# Identifying Mechanical Systems & Improving Duct Systems

# Weatherization Installer/Technician Fundamentals

Learning Objectives

By attending this session, participants will be able to:

* Identify common mechanical systems, including combustion appliances and cooling systems.
* Discuss clearance to combustibles requirements for various vent pipe types.
* Identify various electrical, plumbing, and safety components of mechanical systems.
* Illustrate proper combustion vent system exhaust system installation.
* Explain how a home’s forced air distribution system works.
* Describe mobile home duct configurations.
* Identify and diagnose duct leakage problems.
* Fix leaky ducts using correct materials and techniques.
* Make other duct system improvements.

Key Terminology

Aluminum brake

Aluminum coil stock

Atmospheric

Backdraft

Baffle

Barometric damper

Belly return

Boot

Branch duct

Butyl-backed tape

B-vent

BW-vent

Cad (cadmium) cell

Carbon dioxide (CO2)

Carbon monoxide (CO)

Clearance

Combustion byproducts

Combustion chamber

Combustion efficiency

Condensing furnace

Depressurization

Dilution air

Direct current (DC)

Downflow furnace

Draft

Draft diverter

Draft gauge

Draft hood

Draft reversal

Duct boot

Firing chamber

Flame retention head burners

Furnace blower

Furnace plenum

Hallway return

Heat exchanger

Induced draft furnace

L-vent

Mastic

Natural gas

Net free area (NFA)

NFPA 211

NFPA 31

NFPA 54

Non-flame retention head burners

Pounds per square inch (psi)

Pressure balancing

Pressure pan testing

Return plenum

Revolutions per minute (RPM)

Riser

Spillage

Temperature and pressure relief valve

U.S. DOE Hot Climate Initiative

Under-fired

Upflow furnace

Worst case combustion appliance zone (CAZ) testing

Supplemental Materials

Handouts & Resources

Combustion Analysis Quick Sheet.

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

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

“Mobile Home Series: Advice from Cal Steiner.” *WxTV*. Montana Weatherization Training Center. <www.wxtvonline.org>.

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National Fire Protection Agency. “NFPA31: Standard for the Installation of Oil-Burning Equipment.” <www.nfpa.org>.

National Fire Protection Agency. “NFPA54: National Fuel Gas Code.” <www.nfpa.org>.

Steiner, Cal. “Moisture, Leaks, and Pressures in Mobile Homes.” *Home Energy* 2 Mar. 2006. <www.homeenergy.org>.

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U.S. Department of Energy. Hot Climate Initiative. *Combustion Appliance Safety & Efficiency Testing.*

U.S. Department of Energy. Weatherization Assistance Program. Midwest Regional Field Office. “Midwest Weatherization Best Practices Field Guide.” May 2007: 21-27, 191-194. <www.waptac.org>.

Van der Meer, Bill. “Mobile Home Tool and Material List for Duct Sealing, Air Sealing and Insulation Retrofits.”

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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.

Relevant Standard Work Specifications

5.3000 – Forced Air (All detail within this topic)

Classroom Props & Activities

**Combustion appliances**Set up used appliances so you can perform diagnostic tests on them. Nonoperating appliances can be used to identify components and physical problems. Identify the temperature and pressure valve on a water heater, burn nozzles, and other important features.

* Vented and unvented space heater
* Atmospheric furnace
* Natural draft gas water heater
* Gas cook stove

**Room A/C Unit**These are most common to the clients served by the Weatherization Assistance Program (WAP). Let students take off the housing and removable grille to inspect and become familiar with the parts of the appliance. Have students locate and identify the compressor, filter, coils, and condensate drain.

**Vent materials**

* Type B-vent
* Type BW-vent
* Type L-vent
* Single-wall galvanized vent
* PVC schedule 40 pipe
* Stainless steel chimney liner and cap

**Duct sealing materials**

* Aluminum coil stock
* Mastic
* Butyl-backed tape
* Inspection mirror
* Fiberglass mesh
* Brushes, latex gloves, and cleaning supplies
* Aluminum break

**Miscellaneous**

* Dirty filter and blower
* Oil burner
* Barometric damper (oil)
* Thermostat

**Pressure pan and manometer demonstration**

Demonstrate how to use a pressure pan. Working with students in small groups, familiarize them with the manometer functions.

Offer a case study about sequential pressure pan-guided testing. Draw a long, narrow rectangle representing the shape of a mobile home. Draw a long duct run in the middle of the rectangle with registers at various locations along its length. Put in a few partitions to represent rooms.

Inform students that pressure pan readings at registers along the length of the duct range from 35 Pa at the register in the master bedroom at one end of the home to 10 Pa at the kitchen register at the other end of the home. Investigating the end of the duct below the master bedroom reveals that the end of the duct is completely open. Upon sealing the end of the duct, a subsequent pressure-pan test on the register in the master bedroom reveals that the reading has dropped to 10 Pa.

*Q. What effect will sealing the large hole have on pressure at other register locations in the home?*

*A. It will reduce it. Additional duct sealing at various locations should result in pressure pan readings of 1 Pa or less.*

 **Class Overview**

* Use the presentation, discussion, and handouts to introduce students to the key elements of identifying mechanical systems.
	+ Vent type
	+ Burners
	+ Distribution systems
	+ Compressors and coils, etc.
* Point out the various components of the appliances and have students name them. In groups, have students inspect wiring and fans, look for cracked or corroded heat exchangers, and identify proper vent materials. Test for fuel leaks, safety shut-off, draft, free oxygen (combustion air), CO, cracked heat exchangers, and combustion efficiency.
* Room A/C units are the most common to the clients served by the WAP. Let students take off the housing and removable grille to inspect and become familiar with the parts of the appliance. Have students locate and identify the compressor, filter, coils, and condensate drain.
* Run through the various functions of a combustion analyzer.
* When discussing vent pipes materials, refer to NFPA 211 code requirements. Pass around or display samples of various vent pipes.
* Review protocols for removal and disposal of common mechanical system replacements in your service territory. Discuss proper locations for penetrations in relation to snow load (if applicable) and proximity to windows. Provide instruction on how to tell if an installation is complete. Refer to locally enforced mechanical code.
* Discuss safety issues – Refer to WPN guidance 11-6 (or most current) if asbestos furnace pipe wrap is common in your area. Describe emergency safety shut-offs (electric or fuel shut-offs) for common mechanical systems in your region.
* Use the presentation, discussion, and handouts to introduce students to the key elements of diagnosing, repairing, and improving duct systems, such as:
	+ Performing visual and diagnostic tests.
	+ Repairing and sealing ducts.
	+ Balancing the system.
* Simulate a pressure balance test through the door of the classroom, if possible. Tell students to imagine that a furnace fan is running. Connect a hose to the input port of the manometer and run the other end of the hose through the bottom of the closed classroom door. Simulate a positive number and ask if the room has more supply air than return air because of the positive pressure. The answer is “yes.” Follow up with a question about how to relieve that pressure. The answer is to add more return registers or undercut the door.
* Emphasize that duct repair is probably the single most important retrofit because leakage of conditioned air to the outside through leaky ducts wastes energy and affects a client’s comfort and fuel bills.
* Use various props, demos, or video footage to reinforce technical aspects.
	+ Show and tell duct sealing tools and materials.
	+ Let students work with the manometer and pressure pan in small groups.
	+ Provide students with tools and duct sealing materials, and have them practice duct sealing techniques on the duct sealing prop.