HVAC Design & Installation – Why It's a Problem for Builders, and How to Fix It

EnergyLogic

Nathan Kahre

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Business Development Manager

A recent addition to the team, Nathan Kahre brings his experiences working for a home builder to EnergyLogic. As the Business Development Manager, Nathan works with builders of all sizes to help find areas for improvement and opportunities to grow closer to the idea that all homes can be efficient, healthy, and sustainable.

After graduating with a master's degree in building science from Appalachian State University, Nathan came to the Denver metro area to work for a high-performance production home builder. Time spent working for a builder has helped Nathan understand what is important to builders and what information they need to get the job done. He has presented on building science, renewable energy, and home builder quality assurance throughout the country including sessions at RESNET, EEBA, & IBS.

Nathan is also active in the local community volunteering on issues that are important to him and doing his best to be on a mountain bike as much as possible.

Learning Objectives

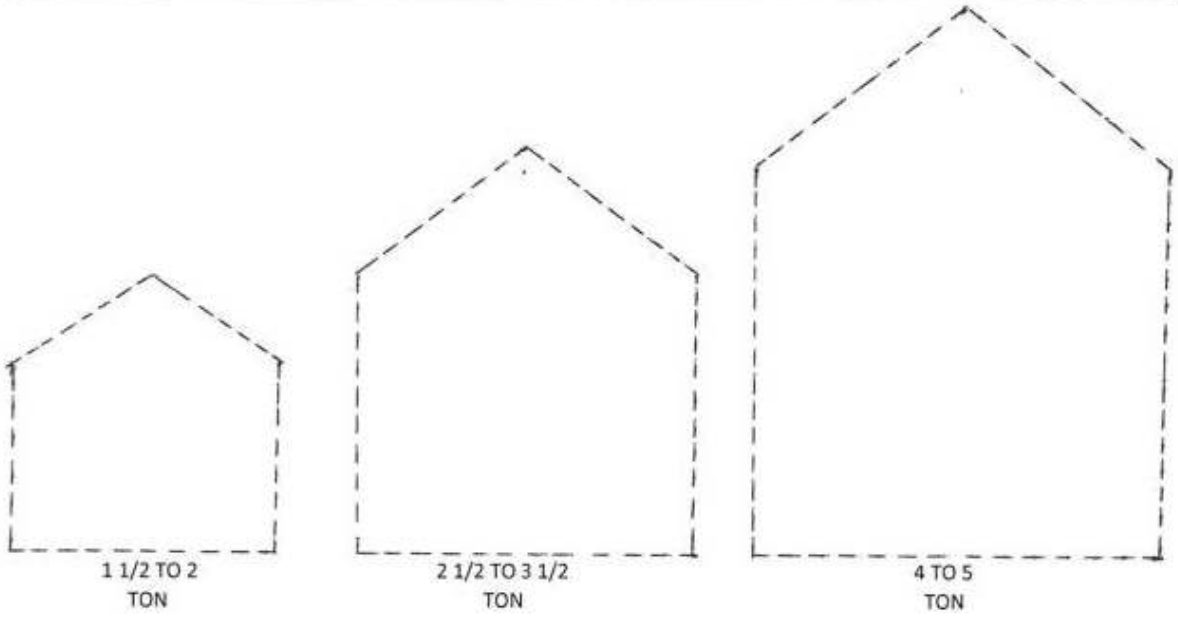
1. Common HVAC issues that lead to comfort complaints
2. The basics of how HVAC systems are designed
3. Why a third-party designed HVAC system may be in your best interest

How It's Always Been Done

Air Conditioner or Heat Pump

SIZING CHART

TRIM OUT HOLES VERY CAREFULLY CUTTING ON THE DOTTED LINES, THEN FOLLOW INSTRUCTIONS SHOWN BELOW



INSTRUCTIONS:

Stand on the curb. Hold out the Sizing Chart approximately one foot from your face and look at the house through each hole. If the house fits in a hole, that's the size unit to use.

* If curb is not available, ask the homeowner there a curb would be if there was one.

Citation: http://hvac-talk.com/vbb/showthread.php?1155861-Air-Conditioner-or-Heat-Pump-Sizing-Chart

How It's Always Been Done

- HVAC subcontractor does design-build
- Systems oversized
- Duct systems not optimized for the house

Why Is This An Issue Now?

1900 Neighborhood

Modern Day Neighborhood

What Do Comfort Complaints Cause?

1. Reputation killers
2. Multiple site visits to address and correct
3. Costly fixes

Common Issues

- Short cycling
- Excessive air movement
  - Noisy
  - Uncomfortable
  - Dusty
- Improper moisture removal
- Hot and cold spots

What Leads To Comfort Complaints

- Customer uneducated on equipment
- Faulty equipment
- Improper install
- Improper design

Customer Uneducated on Equipment

Get buyers the right information for:

- Expectations about control
- Setbacks & timers
- Filter changes
- Common maintenance
- Using the thermostat

Training customers to use the equipment right is the hardest piece!

https://gainesvillemechanical.com/the-basics-of-furnace-filter-replacement/

Faulty Equipment

Can be diagnosed and corrected by qualified technician.

The majority of problems with equipment in new construction are due to damage during construction.

https://gainesvillemechanical.com/the-basics-of-furnace-filter-replacement/

Improper Install

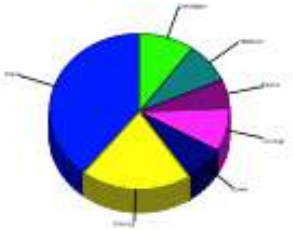
- Doesn’t follow the system design
- Proper fittings aren’t on the truck
- Conflicts with structure and HVAC ductwork

Improper Design

- Accurate data is critical
- Needs to start early in the design process and update as the design changes
- Adding a “fudge factor” is not recommended
- Avoids a high static pressure

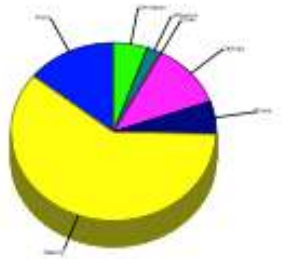
Heating

Component	Btuh/ft²	Btuh	% of load
Walls	2.6	12314	39.3
Glazing	11.6	6282	20.1
Doors	27.3	2293	7.3
Ceilings	1.5	2836	9.1
Floors	1.0	1865	6.0
Infiltration	0.7	2609	8.3
Ducts		0	0
Piping		0	0
Humidification		0	0
Ventilation		3130	10.0
Adjustments		0	
Total		**31330**	**100.0**



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	0.4	1886	14.2
Glazing	14.8	8018	60.4
Doors	9.4	786	5.9
Ceilings	0.8	1560	11.8
Floors	0.0	8	0.1
Infiltration	0.1	298	2.2
Ducts		0	0
Ventilation		715	5.4
Internal gains		0	0
Blower		0	0
Adjustments		0	
Total		**13271**	**100.0**



Latent Cooling Load = 0 Btuh
Overall U-value = 0.040 Btuh/ft²-°F

Data entries checked.

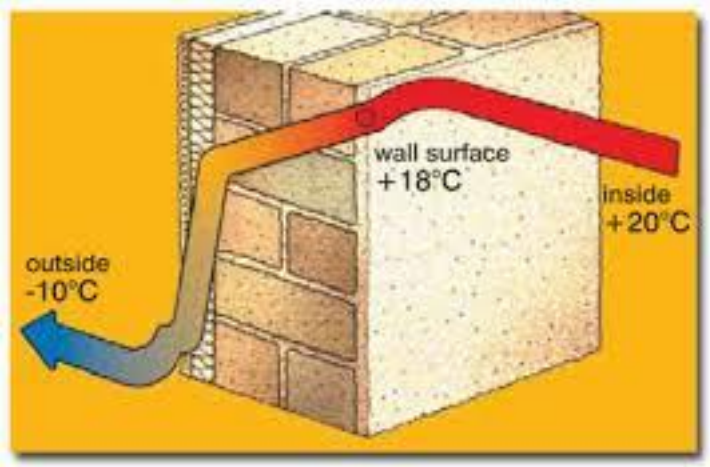
What Does Good HVAC Design Look Like?

Starts early in the design process → Inputs match what is included in the energy model → Follows the Industry Standard Manual J, D, & S → Inspect what you expect

Manual J - Load Calculation

Basic steady state calculation: Q=U-value*Area*ΔT

Calculates peak design load, independent of delivery system.



- Strengths:
  - Significant improvement over rules of thumb
  - Room-by-room loads
  - Required for a Manual D
- Limitations:
  - Very conservative sizing
  - Does not account for internal loads (for heating)
  - Not optimized for high-performance homes

Outdoor Design Temperature

99% Design temp – ignores 88 peak hours per year (both heating and cooling)

- Boulder: 91°F cooling, 0°F heating
- Denver: 90°F cooling, 3°F heating

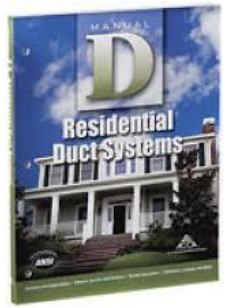
Reality: HVAC contractors don't like callbacks!

Manual S – Equipment Selection

Select proper size equipment, based on these four principles:

- Equipment manufacturer
- Altitude de-rating
- Natural gas de-rating
- Latent heat requirements

Manual D – Duct Layout and Design

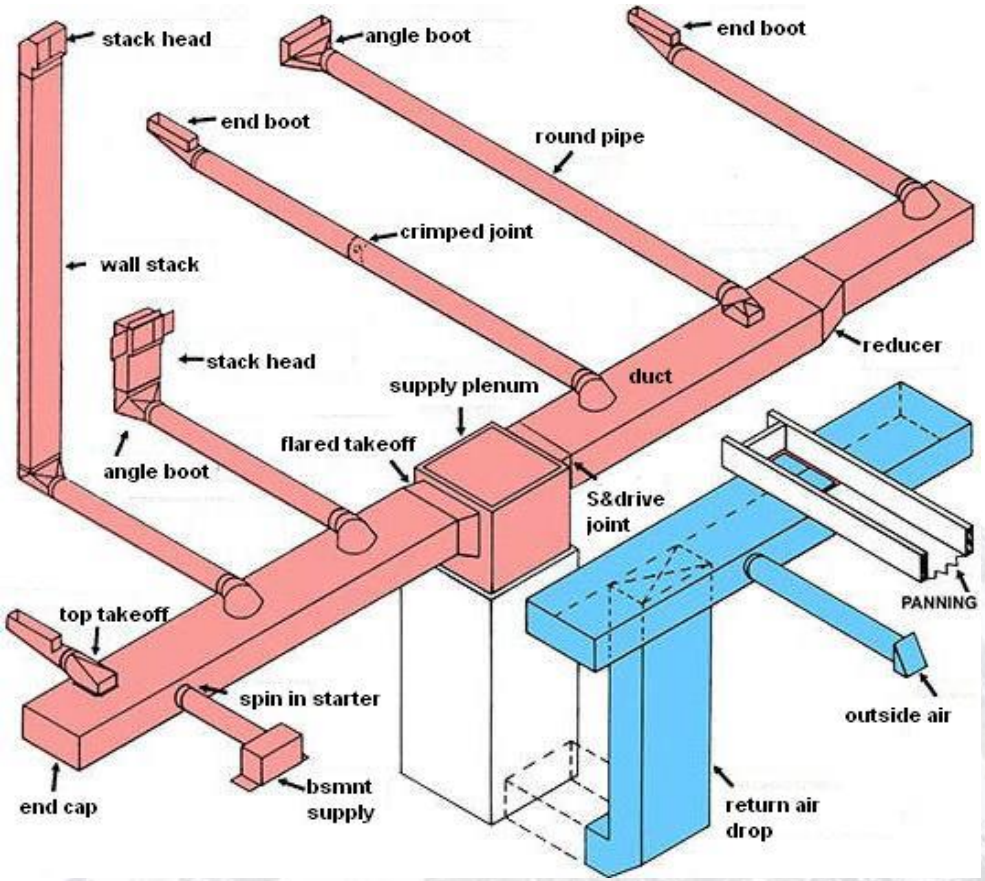


Ducts sized to loads

Low friction design and fittings

Early design integration:

- Fewer design changes
- Better aesthetic integration
- More efficient system



Duct Commissioning – Inspect What You Expect

- Designer works with HVAC subcontractor to ensure *constructability* of duct design.
- Rough duct inspection to ensure system is installed per design.
- Rough duct leakage test to discover/repair any problems before drywall.

Why Use a Third-Party Designer?

1. Independently designed system allows you to compare bids from multiple HVAC installers.

2. Able to submit for permits before awarding work to an HVAC contractor.

3. HVAC design should be done by those that understand the building science behind the envelope of the home.

How Should Your Designer & Contractor Work Together?

Should be a collaborative effort to balance:

- Cost
- Performance
- Constructability

Should have a clear and written process to address comfort complaints before construction begins.

Thank you!

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EnergyLogic
Our vision: A world where all homes are efficient, healthy, and resilient.
ENERGY STAR® Sustained Excellence/Partner of the Year 2009-2014, 2016-2020

About EnergyLogic

Berthoud, Colorado-based EnergyLogic is a software and building consulting company that has provided expert resources, education and support to new home builders and energy raters involved in the construction of high-performance homes since 2006.