Retrofitting Existing Ducted Systems

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

Some Basics of Duct Design and Installation

Ducted Distribution

Good Ducts Start With Good Design
- Design - yeah, right! What constitutes design is usually a mix of afterthought, what happens to be on the truck at the moment, and the need to get the job done quickly.

Duct Design Objective
- Duct delivery system provides year-around comfort with:
  - Efficiency,
  - Little noise,
  - No hazards to occupants,
  - Little maintenance.
Retrofitting Existing Ducted Systems

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.

See Handout 2, Page 2

Low Noise Levels are Important

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.

See Handout 2, Page 3

Duct System Pressures

Measuring Temperature Rise & Calculating CFM

Design Standard is Manual D

See Handout 2, Page 4

See Handout 2, Page 5

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

Rick Karg, R.J. Karg Associates
Retrofitting Existing Ducted Systems

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).

Manual D Procedure (con.)
- Plan location of registers and grilles (Manual T).
- Determine the greatest Total Effective Length (TEL) value for the duct system, supply and return sides. Include measured length and fitting equivalent length.
- Calculate Friction Rate design value (FR).
  - FR = (ASP x 100)/TEL, or use friction chart.
  - Friction rate should be between 0.06” and 0.18” WG/100 feet of duct.

Manual D Procedure (con.)
- Calculate heating and cooling airflow factors.
  - HF = (blower CFM)/(Design heating load)
  - CF = (blower CFM)/(Sensible cooling design load)
- Calculate CFM for each register (room).
  - Room CFM = HF or CF x Room DHL
- Size branch ducts and trunks with use of duct calculator or friction chart.
- Check velocity.
- Select registers and grilles (Manual T, ACCA).
- Balance system with branch balancing dampers.

Ductwork Specification 1

Ductwork Specification 2

Tools for Duct Design & Testing
Retrofitting Existing Ducted Systems

Duct Calculator
From ACCA
See Handout 2, Page 45
Also, Page 36 "Friction Chart"

Duct Blower
The Energy Conservatory Duct Blaster™

Trueflow Air Meter
The Energy Conservatory

Digital Manometer

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

**Blower Door**
A blower door is often needed for duct leakage testing.

**Pressure Pan & Flowbox**

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

**Room-to-Room**
Pressure Testing with Ducted Distribution
- Occupants live within the ducted system.
- Return air paths are critical to a good airflow.
- A closed door can serve as an air distribution damper!!
Room-to-Room Pressure Differences - 2

- Pressure difference across door should be 5 Pascals or less.
- Determine with digital manometer. Relieve higher pressures by:
  - Undercutting doors.
  - Installing a grille in door or wall.
  - Installing a jump or transfer duct.
  - Adding a return to the problem room.

Some Duct Installation Details

Try to Keep Duct Inside

- Inside vs. outside the thermal envelope 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.

Ducts Should Be Permanently Tight

- Mechanically Fastened
- Sealed with Mastic

Pay attention to gores.

Love that Duct Mastic
Retrofitting Existing Ducted Systems

Provide Ability to Adjust Airflow

- If duct 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!!

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.

Analysis of Existing Ductwork
Retrofitting Existing Ducted Systems

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.

See Handout 2, Pages 21–22 and 23–24 (Manual D)

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.

See Handout 2, Pages 21–22 and 23–24 (Manual D)

Analysis of Existing Ductwork 3

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

See Handout 2, Pages 21–22 and 23–24 (Manual D)

Analysis of Existing Ductwork 4

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

See Handout 2, Pages 21–22 and 23–24 (Manual D)

Analysis of Existing Ductwork 5

- 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.

See Handout 2, Pages 21–22 and 23–24 (Manual D)

Now, Perform the Work!
Retrofitting Existing Ducted Systems

**Duct Troubleshooting Tables**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducted</td>
<td>Unbalanced airflow compensation</td>
<td>Increase airflow in duct.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Duct and/or filter plugged</td>
<td>Replace or clean filter.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Overheated filter</td>
<td>更换热过滤器。</td>
</tr>
<tr>
<td>Ducted</td>
<td>System not chilled</td>
<td>Increase airflow in duct.</td>
</tr>
</tbody>
</table>

**Ductwork Troubleshooting 1**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducted</td>
<td>Unbalanced airflow compensation</td>
<td>Increase airflow in duct.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Duct and/or filter plugged</td>
<td>Replace or clean filter.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Overheated filter</td>
<td>更换热过滤器。</td>
</tr>
<tr>
<td>Ducted</td>
<td>System not chilled</td>
<td>Increase airflow in duct.</td>
</tr>
</tbody>
</table>

**Ductwork Troubleshooting 2**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducted</td>
<td>Unbalanced airflow compensation</td>
<td>Increase airflow in duct.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Duct and/or filter plugged</td>
<td>Replace or clean filter.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Overheated filter</td>
<td>更换热过滤器。</td>
</tr>
<tr>
<td>Ducted</td>
<td>System not chilled</td>
<td>Increase airflow in duct.</td>
</tr>
</tbody>
</table>

**Ductwork Troubleshooting 3**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducted</td>
<td>Unbalanced airflow compensation</td>
<td>Increase airflow in duct.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Duct and/or filter plugged</td>
<td>Replace or clean filter.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Overheated filter</td>
<td>更换热过滤器。</td>
</tr>
<tr>
<td>Ducted</td>
<td>System not chilled</td>
<td>Increase airflow in duct.</td>
</tr>
</tbody>
</table>

**Ductwork Troubleshooting 4**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducted</td>
<td>Unbalanced airflow compensation</td>
<td>Increase airflow in duct.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Duct and/or filter plugged</td>
<td>Replace or clean filter.</td>
</tr>
<tr>
<td>Ducted</td>
<td>Overheated filter</td>
<td>更换热过滤器。</td>
</tr>
<tr>
<td>Ducted</td>
<td>System not chilled</td>
<td>Increase airflow in duct.</td>
</tr>
</tbody>
</table>

**Remainder of Handout 2**

- Duct design and analysis: equations, etc (pg 29 – 32).
- Effective length diagrams (pg 33).
- Effective length of fittings (pg 34).
- Friction rate chart (pg 35).
- Friction chart (pg 36).
- Round to rectangular conversion chart (pg 37).
- Air velocity chart (pg 38).
- Manufacturer’s register info. (pg 39).
- Duct sizing example, Manual D (pg 40 – 43).
- ACCA ordering information (44 – 46).