# Mobile Home Assessment

# Weatherization Energy Auditor Single Family

Learning Objectives

By attending this session, participants will be able to:

* Discuss mobile home characteristics and components.
* Evaluate problems and opportunities.
* Review cost-effective retrofit options.
* Determine health and safety measures.
* Discuss diagnostic approaches to evaluating mobile homes.
* Discuss visual checks and specifications.
* Examine conditions for deferral of service.

Key Terminology

Ambient air

Air Conditioning Contractors of America (ACCA)

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

ASHRAE 62.2 2010

Base load

Blower

Cad cell

Carbon dioxide (CO2)

Carbon monoxide (CO)

Certification label

Combustion air

Combustion analyzer

Combustion efficiency

Concentric flue

Conditioned air

Data plate

Deferral of services

Domestic hot water tank (DHWT)

Downflow air distribution system

Dropped down belly

Energy conservation measure (ECM)

Fan-off temperature

Fan-on temperature

Flue gas

Heat exchanger

Heat rise

High limit

House wrap

HUD Code

I-beam

Incidental repair

Manual J

Mobile home belly

Mobile Home Energy Audit (MHEA) software

National Fire Protection Association (NFPA) code

Oak Ridge National Laboratory (ORNL)

Rodent barrier

Roof jack

Savings-to-investment ratio (SIR)

Sealed combustion

Steady state efficiency

Steel chassis

Temperature rise

Thermal boundary

Thermal break

Thermal mass

U.S. Department of Housing and Urban Development (HUD)

Supplemental Materials

Handouts & Resources

Armanda, Larry. “Ventilation Strategies in Weatherization.” *WTC Technical Update* 1.8 (2006). Weatherization Training Center at Pennsylvania College of Technology. <www.pct.edu>.

Beers, Jonathan. “Dryer Venting.” *Home Energy* Nov./Dec. 2003: 14-16.

Greely, Kathy, John Randolph, and Bill Hill. “A Warm Wind Blows South: Virginia’s Weatherization Evaluation.” *Home Energy* Jan./Feb. 1992: 15-21.

Loose-Fill Insulation Coverage Chart.

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

"Mobile Home Series: Determining Existing Insulation for the Audit." WxTV. Montana Weatherization Training Center. <www.wxtvonline.org>.

Mobile Home Tool and Material List for Duct Sealing, Air Sealing, and Insulation Retrofits.

Moyer, Neil. “Moisture Problems in Manufactured Housing.” *Home Energy* Mar./Apr. 2002. <www.homeenergy.org>.

National Fire Protection Association. “Clothes Dryer and Washing Machine Safety Tips.” Undated. <www.nfpa.org>.

National Fire Protection Association. “NFPA Dryer Fact Sheet.” Undated. <www.nfpa.org>.

Scott, Bob, and Lyn M. Bartges. “Weatherizing Mobile Homes.” *Home Energy* July/Aug. 2004. <www.homeenergy.org>.

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

U.S. Department of Energy. EERE. “Combustion Equipment Fact Sheet.” Oct. 2000.

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: 183-215.

Online Platform Lessons

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

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

Classroom Props & Activities

**Scale model of a mobile home:** Use to show framing, ducts, and building cavities, etc. Supplement presentation with show-and-tell on model.

**Mobile home furnace:** Show students various components of a mobile home furnace, such as the heat exchanger, blower, chimney cap, and gas or oil burner. Emphasize differences between mobile home and single-family housing heating systems. Refer to the DOE “Combustion Appliance Safety & Efficiency Testing” document when discussing proper testing locations for CO, efficiency, draft, and clearance to combustibles on various appliances.

**Heating diagnostic equipment:** Break up the presentation by demonstrating various combustion inspection tools. If an operating mobile home furnace is not available, go through the functions of the combustion analyzer to demonstrate CO, O2, flue gas temperatures, etc.

* Combustion analyzer − for sampling flue gases
* Draft gauge − for testing chimney draft
* Combustible gas leak detector − for detecting fuel leaks
* Smoke tester − for testing the amount of chimney smoke that serves an oil-burning furnace
* Inspection mirror − for looking into confined spaces
* Digital probe thermometer − for testing temperature rise and fan operating temperatures

Hands-On Field Activities

If possible, take the class to a mobile home to conduct a full assessment. An in-field visit can serve as an alternative to or supplement breakout sessions in a lab. Find a homeowner who is willing to have an energy audit performed by a group of no more than 10 to 12 students under the direction of a knowledgeable instructor.

The house should be a typical mobile home with an operating forced-air furnace and underfloor distribution system. Plan to spend 2 to 3 hours at the home to conduct a visual assessment and diagnostic tests. Assess the feasibility of underfloor, wall, and ceiling insulation. Provide students with flashlights, measuring tapes, personal protective gear, and clipboards with paper and pencils. Plan to take pictures. Allow students to disperse into two groups (one inside and one outside), then switch. This would necessitate an additional instructor. Come together periodically to assess progress, discuss findings, or watch and take part in activities such as blower door testing and pressure pan testing of the duct system. Check for pressure imbalances between rooms with the furnace fan in operation.

After the field visit, reassemble in the classroom and let the students share their observations. The instructor should facilitate a consensus of the relative importance of each piece of data and how that data will ultimately fit into a fully documented building assessment and work order. Show the pictures taken at the house site to enhance the discussion of specific features observed at the home.

Break the class into groups to create a house sketch showing the floor plan and layout of the duct system and other features. Have each group designate one person to create a simple drawing with others providing input on the content. Drawings should contain basic information obtained at the site, such as exterior dimensions and shape. Note any additions and their features. The drawing should show features such as the location of the heating system, hot water tank, exterior and interior doors, and window air leakage sites. The underfloor should highlight missing rodent barriers, disconnected ducts, hazards, bulk moisture, and disconnected dryer vents. Allow about 30 minutes for this activity, and then ask the groups to turn in their sketches. Take a few moments to examine the sketches and offer feedback or additional information on the white board.

**Pressure pan and manometer:** 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.
* 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.*

**Miscellaneous:**

* Window (old and new units) − Show the differences between an old jalousie window unit and new energy-efficient replacement types. Discuss and demonstrate how to select and measure windows for replacement, per the manufacturer’s instructions. Apply the same principles for door replacement.
* Mobile home hot water tank – Show the features of a used mobile home hot water tank, paying particular attention to its safety features and control systems.
* Ventilation fan (old and new units) − Show the features of mechanical ventilation fans. Refer to the section on “Mechanical Ventilation” in the Installer Intermediate Module for additional detail.
* Dryer vent materials − Show dryer vent materials. Refer to the section on “Dryer Vents” in the Installer Intermediate Module for additional detail.
* Gas cook stove and CO tester − Demonstrate gas cook stove testing if an operating stove with a fuel supply is available. If an operating stove is not available, show the various components and simulate a test. Demonstrate where to insert the probe of the CO tester, and discuss CO and action levels.

Class Overview

* Use the presentation, discussion, and handouts to introduce students to the construction characteristics of mobile homes related to weatherization. Emphasize the differences between mobile homes and other single-family housing types.
* Provide an overview of the various retrofit options for ducts, heating systems, belly insulation, sidewall insulation, roof insulation, and other measures.
* Use the presentation to demonstrate what to look for when doing a visual and diagnostic assessment of a mobile home. The key elements to assess in a mobile home audit are the following:
	+ Air leakage
	+ Duct leakage
	+ Existing insulation levels
	+ Condition of the belly, wall, and roof system
	+ Structural and drainage issues
	+ Health and safety issues, such as the following:
		- Dryer venting
		- Minimum ventilation rate
		- Mechanical ventilation
		- Unvented appliances
		- Electrical (wiring)
		- Moisture
	+ Heating system
	+ Water heater
	+ Exterior doors and windows
* Use the presentation and speaker notes to focus on the kinds of recommendations an auditor should make, including air sealing, insulation, incidental repairs, heating system improvements, and door and window replacements. Use various props or video footage to reinforce the technical aspects of each recommendation. Break from the presentation to show or demonstrate the classroom props listed above.