building envelope, we just might be able to get the ducts down to a size to fit in available interior walls and presto, keeping the ducts inside is no longer a design issue. And that is just what BSC Building America project #3 is all about (see **2.C.1 Final Report: Results on Advanced Residential Systems**). In the meantime, builders and architects need to design space for the ducts and air handlers into their homes or move the conditioned line down into or up into the crawlspace or attic respectively, and educate their home buyers (and building inspectors) on the importance and appropriateness of this approach.

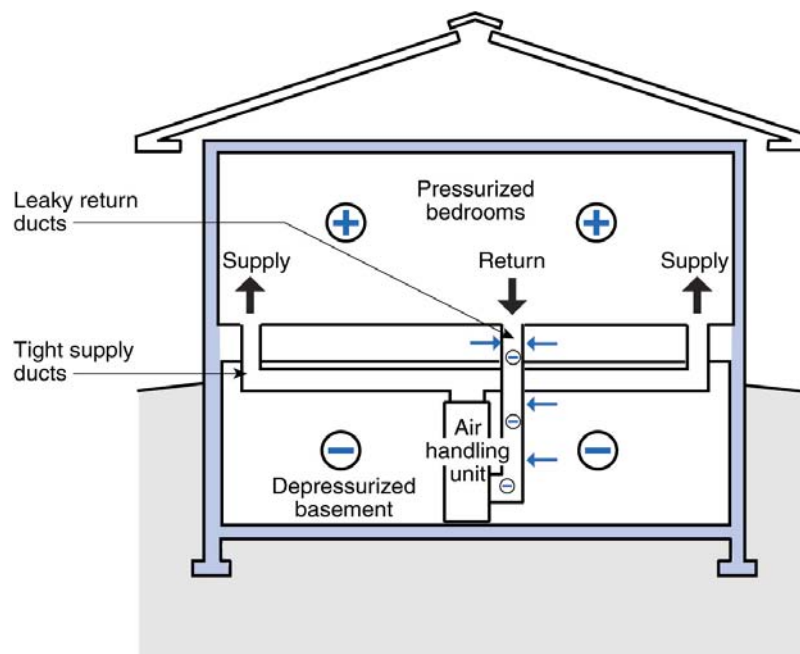


Figure SC-1

Leaky Ductwork and Air Handlers in Basements

- Air pressurization patterns in a house with leaky ductwork in the basement

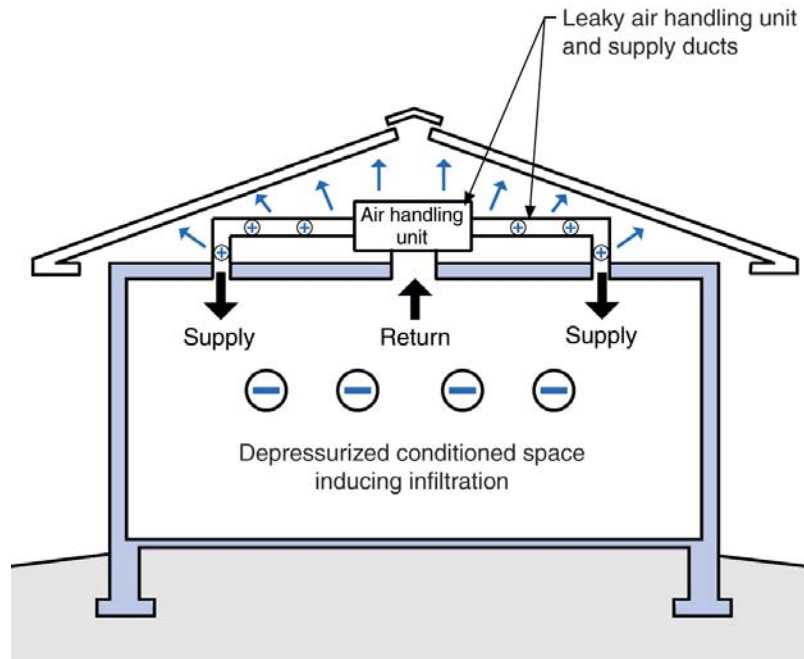


Figure SC-2

Leaky Ductwork and Air Handlers in Vented Attics

- Supply ductwork and air handler leakage is typically 20% or more of the flow through the system

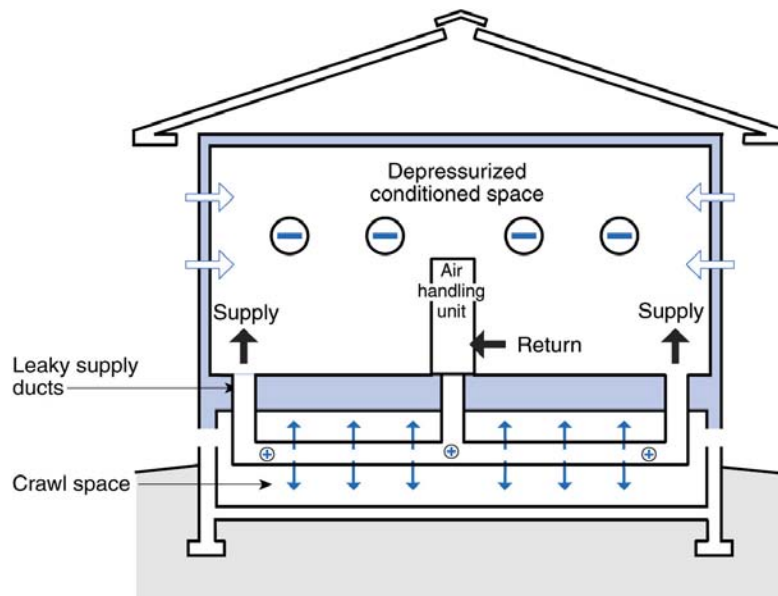


Figure SC-3

Leaky Supply Ductwork in Vented Crawlspace

- Air pressurization pattern with mechanical system ducts in the crawlspace

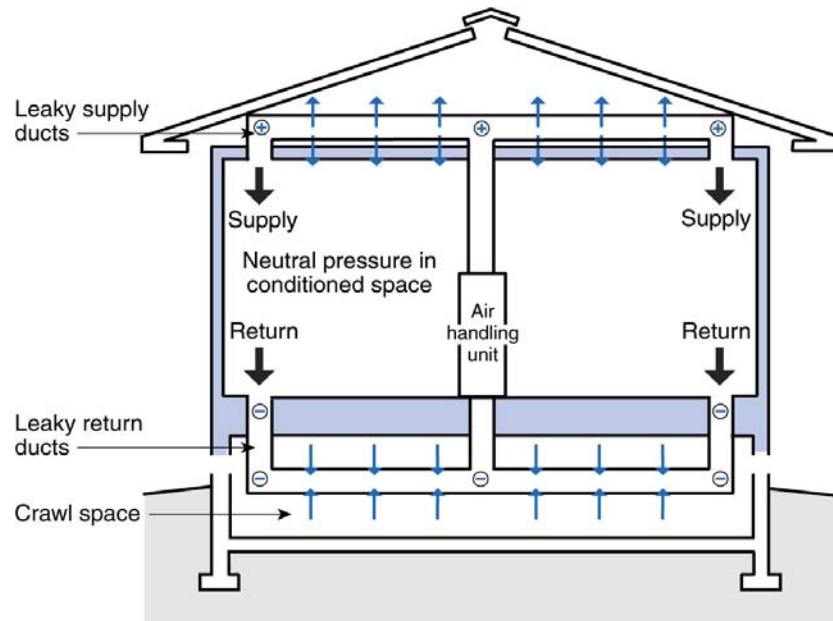


Figure SC-4

Leaky Supply and Return Ducts

- Air pressurization pattern with mechanical system ducts in the attic and crawlspace

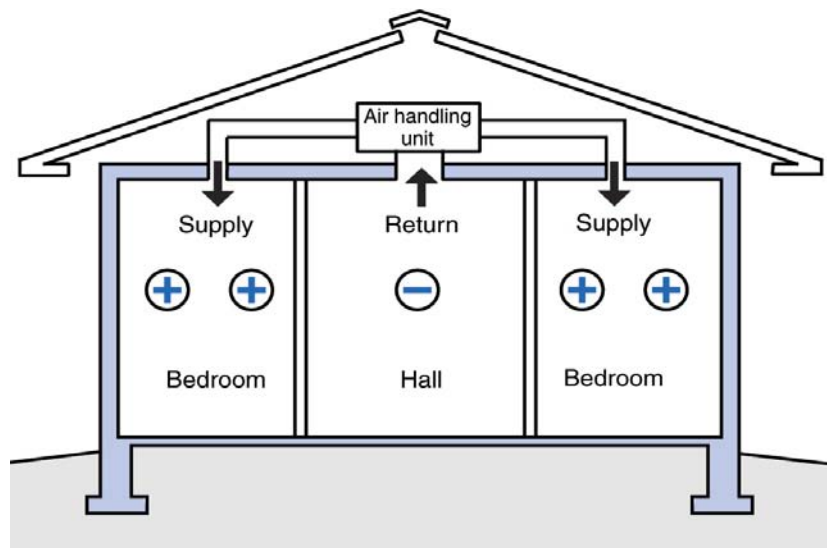


Figure SC-5

Insufficient Return Air Paths

- Pressurization of bedrooms often occurs if insufficient return pathways are provided; undercutting bedroom doors is usually insufficient; transfer grilles, jump ducts or fully ducted returns may be necessary to prevent pressurization of bedrooms
- Master bedroom suites are often the most pressurized as they typically receive the most supply air
- When bedrooms are pressurized, common areas depressurize; this can have serious consequences when fireplaces are located in common areas and subsequently backdraft