Basic Mechanical Permit, Inspection & Installation Guidelines

- The provisions of Chapter 12-24 of the IRC shall apply for residential HVAC work. Check local ordinances and amendments. A copy of the IRC can be found here: https://codes.iccsafe.org/
- Obtain permits prior to starting work
- Code requires heating & cooling loads to be calculated per ACCA Manual J, equipment to be selected per ACCA Manual S and duct systems designed per ACCA Manual D & T. New guidance available in ACCA Manual LLH.
- Submit ACCA Residential System Design Review Form available here: https://www.acca.org/viewdocument/residential-system-design-review-forms-examples
- Passageways to HVAC equipment shall be unobstructed and large enough to remove the equipment but in no case smaller than 22" wide and 30" high
- Walkway to equipment and service deck must be at least 5/8" if joists 16" on center and 3/4" if 24" on center
- Walkway must be at least 24" wide with service deck at least 30"x30"
- Walkway and service deck must be elevated at least 11" such that R-38 attic insulation can be installed underneath (unless performance or total-UA calculations are submitted and approved)
- Equipment shall not exceed 20' from the attic opening to the front of the appliance
- Walkway to the appliance shall be illuminated with a switch at the entry
- Rigid gas line to exit furnace cabinet at least 2"
- Gas sediment trap shall be installed downstream of the shut off and upstream of the flex connector (UMC)
- Gas shut off valves shall be in the same room and no further than 8' from the appliance
- Gas appliance connectors shall not exceed 6' in length
- Venting system to be secured with sheet metal screws to draft hood connection only and maintain at least a 1" clearance. It shall terminate with an approved flashing, storm collar and listed cap
- Primary condensate drains shall be insulated where in unconditioned space
- Condensate drains must have at least a 1% slope and be supported and secured
- Secondary condensate must drain to conspicuous place or have float switch that shuts down equipment
- Equipment supports located inside pan shall be water resistant
- Refrigerant piping shall be insulated to a minimum R-4 and the insulation shall be protected from physical and UV damage – yes, the exposed insulation at the condenser to the house must be protected
- Mechanical ventilation is required. Can be exhaust only, supply only or a combination. A separate fan with an inline air sensor for humidity and temperature does not cost much more and can be ducted into the return plenum. Please consider using this "smart" ventilation strategy. If you insist on using the air handler motor for ventilation (please do not) code requires an ECM motor. Must have manual override/control.
- Outside air must have a damper and monitoring device
- Combustion air ducts to extend 6" above attic insulation and sized appropriately
- At least R-8 flex duct is required for supply unless performance calculations are used and approved
- Support flex duct every 4' and do not allow to sag and CUT THEM TO FIT!
- Starting collars must be sealed and secured with a mechanical tie. Tape/Mastic not allowed for securing collars.
- Condenser pad must be a minimum 3" above grade and must be level
- Fuse and breaker disconnects must match manufacturer requirements
- Refrigerant locking caps are required unless equipment is behind a 6' fence or roof mounted
- HVAC equipment should be identified as to which area it serves
- Elevate equipment where needed per flood hazard in accordance with R322.1.6
- Fibrous glass duct construction shall conform to the SMACNA *Fibrous Glass Duct Construction Standards* or NAIMA *Fibrous Glass Duct Construction Standards.* Available here: http://insulationinstitute.org/wp-content/uploads/2016/01/AH116.pdf
- HVAC register boots must be sealed to the drywall. Seams in boots must be sealed.
- Building framing cavities shall not be used as plenums or ducts
- Return air openings shall comply with M1602.2

This is not a complete list and is simply meant to provide some basic guidance. Feel free to contact Jason at jvandever@eepartnership.org with questions

Myths about Duct Design

- Myth #1 *Ducts designed per Manual D are self-balancing*. Ducts are not self-balancing and to even get close you'd need a return in every room with a supply. Ducts rarely perform in real life like they do on paper. They MUST BE adjusted individually using proper testing and balancing methods and accurate instruments.

- Myth #2 *Sizing returns is easy… Just use 1 square foot per ton or at least 100 square inches per ton.* According to all the manufacturers, the return CANNOT be sized this way. A rule of thumb that will work is to plan for 2 CFM for each square inch of gross grill area.

Return Air Filter Grilles

Typical Grille Sizes			CFM With Filter	CFM W/O Filter
Width x Height Size	Square inch area	Sq.Ft.		
12x12	144	1.00	200	300
14x14	196	1.36	272	408
16x16	256	1.77	354	531
20x16	320	2.22	444	666
18x18	324	2.25	450	675
20x20	400	2.77	554	831
24x20	480	3.33	666	999
25x20	500	3.47	694	1041
24x24	576	4.00	800	1200
25x25	625	4.34	868	1302
30x25	750	5.20	1040	1560

Example: A 20x25 grill has 500 inches of gross area.
500 x 2 CFM = 1000 CFM.
Using this approach, you would need two 20x25 return grills to deliver the 2000 CFM needed for a 5 ton HVAC system.

What may be better?
How about a 20x24 main return and a 12x12 in each of the 4 bedrooms?
20x24 = 480 square inches
12x12 = 144 square inches (x4)
480+144(4) = 2112 CFM

Will this be enough…
A 24x24 return in the hall and a 20x20 in the master bedroom?

Because the typical way to size returns is at 144 square inches per ton, we see most systems returns undersized by 30% or more. In our 5 ton home that would be 720 square inches installed vs. 1000 square inches needed.

- Myth #3 *Just seal the ducts and you can expect dramatic improvements in airflow and comfort.* Performance will only improve if ducts are first properly sized and then sealed. Leaky ducts can cause zonal pressure imbalances. Supply leaks can cause negative pressure issues which not only can be a big energy penalty, if there are draft combustion appliances there can be potential backdrafting and carbon monoxide poisoning issues. Undersized ducts that are well sealed can cause extremely high static pressure, a host of issues and mechanical failure.
  So… SIZE THEM RIGHT AND SEAL THEM TIGHT!

- Myth #4 *Using .10 IWC friction rate on a ductulator will always give me the right sized supply duct.* This always leads to undersized supplies, noisy grills, uncomfortable zones… Use Manual D!
  http://www.hartandcooley.com/tools/friction-loss-calculator-for-flexible-ducts

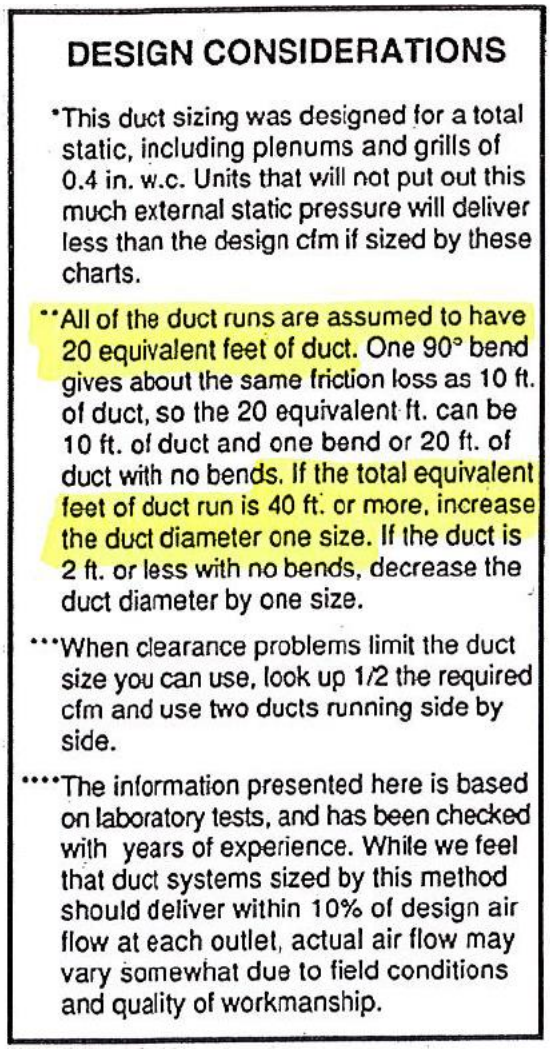
- Myth #5 *An 8" flex duct delivers 200 CFM.* According to the Air Diffusion Council and the flex duct manufacturers, an 8" flex duct will only deliver 160 CFM up to 40 feet. Past 40' and we need a 9". This assumes the flex is installed with less than 4% compression and doesn't have any kinks, sags, sharp bends etc. etc..

Important information from the back of the flex duct calculator

Myth #6 *Installing a new unit is a plug and play process. Put it in and out of the duct comes 400 CFM per ton.* The Bad News – A typical installation is about 30% low on airflow due to undersizing, poor duct install and other errors. That would mean you are only really getting about 280 CFM per ton well below the manufacturers 350 CFM per ton requirement. The Good News – The undersized leaky return will help to keep the coil from freezing up… Oh wait… That's the Good News?!?

Myth #7 *Any old location is fine for supply outlets.* Without the Specific performance of a supply grill regarding throw, spread, drop, and terminal velocity based on calculated airflow and velocity, we cannot properly located a supply register. Manual T in conjunction with Manual D is the only correct solution. Improper location will result in drafts, hold and cold spots and comfort complaints.

Myth #8 *Flex duct comes in 25' sections which are less that Typically needed for a run. A ductulator calculates airflow for 100' so we should have more than enough airflow.* We have to calculate all the components into the total effective length NOT just the length of the flex. Remember the 124' total equivalent length example on a 14' piece of flex? When the fittings, dampers, bends etc. are taken into account, the total equivalent length of a duct run is often over 300 feet!



DESIGN CONSIDERATIONS

*This duct sizing was designed for a total static, including plenums and grills of 0.4 in. w.c. Units that will not put out this much external static pressure will deliver less than the design cfm if sized by these charts.

**All of the duct runs are assumed to have 20 equivalent feet of duct. One 90° bend gives about the same friction loss as 10 ft. of duct, so the 20 equivalent ft. can be 10 ft. of duct and one bend or 20 ft. of duct with no bends. If the total equivalent feet of duct run is 40 ft. or more, increase the duct diameter one size. If the duct is 2 ft. or less with no bends, decrease the duct diameter by one size.

***When clearance problems limit the duct size you can use, look up 1/2 the required cfm and use two ducts running side by side.

****The information presented here is based on laboratory tests, and has been checked with years of experience. While we feel that duct systems sized by this method should deliver within 10% of design air flow at each outlet, actual air flow may vary somewhat due to field conditions and quality of workmanship.

Additional HVAC Resources

- YouTube: Search for "SPEER Communications"
- ACCA video series on YouTube – "What Code Officials Need to Know About HVAC System Design"
- Design Conditions: https://higherlogicdownload.s3.amazonaws.com/ACCA/c6b38bda-2e04-4f93-bd51-7a80525ad936/UploadedImages/Outdoor-Design-Conditions-1.pdf
- https://basc.pnnl.gov/home-improvement-expert/checklists - GREAT HVAC Checklists!
- https://www.hvacrschool.com/ - Great all around resource. Podcasts, tips, etc.
- HVAC and water heater product database: https://www.building-center.org/
- Coolcalc.com (free Manual J load calculation software)
- Google: "Fibrous Glass Duct Construction Standards"
- Flex Duct installation instructions: https://flexibleduct.org/images/ADC~IR5E.pdf (or Google)
- https://www.acca.org/viewdocument/residential-system-design-review-forms-examples or Google: "Residential System Design Review Form"
- Video on **buried ducts** and more: https://www.energycodes.gov/training
- Junction box info: https://www.nrel.gov/docs/fy14osti/61438.pdf
- Good general HVAC code & installation info: https://basc.pnnl.gov/building-components
- Free Digital Code Books (all ICC code books): https://codes.iccsafe.org/
- https://www.energyvanguard.com/blog/how-read-manual-j-load-calculation-reports (good how to read Man J)
- Great HVAC checklist – google "energy star HVAC checklist"

Questions or concerns… Contact Jason Vandever at jvandever@eepartnership.org