Duct Diagnostics: What’s Wrong with this System

Some Basics of Duct Design and Installation

Good Ducts Start With Good Design

Duct Design Objective

Topics Addressed in Session
- Ductwork sizing discussion.
- Tools for duct design and commissioning.
- Some duct installation details.
- Analysis of existing ductwork.
- Ductwork trouble-shooting.
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Low Noise Levels are Important

A Well Designed Duct System

- Properly balanced.
- Look good.
- Be inexpensive to install.
- Help create a comfortable environment.
- Be very quiet while air handler is operating.
- Be economical to operate.
  - Proper insulation, tight ducts, no pressure imbalance.
  - Be healthy for occupants (e.g., from pressure imbalances).
  - Be easy to maintain.

Duct Design Rules

- Place air handler in central location.
- Plan for symmetrical duct system.
- Keep duct runs short.
- Support ducts properly.
- Use minimum number of fittings.
- Keep aspect ratio low.
- Select registers properly.
- Install return in each room having a working door.
- Etc.

Duct System Pressures

Static Pressure
- Static pressure measurement at different points throughout the system.
- Static pressure difference is not due to changes in the flow.
- Flow always to the direction from high to low pressure.
- Static pressure measurement at end of the run.
- Static pressure measurement before and after a change in the system.

Velocity Pressure
- Velocity pressure is adjusted to the direction of flow.
- Velocity pressure causes a change in pressure to occur as a result of static pressure.
- It is duct, it cannot be measured.
- Measuring velocity pressure difference between two points involves the velocity pressure.
- Velocity pressure is caused to change or maintain the same.

Measuring Temperature Rise & Calculating CFM

Design Standard is Manual D

Available from
ACCA
2800 Shirlington Road, Suite 300
Arlington, VA 22206
(703) 575-4477
www.acca.org

Pages 47 and 35 - 49
Manual D Procedure

- Calculate DHL/DCL (Manual J, ACCA).
- Determine External Static Pressure (ESP) from manufacturer’s data.
- Determine device pressure losses (DPL) that are added to distribution system.
- Determine Available Static Pressure (ASP).
  - ASP = ESP – DPL (Equal to about 0.2” WG, limits of range are 0.10” to 0.35” WG).
- Check velocity.
- Calculate CFM for each register (room).
  - Room CFM = HF or CF x Room DHL
- Plan location of registers and grilles (Manual T).
- Visual inspection.
- Visual inspection.
- Visual inspection.
- Select registers and grilles (Manual T, ACCA).
- Balance system with branch balancing dampers.
- Tools for Duct Design & Testing
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Duct Calculator
From ACCA

Duct Blower
The Energy Conservatory
Duct Blaster™

Duct Leakage Testing
- If you don’t test, you don’t know.
- Duct leakage testing is essential to producing comfort and efficiency.

Blower Door
A blower door is often needed for duct leakage testing.
**Duct Diagnostics: What's Wrong with this System?**

**Pressure Pan & Flowbox**

- The volumetric capture bag.
- AKA the garbage bag.
- Works by timing how long it takes to fill a known volume with air.

**Measuring Air Flow**

- **Garbage Bag Flow**
  - Graph showing flow rates over time.
  - 31 grams, 43 grams.
  - Seconds to fill bag.

**Some Duct Installation Details**

- Try to Keep Duct Inside
  - Inside vs. outside the air and thermal barrier of the house.
  - If the ducts are outside, more work is required to make them efficient.

- Do not use duct tape on ducts!
  - But, it's really good for many other needs.
Duct Diagnostics: What's Wrong with this System?

**Ducts Should Be Permanently Tight**
- Mechanical Fastening
- Sealed with Mastic

Pay attention to gores

**Love that Duct Mastic**

**Provide Ability to Adjust Airflow**
- If ducts are large enough, airflow can be adjusted to meet individual comfort levels or differences in heating and cooling loads.

Balancing damper handle

**Temperature Measurements**

Simple temperature readings can help locate leaks or loss of cooling or heating energy in a ducted system.

**Impact of an Air Handler**

- What happens to air leakage as a result of the closed bedroom door?
- What if a return is installed in the basement return trunk?
- What if the supply trunk leaks to the outdoors?

**Multiple Returns are Essential**
- Return air paths are critical to a good duct system.
- A closed door can serve as an air distribution damper!!
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Return Side Retrofit

For a furnace/AC to operate at maximum efficiency and capacity, the volume-carrying capacity of the return air must equal that of the supply air. However, many residential systems are undersized on the return side, causing pressure imbalances and discomfort. To balance the return and supply sides, additional return grilles and ductwork might have to be added.

Source: Journal of Light Construction, 2/94, page 49

Analysis of Existing Ductwork 1

- Interview occupants about thermal comfort of existing system.
  - Ask such things as:
    - Uncomfortable rooms.
    - Excessive noise.
    - Frequent cycling of air handler blower.

Analysis of Existing Ductwork 2

- Inspect air handler and ductwork for such things as:
  - Anticipator setting.
  - Duct leakage.
  - Restricted returns.
  - Panned floor joists.
  - Ducts in unconditioned spaces.
  - Balancing dampers.

Analysis of Existing Ductwork 3

- Do technical appraisal of duct system and equipment:
  - Temperature rise.
  - Static pressure measurements.
  - Blower CFM.

Analysis of Existing Ductwork 4

- Do pressure testing of existing system:
  - Room-to-room pressures.
  - Duct leakage testing
    - Blower door.
    - Duct blower.
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Analysis of Existing Ductwork

- Determine strategies for duct repair:
  - Write down possible problems.
  - Check trouble-shooting list.
  - Determine required alterations to furnace/AC and ductwork.
  - Decide on consumer education strategies.

Now, Perform the Work!

Duct Trouble-Shooting Tables

Ductwork Troubleshooting 1

Ductwork Troubleshooting 2

Ductwork Troubleshooting 3
### Ductwork Troubleshooting 4

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Too High/Material Too High</td>
<td>Incorrect Air Flow Through System</td>
<td>Increase Air Flow</td>
</tr>
<tr>
<td>High Return Temp</td>
<td>Dirty or Restricted Return Air System</td>
<td>Replace Return Filter</td>
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<td>High Return Temp</td>
<td>Undersized Return Air System</td>
<td>Repair Return Air System</td>
</tr>
</tbody>
</table>

- **Notes:** The causes for high temperature and material temperature are not listed in the table.

| Temperature Too Low/ material too low | Incorrect Air Flow Through System | Increase Air Flow |
| Low Return Temp | Dirty or Restricted Return Air System | Replace Return Filter |
| Low Return Temp | Dirty or Restricted Return Air System | Replace Return Filter |
| Low Return Temp | Undersized Return Air System | Repair Return Air System |
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