EEBA
Energy & Environmental Building Association ™

SUNBELT
BUILDERS SHOW

Building Solutions Conference

Gaylord Texan Resort & Convention Center

October 20-23, 2004 - Dallas, Texas

PRODUCING AIRTIGHT DUCTS

Neil Moyer

FLORIDA SOLAR ENERGY CENTER

A Research Institute of the University of Central Florida

Building AMERICA
U.S. Department of Energy
Industrialized Housing Partnership

U.S. Department of Energy

Office of Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Building America SM
U.S. Department of Energy

Building America works with members of the home-building industry to produce quality homes that use less energy without costing more to build.

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- SYSTEMS ENGINEERING APPROACH
- PROJECT LOCATIONS
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Featured Site

Building America is part of DOE's Building Technologies Program (BT).

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Research Project Highlights

The Top 25 Web Sites for Home Builders and Home Buyers of Energy-Efficient Homes
(PDF 129 KB) Download Acrobat Reader.

***Lighting for Tomorrow* is Good for the Environment and the Eyes**

Lighting for Tomorrow is a competition held to promote well-designed fixtures for compact fluorescent lights. The competition is sponsored by the American Lighting Association (ALA), Consortium for Energy Efficiency (CEE), and the U.S. Dept. of Energy (represented by the Pacific Northwest National Laboratory). Submitted designs were required to use an energy-efficient light source and were rated for their use in residential buildings in seven different categories.
Learn More

Best Design 2003 for "Aliante Pendant" by Stefano Casciani of Ivalo Lighting, Inc.

Building America teams strive to construct energy-efficient houses using specific climate-zone weather data.

Many US Cities Saw Increase in Cooling and Moisture Loads in 2002

Michael Kjelgaard, author of "The Weather Report" column in Engineered Systems magazine, reported that many cities in the United States exceeded average ASHRAE cooling load design conditions in 2002.

ASHRAE's design condition recommendations are based on long-term average weather data and are used to size space-conditioning equipment. According to predictions based on long-term weather data, ASHRAE's 0.4%, 1% and 2% temperature design points for a given city should be exceeded on average by 35 hours, 88 hours, and 175 hours, respectively. In 2002, the duration of cooling conditions based on actual outdoor temperature data were significantly longer than would have been predicted by long-term weather data.
Learn More. (PDF 59 KB)

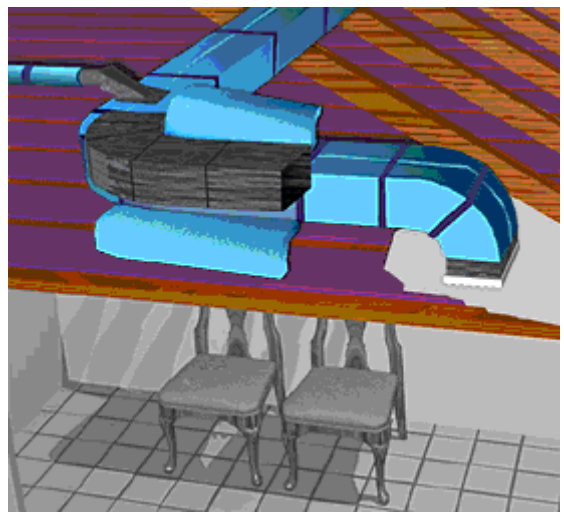
Building America Consortia Members

- U.S. Department of Energy
- Building America Industry Partnership
- BIRA Building Industry Research Alliance
- CONSORTIUM FOR ADVANCED RESIDENTIAL BUILDINGS
- Building Science Consortium — Architecture and Building Science
- IBACOS
- BIRA Building Industry Research Alliance
- NREL Center for Buildings and Thermal Systems
- ornl

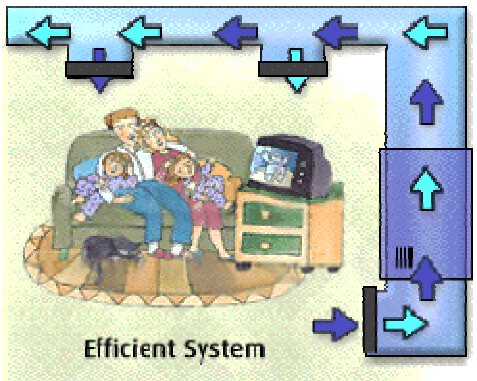
www.buildingamerica.gov

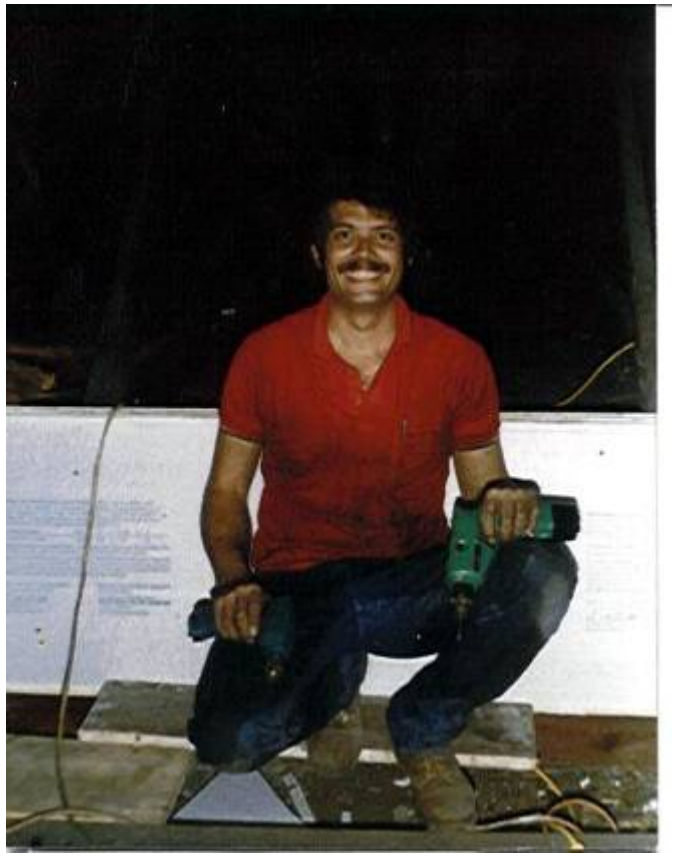
Get Your Ducts in a Row

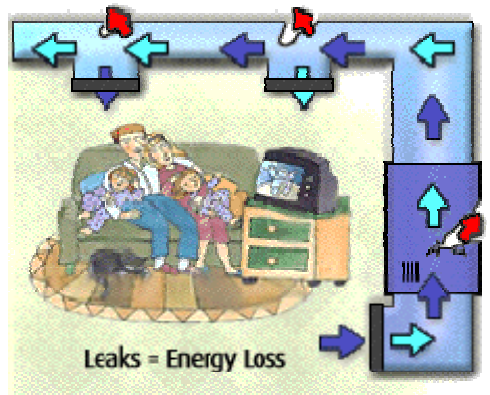
- Why airtight ducts are essential
- Options for duct systems
- Sealing materials and
- Diagnostic procedures



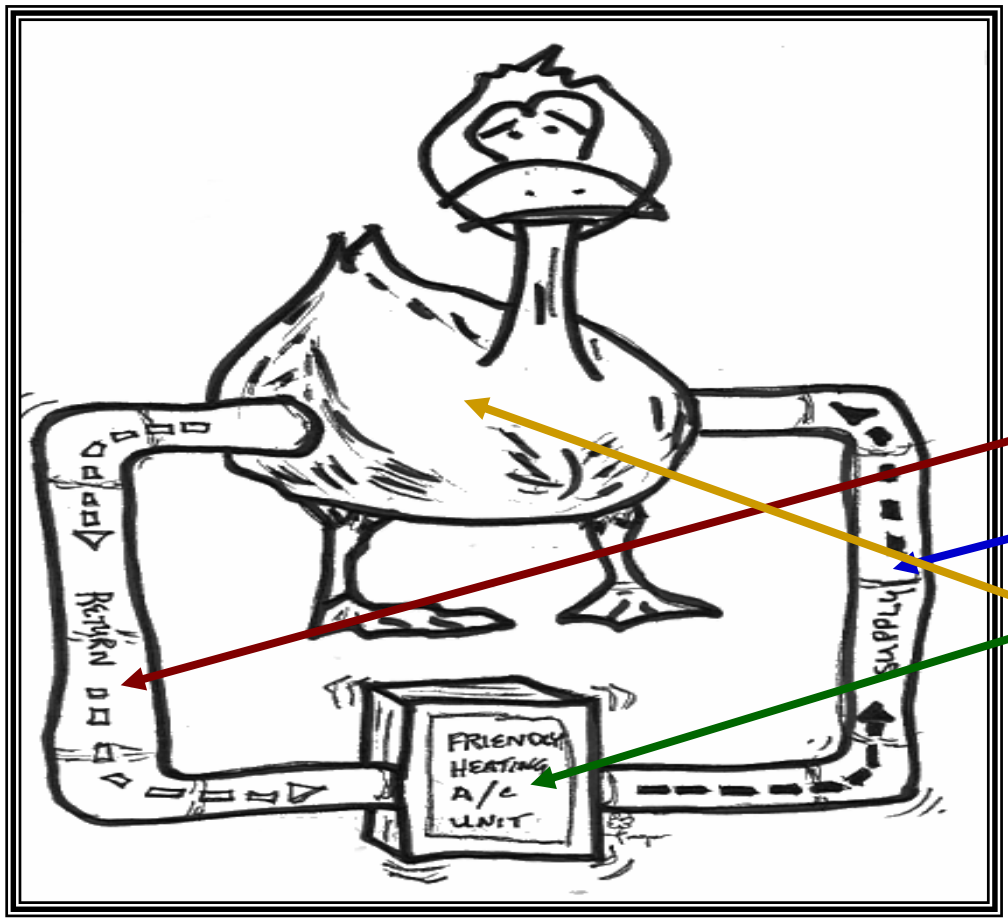
Some Background







Schematic: The Duct



Return

Supply

Air handler

HOUSE

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

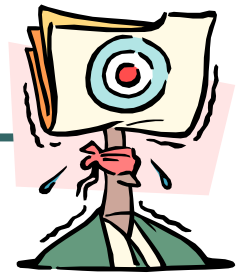
Temperature, Humidity, Filtration

Energy Efficiency

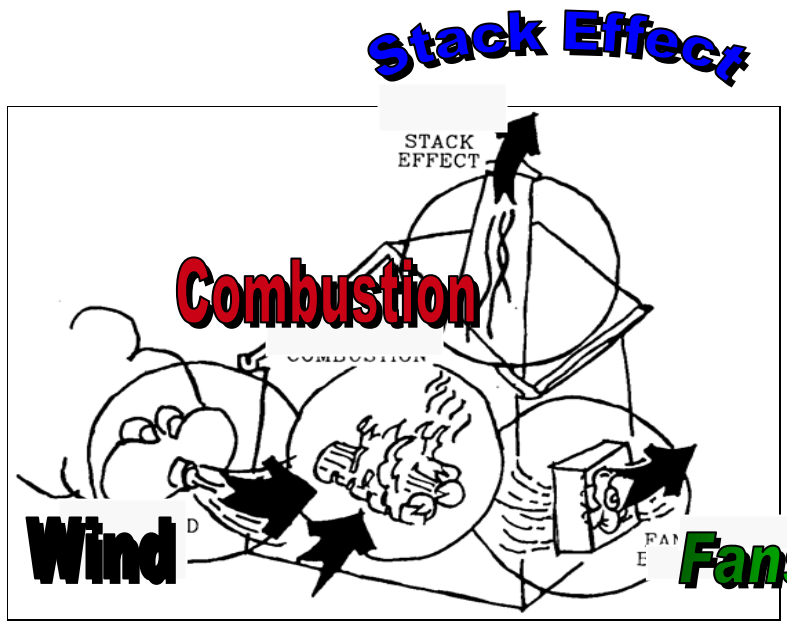
Decreases energy use

Understanding Pathways & Pressures

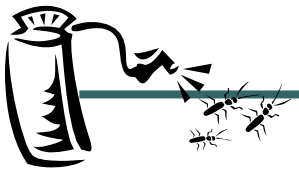
Building Pressures

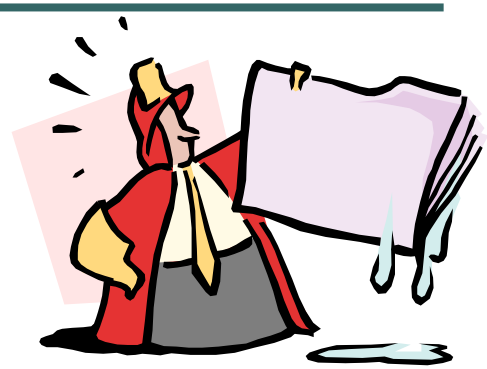


- Driving Forces of Building Leakage
  - Natural
    - Wind
    - Stack
  - Human Interaction
    - Combustion
    - Fans
    - Duct Leakage
    - Door Closure

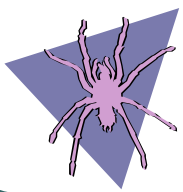


Common Callbacks in Residential Buildings -



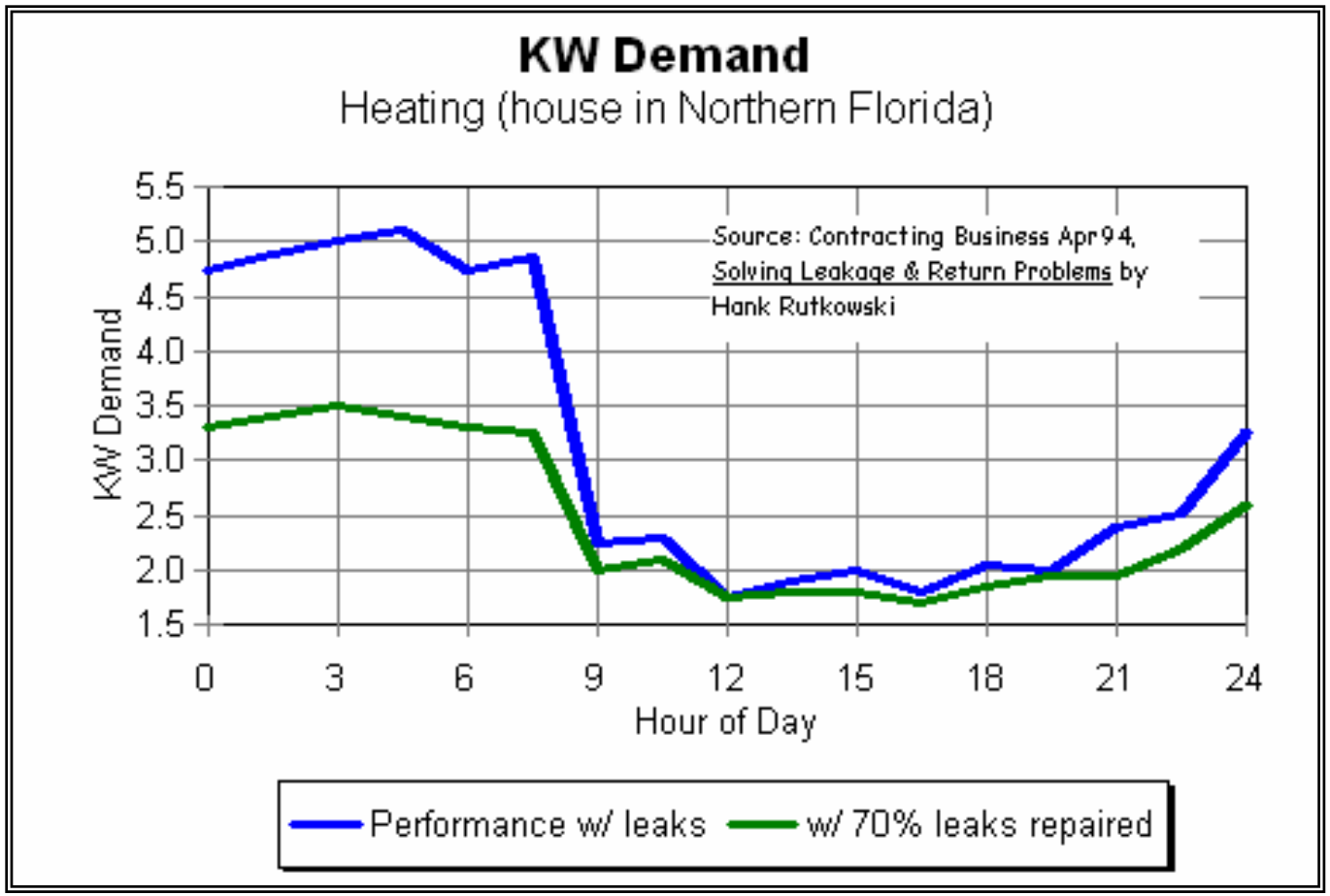


- High interior humidity level
- Wet crawlspaces & basements
- High cooling bills
- Uneven temperatures
- Drafts
- Indoor mold concentrations
- Insects

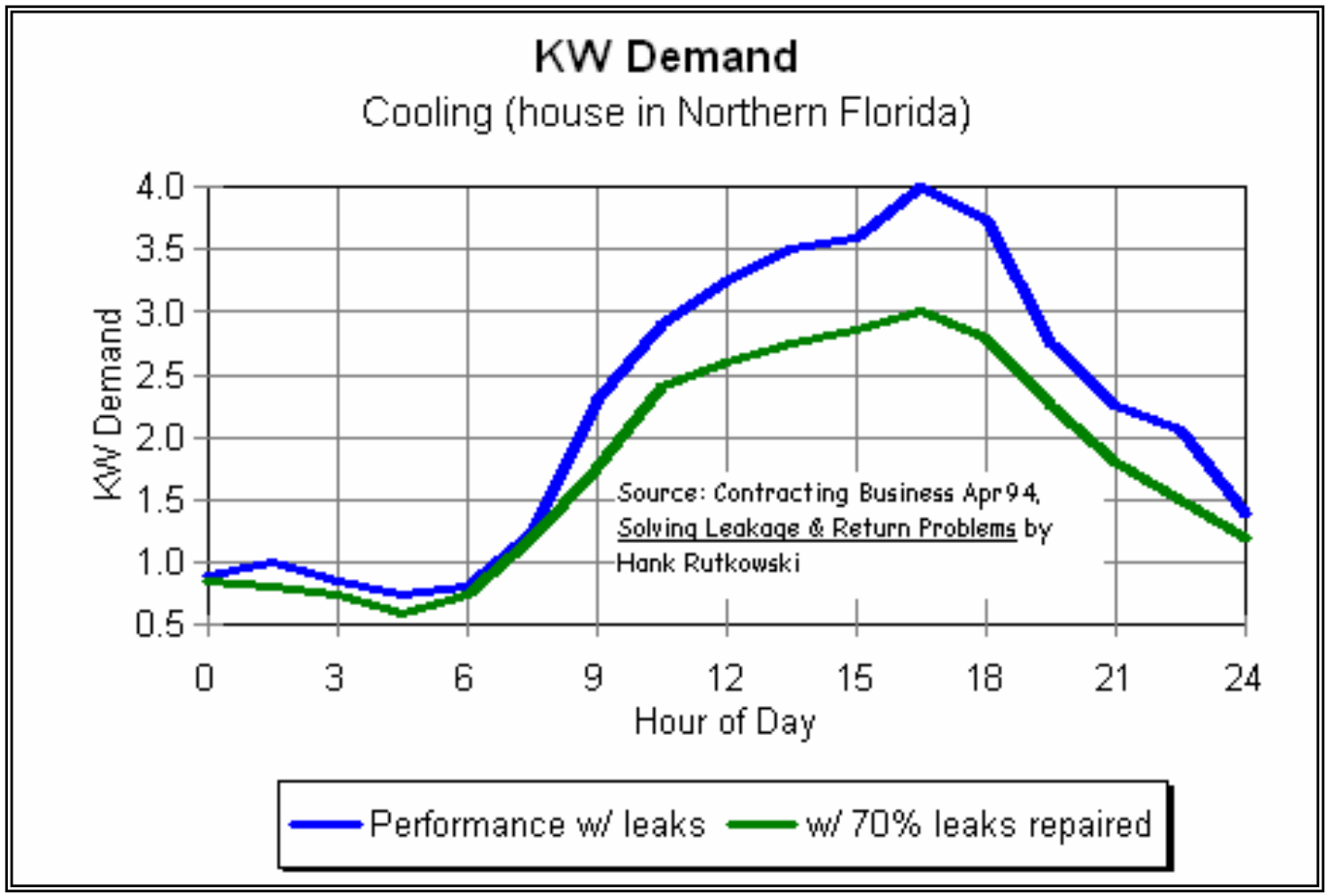


Duct Leakage

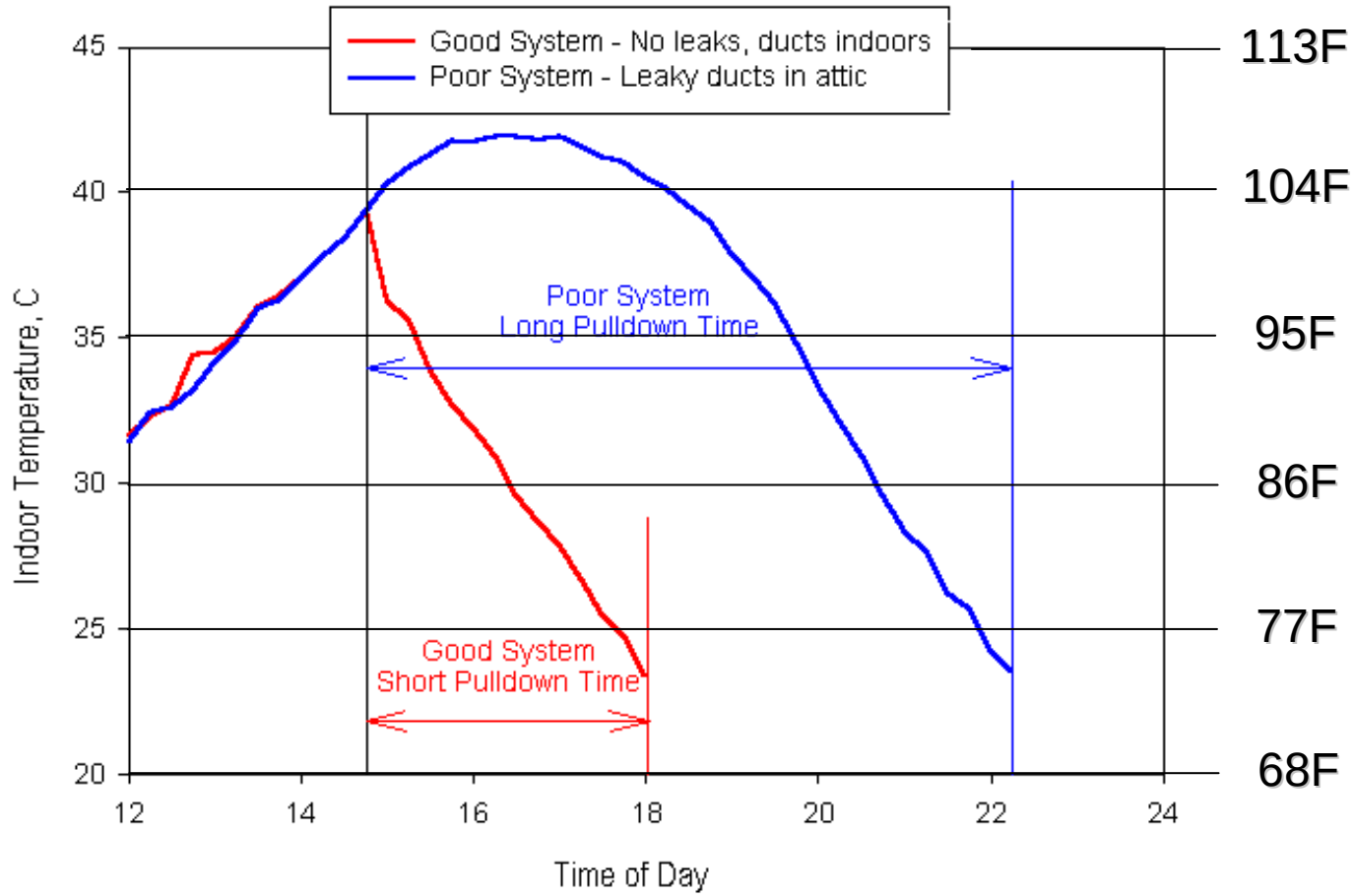
Duct Leakage Heating



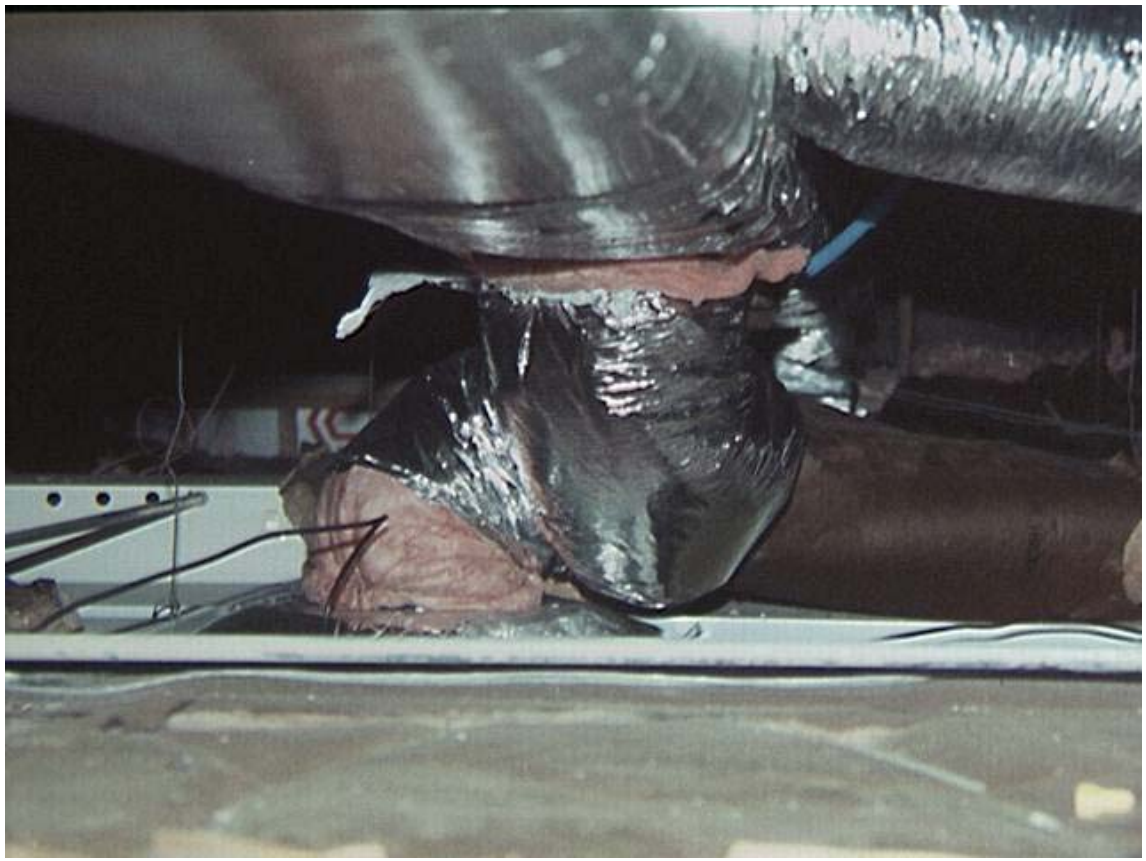
Duct Leakage Cooling



a/c pulldown times



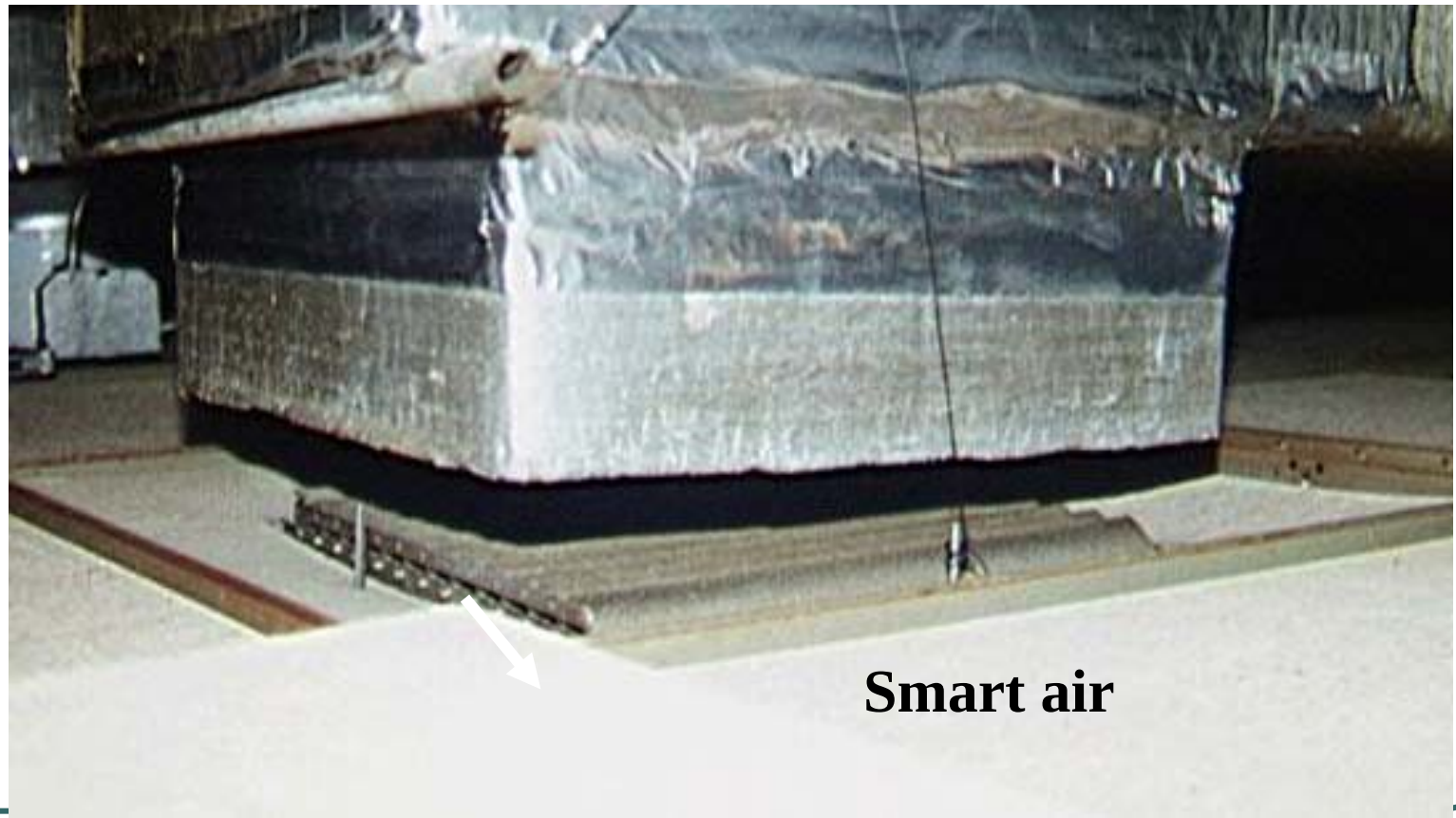
Florida Ducts

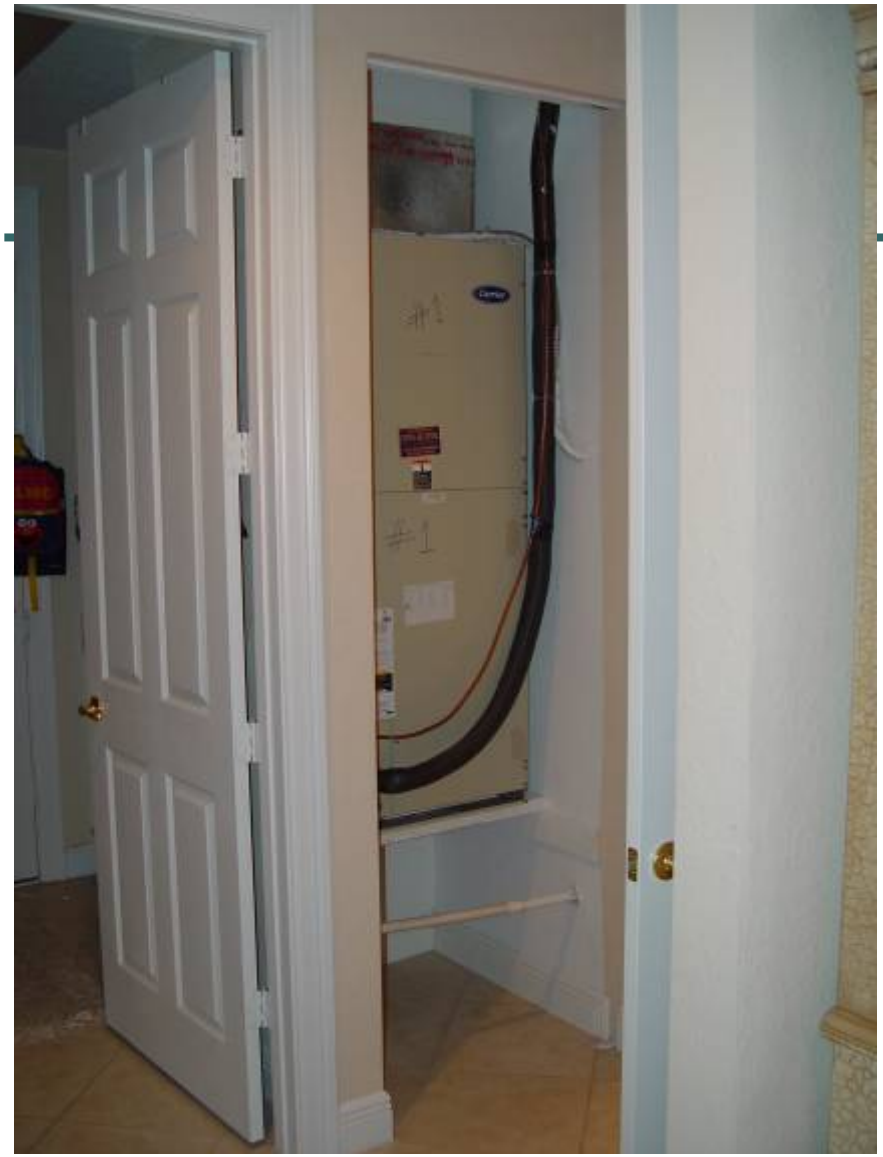


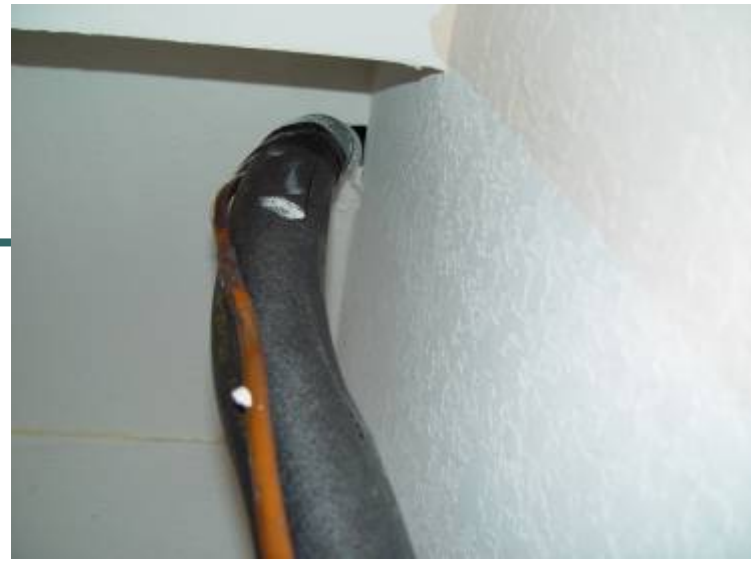
Florida Ducts

Popular Duct Leaks

Popular Duct Leaks







Popular Duct Leaks

Mastic over tape

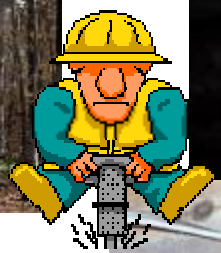
South Carolina Ducts

Creative duct work increasing energy use and decreasing comfort

Ducts and Stuff

Wow – what a leak

North Carolina Ducts



New Jersey Ducts

New house in the country

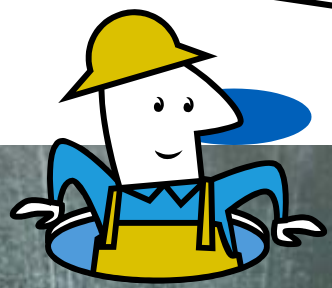
RA duct leaks
depressurizing insulation to ~1pa

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

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

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

Warping wallboard

MFG Housing Damage

Walls

Ceilings

Floors

Light -
Just a little off the top

Focus on the SEER FACTS to provide the highest performance…

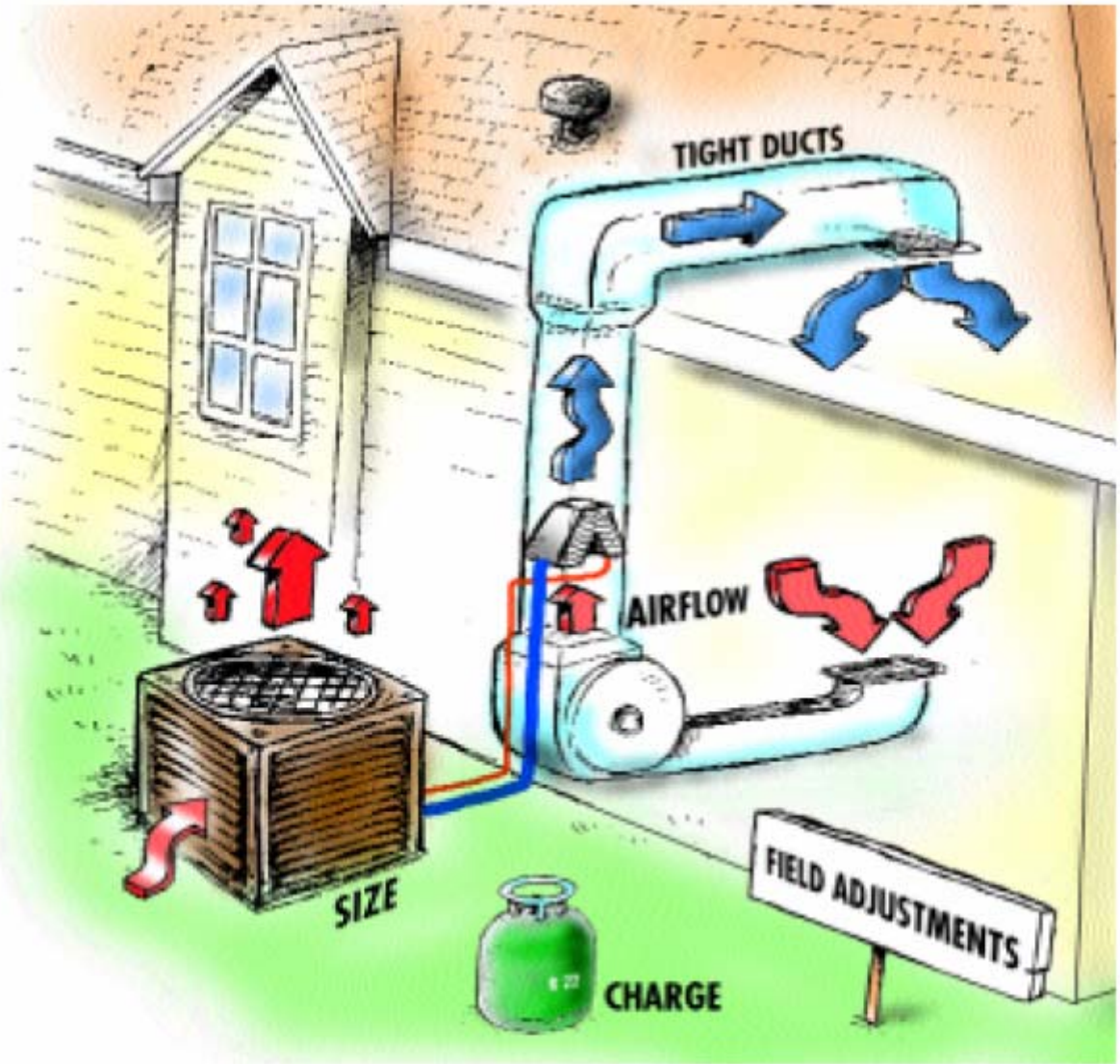
Field **Adjustment** performance factors:

Airflow for the system near 400 cfm per ton

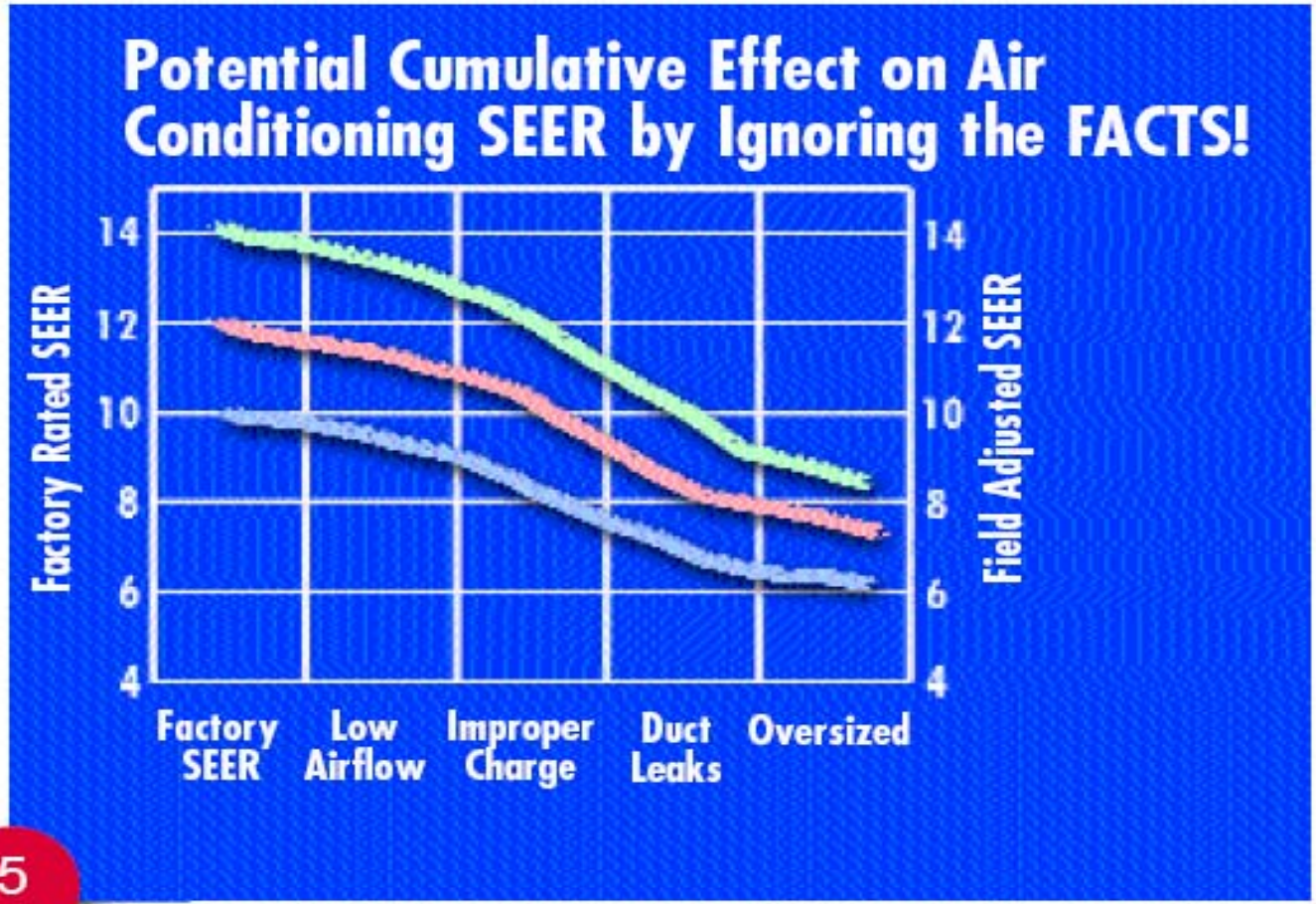
Charge refrigerant properly

Tight ducts — avoid leak to outside

Size equipment correctly



Advanced ENERGY



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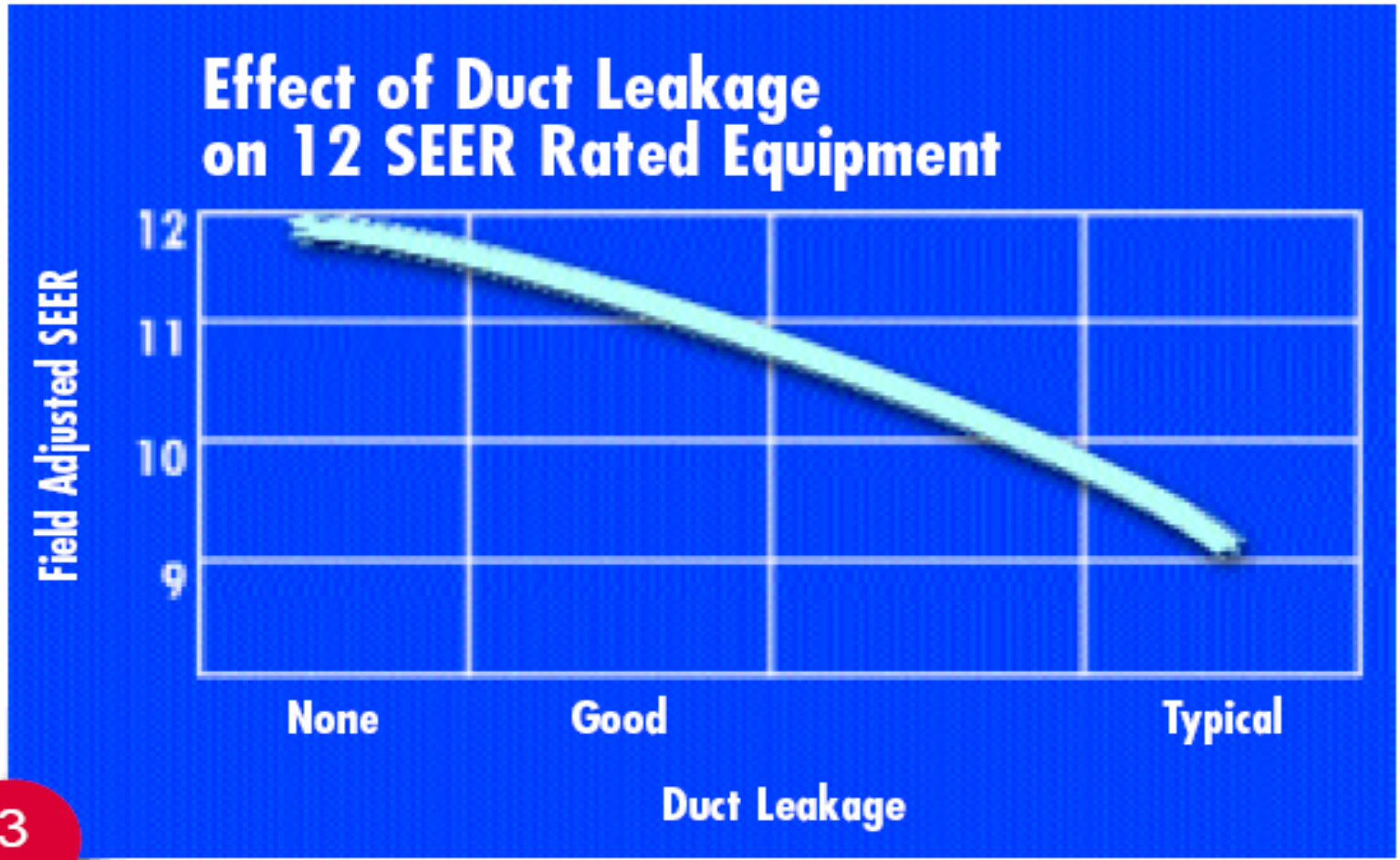
Each of the Field Adjustment factors are assumed to act on SEER independent of each other; the actual combined effect may, in fact, be different than what is represented in this chart.

Values on this chart reflect fixed orifice air conditioning systems.



3

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

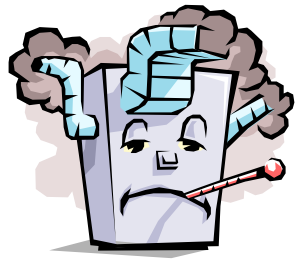
Typical: single story, crawlspace, metal & flex ducts in attic & crawlspace

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

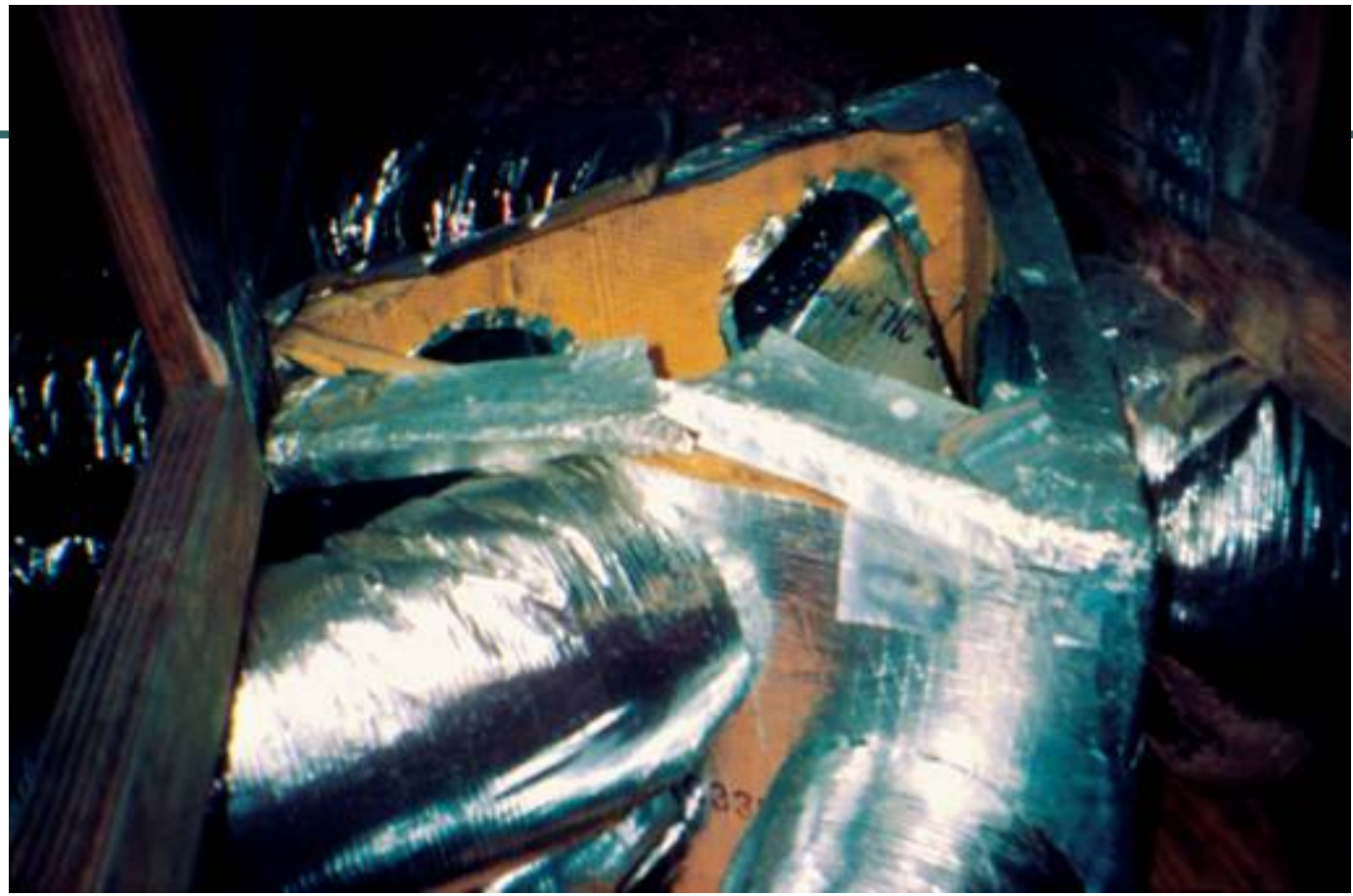
Typical: single story, basement houses, metal & flex duct located in basement & attic.

Causes of Duct Leaks



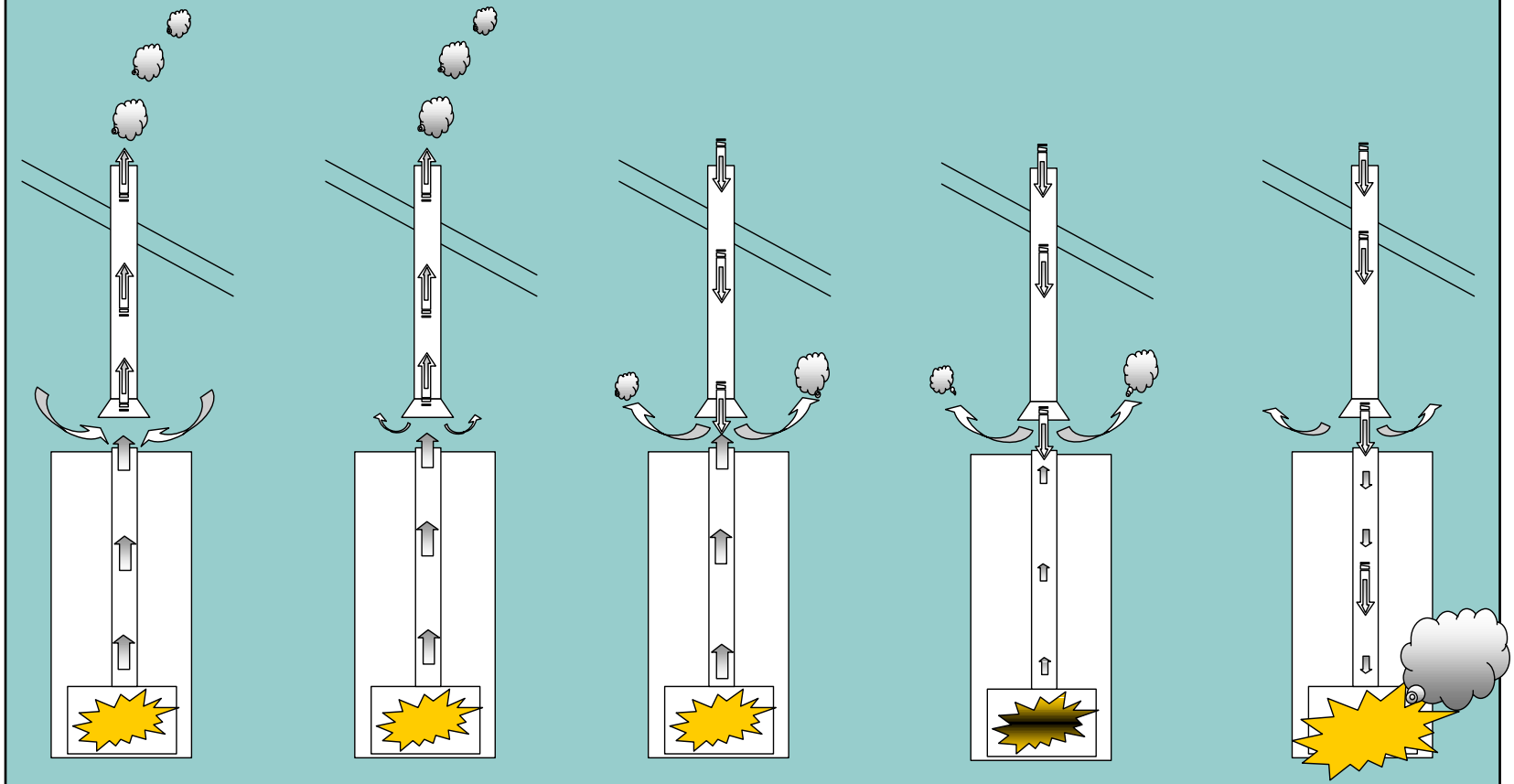
- Use of sealing materials which are not durable over time
- Improper application of sealing materials
- Building cavities used as a duct
- Lack of duct support

- 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	Spillage	Backdraft	Incomplete Combustion	Flame Rollout
CAZ wrt Out	CAZ wrt Out	CAZ wrt Out	CAZ wrt Out	CAZ wrt Out
0 pascal	-5 pascals	-8 pascals	-15 pascals	-25 pascals

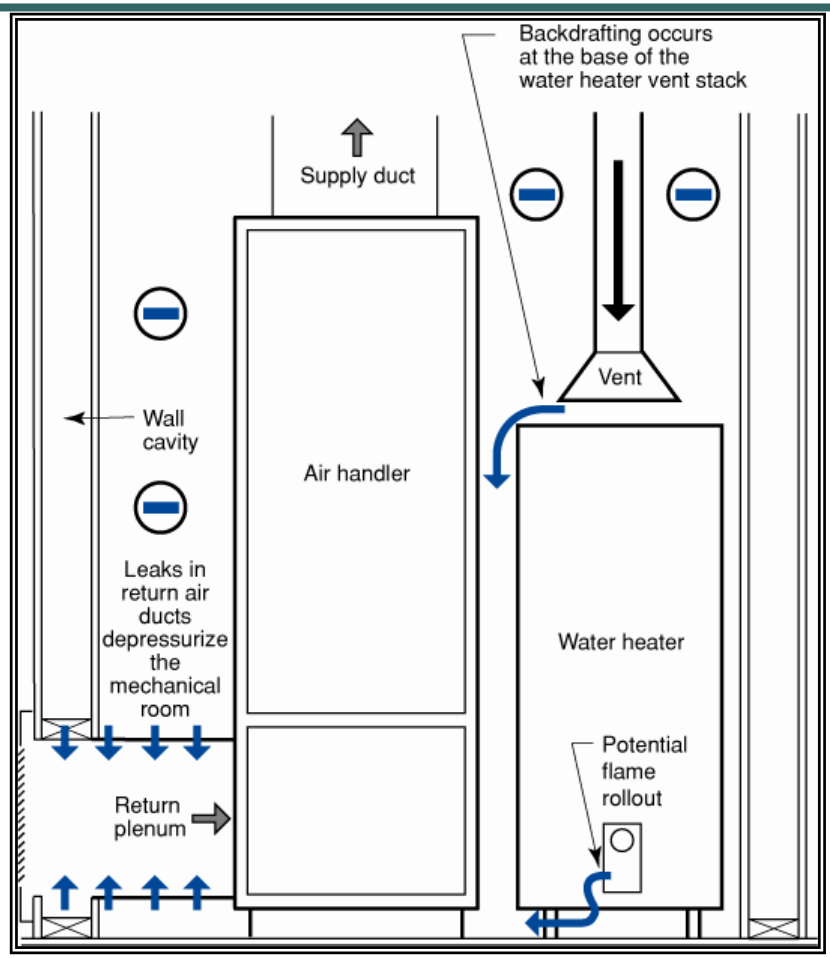
Canadian Study Depressurization Limits[1]

	Chimney Height	Unlined Chimney	Lined or Insulated Chimney
Gas Furnace or DHW	<14’	5 pa	5 pa
Gas Furnace or DHW	14-20’	5 pa	6 pa
Gas Furnace or DHW	>20’	5 pa	7 pa
Oil Furnace or DHW	<14’	4 pa	4 pa
Oil Furnace or DHW	14-20’	4 pa	5 pa
Oil Furnace or DHW	>20’	4 pa	6 pa
Fireplace	NA	3 pa	4 pa

1 *Chimney Safety Users’ Manual: Procedures for Determining the Safety of Residential Chimneys*; CMHC, 1988.

Backdrafting in Mechanical Room

- Mechanical room depressurized by return system leakage




12. 23. 2001


12. 23. 2001


12. 23. 2001

Potential Failures by UAF

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

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.*

CO (carbon monoxide) poisoning & flame roll-out from vented combustion devices

And then there are fireplaces...

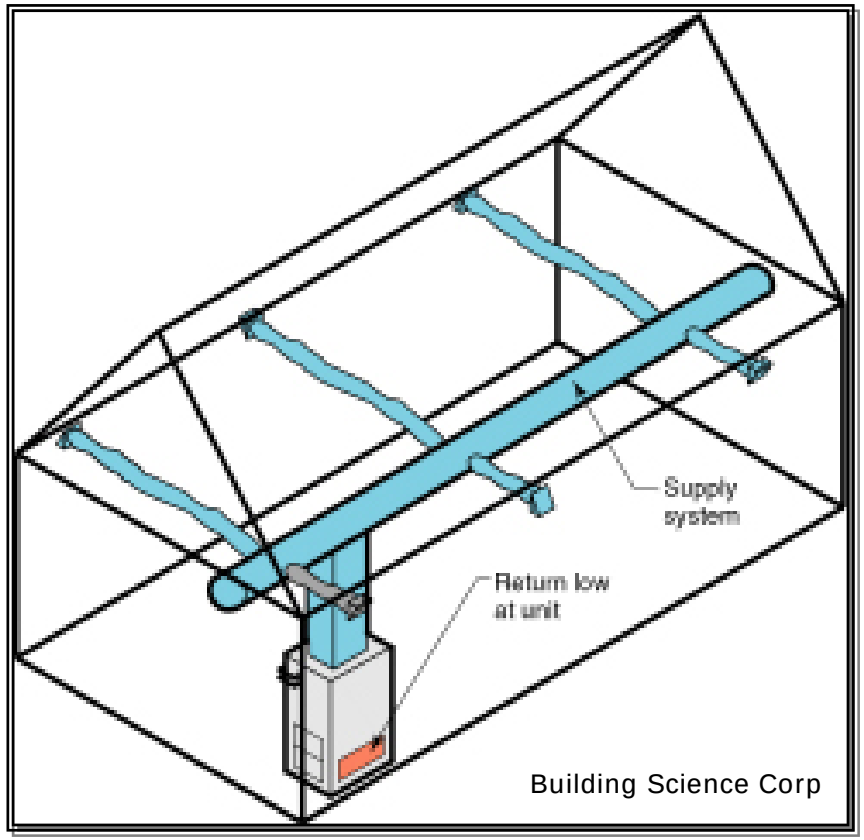
Hearth Products Association

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)



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

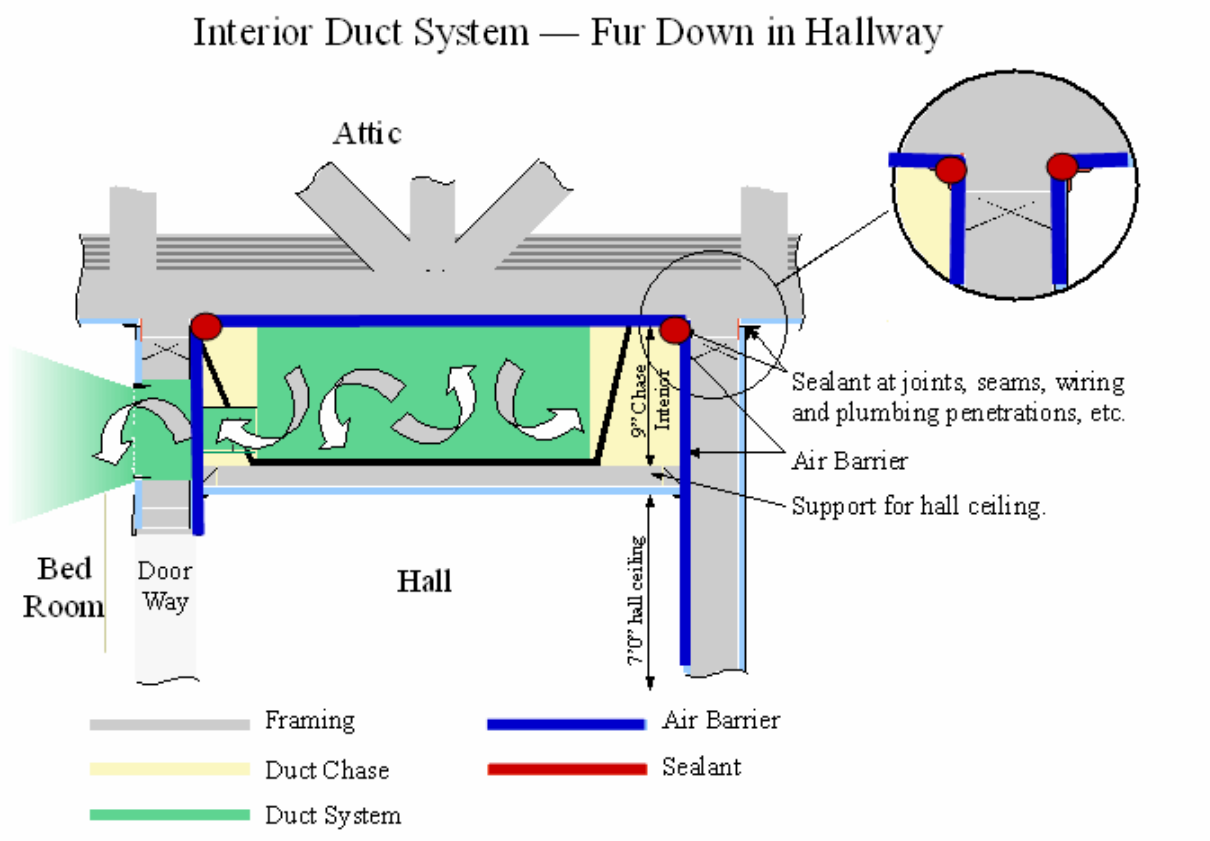
Reducing the Impact of Ducts in Unconditioned Spaces

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

- Unvented Attics and Crawlspaces – 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.

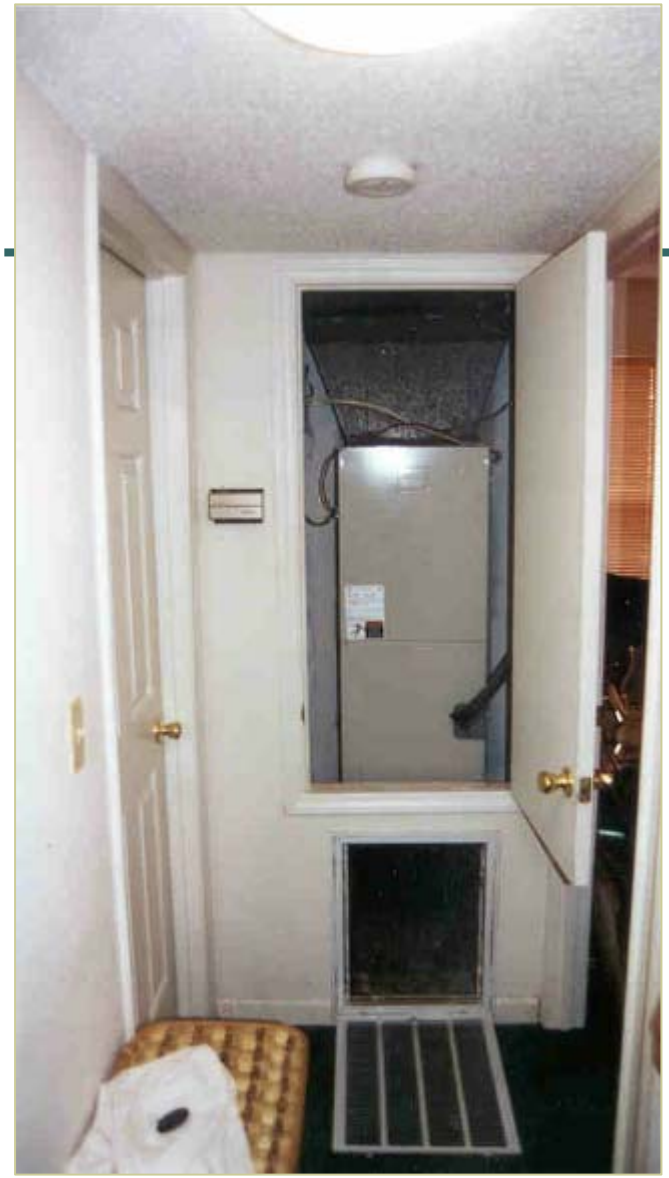
Interior Ducts - Schematic



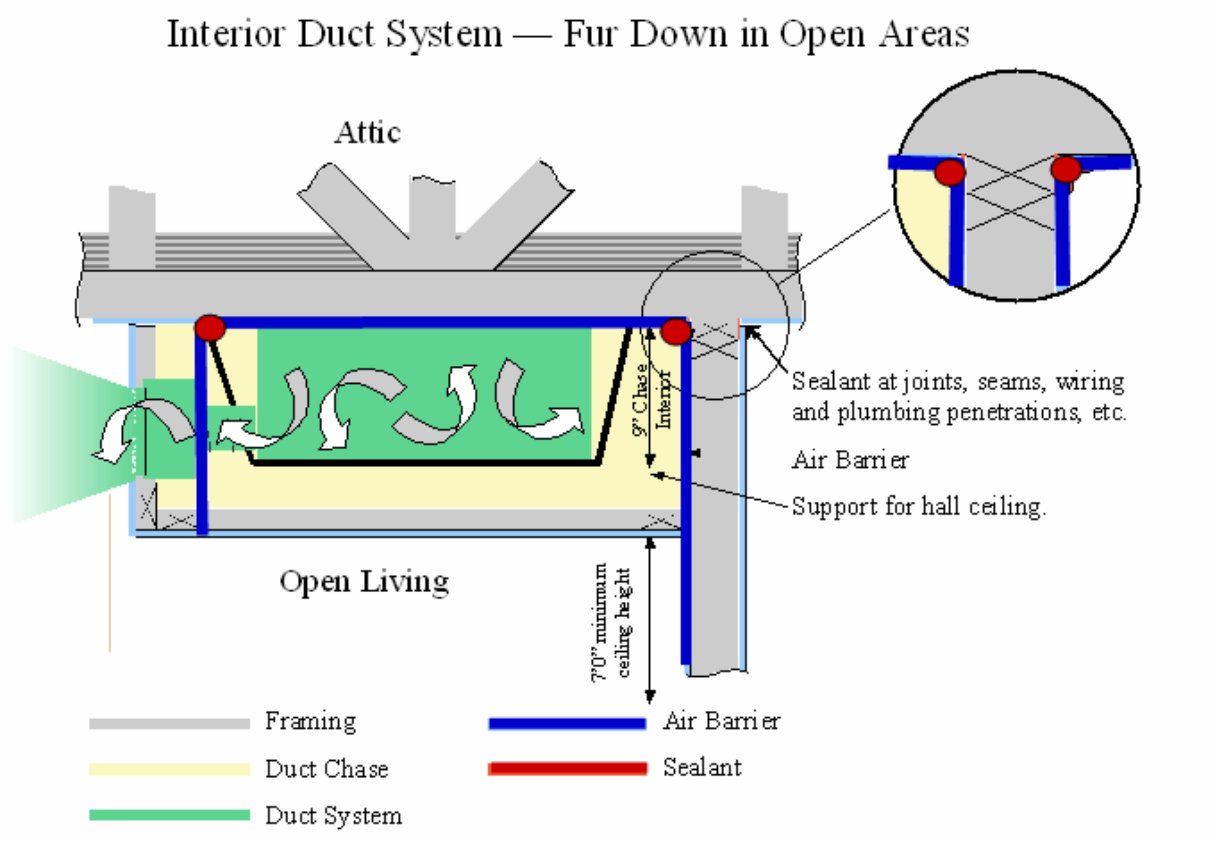
Interior Duct Chase: Air Barrier in Place

Sealed

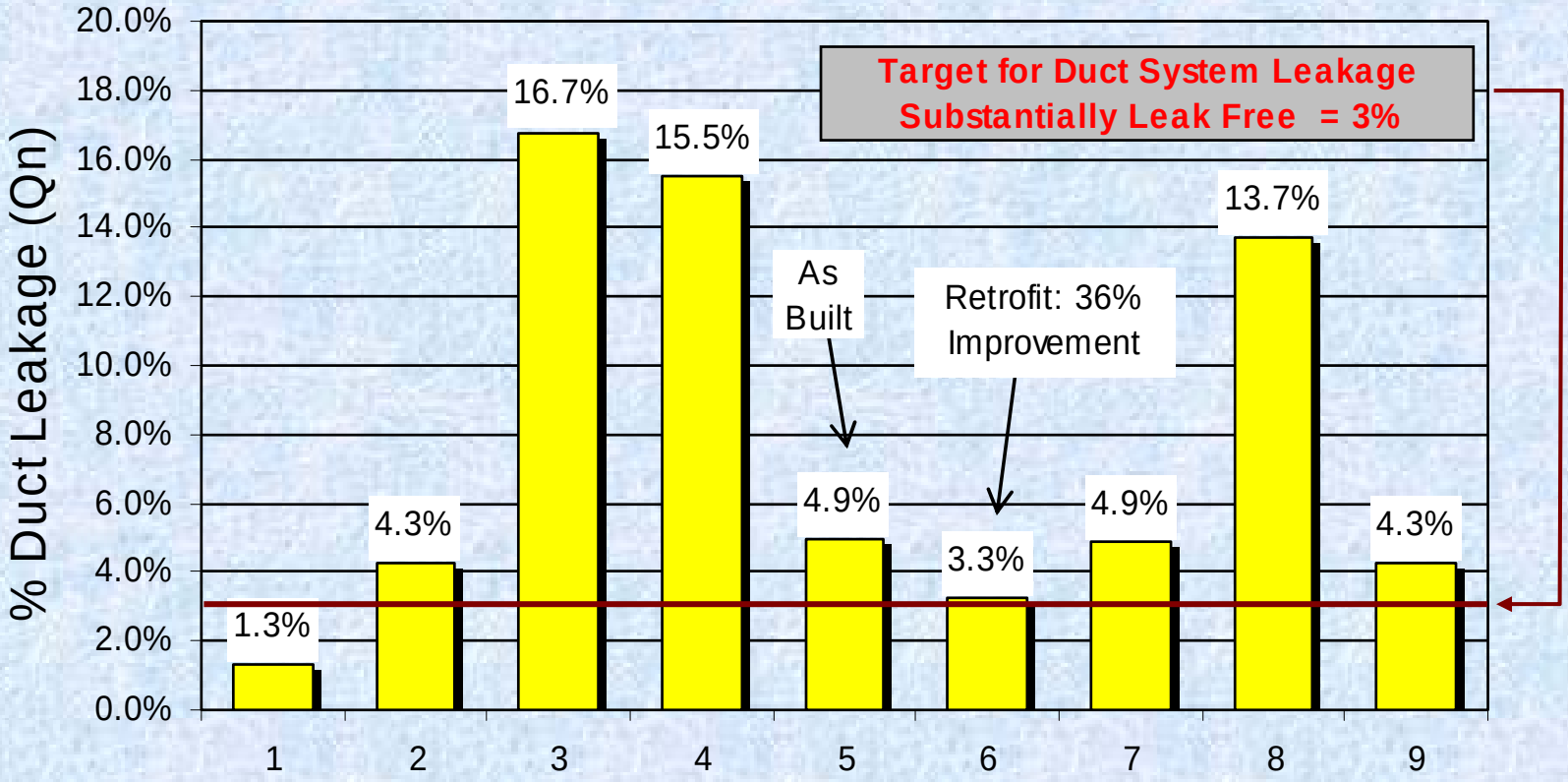
Not Sealed



Interior Ducts - Schematic Design

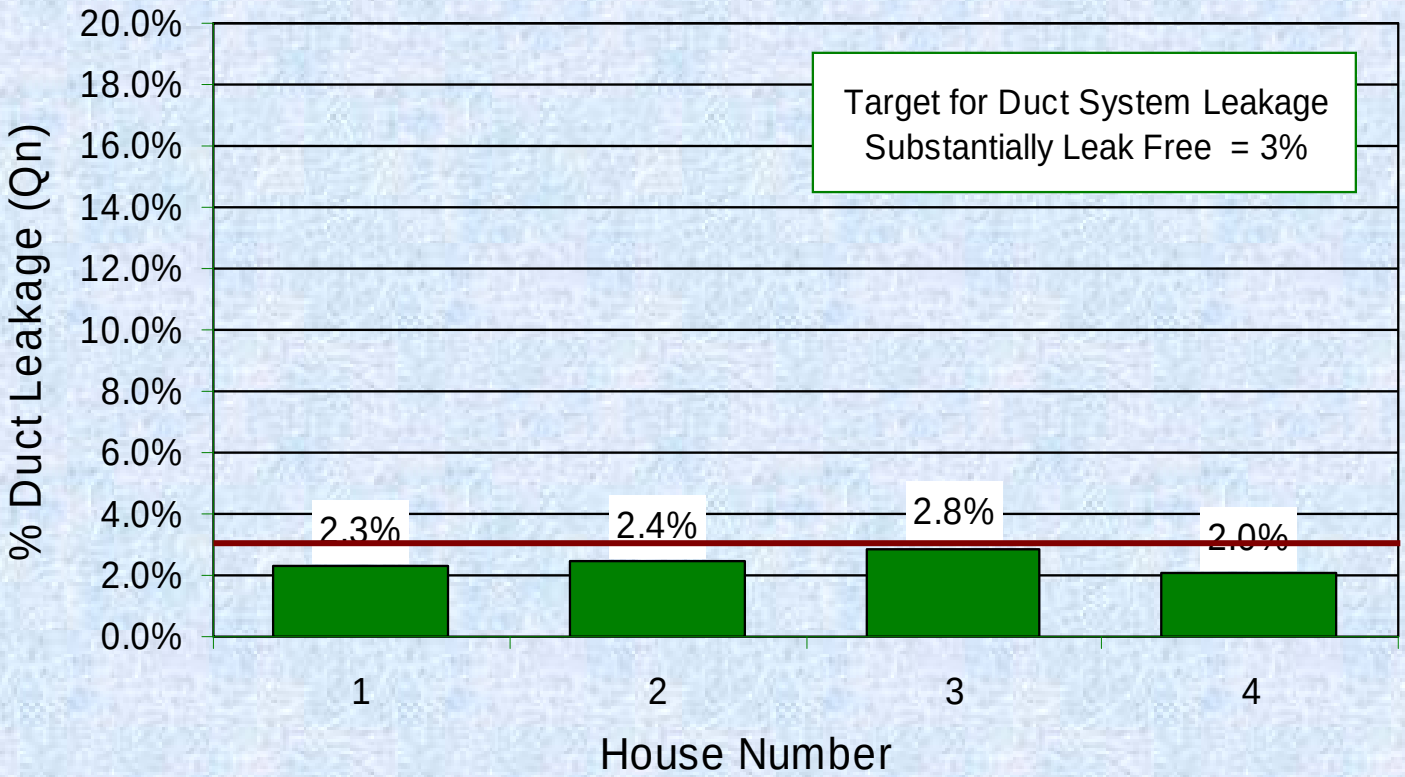


Texas Houses



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

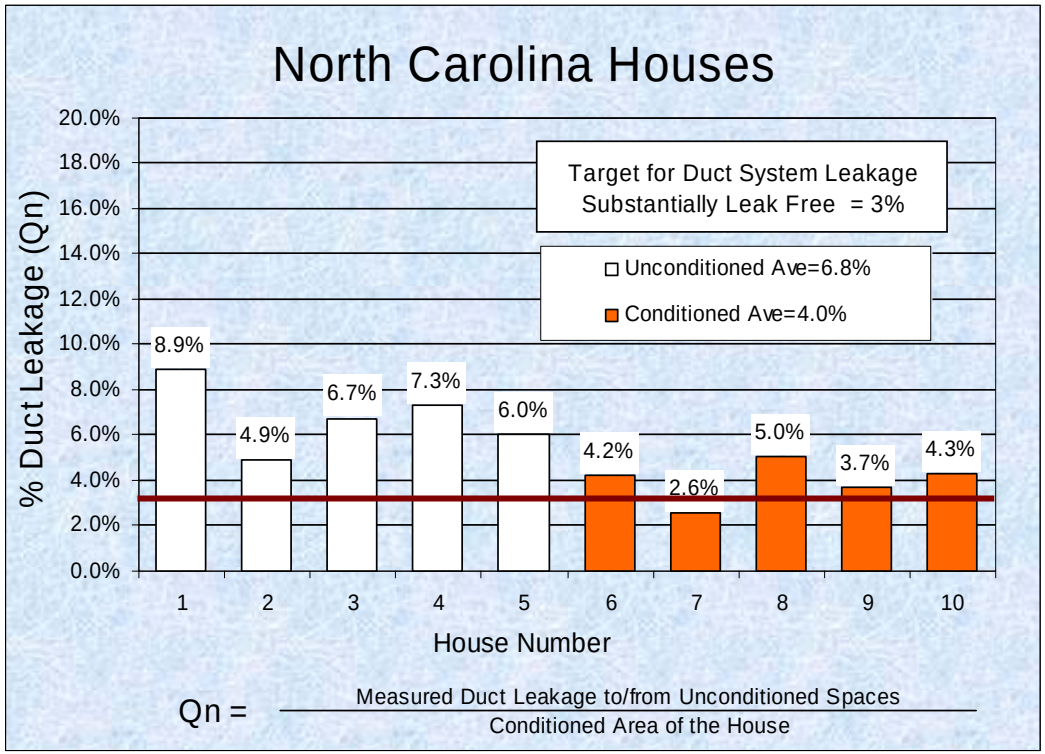
Florida Houses



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

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

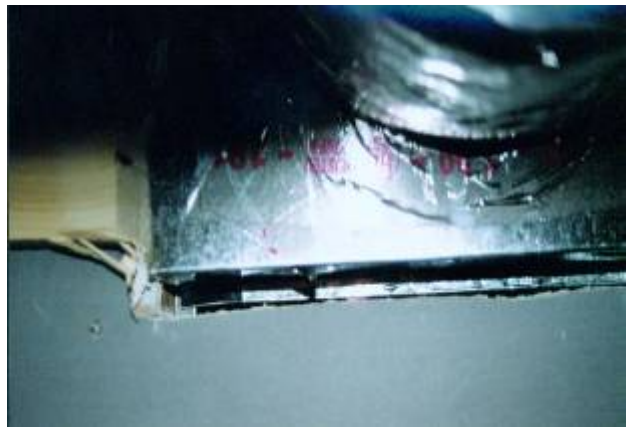
Limitations and Applicability

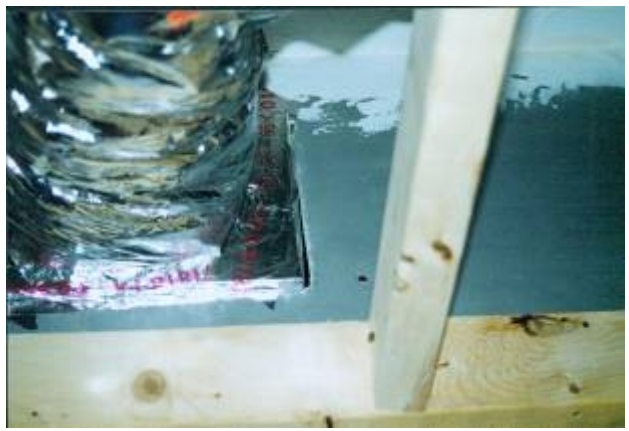
- Excessive cost: $3,000 for modified trusses and run outs ☹
- $3000/$120 = not cost effective based on energy savings
- Lesson: Learn from others' mistakes
- Applicability: New construction, renovation, remodeling.
- Limitations: Requires advance planning, excellent site supervision, and group effort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

Modified Trusses

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

Attention to Detail…

Ducts are contained in redesigned cavities that keep all the ducts out of the attic

This increases performance and improves attic insulation coverage

Attention to Detail…

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

Sealing Materials

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 shall be removed.

Good Ducts - (cont.)

- 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.

Good Ducts - (cont.)

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

HARDCAST
CARLISLE

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
A latex based sealant designed for indoor/outdoor galvanized HVAC duct systems. Gray in color and fiber-free. U.L. 81 B-M Listed. U.L. 723 Classified.

VERSA-GRIP 181
A premium grade, water based duct sealant for use on indoor/outdoor metal duct, fiberglass ductboard and flexible duct. White in color with built-in fiber reinforcement for added strength. U.L. 181 A-M listed/U.L. 181 B-M Listed.

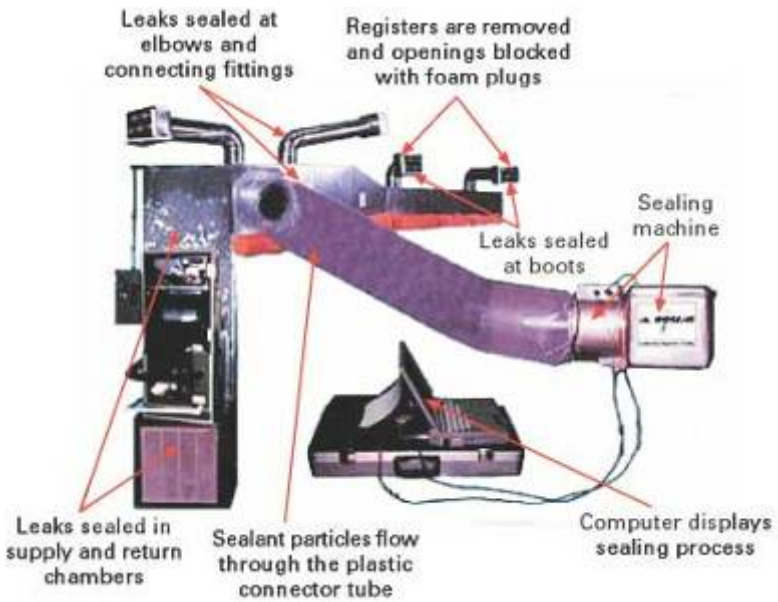
VERSA-GRIP 102
A general purpose water based duct sealant for use on indoor/outdoor metal duct, fiberglass ductboard and flexible duct. White in color with built-in fiber reinforcement for added strength. U.L. 181 A-M listed/U.L. 181 B-M Listed.

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.

Just a Few Products

Aeroseal movie



The duct sealing process:

To start the Aeroseal duct sealing process, all room ceiling or floor registers are replaced with foam plugs.

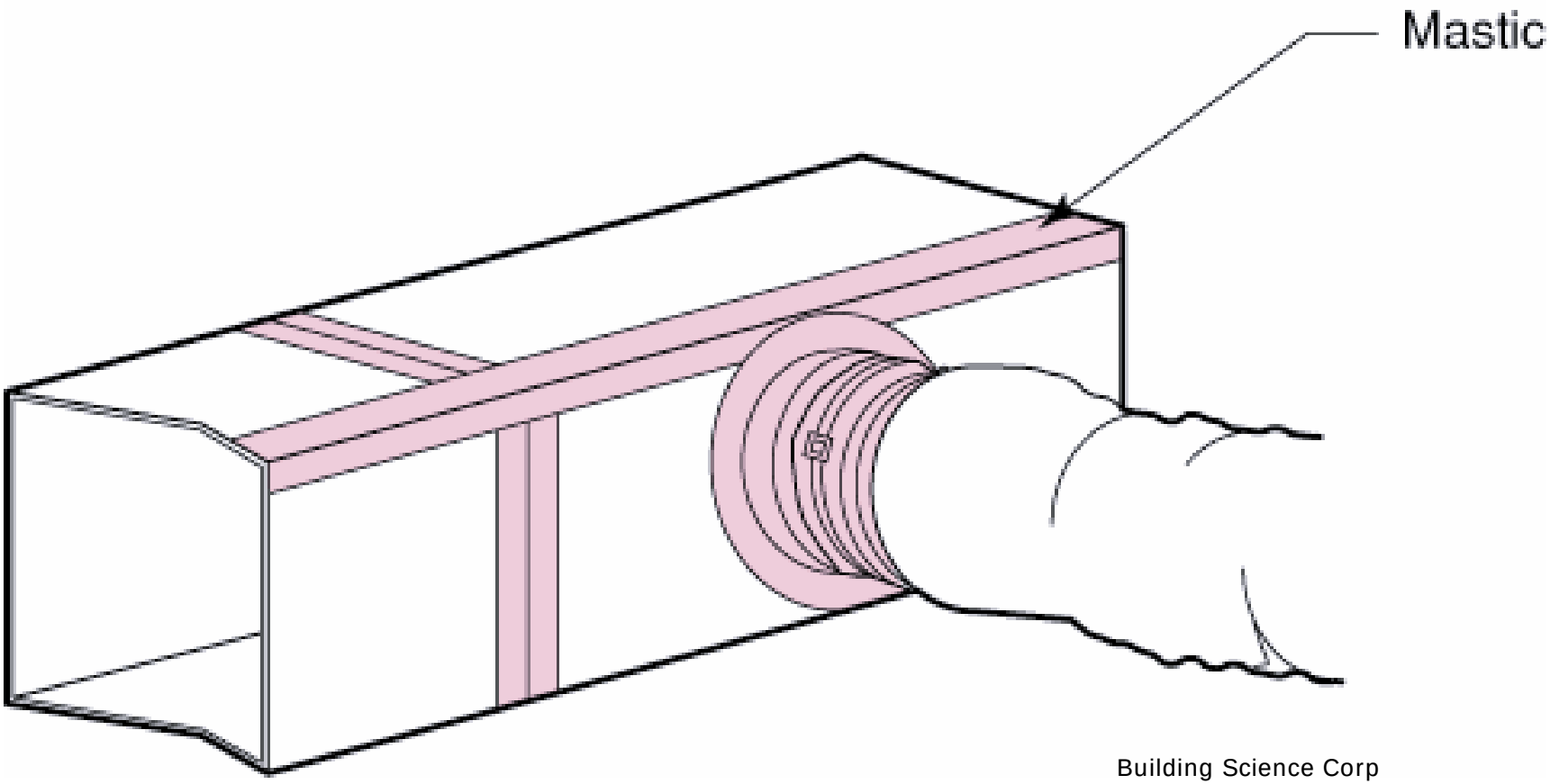
A small access hole is cut into the supply or return air plenum and a temporary collar is attached. The air conditioning indoor coil, fan, and furnace are temporarily blocked with a foam plug to avoid the entrance of any sealing particles into this equipment.

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

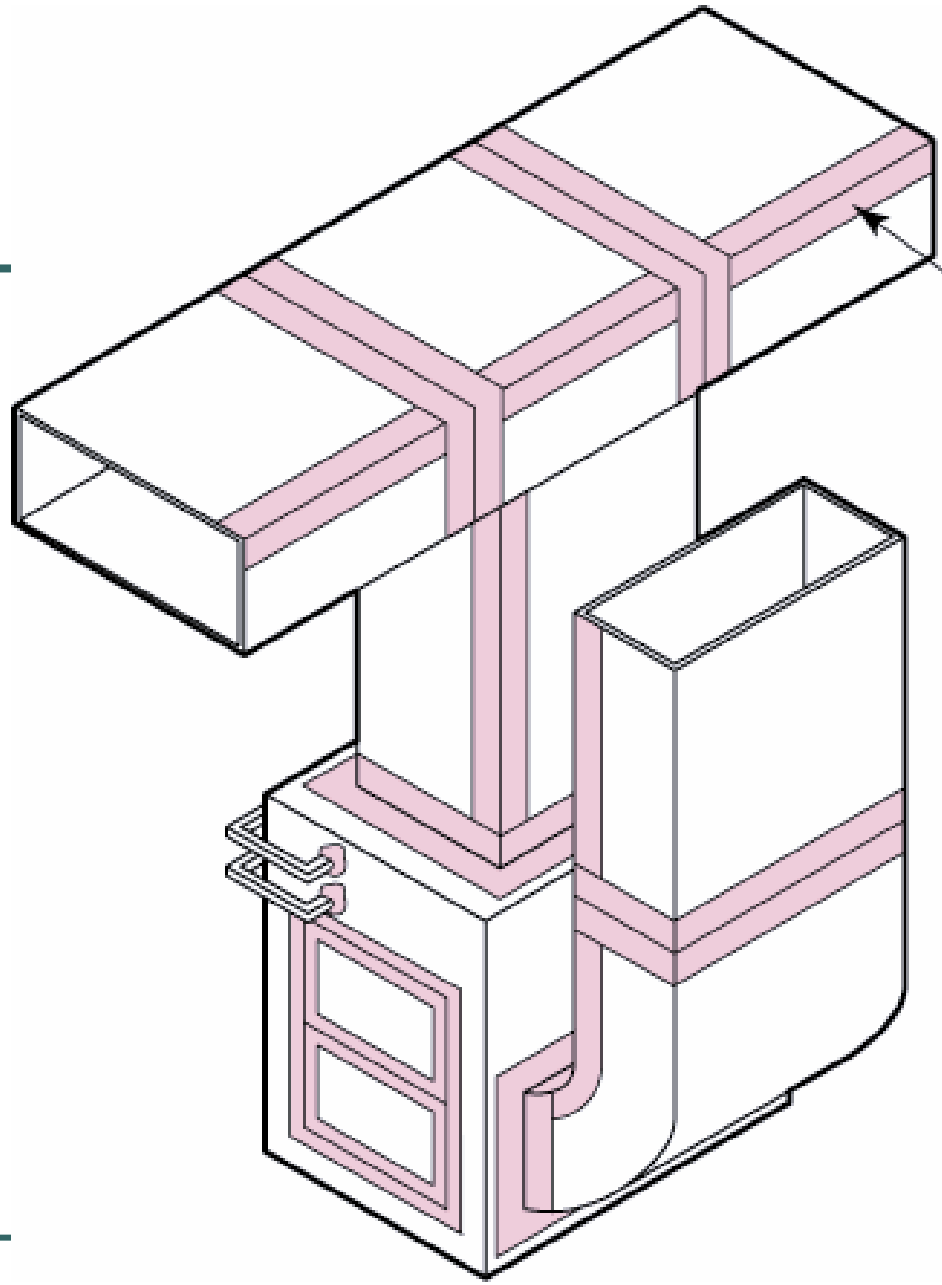
The exclusive Aeroseal duct sealing system injects adhesive particles into the air duct system. The particles travel through the air duct system seeking holes and cracks that are located throughout the ductwork. The adhesive duct sealing particles attach directly onto the edges of any hole and crack 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



Building Science Corp



NOT Duct Tape!

Building Science Corp

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]

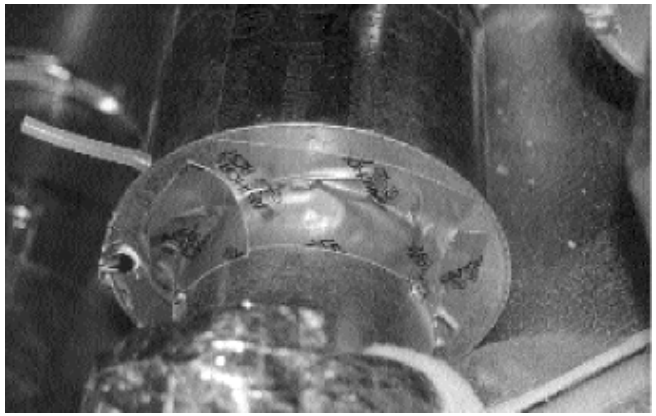
http://epb1.lbl.gov/EPB/ducts/

Dr. Duct aka Max Sherman

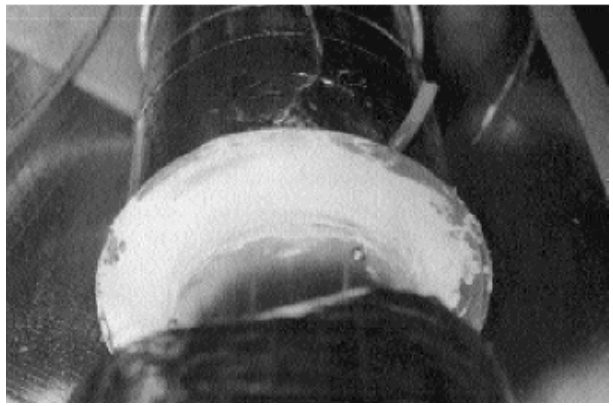
The accelerated-aging rig simulates realistic conditions by running the air at about 100 Pascals. Each duct sample contains a hard-to-seal joint: finger-jointed sheet-metal duct joining a stepped transition, typical of how ducts join plenums. Different duct sealants have very different longevities under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

http://epb1.lbl.gov/EPB/ducts/ducttape/index.html

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

Duct Tape Failures		
# of Tests	**Sealant Type**	**Approximate Duration**
Aging Test		
8	5 different grades of duct tape	7 days, failed
3	181B-FX-approved duct tape	10 days, failed
1	181B-FX-approved duct tape	3 months
1	15-mil foil-backed butyl tape	3 months
1	Aerosol sealant	3 months
1	181A-M- and 181B-M-approved mastic	3 months
1	181A-P-approved foil tape	3 months
1	181A-P- and 181B-FX-approved foil tape	1 month
1	Packing tape	3 months
1	181B-FX-approved packing tape	1 month

Grey bars denote failed samples

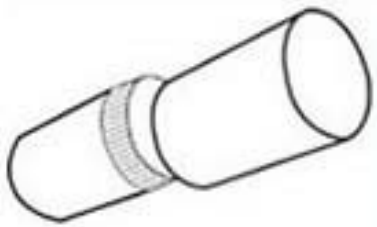
A COUPLE MORE TESTS

Baking Test		
5	3 different grades of duct tape	34 days, failed
1	181B-FX-approved duct tape	60 days, failed
2	Duct tape	4 months
3	181B-FX-approved duct tape	4 months
1	Packing tape	4 months
1	181A-P-approved foil tape	4 months
1	Aerosol sealant	4 months
Cycling Test		
4	Aerosol sealant under pressure cycling only	2 years
4	Aerosol sealant with heat and pressure cycling	2 years

Grey bars denote failed samples

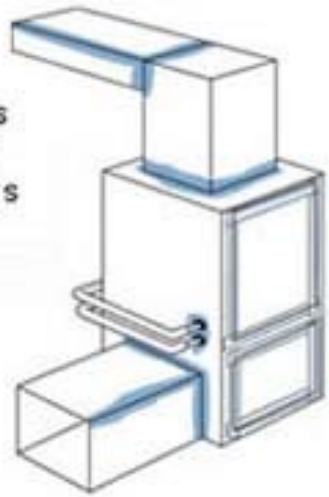
Where to Look for Leaky Ducts

1. Disconnected ducts



2. Building cavities used as duct

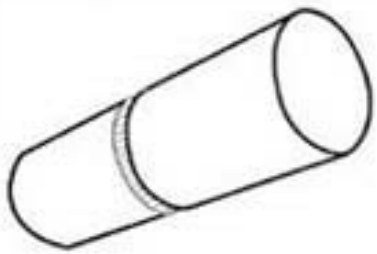
3. Plenums and air handlers



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

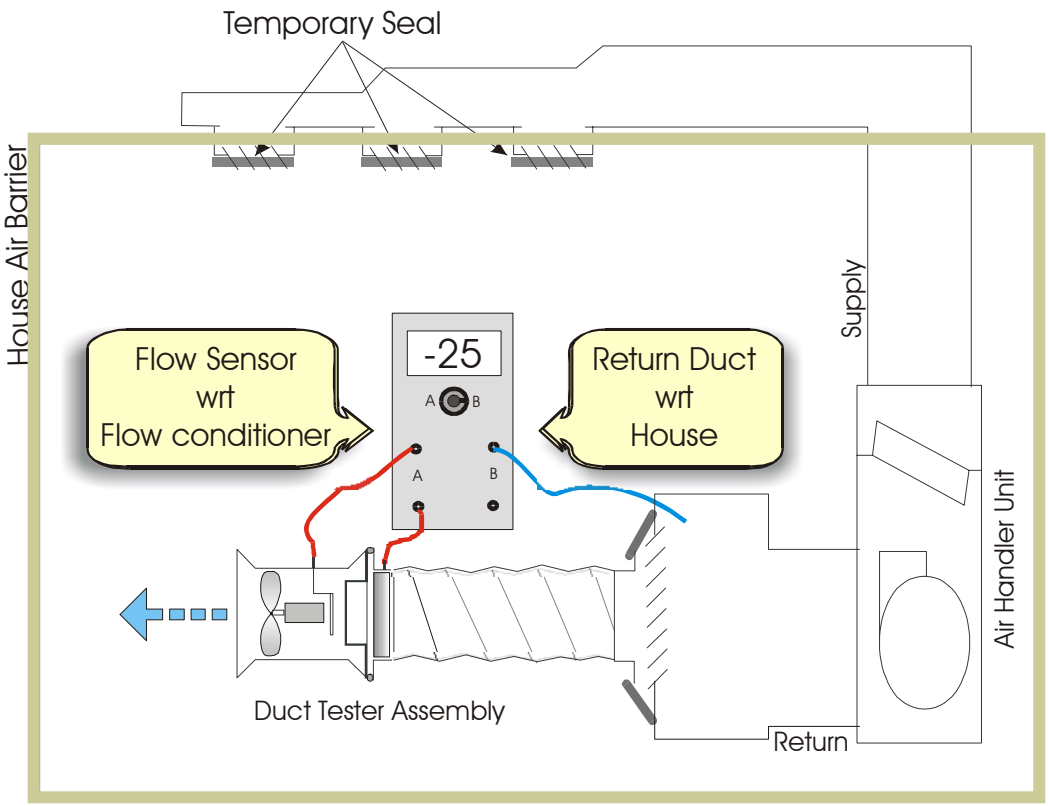
Energy Conservatory

Infiltec

McGill

Retrotec

Duct Airtightness - Total



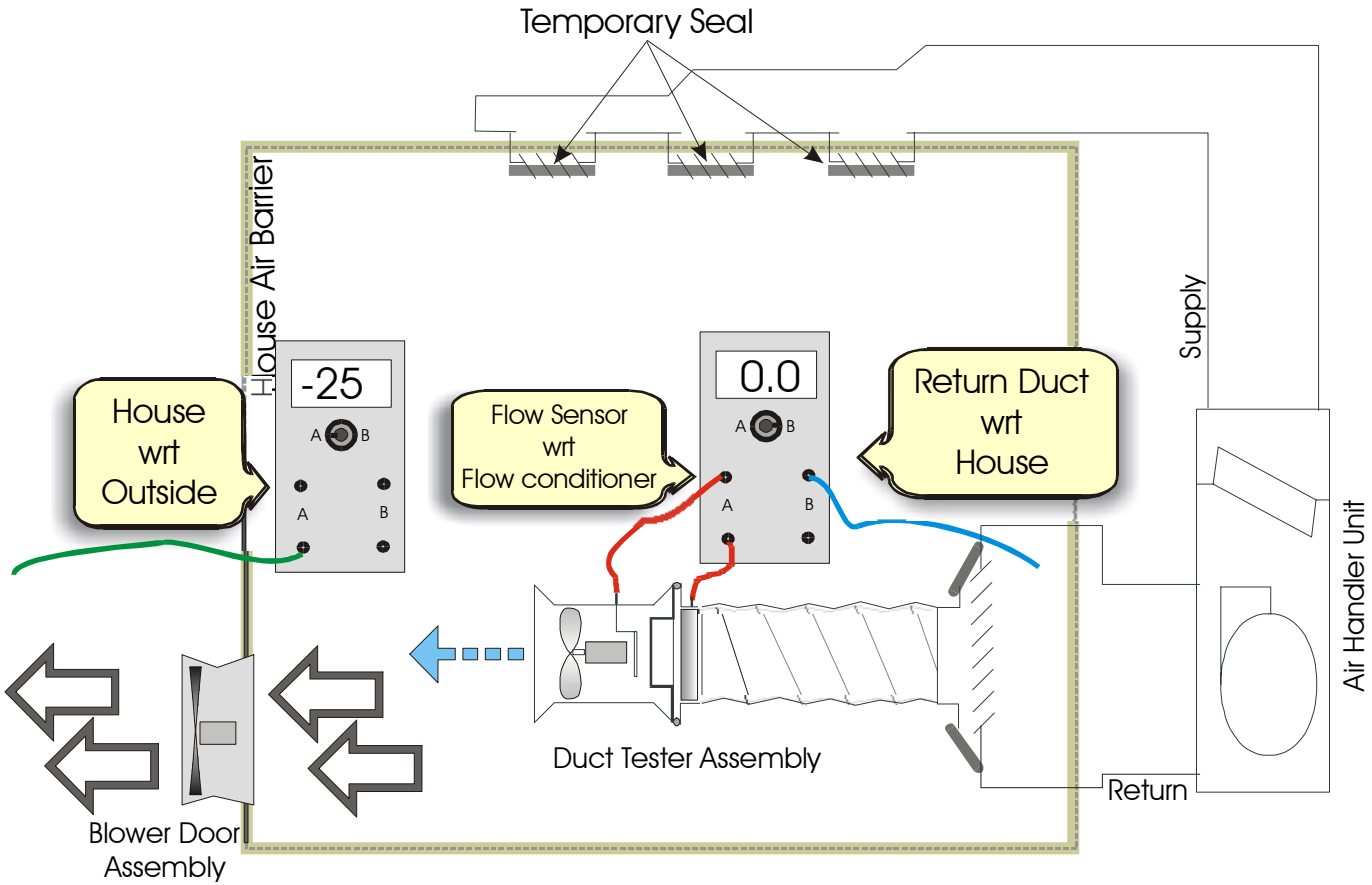
Total Duct Airtightness Test

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


9/26/2000

Duct Airtightness -Leakage Out

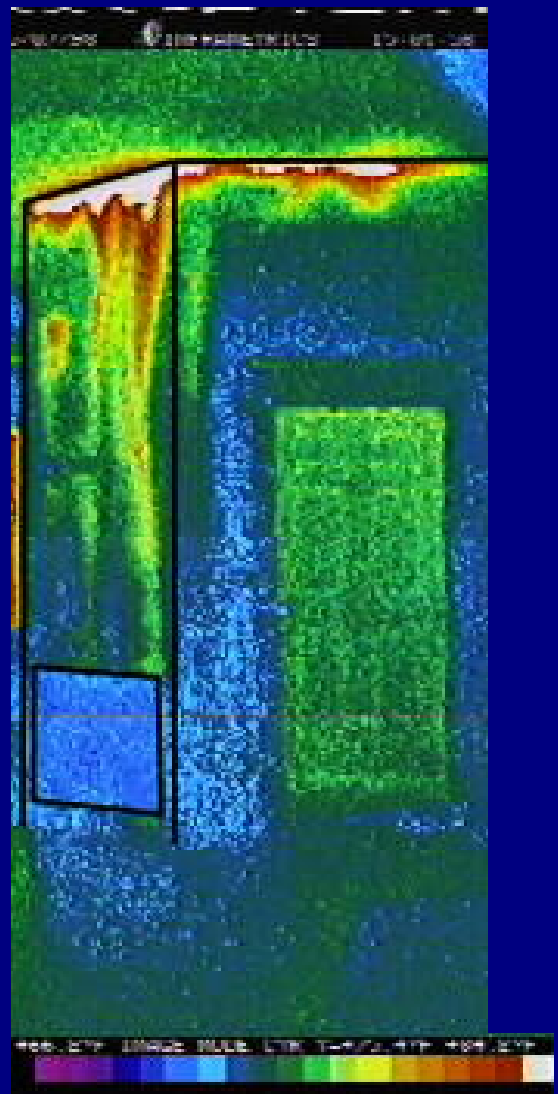


Outside Duct Airtightness Test

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

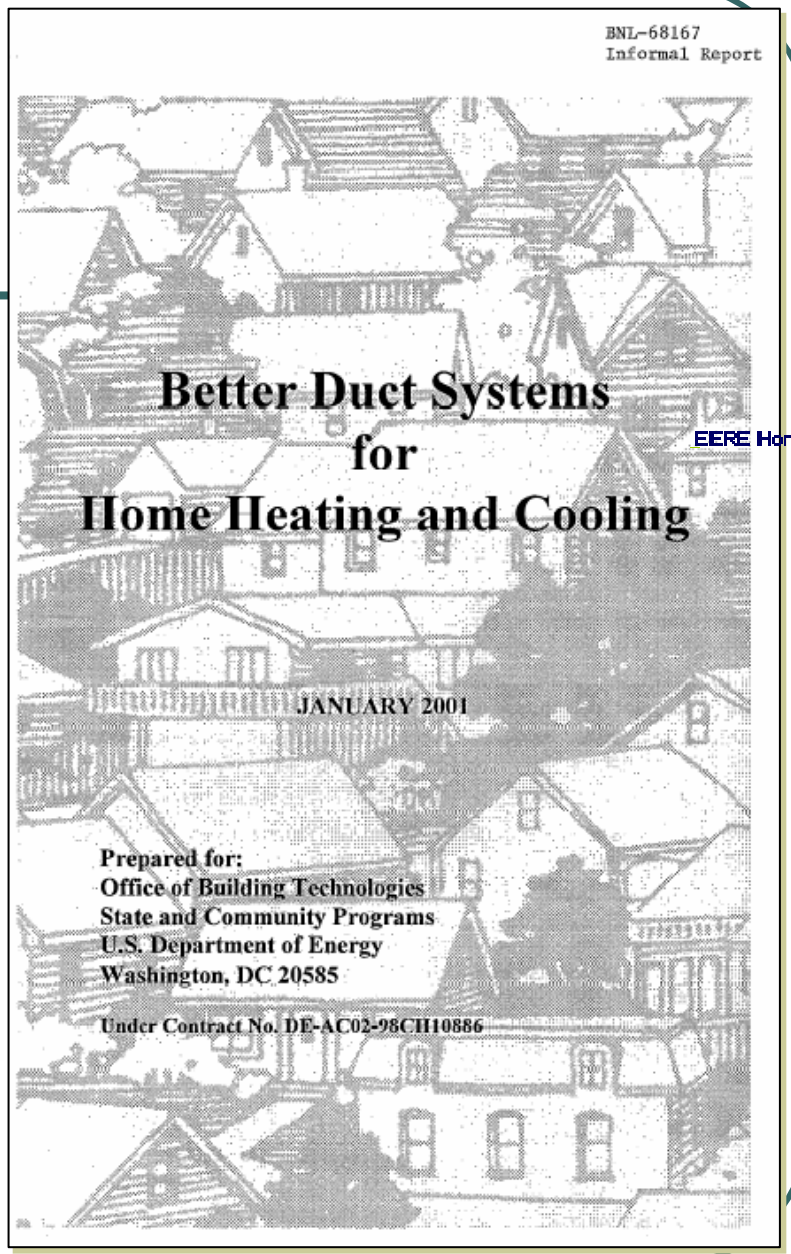


a few reference materials

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Building Technologies Program

Volume Title	Topic	Main Audiences
1. Duct Basics	How ducts lose energy Introduction to remaining topics	All audiences: Contractors, Technicians, Builders, Homeowners
2. Health, Safety, and Comfort Issues in Residential Ducts	Toxic gases and vapors Molds and mildews Inadequate cooling performance	All audiences: Contractors, Technicians, Builders, Homeowners
3. Customer Benefits from Better Duct Systems	Situations where duct repair is a big win-win for the contractor and the customer	Contractors, Builders
4. Duct Design Strategies	Recommended design options: 1. Ducts in conditioned space 2. Leak-free, insulated ducts	Designers responsible for laying out a duct system for a contractor or builder
5. Testing and Diagnosing Duct Systems	Testing for duct leakage Finding distribution efficiency	Technicians, Contractors, Builders
6. Installation and Repair of Duct Systems	Sealing and insulating ducts Correcting pressure imbalances Installing new duct systems	Technicians, Contractors, Builders



www.eere.energy.gov/buildings/info/documents/pdfs/22291.pdf

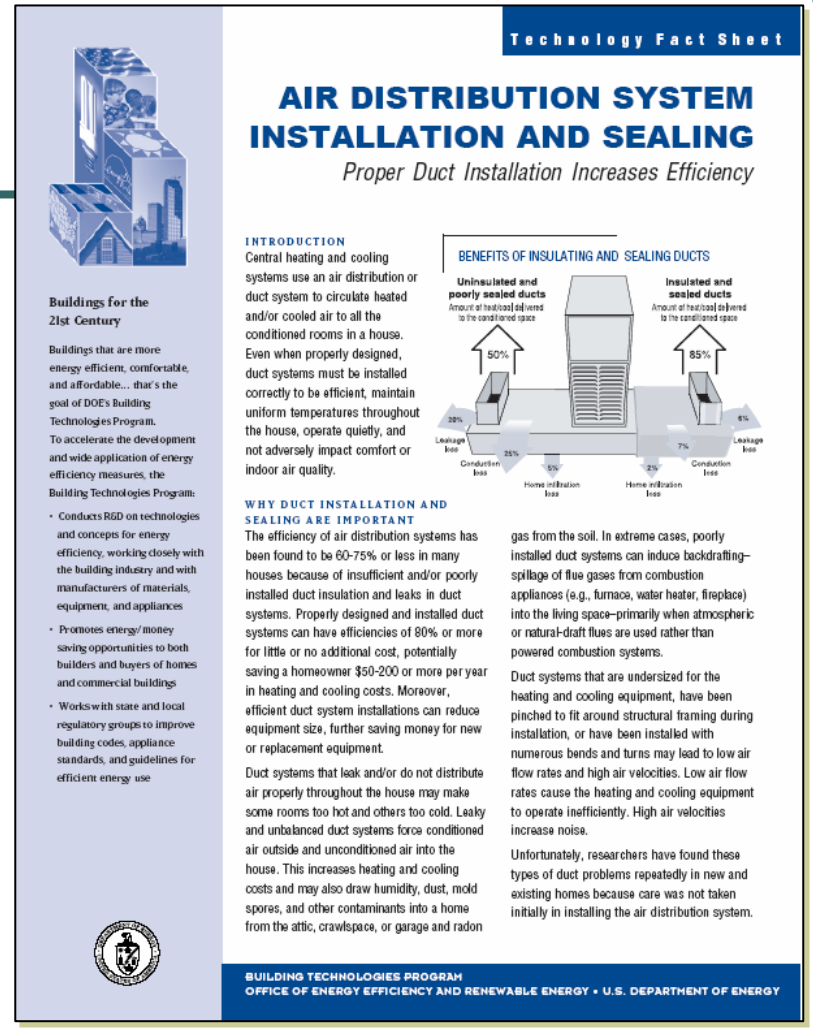
U.S. Department of Energy
Energy Efficiency and Renewable Energy

Building Technologies Program

DUCTINSTALLATIONPRINCIPLES

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.



Technology Fact Sheet

AIR DISTRIBUTION SYSTEM INSTALLATION AND SEALING

Proper Duct Installation Increases Efficiency

Buildings for the 21st Century

Buildings that are more energy efficient, comfortable, and affordable... that's the goal of DOE's Building Technologies Program. To accelerate the development and wide application of energy efficiency measures, the Building Technologies Program:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with state and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use

INTRODUCTION

Central heating and cooling systems use an air distribution or duct system to circulate heated and/or cooled air to all the conditioned rooms in a house. Even when properly designed, duct systems must be installed correctly to be efficient, maintain uniform temperatures throughout the house, operate quietly, and not adversely impact comfort or indoor air quality.

BENEFITS OF INSULATING AND SEALING DUCTS

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 insufficient and/or poorly installed duct insulation and leaks in duct systems. Properly designed and installed duct systems can have efficiencies of 80% or more for little or no additional cost, potentially saving a homeowner $50-200 or more per year in heating and cooling costs. Moreover, efficient duct system installations can reduce equipment size, 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 unbalanced duct systems force conditioned air outside and unconditioned air into the house. This increases heating and cooling costs and may also draw humidity, dust, mold spores, and other contaminants into a home from the attic, crawlspace, or garage and radon gas from the soil. In extreme cases, poorly installed duct systems can induce backdrafting–spillage of flue gases from combustion appliances (e.g., furnace, water heater, fireplace) into the living space–primarily when atmospheric or natural-draft flues are used rather than powered combustion systems.

Duct systems that are undersized for the heating and cooling equipment, have been pinched to fit around structural framing during installation, or have been installed with numerous bends and turns may lead to low air flow rates and high air velocities. Low air flow rates cause the heating and cooling equipment to operate inefficiently. High air velocities increase noise.

Unfortunately, researchers have found these types of duct problems repeatedly in new and existing homes because care was not taken initially in installing the air distribution system.

BUILDING TECHNOLOGIES PROGRAM
OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY


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