# HVAC Distribution Systems

# Weatherization Energy Auditor Single Family

Learning Objectives

By attending this session, participants will be able to:

* Name functions of the components of forced warm air, hot water, and steam distribution systems.
* Demonstrate common diagnostic and assessment methods for ducted distribution systems.
* Describe common problems for each distribution system type.
* Explain solutions to these common problems.

Key Terminology

Air changes per hour (ACH)

Aquastat

Backdrafting

Balancing

Balancing damper

British thermal units (BTU)

British thermal units per hour (BTUH)

Carbon monoxide (CO)

Circulator pump

Combustion appliance zone (CAZ)

Convector

Cubic feet per minute (CFM)

Cut-in pressure

Cut-out pressure

Damper fin

Design heat load (DHL)

Distribution system

Domestic hot water (DHW)

Duct blower

Exfiltration

Expansion tank

External static pressure (ESP)

Fan control

Feet per minute (FPM)

Flame roll-out

Free vent area

Friable

Health and safety (H&S)

Heat exchanger

Hydronic

Inches of water column (IWC)

Limit control

Low-water cutoff

Manometer

Mastic

Panned floor joist

Panning

Parts per million (ppm)

Pascals (Pa)

Plenum

Pounds per square inch (psi)

Pressure control

Pressure pan

Rocking on the high limit

Runout

Series loop hot water distribution system

Sight glass (also gauge glass)

Static pressure

Total duct leakage

Total pressure

Velocity pressure

Zone valve

Supplemental Materials

Handouts & Resources

American Gas Association. “Fact Sheet: Furnace Heat Exchanger Leakage Test.” Dec. 1986.

Duct Blaster Manual

Duct Sealing." *WxTV*. Montana Weatherization Training Center. <www.wxtvonline.org>.

Duct System Sizes and Air Flow Quick Chart

Francisco, Paul W. “Field Evaluation of an Updated Delta-Q Test for Duct Leakage at Operating Conditions.” Building Research Council, University of Illinois. Undated.

Krigger, John T., and Chris Dorsi. *Residential Energy Cost Savings and Comfort for Existing Buildings*. 4th ed. New York: Saturn Resource Management, 2004, pp. 156–160, 163–168.

MacPhaul, David and Christy Etter. “HVAC System Design for Humid Climates.” WBDG.org.National Institute of Building Sciences. <www.wbdg.org>.

Manclark, Bruce. “Of Mastic and Mistakes.” Home Energy May/June 2001. <www.homeenergy.org>.

McIlvaine, Janet, and David Beal. “Chasing Interior Ducts.” Home Energy May/June 2002. <www.homeenergy.org>.

Pressure Pan User Manual.

Ternes, Mark P. “Weatherization Test Drives Spray Sealant.” Home Energy Nov./Dec. 2001. <www.homeenergy.org>.

The Energy Conservatory. "Minneapolis Duct Blaster Operation Manual (Series B Systems)." The Energy Conservatory. <www.energyconservatory.org>.

True Flow Quick Guide.

U.S. Department of Energy. Weatherization Assistance Program. Midwest Regional Field Office. Midwest Weatherization Best Practices Field Guide May 2007, pp. 27-36. <[www.karg.com/pdf/Midwest\_Wx\_Best\_Practices\_May\_2007.pdf](http://www.karg.com/pdf/Midwest_Wx_Best_Practices_May_2007.pdf)>.

Walker, Iain, and Max Sherman. “An Easier Way to Measure Duct Leaks.” Home Energy Sept./Oct. 2002. <www.homeenergy.org>.

Walker, Iain, and Max Sherman. “What’s Up with Duct Tape?” Home Energy Nov./Dec. 2004. <www.homeenergy.org>.

Whitman, William C., William M. Johnson, and John Tomczy. “Duct System Sizes & Air Flows Quick Chart.” Refrigeration and Air Conditioning Technology. 5th ed. Cengage Learning, 2004.

Online Platform Lessons

Use these online interactive training modules as prerequisites before students attend the course or as in-class computer lab sessions. To access, users must first create an account at [www.nterlearning.org](http://www.nterlearning.org).

a- 8.3 Mechanical Ventilation <https://www.nterlearning.org/web/guest/course-details?cid=248>

a- 9.1 Measuring Duct Leakage with a Blower Door   
<https://www.nterlearning.org/web/guest/course-details?cid=248>

a- 9.2 Pressure Pan Testing <https://www.nterlearning.org/web/guest/course-details?cid=248>

a- 9.3 Dominant Duct Leakage <https://www.nterlearning.org/web/guest/course-details?cid=248>

a- 9.4 Duct-Blower Leak Testing <https://www.nterlearning.org/web/guest/course-details?cid=248>

a- 9.5 Duct Induced Room Pressure Imbalance   
<https://www.nterlearning.org/web/guest/course-details?cid=248>

c- 10.1 Identifying Heating Equipment <https://www.nterlearning.org/web/guest/course-details?cid=247>

**Classroom Props & Activities**

* Smoke puffer
* Flashlight and mirror
* Small probe thermometers
* Manometer
* Pressure pan
* Duct blower
* Static pressure tip
* Air handler flow meter

Hands-on Props & Activities

Demonstrate each of the following tools and have students perform the various tests.

**Smoke puffer** – Demonstrate how to use smoke to determine the direction of airflow or detect leakage in air distribution systems.

**Flashlight and mirror** – Demonstrate how to visually inspect the integrity of air distribution systems, especially the heat exchanger.

**Small probe thermometers** – Use two thermometers to demonstrate how to perform a temperature rise test.

**Manometer** – Demonstrate how to use a manometer to measure room pressure imbalances.

**Pressure pan** – With a blower door, pressure pan, and manometer, demonstrate how to use a pressure pan to measure duct leakage to the outside.

**Duct blower** – Demonstrate how to use a duct blower to measure total duct leakage and duct leakage to the outside.

**Static pressure tip** – Demonstrate how to use a static pressure tip to measure static pressure in ductwork.

**Air handler flow meter** – Demonstrate how to measure air handler flow.

**Lab Demonstration**: If possible, set up forced air and hydronic systems in a lab to identify system components and perform diagnostic tests. If that isn’t possible, arrange a field trip to a home with a furnace or hydronic system.

Class Overview

* Use the presentation, discussion, and handouts to introduce students to the key elements of distribution systems, including:
* System components.
* Design.
* Functions.
* Diagnostic testing.
* Troubleshooting.
* Divide the presentation into segments so that lab demonstrations or exercises immediately follow the related portion of the presentation. For instance, a segment on design and components would be immediately followed by a lab demonstration. Ask students to identify components based on what they have learned in the lecture. Do the same for diagnostic procedures on hydronic or steam systems.
* A considerable amount of time and effort should be dedicated to teaching students how to use diagnostic tools and the procedures for analyzing forced air distribution systems. During lectures, pass around the tools described above as prompted by the slide presentation. Proceed to the lab and perform tests on an operating system using the same equipment. Keep the class size small (no more than 10 students). Demonstrate each procedure, and then check that each student understands the purpose of the tests, use of the equipment, and steps involved. Employ an assistant if possible. Allow students to practice diagnostic tests on their own.
* Be patient and reinforce the why and how. Encourage quiet students to become involved and more advanced students to mentor slower students. Don’t let up until you’re sure everyone really gets it.