PRODUCING AIRTIGHT DUCTS

Neil Moyer
FLORIDA SOLAR ENERGY CENTER
A Research Institute of the University of Central Florida
GET YOUR DUCTS IN A ROW

- Why airtight ducts are essential
- Options for duct systems
- Sealing materials and
- Diagnostic procedures
SOME BACKGROUND
Schematic: The Duct
FORCED AIR DISTRIBUTION SYSTEM
Heats, Cools & Sometimes Ventilates
WHY AIRTIGHT DUCTS ARE ESSENTIAL
Air Tight Ducts Promote...

Health & Safety
Air transported contaminants, Combustion

Building Durability
Deterioration, Pests, Fire

Comfort
Temperature, Humidity, Filtration

Energy Efficiency
Decreases energy use
Understanding Pathways & Pressures
Driving Forces of Building Leakage

- Natural
  - Wind
  - Stack
- Human Interaction
  - Combustion
  - Fans
  - Duct Leakage
  - Door Closure
Common Callbacks in Residential Buildings -

- High interior humidity level
- Wet crawlspaces & basements
- High cooling bills
- Uneven temperatures
- Drafts
- Indoor mold concentrations
- Insects
DUCT LEAKAGE
DUCT LEAKAGE HEATING

KW Demand
Heating (house in Northern Florida)

Source: Contracting Business Apr 94,
Solving Leakage & Return Problems by
Hank Rutkowski

Performance w/ leaks  w/ 70% leaks repaired
DUCT LEAKAGE COOLING

KW Demand
Cooling (house in Northern Florida)

Source: Contracting Business Apr 94,
Solving Leakage & Return Problems by
Hank Rutkowski

Hour of Day

Performance w/ leaks  w/ 70% leaks repaired
a/c Pulldown Times

- Good System - No leaks, ducts indoors
- Poor System - Leaky ducts in attic

Diagram showing indoor temperature over time of day.
FLORIDA DUCTS
FLORIDA DUCTS
POPULAR DUCT LEAKS

More tape, more tape…
POPULAR DUCT LEAKS

Smart air
POPULAR DUCT LEAKS

Mastic over tape
South Carolina Ducts

Creative duct work increasing energy use and decreasing comfort

Special kinky duct for reducing airflow?

Truss-n-duct application
DUCTS AND STUFF

Wow – what a leak
New Jersey Ducts

New house in the country

Disconnected SA duct over living room

RA duct leaks depressurizing insulation to ~1pa
NEW JERSEY DUCTS (cont)

Duct leaks only add to an already serious problem
NEW YORK DUCTS

SA leak with homeowner repairs

RA leaks in basement ooops...forgot to attach a duct or 2
WARM MOIST AIR COMING IN
Texas Ducts

House at –6pa when central a/c operates...all because of disconnected duct in attic.

1 of 2 additional a/c & window treatment...electric bills near $500/month

Warping wallboard
MFG HOUSING DAMAGE

Walls

Ceilings

Floors
Focus on the SEER FACTS to provide the highest performance...

Field Adjustment performance factors:

Airflow for the system near 400 cfm per ton

Charge refrigerant properly

Tight ducts — avoid leak to outside

Size equipment correctly
Each of the Field Adjustment factors are assumed to act on SEER independent of each other; the actual combined effect may, in fact, be different than what is represented in this chart.

Values on this chart reflect fixed orifice air conditioning systems.
Effect of Duct Leakage on 12 SEER Rated Equipment

Field Adjusted SEER

None       Good       Typical

Duct Leakage

Impacts of Duct Leakage on Rated SEER
DUCT LEAKAGE STATS

Florida

- 50 all electric homes
- 13% total building leakage in duct system
- 17% savings
- $200 cost

Typical: single story, slab on grade, duct board ducts in attic
DUCT LEAKAGE STATS

- North Carolina
  - 5 Heat pump houses
  - 15% total house leakage in ducts
  - 10-13% savings
  - $200 repair

Typical: two story house on crawlspace, metal & flex duct system located in both attic and crawlspace.
DUCT LEAKAGE STATS

- California
  - 51 Heat pump houses
  - 16 disconnects
  - 33 major leaks
  - 8% building leakage in ducts
  - 15% savings
  - $185 repair cost

Typical: single story, crawlspace, metal & flex ducts in attic & crawlspace
DUCT LEAKAGE STATS

- Arkansas
  - 24 houses combination gas (19) & heatpump (5)
  - 21% total house leakage in duct system
  - 31% savings for heatpumps
  - 30% savings for gas
  - $300 repair cost

Typical: single story, basement houses, metal & flex duct located in basement & attic.
Causes of Duct Leaks

- Use of sealing materials which are not durable over time
- Improper application of sealing materials
- Building cavities used as a duct
- Lack of duct support
- Failure to isolate plenum cavities from adjoining building structure
- Exposure to UV
- Rodent/human damage
- Poor design (diapered ducts)
- Workmanship
COMBUSTION RELATED
Combustion Safety Problems
Caused by Depressurization of the Combustion Zone

- Normal Draft: CAZ wrt Out - 0 pascal
- Spillage: CAZ wrt Out - 5 pascals
- Backdraft: CAZ wrt Out - 8 pascals
- Incomplete Combustion: CAZ wrt Out - 15 pascals
- Flame Rollout: CAZ wrt Out - 25 pascals
**CANADIAN STUDY DEPRESSURIZATION LIMITS**

<table>
<thead>
<tr>
<th>Chimney Height</th>
<th>Unlined Chimney</th>
<th>Lined or Insulated Chimney</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Furnace or DHW</strong></td>
<td>&lt;14’</td>
<td>5 pa</td>
</tr>
<tr>
<td>14-20’</td>
<td>5 pa</td>
<td>6 pa</td>
</tr>
<tr>
<td>&gt;20’</td>
<td>5 pa</td>
<td>7 pa</td>
</tr>
<tr>
<td><strong>Oil Furnace or DHW</strong></td>
<td>&lt;14’</td>
<td>4 pa</td>
</tr>
<tr>
<td>14-20’</td>
<td>4 pa</td>
<td>5 pa</td>
</tr>
<tr>
<td>&gt;20’</td>
<td>4 pa</td>
<td>6 pa</td>
</tr>
<tr>
<td><strong>Fireplace</strong></td>
<td>NA</td>
<td>3 pa</td>
</tr>
</tbody>
</table>

**Backdrafting in Mechanical Room**

- Mechanical room depressurized by return system leakage
POTENTIAL FAILURES BY UAF
### CO (carbon monoxide) poisoning & flame roll-out from vented combustion devices

<table>
<thead>
<tr>
<th>Concentration of CO in air</th>
<th>Inhalation time and toxic symptoms developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 ppm 0.0009%</td>
<td>The maximum allowable concentration for short term exposure in a living area according to ASHRAE</td>
</tr>
<tr>
<td>35 ppm 0.0035%</td>
<td>The maximum allowable concentration for continuous exposure in any 8-hour period, according to federal law.</td>
</tr>
<tr>
<td>200 ppm* 0.02%</td>
<td>Slight headache, tiredness, dizziness, nausea after 2-3 hours</td>
</tr>
<tr>
<td>400 ppm 0.04%</td>
<td>Frontal headaches within 1-2 hours, life threatening after 3 hours, also maximum ppm in flue gas according to EPA and AGA</td>
</tr>
<tr>
<td>800 ppm 0.08%</td>
<td>Dizziness, nausea and convulsions within 45 minutes. Unconsciousness within 2 hours. Death within 2-3 hours.</td>
</tr>
<tr>
<td>1600 ppm 0.16%</td>
<td>Headache, dizziness and nausea within 20 minutes. Death within 1 hour.</td>
</tr>
<tr>
<td>3200 ppm 0.32%</td>
<td>Headache, dizziness and nausea within 5-10 minutes. Death within 30 minutes.</td>
</tr>
<tr>
<td>6400 ppm 0.64%</td>
<td>Headache, dizziness and nausea within 1-2 minutes. Death within 10-15 minutes.</td>
</tr>
<tr>
<td>12800 ppm 1.28%</td>
<td>Death within 1-3 minutes.</td>
</tr>
</tbody>
</table>

10000 ppm (parts per million) = 1% by volume.

*Maximum CO concentration for exposure at any time as prescribed by OSHA. Effects can vary significantly based on age, sex, weight, and overall state of health.
AND THEN THERE ARE FIREPLACES...
Four Reasons Fireplaces Smoke

1. Cold Chimney
2. Stack Effect
3. Mechanical systems
4. Wind
Air Distribution System

- Innovative system
- Ductwork located inside of the building envelope in the dropped plenum (i.e. not in vented attics, exterior walls, attached garages)

Building Science Corp
A COUPLE OF OPTIONS
FOR DUCT SYSTEMS
INTERIOR DUCT SYSTEM DESIGN, CONSTRUCTION, AND PERFORMANCE

- FSEC
  - Janet McIlvaine, David Beal, Philip Fairey

- U.S. Dept of Energy Cooperative Agreement
  - Esher Kweller, DOE
  - Bill Hasslebacher, NETL

- Research Support
  - Jim Cummings, Neil Moyer: FSEC
  - Bruce McKendry: WattsRight
  - Jon Andrews: Brookhaven National Lab
THE NORM: DUCTS IN UNCONDITIONED SPACES

- **Losses and Risks?**
  - IAQ Issues
  - Durability Losses
  - Conductive gains/losses
  - Duct Leakage

- **Consequences**
  - Increased machine run time
    - Durability & Cost
  - Unplanned air exchange
    - Extreme thermal conditions
    - Mold, Condensation, & Rot
    - Allergens & Irritants
Reducing the Impact of Ducts in Unconditioned Spaces

- Sealed and Insulated Ducts: continuous thermal barrier and sealed with mastic and mesh *including the return plenum*.

- Unvented Attics and Crawlspace – move the air and thermal barriers to the other side of the air distribution system.

- Interior Duct Systems – move the air distribution system to the inside of the house’s thermal and air barriers.
INTERIOR DUCT CHASE: AIR BARRIER IN PLACE

Sealed

Not Sealed
Interior Duct System — Fur Down in Open Areas

- Attic
- Open Living
- Sealing at joints, seams, wiring, and plumbing penetrations, etc.
- Air Barrier
- Support for hall ceiling

- Framing
- Duct Chase
- Duct System
- Air Barrier
- Sealant
Texas Houses

% Duct Leakage (Qn)

1.3% 4.3% 16.7% 15.5% 4.9% 3.3% 4.9% 13.7% 4.3% 16.7% 0.0% 2.0% 4.0% 6.0% 8.0% 10.0% 12.0% 14.0% 16.0% 18.0% 20.0%

House Number
(5 & 6 Same House - Before & After Retrofit)

Qn = \frac{\text{Measured Duct Leakage to/from Unconditioned Spaces}}{\text{Conditioned Area of the House}}

Target for Duct System Leakage Substantially Leak Free = 3%

As Built

Retrofit: 36% Improvement
Florida Houses

Qn = \frac{\text{Measured Duct Leakage to/from Unconditioned Spaces}}{\text{Conditioned Area of the House}}

Target for Duct System Leakage
Substantially Leak Free = 3%

House Number

1 2 3 4

% Duct Leakage (Qn)

2.3% 2.4% 2.8% 2.0%
Savings and Ratings

- North Carolina Houses: 1014 sq ft
- 5 with Ducts in Crawl Space
  - Average loss of air 6.8%
  - 68.9 CFM25out
  - Annual Est. Energy Cost = $1099
  - HERS Rating 82.3
- Ducts in Conditioned Space with Qn = 4% (average)
  - Average loss of air 4%
  - 40.64 CFM25out
  - Annual Est. Energy Cost = $1013
  - HERS Rating 85.1
- Estimated Annual Savings = $86
- HERS Rating Improvement = 3.2
Cost Effectiveness

Example Economics from North Carolina Houses

- $0  No incremental cost for duct installation
- +$200  Drywall for miscellaneous air barriers
- $0  Ceiling insulation will be thermal barrier
- +$350  Labor + materials to install and seal air barrier
- - $250  ~1/2 ton reduction in heating/cooling
- $300  FIRST COST

Annual Savings = $86
Simple payback $300/$80 = 3.75 years
Limitations and Applicability

- Excessive cost: $3,000 for modified trusses and run outs 😞
- $3000/$120 = not cost effective based on energy savings
- Lesson: Learn from others’ mistakes
- Applicability: New construction, renovation, remodeling.
- Limitations: Requires advance planning, excellent site supervision, and group effort among sub contractors.
- Savings: Estimated $80-$120 annually; no measured data.
**Problems Identified During Testing**

- **Discontinuous Air Barrier:**
  - **Leaky chases**
    - Adjacent interior walls
    - Drywall to top plate
    - Electrical and plumbing penetrations
    - Unsealed gap between chase walls and ceiling drywall (Attic fur-up only)
  - **Building cavities used as returns and/or supplies**
    - Leak to attic
    - Leak to exterior
FUR UP CHASE IN RAFTER FRAME ATTIC

**Problems:**
- Platform Return
  - Not sealed from adjacent interior walls
- Attic Fur-up
  - Holes from other trades
  - No connection to drywall ceiling
  - Missing insulation
  - Trade Coordination
    - Plumbing, electrical, alarm, and phone installers view chase as dropped ceiling
    - Drill holes for pipe and wiring and don’t seal.

**Solution:**
- Add blocking between bottom of chase wall and ceiling drywall
- Spray foam on chase walls and top of AHU Closet

**Result:**
- 36% Reduction in CFM25out
**Recommendations - Before Construction**

**Design**
- Completely think through the construction during design
- Make the path of the chase as simple as possible
- Avoid miscellaneous framing under the trusses
- Take advantage of space above cabinets and tops of closets
- Do not locate supply registers above doors
- Show the chase on at least the dimensional, mechanical, and framing plans
- Provide a detailed section indicating materials and sealant locations

**Logistics**
- Have air barrier material on site when needed
- Mark position of door framing on chase walls before framing out the bottom – allow for floor finish and chase structure

**Trade Coordination**
- Communicate the intent and location of the chase to all trades affected by the chase
- Identify the chase on all plans
**Recommendations - During Construction**

- **On-site Coordination of Trades**
  - GC level supervision
  - Site Communication (color codes, symbols)
    - Post drawing of the detail for reference
    - Mark location of chase at the bottom plate
    - Mark supply registers on chase walls
  - Post M/E/P inspection “seal up”
  - He who drills it, seals it.

- **Seal the top of the chase to the walls** of the chase as if it were a ceiling to interior walls

- **Avoid unducted returns** - Seal non-ducted plenums with mastic

- Detailed design and construction guidelines available, contact:
  - Janet McIlvaine 321-638-1434 janet@fsec.ucf.edu
  - David Beal 321-638-1433 david@fsec.ucf.edu
Ducts are contained in redesigned cavities that keep all the ducts out of the attic. This increases performance and improves attic insulation coverage.
The finished product now has added value and improved performance.
“CONDITIONED” SPACE

- Equipment
- Storage
- Future expansion
HOAK HOUSE

4,250 square foot home in Orlando completed in February 2001 uses 2.5 ton A/C
GOOD DUCTS - S.T.I.R
(Sealed Tight & Insulated Right)

- Closure System Application
  - Closure products shall be applied to the air barriers to form a continuous air barrier.

- Access To Seal
  - Sufficient space shall be provided adjacent to all mechanical components to assure adequate access for (1) construction and sealing and (2) cleaning and maintenance.

- Receiving Surface Preparation
  - The surfaces shall be clean and dry. Dust, dirt, oil, grease, moisture, or other substances should be removed.
Mechanical Fastening

- All joints between sections of air ducts & plenums, intermediate & terminal fittings & other components fastened to secure sections *independently* of the closure system.

- Approved attachments include...
  - Fibrous glass duct - clinching staples
  - Flexible duct - drawbands
  - Sheet metal duct - screws, rivets, welds, interlocking joints
  - Metal to fibrous glass duct - bend taps or screw taps & flanges
GOOD DUCTS - (CONT.)

Closure Products

• Any material or system of materials may be used as an air barrier if the following requirements are met:
  • Flame spread rating < 25 without evidence of continued progressive combustion and a smoke development rating < 50 when in the final dry state. (Class I sealant)
  • Must be CONTINUOUS.
  • Must be able to WITHSTAND the air pressure loading which act on it -- both negative and positive.
  • Must be IMPERMEABLE to the passage of air.
  • Must be adequately stiff or RIGID.
  • Must be DURABLE over the service life of the system.
Definitions

- Seal(ing): The use of welds, mastics, mastic+embedded fabric, adhesives, caulking, gaskets, pressure sensitive tapes, heat activated tapes, or combination, to close cracks, joints, seams and openings in the air barrier.

- Air Barrier: A material which impedes or restricts the free movement of air.
  - Fibrous glass duct - the foil cladding
  - Flexible non-metal duct - the non-porous core
  - Sheet metal duct - metal in contact with air stream
  - Air handler units - metal in contact with air stream
**McGill AirSeal Corporation**

**IRON-GRIP 601**
A premium grade, latex based sealant for indoor/outdoor low, medium and high pressure galvanized HVAC duct systems. Gray in color; this fiber-free product cures to form a tough flexible film. U.L. 181 B-M Listed. U.L. 723 Classified.

**FLEX-GRIP 550**

**VERSA-GRIP 181**

**VERSA-GRIP 102**

**DUCT-SEAL 321**
An all purpose, industrial grade, water based duct sealant for all types of low, medium and high pressure indoor/outdoor duct work. Product is gray in color, with a smooth texture. U.L. 181 B-M Listed. U.L. 723 Classified.

**SURE-GRIP 404**
A strong, solvent based, non-sag, flexible duct sealant for indoor use on low, medium and high pressure galvanized metal duct systems. Gray in color and U.L. 723 Classified.
The duct sealing process:
To start the Aeroseal duct sealing process, all room ceiling or floor registers are replaced with foam plugs.

A small access hole is cut into the supply or return air plenum and a temporary collar is attached. The air conditioning indoor coil, fan, and furnace are temporarily blocked with a foam plug to avoid the entrance of any sealing particles into this equipment.

Once the system is properly sealed the patented injection machine is connected to the air duct system using a flexible plastic tube.

The exclusive Aeroseal duct sealing system injects adhesive particles into the air duct system. The particles travel through the air duct system seeking holes and cracks that are located throughout the ductwork. The adhesive duct sealing particles attach directly onto the edges of any hole and crack effectively sealing it without coating the inside of the ductwork.
Plan for a Successful Duct System

1-Must be FUN
   • Financially sound
   • Undoubtedly right
   • Notably rewarding

2-Must save lives

3-Must save buildings

4-Must save money / comfort

5-Must be done right the 1st time
Mastic

NOT
Duct Tape!
Feds Spy on Duct Tape

The Original DuctTapeCam with RemotePan

This live camera image is updated ASAP! Hit reload on your browser to get the latest image.

If the duct tape isn't responding right now, you can look at these previous images:
- Early this morning / Yesterday evening / Feeding / Sleeping
- [The Duct Tape page]

http://epb1.lbl.gov/EPB/ducts/
The accelerated-aging rig simulates realistic conditions by running the air at about 100 Pascals. Each duct sample contains a hard-to-seal joint: finger-jointed sheet-metal duct joining a stepped transition, typical of how ducts join plenums. Different duct sealants have very different longevities under these conditions.
And the winner is...

Duct tape can form a good seal--initially. But under the challenging conditions of the aging rig, it quickly fails.

- Mastic has performed very well in the aging rig, with no noticeable increase in leakage over time.
## Aging Test

<table>
<thead>
<tr>
<th># of Tests</th>
<th>Sealant Type</th>
<th>Approximate Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>5 different grades of duct tape</td>
<td>7 days, failed</td>
</tr>
<tr>
<td>3</td>
<td>181B-FX-approved duct tape</td>
<td>10 days, failed</td>
</tr>
<tr>
<td>1</td>
<td>181B-FX-approved duct tape</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>15-mil foil-backed butyl tape</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>Aerosol sealant</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>181A-M- and 181B-M-approved mastic</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>181A-P-approved foil tape</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>181A-P- and 181B-FX-approved foil tape</td>
<td>1 month</td>
</tr>
<tr>
<td>1</td>
<td>Packing tape</td>
<td>3 months</td>
</tr>
<tr>
<td>1</td>
<td>181B-FX-approved packing tape</td>
<td>1 month</td>
</tr>
</tbody>
</table>

Grey bars denote failed samples
# A Couple More Tests

## Baking Test

<table>
<thead>
<tr>
<th>#</th>
<th>Material</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3 different grades of duct tape</td>
<td>34 days, failed</td>
</tr>
<tr>
<td>1</td>
<td>181B-FX-approved duct tape</td>
<td>60 days, failed</td>
</tr>
<tr>
<td>2</td>
<td>Duct tape</td>
<td>4 months</td>
</tr>
<tr>
<td>3</td>
<td>181B-FX-approved duct tape</td>
<td>4 months</td>
</tr>
<tr>
<td>1</td>
<td>Packing tape</td>
<td>4 months</td>
</tr>
<tr>
<td>1</td>
<td>181A-P-approved foil tape</td>
<td>4 months</td>
</tr>
<tr>
<td>1</td>
<td>Aerosol sealant</td>
<td>4 months</td>
</tr>
</tbody>
</table>

## Cycling Test

<table>
<thead>
<tr>
<th>#</th>
<th>Test Description</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Aerosol sealant under pressure cycling only</td>
<td>2 years</td>
</tr>
<tr>
<td>4</td>
<td>Aerosol sealant with heat and pressure cycling</td>
<td>2 years</td>
</tr>
</tbody>
</table>

*Grey bars denote failed samples*
WHERE TO LOOK FOR LEAKY DUCTS

1.Disconnected ducts
2. Building cavities used as duct
3. Plenums and air handlers
4. T's, Y's, and L's
5. Boots
6. Straight joints
DUCT REPAIR IN PROGRESS

Mastic
Use a UL 181A-M and UL 181 B-M Listed mastic designed for the type of duct being installed or repaired. Mastic can be applied by gloved hand, brush, trowel or caulking gun. Insulation can be installed over mastic that is still wet.
PLAN FOR SUCCESSFUL DUCT SYSTEM

The only way to know that your ducts are tight

TEST’em!
DIAGNOSTICS - SOME TOOLS
The Pressure Pan
a FEW DUCT TESTERS

Energy Conservatory

Infiltec

McGill

Retrotec
DUCT AIRTIGHTNESS - TOTAL

Total Duct Airtightness Test

House Air Barrier
Temporary Seal
Flow Sensor wrt Flow conditioner
Return Duct wrt House
Duct Tester Assembly
-25

Supply
Air Handler Unit
Return

EEBA 2004
DUCT AIRTIGHTNESS - PREP

- Air handler unit (ahu) off & remove filters.
- Attach tester to either the ahu cabinet or the largest & closest return to the ahu.
- Seal off all supply registers and return grills.
- Close outside air ducts
**DUCT AIRTIGHTNESS - LEAKAGE OUT**

Outside Duct Airtightness Test

**Temporary Seal**

- **Blower Door Assembly**
- **House Air Barrier**
- **Flow Sensor wrt Flow conditioner**
- **Duct Tester Assembly**
- **Return Duct wrt House**
- **House wrt Outside**
- **Return**
- **Supply**
- **Air Handler Unit**

**Outside Duct Airtightness Test**

EEBA 2004
DUCT AIRTIGHTNESS - OUT

- Depressurize return duct to 25 pascals wrt outside.
  (0 pascals wrt house)
- If supply duct pressure < 22 pascals, then take supply to 25 pascals & average the flows.
- CFM25out is flow required to depressurize ducts to 25 pascals wrt outside.
DUCT TESTING: IN CONSTRUCTION
A FEW REFERENCE MATERIALS
<table>
<thead>
<tr>
<th>Volume Title</th>
<th>Topic</th>
<th>Main Audiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Duct Basics</td>
<td>How ducts lose energy</td>
<td>All audiences:</td>
</tr>
<tr>
<td></td>
<td>Introduction to remaining topics</td>
<td>Contractors, Technicians,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Builders, Homeowners</td>
</tr>
<tr>
<td>2. Health, Safety, and Comfort Issues in</td>
<td>Toxic gases and vapors</td>
<td>All audiences:</td>
</tr>
<tr>
<td>Residential Ducts</td>
<td>Molds and mildews</td>
<td>Contractors, Technicians,</td>
</tr>
<tr>
<td></td>
<td>Inadequate cooling performance</td>
<td>Builders, Homeowners</td>
</tr>
<tr>
<td>3. Customer Benefits from Better Duct</td>
<td>Situations where duct repair is a</td>
<td>Contractors, Builders</td>
</tr>
<tr>
<td>Systems</td>
<td>big win-win for the contractor and the customer</td>
<td></td>
</tr>
<tr>
<td>4. Duct Design Strategies</td>
<td>Recommended design options:</td>
<td>Designers responsible for</td>
</tr>
<tr>
<td></td>
<td>1. Ducts in conditioned space</td>
<td>laying out a duct system for a</td>
</tr>
<tr>
<td></td>
<td>2. Leak-free, insulated ducts</td>
<td>contractor or builder</td>
</tr>
<tr>
<td>5. Testing and Diagnosing Duct Systems</td>
<td>Testing for duct leakage</td>
<td>Technicians, Contractors,</td>
</tr>
<tr>
<td></td>
<td>Finding distribution efficiency</td>
<td>Builders</td>
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<tr>
<td>6. Installation and Repair of Duct</td>
<td>Sealing and insulating ducts</td>
<td>Technicians, Contractors,</td>
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<td>Systems</td>
<td>Correcting pressure imbalances</td>
<td>Builders</td>
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<td>Installing new duct systems</td>
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Better Duct Systems for Home Heating and Cooling

JANUARY 2001

Prepared for:
Office of Building Technologies
State and Community Programs
U.S. Department of Energy
Washington, DC 20585

Under Contract No. DE-AC02-98CH10886
DUCT INSTALLATION PRINCIPLES

The objectives of a properly designed and installed duct system are occupant comfort, proper air distribution, economical heating and cooling system operation, and economical duct installation. Such a duct system is one that...

- Provides conditioned air to meet all room heating and cooling loads.
- Ensures that the pressure drop across the air handler is within manufacturer and design specifications.
- Provides proper air flow.
- Prevents air from entering the house or duct system from polluted zones.
- Maintains a neutral pressure in the house by having balanced air flows between the supply and return systems.
- Minimizes duct air temperature gains or losses between the air handler and supply outlets, and between the return register and air handler.

AIR DISTRIBUTION SYSTEM INSTALLATION AND SEALING

Proper Duct Installation Increases Efficiency

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Why Duct Installation and Sealing Are Important

The efficiency of air distribution systems has been found to be 60-75% or less in many houses because of insufficiently or improperly installed duct insulation and leaks in duct systems. Poorly designed and installed duct systems can have efficiencies of only 30% or less for fans or no additional cost, potentially saving a homeowner $500-2000 or more per year in heating and cooling costs. Moreover, inefficient duct system installations can reduce equipment life, further saving money for new or replacement equipment.

Duct systems that leak and/or do not distribute air properly throughout the house may make some rooms too hot and others too cold. Leaky and underinsulated duct systems lose conditioned air outside and unconditioned air into the house. This increases heating and cooling costs and may also alter humidity, dust, mold spores, and other contaminants into a home from the attic, crawl space, or garage and return gas from the oil. In some cases, poorly installed duct systems can cause backdrafting—spills of flue gases from combustion appliances (e.g., furnaces, water heater, fireplace) into the living space—causing smoke, odors, or carbon monoxide that are not envisioned in properly sealed and insulated duct systems.

Duct systems that are installed by subcontractors who are independent service providers may be installed in a way that can lead to low airflow rates and high air velocities. Low airflow rates cause heating and cooling equipment to operate inefficiently, while air velocities increase costs.
Thank You

But they that wait upon the LORD shall renew [their] strength; they shall mount up with wings as eagles; they shall run, and not be weary; [and] they shall walk, and not faint.

Isaiah 40:31