Energy Code Support

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Purpose of this class

- Introduction to duct sealing & testing requirements for the 2009 WSEC.
- Basic understanding of the purpose of duct sealing & testing.
- Discussion of benefits of moving ducts to the inside.

Note: this class does not provide qualification for ENERGY STAR, PTCS, tax credits or other beyond code programs.
Why Do We Seal Ducts?

- Health & Safety
- Comfort
- Energy Savings
- More Durable Buildings
Implications of leaky ducts

- Leaky ducts typically raise heating and cooling costs **20% - 40%**

- This figure may **double** if the ducts are not insulated

- A conservative estimate is ducts waste over $10 billion in energy in SFR’s alone
Duct System Supply Leakage

105° – 140°
Where is the air coming from?
Duct System Return Leakage in Heating Season
Outside – 30\(^\circ\)

Inside – 70\(^\circ\)

Warm, moist air

Dew Point

Condensing Surface

R-21
Duct System Return Leakage in Cooling Season
System Deficiencies

Hole at Dovetail Connection
Large hole where down drafting furnace connects to supply plenum
Leakage & Energy Loss

- The hole needs to be connected to the outside.

- Heat loss is proportional to temperature and pressure differences.

- Holes that see high pressures and high temperature differences are most important for energy savings.
  - **Heating Climates** this is the supply side near the air handler.
  - **Cooling climates** this is the return side near the air handler.
What does the code require?

- Air sealing of all joints & seams on all ducts, air handlers, and filter boxes.

- Duct testing performed & permanently documented.
  - Signed affidavit (duct tester’s responsibility)
  - Test results must be recorded on certificate for new construction (builder’s responsibility)
Terminology

- **CFM**: Cubic Feet per Minute
- **Pa**: Pascals
- **Conditioned Floor Area (CFA)**: Square footage of all heated areas
- **Manometer**: Digital pressure reading device
- **Duct Tester**: Equipment used to pressurize ducts
- **Blower Door**: Equipment used to pressurize (or depressurize) a structure
Airflow Basics

- Airflow Requires
  - *Driving force* (pressure or temperature difference)
  - A hole
  - Air moves from High to Low pressure areas

\[
P_1 - P_2 = \Delta P
\]

Airflow \approx \text{Hole size} \times \Delta P
Air in = Air out

1 cfm (infiltration)

Perfect Duct System

1 cfm
What a duct tester tells us

- **Airflow in = airflow out**, so flow through fan = flow through leaks in system.

- **CFM$_{25}$** is an aggregation of all of the holes throughout the entire duct system – that’s all!
  - It doesn’t tell us where to find the holes
  - It doesn’t tell us how much the ducts leak under normal operating conditions.
  - Without a blower door, it doesn’t tell us how much of the holes are connected to the outside.
Two Duct Test Options:

- **Total duct leakage** measures leakage to both indoors & outdoors

- **Duct leakage to the outdoors** – measures *effective duct leakage to the outside*

  Combines a blower door with the duct blower

Both tests provide Cubic Feet per Minute (CFM) duct leakage numbers
Duct Testing Standards:

At Rough-In

- **Total leakage ≤ 6 cfm per 100 sf** of conditioned floor area @ 25 Pa for a complete system

- **Total leakage ≤ 4 cfm per 100 sf** of conditioned floor area @ 25 Pa if air handler *has not been* installed
Duct Testing Standards:

Post Construction

- **Total leakage test:** \( \leq 8 \text{ cfm per 100 sf} \) of conditioned floor area @ 25 Pa

- **Leakage to exterior test:** \( \leq 6 \text{ cfm per 100 sf} \) of conditioned floor area @ 25 Pa
Examples:

**Total leakage**

- House size: 2240 Ft$^2$
  
  \[
  2240 \times 0.08 = 179 \text{ CFM} \quad \text{maximum}
  \]

**Leakage to exterior** (requires a blower door)

- House size: 2240 Ft$^2$
  
  \[
  2240 \times 0.06 = 134 \text{ CFM} \quad \text{maximum}
  \]
Resources for Standard and Testing

Duct Testing Affidavit

Test Result Calculator
Duct Testing Standards

Exceptions:

Duct tightness test is **not required** if

- The air handler and all ducts are located within conditioned space.

  or

- The furnace is a nondirect vent type combustion appliance in an unconditioned space with a **maximum of 6 feet** of ductwork in the unconditioned space.
Original
Duck
Blaster
Necessary Equipment

- Duct Blaster (or equivalent)
- Manometer
- Register blocks or “mask”
Set up

- Connect Duct Blaster to furnace cabinet or return grill
- Close/seal outside ventilation air openings
- Block (seal) all registers
- *Remove* furnace filter
- Insert static pressure tap
- Program Manometer
“Duct Blaster” attached to duct system

Example: Air flow down into ducts in crawlspace
Seal Registers to Pressure Test
1. Insert **Static Probe** into duct
2. Point toward air flow direction
Bent tubing is *NOT* a Static Pressure Tap
Pressure meter set-up: details

- Meters measure pressures only
- Most meters will convert pressures into flow rate
- Attention to meter details is critical:
  - Garbage in = garbage out
Other Equipment

RetroTec Meter
all the same stuff …
Total Duct Leakage Test

Step 1: Seal all registers and grills

Also: integrated fresh air duct sealed

Mask or foam blocks

Integrated fresh air duct sealed
Static Pressure Tap

Insert in *Supply Side* (in or near supply plenum)
Total Duct Leakage Test

Step 3: Connect Duct Blower to System

Integrated fresh air duct sealed
**Total Duct Leakage Test**

1. Seal all registers and grills
2. Seal fresh air duct and/or HRV
3. Install static pressure tap in supply side
4. Attach duct blower to system
5. Set up pressure gauge
6. Pressurize system to + 25 Pa
7. Record air flow into system @ + 25 Pa
8. Document set-up configurations
Duct Leakage to the *Exterior* incorporates *Blower Door*.

Yields duct leakage CFM to the *exterior*.
Duct Leakage to the *Exterior*

Seal and pressurize ducts to **+ 25 Pa**

Blower door pressurizes building to **+ 25 Pa**
Duct Leakage to the *Exterior*

*Incorporates Blower Door*

1. Seal all registers and grills
2. Seal fresh air duct and/or HRV
3. Install static pressure tap in supply side
4. Attach duct blower to system
5. Install blower door and close-up the house
6. Set up pressure gauges
7. Pressurize house to +25 Pa (Blower Door)
8. Pressurize duct system to +25 Pa (Duct Blower)
9. Record air flow into system @ +25 Pa
10. Document set-up configurations
Duct Sealing

- Any duct outside the conditioned space must be sealed with approved material
  - See IMC 603.9 or IRC M1601.3
  - UL 181A listed tapes can be used with listed fiberglass ducts*
  - UL 181B listed tapes can be used with flex ducts*

*Must be installed in accordance with the listing*
Duct Tape

Duct tape may be used if:

- Installed in accordance with mfg’s installation instructions
- Must contain detailed info specific to application on ducts
- Info must contain approved duct materials and surface cleaning requirements

Please let us know if you find this information from any manufacturer!
How to pass the test (or fail it)
All Joints Must Be Sealed
Mastic is NOT paint
apply “nickel thick”
What do you expect for $850,000?
A good duct system?
Don’t do this!
Residential duct insulation

- Attics, crawl spaces, garages require $R-8$
- In slabs or underground require $R-5$
- On a roof or exterior of a building require $R-8$ and a weatherproof barrier
Vapor barriers on cooling ducts?

- Required when the mean dewpoint temperature in June, July, and August exceeds $60^\circ F$

- Although a code requirement, this does not happen in Washington

The closest is Olympia at $52^\circ$
Duct liner

- Typical duct liner requires 2 inches to meet code

- Most duct liner is R-4 per inch
Related code changes

- Installation of ducts in exterior walls, floors, or ceilings shall not displace required insulation.

- Building cavities *may not* be used as ducts.

- Duct testing required when replacing HVAC equipment, and shall be sealed.
  - Includes:
    - Air handler replacement
    - Outdoor condensing unit (AC or HP)
    - Cooling or heating coils
    - Furnace heat exchanger
Duct Sealing (Existing Houses)

Field Verification Compliance Options

- Maximum leakage rates:
  - 8% CFA for *Total duct leakage*
  - 6% CFA for *Leakage to exterior*
  or

- Post installation duct leakage reduced by 50%
  or

- Verification by 3\textsuperscript{rd} party inspector that all accessible leaks have been sealed

Duct testing standards are posted at:

[www.energy.wsu.edu/code](http://www.energy.wsu.edu/code)
Exceptions for Existing Houses:

- Ducts that are contained within the conditioned space
- Ducts that have been previously tested
- Ducts with less than 40 lineal feet in unconditioned spaces
- Ducts containing asbestos
A Better Way: Move the Ducts Inside!

- Habitat for Humanity
- First WA Energy Star
- All Duct Inside
- 1000 FT2
- All Electric < $40/month
Ducts in Dropped Ceiling in Hall
After Drywall
Air Handler Inside

Supply Register In Wall
Dropped Soffit with Duct in Bathroom
Vancouver Demonstration
Duct Between Floors
Ducts between floors

High efficiency furnace inside the structure
House Air Leakage Testing
Building Air Leakage/Tightness Testing

Closed house condition
Blower door creates negative pressure
Measure house pressure + air flow out

Use - 50 pascal pressure

High air flow @ 50 pascals = large air leakage
Low air flow @ 50 pascals = small air leakage
Measure the pressure in building

Measure the volume of air out fan

Calculate the leakage area

Estimate air exchange
Necessary Equipment

- Blower door
  - Fan
  - Panel
  - Frame

- Manometer
Set-up

- Assemble frame, place nylon canvas over frame secure in exterior door frame.
- Insert fan in panel
- Connect tubing to manometer, fan and exterior
- Properly program manometer
- Depressurize to 50Pa and record CFM
DG-700 Pressure & Flow Meter

Device Select

Mode Select

Device Configuration Select

“Input” ports

“REF” ports
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<thead>
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<th>DEVICE</th>
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<td>BD 3</td>
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**PR/ FL**

- **Pa**
- **CFM**

**MODE**

- **DEVICE**
- **UNITS**
- **CONFIG**
  - Cruise Target
- **MODE**
  - Stop Fan
- **CLEAR**
- **TIME AVG**

**BG = Blower Door**
DG-700 Pressure & Flow Gauge

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**DG-700 Pressure & Flow Gauge**

- **MODE**
- **DEVICE**
- **UNITS**
- **CONFIG**
- **CLEAR**
- **TIME AVG**
During Testing

- Exterior windows and doors closed
- Fireplace and stove doors closed
- Close dampers (depressurizing the house sucks gravity dampers closed)
- Interior doors open
During Testing

- Open access hatches to conditioned attics or crawl spaces
- Exterior ventilation openings closed and sealed
- HVAC ducts and registers not sealed
- HVAC, water heater, OFF
What the numbers mean

Pressure (in Pascals)

Flow rate (CFM)
Calculating SLA

(Specific Leakage Area)

- \[ SLA = \frac{\text{CFM}50 \times 0.055}{\text{CFA} \times 144} \]

- \[ SLA = \frac{1790 \times 0.055}{2240 \times 144} \]

- \[ SLA = \frac{98.45}{322,560} \]

- \[ SLA = 0.00030 \]