

Weatherization Assistance Program Standardized Training Curricula

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The Weatherization Network is encouraged to adopt and adapt the materials contained in the Curricula to meet network training needs. All resources are provided at no fee.

The Curricula is a work-in-progress and will be available as such. Each Module contains a Sample Course Schedule, Hands-on Props where applicable, and a glossary of Key Terminology. A Module is broken into smaller chapters or sections, each including a PowerPoint Presentation with detailed Speaker Notes, a Lesson Plan with prop lists and creative ideas to engage trainees, and suggested Handouts & Resources, including worksheets, articles, and other materials the instructor can use for background research or as homework in the class.

Modules:

- Weatherization Installer/Technician Fundamentals
- Weatherization Installer/Technician Intermediate
- Weatherization Installer – Mobile Homes
- Crew Chief
- Weatherization Energy Auditor – Single Family
- Weatherization Energy Auditor – Multifamily
- **Technical Monitor/Inspector**
- Heating Systems for Energy Auditors and Inspectors – Single Family
- Mechanical Systems - Multifamily
- Train the Trainer

The Technical Monitor/Inspector was designed to lay the groundwork for new/existing weatherization technical monitors/inspectors interested in understanding and expanding on his/her knowledge of monitoring/inspecting weatherized units. The materials provided in this section can be delivered by a trained weatherization professional to small and large groups. Topics cover “Regulations and Standards”, “Purpose of Monitoring and Inspecting”, “Site Monitoring” and much more.

This body of work is compiled from many of the building science resources that have been used by Weatherization professionals as the “best practices.” Of course, special thanks and recognition is given to the Weatherization Trainers’ Consortium members who conceived of this idea to make these materials available to all Weatherization trainers. This group has provided invaluable assistance, sharing resources and experiences and providing feedback throughout the process.

For additional information on the materials provided in the Technical Monitor/Inspector Module, to provide feedback and/or to submit additional materials to include in the “Resources” section, contact SMS via email (info@sms-results.com) or telephone (301.299.2977).

Weatherization Works!

DOE WAP Standardized Curriculum Main Contacts and Contributors By Module

Project History

The Standardized Curricula Project was conceived among members of the Trainers' Consortium as a way to share the best information and provide standardized material that should be included in a well-rounded Weatherization Curricula. Because many trainers had their own materials, simply not in a format conducive to sharing nationally, DOE agreed to fund the compilation of this information to make a body of materials available nationally to assist in training an onslaught of Weatherization workers. Alex Moore, SMS, invited the full membership of the Trainers' Consortium to participate – authors, contributors, reviewers, or simply to critique the materials being assembled to ensure the base of material met the needs of the Weatherization trainers.

The following list of individuals represents those that participated, either actively or passively in the development of this material. The names listed below do not constitute endorsement of this material by those named, but acknowledgement of the sources from which the material in the Standardized Curricula was derived.

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Technical Monitor/Inspector

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- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

II. House as a System

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

III. Regulations and Standards

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

IV. Incidental Repairs and Health & Safety Measures

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

V. Purpose of Monitoring and Inspecting

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

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- a. Lesson Plan
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- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

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- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

- **Building Assessment**

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

- **Interpreting Infrared**

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

- **In-Progress Monitoring and Inspecting**

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

VIII. Report Monitoring

- a. Lesson Plan
- b. Speaker Notes
- c. PowerPoint Presentation
- d. Resources (Folder contains public files as of August 2010)

B. Glossary

- a. *Commonly Used Acronyms*
- b. *WAP Standardized Curricula Glossary*

C. Weatherization Core Competencies

D. Handouts & Resources List

Sample Course Schedule

Technical Monitor/Inspector

Day 1

Registration, Introductions, and Orientation

- **Introduction to WAP for Technical Monitors/Inspectors**
- **House as a System**
- **Regulations and Standards**
- **Incidental Repairs and H&S Measures**

Day 2

Review Day 1

- **Purpose of Monitoring and Inspecting**
- **Desk Monitoring**
- **Inspector's Toolbox**
- **Building Assessment**

Day 3

Review Day 2

- **Review on-site building assessment**
- **Interpreting Infrared**
- **In-Progress Monitoring/Inspecting**
- **Report Writing**
- **Wrap-up, evaluations and goodbyes**

Refer to the Lesson Plan for each section.

Introduction to Weatherization

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Gain historical perspective of the Weatherization Assistance Program.
- Understand characteristics of the client base served by the program.
- Recognize that building science guides the selection of measures installed with program dollars.
- Understand the principles of cost-effectiveness and the savings-to-investment ratio (SIR).
- Recognize modern weatherization measures.

Key Terminology

Air-Handling Unit (AHU)

American Recovery and Reinvestment Act (ARRA)

Base load

Community Action Program (CAP)

Energy burden

Energy Information Administration (EIA)

Health and Safety (H&S)

Incidental repairs

Lead Safe Weatherization (LSW)

Present value

Savings-to-Investment Ratio (SIR)

Training and Technical Assistance (T&TA)

U.S. Department of Energy (DOE)

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

Weatherization Assistance Program (WAP)

Supplemental Materials

Handouts & Resources

Virginia Program Evaluation Summary

Lawrence National Laboratory Estimated Energy Usage by Source chart

2009 Weatherization Works Video

Brown, Marilyn., Berry, Linda. "Weatherization Assistance: The Single Family Study." *Home Energy* Sept./Oct. 1993. www.homeenergy.org.

Haywood, Talmon. "More Than Just Patching Holes." *Home Energy* Mar./Apr. 2002. www.homeenergy.org

Class Overview

- Use the presentation and discussion to teach students about the history and future of the Weatherization Assistance Program (WAP).
- Calculate the simple payback of a refrigerator replacement using local prices. Explain the relationship to savings-to-investment ratio.
- Discuss the Virginia program evaluation considering the effectiveness of “old-school” versus modern weatherization measures.
- Break up class time by showing the “2009 Weatherization Works” video presented at the 2009 National Weatherization Training Conference. The video provides a perfect summary of the facts and benefits of the program for clients and the nation.
- Describe weatherization success stories from your own experience to emphasize the value of weatherization done right.

As wrap-up, have students brainstorm the many benefits of weatherization and keep a running list on the board.

Introduction to Weatherization

Technical Monitor/Inspector

Key Terminology

Air-Handling Unit (AHU)

American Recovery and Reinvestment Act (ARRA)

Base load

Community Action Program (CAP)

Energy burden

Energy Information Administration (EIA)

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Incidental repairs

Lead Safe Weatherization (LSW)

Present value

Savings-to-Investment Ratio (SIR)

Training and Technical Assistance (T&TA)

U.S. Department of Energy (DOE)

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

Weatherization Assistance Program (WAP)

Section Transition

Learning Objectives (Slide #3)

By attending this session, participants will:

- Gain an understanding of the background of the Weatherization Assistance Program (WAP).
- Understand characteristics of the client base served by the program.
- Recognize that building science guides the selection of measures installed with program dollars.
- Understand the principles of cost-effectiveness and the savings-to-investment ratio (SIR).
- Recognize modern weatherization measures.

Mission (Slide #4)

The legislative mission of the program:

- To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their **health and safety (H&S)**.

The purpose of the program was changed in the law to include health and safety in the enabling legislation of 1990.

Organization (Slide #5)

Illustrates the flow of dollars through the program:

- The Federal government distributes funds to the **U.S. Department of Energy (DOE)**, where the program is managed by the Project Management Center (PMC).
- Funds pass to each of the Grantees: the 50 State Offices, the District of Columbia, Native American Tribal Organizations, and the 5 Territories.
- Grantees distribute funds to over 900 local agencies nationwide according to approved budgets.
- The money is used to install cost-effective energy-saving measures in low-income households.

Lyndon Johnson's "War on Poverty" laid the groundwork for the **Weatherization Assistance Program (WAP)** by creating the infrastructure of **Community Action Programs (CAPs)** that now exist in every State. These CAPs often act as subgrantees. The War on Poverty included Head Start, the Low-Income Home Energy Assistance Program (LIHEAP), and after-school programs for children so parents could be part of the work force.

CAPs have the right of first refusal to be a local weatherization agency. Only non-profits and local government agencies are also allowed to act as subgrantees.

Weatherization Process (Slide #6)

This flow chart provides an overview of how a client home progresses through the weatherization process.

- WAP promotion and client recruitment – This can be done through radio or other advertisements, posting notices at community centers, churches, and senior centers, through LIHEAP referrals, and so on.
- Intake and eligibility determination – This is usually done by designated administrative staff that verifies income eligibility and help applicants fill in the necessary forms, as needed.
- Applicant selection and preparation – Many agencies prioritize clients based on elderly, disabled, or children in the home, energy use/energy burden, or some combination of these factors. This is also often where the client learns what they can expect from the weatherization process.
- Auditor background familiarization – When possible, the auditor can review utility data and other relevant information before actually visiting the home.
- Initial site visit/audit – The auditor collects site-specific information to enter into a software audit program or determine the applicability of a relevant priority list. In some cases, the auditor determines that the structure is unsound and defers services on the home.
- Work scope development – Using the data collected on-site and local costs and savings related to various measures, the auditor develops a cost-effective list of measures to be installed in the home.
- Work scope implementation/installation – Crew and contractors install measures listed in work order and notify the local agency of any new issues discovered during installation, sometimes adding energy savings or health and safety measures based on necessity.

- Contractor/crew final inspection – Contractors and crews perform a final inspection on their work to ensure no measures were skipped and that measures were installed in accordance with local technical and quality guidelines.
- Agency final inspection – The local agency is responsible for checking each home.
- Client follow-up – If clients call with questions, thanks, or complaints, agency staff help tie up loose ends.

Low-Income Households (Slide #7)

Characteristics of Low-Income Households

Facts¹:

- More than 90% of low-income households have annual incomes less than \$15,000.
- More than 13% of these low-income households have annual incomes less than \$2,000.
- According to DOE's ***Energy Information Administration (EIA)***, low-income households spend 14.4% of their annual income on energy, while other households only spend 3.3%.
- The average energy expenditure in low-income households is \$1,800 a year.
- The elderly occupy 34% of low-income homes.

These statistics highlight the importance of reducing the ***energy burden*** on our clients. Energy burden refers to the percentage of a household's income that must be used for energy bills. The energy burden for low-income households is more than four times that of other households.

History – 1976 to Early 1980s (Slide #8)

The Weatherization Assistance Program was created in 1976, after the first oil embargo and before DOE was formed. Local programs with the same goals had been in operation, but this was the formal beginning of a national program.

- Started in Maine as "Winterization" – Maine's program was used as a model for the national program.
- Originally administered by the Community Services Administration.
- Later managed by the Federal Energy Administration, a predecessor to DOE.
- Used volunteer labor, who stapled plastic over windows.
- Installed low-cost measures – there was very little insulation installation.
- Little or no production or financial accountability.

¹ This data, provided by Joel Eisenberg, Oak Ridge National Laboratory, and Meg Power, Economic Opportunity Studies, is based on raw data from the Residential Energy Consumption survey conducted by EIA. Source 1: ORNL/CON-493, ORNL/CON-484, EIA February 2008 Short-Term Energy Outlook Source 2: ORNL/TM-2010/66, EIA February 2010 Short Term Energy Outlook

History – Early 1980s to Late 1980s (Slide #9)

The program grew in the early 1980s.

- Used volunteer labor from the Comprehensive Employment and Training Act under Department of Labor.
- Often installed temporary measures.
- Little or no diagnostic technology.
- Project Retro-Tech – This paper energy audit allowed users to enter in the areas and difference in R-value in the home and do very basic heat transfer calculations.
- Addressed the building envelope.
- “Blow and Go” – Workers blew insulation into attics. It was a “quick and dirty” program that completed houses quickly, but with much less improvement to the home than is common today.

History – 1990s (Slide #10)

The program was evaluated in 1991 and it became clear that the cost-effectiveness of installed measures must be tracked. Measures expanded from shell work to heating and cooling systems.

The program was finally allowed to pay for labor. Groundbreaking States began using blower doors and created diagnostic techniques that have been refined over the years.

Structured ***Training and Technical Assistance (T&TA)*** addressed the program’s shortcomings. There is now a feedback loop and accountability. When an inspector notices work in the field that is not up to State standards, training at a recognized facility can be required, or technical assistance will be sent to the local agencies to provide on-the-job training.

- Used paid professional labor.
- Addressed both building envelope and mechanical heating systems.
- Diagnostic tools used in some States.
- Various components of program computerized.
- State and national evaluations conducted.
- Structured training and technical assistance provided.

1990s to Present (Slide #11)

Testing and diagnostics are refined and effective, and installation is often conducted by highly trained crews.

- Weatherization measures are permanent and cost-effective.
- States have rental plans to ensure that weatherization benefits, i.e., savings on utility bills, accrue to tenants, not landlords.
- States have health and safety plans that establish protocols for energy-related health and safety measures, like relining chimneys or replacing faulty furnaces.
- There is increased use of advanced diagnostic tools and energy audits.
- Several States leverage funds from other Federal programs and often through utilities to expand the reach of their WAP.
- Through coordination with the **U.S. Department of Housing and Urban Development's (HUD)** housing agencies, comprehensive rehabilitation and weatherization is possible.

"Old School" Weatherization Measures (Slide #12)

Many weatherization programs without strong management turned into "doors and windows" programs that often included:

- Replacing windows.
- Adding storm windows.
- Replacing doors.
- Adding weatherstripping.
- Adding some attic insulation.
- Caulking (by the case).

Doors and windows especially are highly visible and get much publicity, but typically they aren't cost-effective. The measures that save the most energy - air sealing and adding insulation - are largely invisible.

Modern Weatherization Measures (Slide #13)

The program has improved dramatically over the years. Modern measures provide cost-effective savings based on computerized energy audits. These are more than just shell measures.

- Blower door-directed air sealing.
- Attic insulation.
- Dense-pack sidewall insulation.
- Heating and cooling equipment repair and replacement.
- Duct sealing and modification.
 - o Duct modification includes adding returns to provide the **air-handling unit (AHU)** with enough air, or reconnecting ducts in attics. Occasionally, a duct system is redesigned to use a trunk line. Generally, modifications are done to make sure that the returns are adequately sized, and to replace the floor grills if they've been smashed shut.

- Electric **base load** measures.
 - Installation of compact fluorescent lamps (CFLs).
 - Refrigerator replacement.
 - Water heater modification.

Modern weatherization methods mean looking at the whole house - including the building shell, the mechanicals, and the base load - as a system.

Results (Slide #14)

A comprehensive national evaluation found that compared to utility-sponsored and local weatherization programs; DOE's program was the most effective. The evaluation determined the program to be beneficial on many levels, from energy reduction to jobs creation.

- More than 6.4 million homes have been weatherized to date with Federal and leveraged funds such as State and utility monies and fuel assistance program funds.
- The average reduction in energy used for space heating is 35%.²
- Favorable benefit-cost ratio of 1.8:1³
- Supports tens of thousands of direct and indirect jobs nationwide; 52 direct jobs for every million dollars invested (before the Recovery Act). This number is changing dramatically with deployment of the ***American Recovery and Reinvestment Act (ARRA)*** funds.

Cost-Effectiveness Requirements (Slide #15)

The success of the program is due to the hard work and dedication of its workers.

Two key principles guide the installation of measures: cost-effectiveness and the availability of health and safety funds.

Each individual weatherization material - and the package of weatherization materials installed - must be cost-effective.

Cost-effectiveness is measured by the ***savings-to-investment ratio (SIR)***, the amount of energy savings versus the cost to install a measure.

² This average reduction is extrapolated from natural gas reductions attributed to space heating; batch fuels like propane and fuel oil are difficult to impossible to monitor.

³ National evaluation resulted in three benefit-cost ratios. The lowest one (1.8) measures materials and labor spent at the house (denominator), against the projected energy savings over the life of the measures (numerator). This doesn't include administrative costs. Other ratios include societal benefits and other non-energy benefits: indirect jobs, pollution reduction, improved health and productivity of those served, etc. Including societal benefits increases the benefit-cost ratio.

- An SIR of 1 or higher means the savings earned over the lifetime of a given measure are greater than the full cost of installing that measure.
- The SIR of each individual measure and of the package as a whole must be greater than or equal to 1.
- Energy-related health and safety work is not included in the SIR.
 - There is no federally mandated upper limit for H&S funds. Each State designates this in its State plan.
 - Historically, States have set their upper limit around 6-7%. With an increase in the amount of **Lead Safe Weatherization (LSW)** and furnace replacements, that number has gone up.
- Higher requests for H&S can encourage increased scrutiny of the State plan.

Cost-Effectiveness Requirements (Slide #16)

- $SIR \geq 1$ means energy cost savings over the lifetime of the measure(s), discounted to **present value**, equal or exceed the cost of materials, installation, and onsite supervisory personnel.
 - For example, cost-effectiveness of a refrigerator replacement measures the present value of the energy savings over the lifetime of the appliance against the cost to purchase and install a new unit, as well as remove and decommission the old unit.
 - Present value accounts for the time value of money: \$10 was worth more 15 years ago than it is today, and \$10 spent today is probably worth more than \$10 saved 15 years from now.
- States may include overhead costs in their cost-effectiveness requirements, but this limits the weatherization measures that can be cost-effectively done to the house.
- **Incidental repair** costs must be included in the overall SIR.
 - Incidental repairs are those repairs necessary for the effective performance or preservation of weatherization materials. They may include adding framing or making limited roof repairs so attic insulation doesn't get wet. Costs do not cover roof replacement.
 - A cold water leak in a mobile home is considered an incidental repair, since it will keep the belly insulation dry, but repairing a toilet drain comes under H&S.
 - On a home needing significant repairs, the SIR for the entire package might be less than one, even though each measure has an SIR greater than one. For entire package calculations, the cost of incidental repairs enters the denominator. This puts a limit on the incidental repairs that can be done. H&S measures do not enter the cost-effectiveness equation.

Typical Savings & Payback Table (Slide #17)

This study dispels the myths that windows and doors are the most cost-effective energy-savings measures. Air sealing and adding insulation save more energy and cost less, so have a much quicker payback than doors and windows.

VA savings have gone up even more since this study was done.

Summary (Slide #18)

- The mission of WAP is to reduce the energy bills of low- to moderate-income households.
- Clients typically have a high energy burden.
- Modern weatherization measures are based on principles of building science and cost-effectiveness.
- There are limits on spending for incidental repairs, but not for health and safety.
- National evaluation in early 1990s determined program is effective at energy use reduction and jobs creation.



Technical Monitor/Inspector

Weatherization Assistance Program Standardized Training Curriculum
August 2010



TECHINICAL MONITOR/INSPECTOR

Introduction to Weatherization

WEATHERIZATION ASSISTANCE PROGRAM STANDARDIZED CURRICULUM – August 2010

Learning Objectives

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

INTRODUCTION TO WEATHERIZATION

- Gain an understanding of the background of the Weatherization Assistance Program (WAP).
- Understand characteristics of the client base served by the program.
- Recognize that building science guides the selection of measures installed with program dollars.
- Understand the principles of cost-effectiveness and the Savings-to-Investment Ratio (SIR).
- Recognize modern weatherization measures.

3 | WEATHERIZATION ASSISTANCE PROGRAM STANDARDIZED CURRICULUM – August 2010eere.energy.gov

By attending this session, participants will:

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Mission

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

INTRODUCTION TO WEATHERIZATION

Mission of the Weatherization Assistance Program

To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their health and safety (H&S).

4 | WEATHERIZATION ASSISTANCE PROGRAM STANDARDIZED CURRICULUM – August 2010eere.energy.gov

The legislative mission of the program:

- To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their ***Health and Safety (H&S)***.

The purpose of the program was changed in the law to include health and safety in the enabling legislation of 1990.

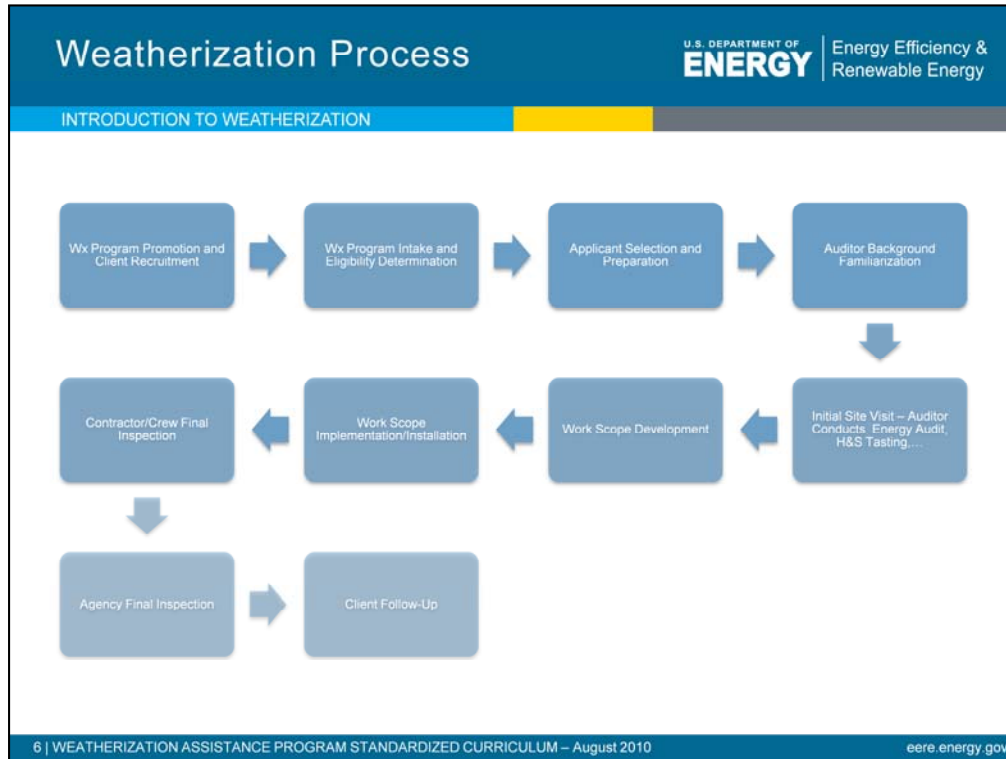


Illustrates the flow of dollars through the program:

- The Federal government distributes funds to the **U.S. Department of Energy (DOE)**, where the program is managed by the Project Management Center (PMC).
- Funds pass to each of the Grantees: the 50 State Offices, the District of Columbia, Native American Tribal Organizations, and the 5 Territories.
- Grantees distribute funds to over 900 local agencies nationwide according to approved budgets.
- The money is used to install cost-effective energy-saving measures in low-income households.

Lyndon Johnson’s “War on Poverty” laid the groundwork for the **Weatherization Assistance Program (WAP)** by creating the infrastructure of **Community Action Programs (CAPs)** that now exist in every State. These CAPs often act as subgrantees. The War on Poverty included Head Start, the Low-Income Home Energy Assistance Program (LIHEAP), and after-school programs for children so parents could be part of the work force.

CAPs have the right of first refusal to be a local weatherization agency. Only non-profits and local government agencies are also allowed to act as subgrantees.



This flow chart provides an overview of how a client home progresses through the weatherization process.

- WAP promotion and client recruitment – This can be done through radio or other advertisements, posting notices at community centers, churches, and senior centers, through LIHEAP referrals, and so on.
- Intake and eligibility determination – This is usually done by designated administrative staff that verifies income eligibility and help applicants fill in the necessary forms, as needed.
- Applicant selection and preparation – Many agencies prioritize clients based on elderly, disabled, or children in the home, energy use/energy burden, or some combination of these factors. This is also often where the client learns what they can expect from the weatherization process.
- Auditor background familiarization – When possible, the auditor can review utility data and other relevant information before actually visiting the home.
- Initial site visit/audit – The auditor collects site-specific information to enter into a software audit program or determine the applicability of a relevant priority list. In some cases, the auditor determines that the structure is unsound and defers services on the home.
- Work scope development – Using the data collected on-site and local costs and savings related to various measures, the auditor develops a cost-effective list of measures to be installed in the home.
- Work scope implementation/installation – Crew and contractors install measures listed in work order and notify the local agency of any new issues discovered during installation, sometimes adding energy savings or health and safety measures based on necessity.
- Contractor/crew final inspection – Contractors and crews perform a final inspection on their work to ensure no measures were skipped and that measures were installed in accordance with local technical and quality guidelines.
- Agency final inspection – The local agency is responsible for checking each home.
- Client follow-up – If clients call with questions, thanks, or complaints, agency staff help tie up loose ends.

Low-Income Households

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INTRODUCTION TO WEATHERIZATION

Characteristics of Low-Income Households

- Over 90% of low-income households have annual incomes less than \$15,000.
- More than 13% of these low-income households have annual incomes less than \$2,000.
- According to DOE's Energy Information Administration (EIA), low-income households spend 14.4% of their annual income on energy, while other households only spend 3.3%.
- The average energy expenditure in low-income households is \$1,800 annually.
- The elderly occupy 34% of low-income homes.

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Characteristics of Low-Income Households

Facts:¹

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- The elderly occupy 34% of low-income homes.

These statistics highlight the importance our work and why the effectiveness of what we do is so important. Our goal is to reduce the **energy burden** on our clients. Energy burden refers to the percentage of a household's income that must be used for energy bills. High energy burden means a high percentage of income is spent on energy bills. The energy burden for low-income households is over four times that of other households.

¹This data, provided by Joel Eisenberg of the Oak Ridge National Laboratory and Meg Power of Economic Opportunity Studies, is based on raw data from the Residential Energy Consumption survey conducted by EIA.

Source 1: ORNL/CON-493, ORNL/CON-484, EIA February 2008 Short-Term Energy Outlook

Source 2: ORNL/TM-2010/66, EIA February 2010 Short Term Energy Outlook

History

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1976 to Early 1980's (First Generation)

- Started in Maine as “Winterization” – Maine’s program was used as a model for the national program.
- Originally administered by the Community Services Administration.
- Later managed by the Federal Energy Administration, a predecessor to DOE.
- Used volunteer labor, who stapled plastic over windows.
- Installed low-cost measures – there was very little insulation installation.
- Little or no production or financial accountability.

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The Weatherization Assistance Program was created in 1976, after the first oil embargo and before DOE was formed. Local programs with the same goals had been in operation, but this was the formal beginning of a national program.

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History

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INTRODUCTION TO WEATHERIZATION

Early 1980's to Late 1980's (Second Generation)

- Used volunteer labor from the Comprehensive Employment & Training Act under the Department of Labor.
- Often installed temporary measures.
- Little or no diagnostic technology.
- Project Retro-Tech – This paper energy audit allowed users to enter in the areas and difference in R-value in the home and do very basic heat transfer calculations.
- Addressed the building envelope.
- “Blow and go” – Worker blew insulation into attics. It was a “quick and dirty” program that completed house quickly, but with much less improvement to the home than is common today.

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The program grew in the early 1980s.

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History

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INTRODUCTION TO WEATHERIZATION

1990's (Third Generation)

- Used paid professional labor.
- Addressed both building envelope and mechanical heating systems.
- Diagnostic tools used in some States.
- Various components of program computerized.
- State and national evaluations conducted.
- Structured training and technical assistance provided.

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The program was evaluated in 1991 and it became clear that the cost-effectiveness of installed measures must be tracked. Measures expanded from shell work to heating and cooling systems.

The program was finally allowed to pay for labor. Groundbreaking States began using blower doors and created diagnostic techniques that have been refined over the years.

Structured ***Training and Technical Assistance (T&TA)*** addressed the program's shortcomings. There is now a feedback loop and accountability. When an inspector notices work in the field that is not up to State standards, training at a recognized facility can be required, or technical assistance will be sent to the local agencies to provide on-the-job training.

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History

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INTRODUCTION TO WEATHERIZATION

1990's to Present (Fourth Generation)

- Weatherization measures are permanent and cost effective.
- States have rental plans to ensure that weatherization benefits, i.e., savings on utility bills, accrue to tenants, not landlords.
- States have health and safety plans that establish protocols for energy-related health and safety measures, like realigning chimneys or replacing faulty furnaces.
- There is increased use of advanced diagnostic tools and energy audits.
- Several States leverage funds from other Federal programs and often through utilities to expand the reach of their WAP.
- Through coordination with the U.S. Department of Housing and Urban Development's (HUD) housing agencies, comprehensive rehabilitation and weatherization is possible.

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Testing and diagnostics are refined and effective, and installation is often conducted by highly trained crews.

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Measures

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INTRODUCTION TO WEATHERIZATION

“Old School” Weatherization Measures

Many Weatherization programs with out strong management, turned into “doors and windows” programs that often included:

- Replacing windows.
- Adding storm windows.
- Replacing doors.
- Adding weather stripping.
- Adding some attic insulation.
- Caulking (by the case).

Doors and windows especially, are highly visible and get much publicity, but typically they aren’t cost-effective. The measures that save the most energy – air sealing and adding insulation – are largely visible.

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Measures

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INTRODUCTION TO WEATHERIZATION

Modern Weatherization Measures

- Blower door-directed air sealing
- Attic insulation
- Dense-pack sidewall insulation
- Heating and cooling equipment repair and replacement
- Duct sealing and modification
- Electric base load measures
 - Compact Fluorescent Light bulbs (CFLs)
 - Refrigerator replacement
 - Water heater modification and replacement

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The program has improved dramatically over the years. Modern measures provide cost-effective savings based on computerized energy audits. These are more than just shell measures.

- Blower door-directed air sealing.
- Attic insulation.
- Dense-pack sidewall insulation.
- Heating and cooling equipment repair and replacement.
- Duct sealing and modification.
 - o Duct modification includes adding returns to provide the **air-handling unit** (AHU) with enough air, or reconnecting ducts in attics. Occasionally, a duct system is redesigned to use a trunk line. Generally, modifications are done to make sure that the returns are adequately sized, and to replace the floor grills if they've been smashed shut.
- Electric **base load** measures.
 - o Installation of compact fluorescent lamps (CFLs).
 - o Refrigerator replacement.
 - o Water heater modification.

Modern weatherization methods mean looking at the whole house - including the building shell, the mechanicals, and the base load - as a system.

Results

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- Over 6.4 million homes have been weatherized to date with Federal and leveraged funds such as State and utility monies and fuel assistance program funds.
- The average reduction in energy used for space heating is 35%.
- Favorable benefit-cost ratio of 1.8:1.
- Supports tens of thousands of direct and indirect jobs nationwide; 52 direct jobs for every million dollars invested (before the Recovery Act). This is changing dramatically with deployment of the American Recovery and Reinvestment Act (ARRA) funds.

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A comprehensive national evaluation found that compared to utility-sponsored and local weatherization programs; DOE's program was the most effective. The evaluation determined the program to be beneficial on many levels, from energy reduction to jobs creation.

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- Supports tens of thousands of direct and indirect jobs nationwide; 52 direct jobs for every million dollars invested (before the Recovery Act). This number is changing dramatically with deployment of the ***American Recovery and Reinvestment Act (ARRA)*** funds.

This average reduction is extrapolated from natural gas reductions attributed to space heating; batch fuels like propane and fuel oil are difficult to impossible to monitor.

National evaluation resulted in three benefit-cost ratios. The lowest one (1.8) measures materials and labor spent at the house (denominator), against the projected energy savings over the life of the measures (numerator). This doesn't include administrative costs. Other ratios include societal benefits and other non-energy benefits: indirect jobs, pollution reduction, improved health and productivity of those served, etc. Including societal benefits increases the benefit-cost ratio.

Cost-Effectiveness

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Cost-Effectiveness Requirements

- An SIR of 1 or higher means the savings earned over the lifetime of a given measure are greater than the full cost of installing that measure.
- The SIR of each individual measure and of the package as a whole, must be greater than or equal to 1.
- Energy-related health and safety work is not included in the SIR.
- There is no federally mandated upper limit for Health and Safety (H&S) funds. Each state designates this in its Weatherization State plan.
 - Historically, States have set their upper limit around 6-7%. With an increase in the amount of Lead Safe Weatherization (LSW) and furnace replacements, that number has gone up.
- Higher requests for H&S can encourage increased scrutiny of the State plan.

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The success of the program is due to the hard work and dedication of its workers.

Two key principles guide the installation of measures: cost-effectiveness and the availability of health and safety funds.

Each individual weatherization material - and the package of weatherization materials installed - must be cost-effective.

Cost-effectiveness is measured by the **savings-to-investment ratio (SIR)**, the amount of energy savings versus the cost to install a measure.

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Cost-Effectiveness Requirements (Cont.)

- $SIR \geq 1$ means energy cost savings over the lifetime of the measure(s), discounted to present value, equal or exceed the cost of materials, installation, and onsite supervisory personnel.
 - For example, cost-effectiveness of a refrigerator replacement measures the present value of the energy savings over the lifetime of the appliance against the cost to purchase and install a new unit, as well as remove and decommission the old unit.
 - Present value accounts for the time value of money: \$10 was worth more 15 years ago than it is today, and \$10 spent today is probably worth more than \$10 saved 15 years from now.
- States may include overhead costs in their cost-effectiveness requirements, but this limits the weatherization measures that can be cost-effectively done to the house.

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- States may include overhead costs in their cost-effectiveness requirements, but this limits the weatherization measures that can be cost-effectively done to the house.
- **Incidental repair** costs must be included in the overall SIR.
 - Incidental repairs are those repairs necessary for the effective performance or preservation of weatherization materials. They may include adding framing or making limited roof repairs so attic insulation doesn't get wet. Costs do not cover roof replacement.
 - A cold water leak in a mobile home is considered an incidental repair, since it will keep the belly insulation dry, but repairing a toilet drain comes under H&S.
 - On a home needing significant repairs, the SIR for the entire package might be less than one, even though each measure has an SIR greater than one. For entire package calculations, the cost of incidental repairs enters the denominator. This puts a limit on the incidental repairs that can be done. H&S measures do not enter the cost-effectiveness equation.

Typical Savings & Payback		
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INTRODUCTION TO WEATHERIZATION		
TYPICAL MEASURES INSTALLED	ENERGY SAVINGS	PAYBACK PERIOD
Virginia homes weatherized July 1988 to June 1989		
• Caulking	Single family – Gas heat.....10%	30 years
• Weatherstripping	Single family – Electric heat.....5%	21 years
• Replacement windows	Mobile homes.....10%	53 years
• Storm windows		
• Attic insulation		
Virginia homes weatherized July 1989 to June 1990		
• Advanced air sealing	Single family – Site built.....24%	10 years
• Attic insulation	Mobile homes.....17%	17 years
• High-density wall insulation		
• Heating safety and efficiency improvements		
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This study dispels the myths that windows and doors are the most cost-effective energy-savings measures. Air sealing and adding insulation save more energy and cost less, so have a much quicker payback than doors and windows.

VA savings have gone up even more since this study was done.

Summary

INTRODUCTION TO WEATHERIZATION

- The mission of WAP is to reduce the energy bills of low-to moderate-income households.
- Clients typically have a high energy burden.
- Modern weatherization measures are based on principles of building science and cost-effectiveness.
- There are limits on spending for incidental repairs, but not for health and safety measures
- National evaluation in the early 1990's, determined program is effective at energy use reduction and jobs creation.

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- Clients typically have a high energy burden.
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House as a System

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Become aware of the potential for interaction among building components and mechanical systems.
- Understand how air sealing a home can negatively affect indoor air quality.
- Be able to recognize typical air leakage sites and know how to deal with them.

Key Terminology

Aldehydes

Backdraft

Bypass

Carbon Monoxide (CO)

Chimney chase

Dropped soffit

Indoor Air Quality (IAQ)

Spauling

Stack effect

Vapor retarder

Supplemental Materials

Handouts & Resources

Partnership for Advancing Technology in Housing (PATH). *Your House is a System: Tips for the Handy Homeowner* Jan. 2006. www.pathnet.org/si.asp?id=1889.

Lstiburek, Joseph, and John Carmody. "Fundamentals of Moisture in Houses." *Home Energy* Nov./Dec. 1995. www.homeenergy.org.

McWilliams, Jennifer A., and Iain S. Walker. "Retrofitting Residential HVAC Systems." *Home Energy* Jan/Feb. 2005. www.homeenergy.org.

Van der Meer, Bill. "Avoiding Moisture Problems." *The Weatherization Training Center Technical Update* 1 (Feb. 2003)

Classroom Props & Activities

House of Pressure: Illustrate the interrelationships of home mechanical systems, air-tightness, and connectivity to the basement or garage as they relate to energy efficiency and IAQ issues.

Class Overview

- Use the presentation and class discussion to teach students that each house is a system of interrelated components.
- Have students discuss the problems that can arise if:
 - A home with no exhaust fans or with kerosene space heaters is air sealed (moisture issues).
 - An older furnace is replaced with a 90+ direct vent appliance, orphaning the water heater (backdrafting).
- Introduce the concept of mounting savings:
 - Air sealing and insulating reduce load on heating and cooling appliances, making it possible to downsize equipment. Smaller equipment costs less to purchase and operate.
 - Sealing ducts gets conditioned air where it belongs, reducing the need for extra space heaters in rooms far from the heating source.
 - Air sealing and insulating the attic prevent warm, moist air from escaping, reducing residents' heating bills and preventing ice dams and the costly repairs associated with them.

House as a System

Technical Monitor/Inspector

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Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will:

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- Be able to recognize typical air leakage sites and know how they should be dealt with.

House as a System (Slide #3)

A house is a system of interdependent parts: Mechanical and physical components.

- The operation of one part affects many others.
- When they all work together, the house is comfortable, safe, efficient, and durable.

Approaching the house as a system of interactive parts, the savings mount and we avoid creating health and safety issues.

Air sealing and insulating a home reduces the heating and cooling load. A replacement furnace in a sealed and insulated home can be smaller than the existing furnace. The initial price of the smaller unit is lower, and the long-term operating costs will be less.

A house will experience problems when its house parts don't work together properly.

- Some problems are obvious, some invisible.
- Some problems appear now, some years down the road.

Building failures are symptoms of failures in the house as a system. As weatherization workers, we need to find the underlying problem, not just replace the rotted wood.

House as a System (Slide #4)

Click to highlight arrows pointing to various elements, as outlined in list below.

- Buildings are systems. Everything in a building has the potential to interact with everything else:
 - o Moisture through concrete, grading, landscaping, gutters, and downspouts.
 - o Moisture from cooking, showering, and faucet aerators.
 - o Air infiltration at windows and doors.
 - o Air exfiltration at cathedral ceilings and recessed light fixtures, i.e., “can lights” or “pot lights.”
 - o Garages and **carbon monoxide (CO)**.
 - o Atmospheric combustion appliances.
 - o Occupants and how they use the home.
- The tighter the building, the stronger the interaction will be.
- Codes that control trades practices were, for the most part, written when this potential was essentially insignificant. Consequently, individual tradesmen performing code-compliant work can create potentially harmful situations without realizing they have done so.
 - o Example: Heating codes commonly ensure sufficient combustion air by requiring so many cubic feet of space per BTU/hr input of the appliance. These codes were established when basements were commonly rubble stone or granite slabs. Concrete is inherently tighter, but the codes haven't changed to reflect that.
- Energy auditors, and now technical monitors and inspectors, are the only people commonly trained in House as a System Science!

Examples – House as a System (Slide #5)

- An uninsulated attic or other failure in the thermal boundary or air barrier makes the heating and/or cooling system work harder.

Examples - House as a System (Slide #6)

- Leaky recessed light fixtures increase heat loss and gain, and can cause ice dams and moisture problems.

Examples - House as a System (Slide #7)

- Fans that exhaust into the attic or crawl space cause moisture to condense on the roof deck and trusses, weakening the structure. This problem could exist unnoticed for years, causing poor **indoor air quality (IAQ)** and expensive structural damage.

Ventilation and Air Change (Slide #8)

Click to reveal arrows indicating air leaking in, and again to reveal air leaking out.

- Plugging the holes and then putting in fans is counterintuitive to most people.
- The “old-timers” believed that “houses have to breathe,” so left them loose, but leaving houses leaky enough to provide good **indoor air quality** in spring and fall also leaves them drafty, which makes them expensive to heat in the winter and cool in the summer.
- The first energy crisis inspired a wave of insulating without considering moisture build-up or IAQ. The results were odors, rot, and mold.
- A house that is properly air sealed and mechanically vented has the correct amount of air exchange all the time. Heating properly air-sealed homes is also significantly cheaper than “letting the house breathe.”
- The blue arrows represent infiltration, the red arrows, exfiltration. Because holes at the top and bottom are the ones most involved with the **stack effect**, sealing them is the first priority.
- Intermediate-level holes—those around living space windows and doors—are more of a comfort issue than an energy conservation issue simply because the stack effect has little effect on them.
 - Wind-driven air leakage, which can occur at windows and doors, is mostly a function of building exposure. Unless the building is severely exposed to the wind, window and door leakage will have little effect on the air change rate. In homes with normal exposure, it is acceptable to only weatherstrip and air seal the windows and doors the homeowner complains about.

In the Attic (Slide #9)

- Small holes in the attic floor—at pipes, wires, and the **chimney chase**—allow heated air from the living space to enter the attic.
- The entering air will be relatively warm and wet compared to a cold attic in winter.
- Moisture from the warm-wet air condenses on the first cold surface it contacts—typically, the most northerly walls and the underside of the roof deck.
- The water reacts to gravity, runs down to stain the ceiling, and looks like a roof leak.

Pipe/Wire Bypasses (Slide #10)

- Dirty insulation—particularly fiberglass—can help you pinpoint air **bypasses**.

Chimney Chases (Slide #11)

- Chimney chases are almost universally ignored during initial construction. There is little differentiation between new and old construction.
- From an energy perspective, the area around the chimney is absolutely the worst place to have a vertical hole in a house.
 - o It is the only hole that's guaranteed to be a bypass between the basement and the attic. The chimney's heat causes the air column around it to suck air from the basement and pressurize the attic.
 - o Many a prematurely failed roof in heating climates is solely attributable to an unsealed chimney chase simply because the air pulled from the basement is often very humid. The resulting condensation on the underside of the roof deck can cause it to rot and load the underside of the shingles with moisture, causing them to expand and curl up at the ends. As the sun dries, the shingles contract back to their normal shape. The constant flexing causes premature shingle failure.

Treating the Chimney Chase (Slide #12)

- Dirty fiberglass around the chimney points to an air leak from below.
- Clearances are important. Fire code requires a 2" clearance from combustibles.
- The air seal from the chimney to the ceiling below must be complete.

Note the "shine" below the tape to the left of the chimney in the upper right of the picture. That's a light reflecting off the boiler smoke pipe in the basement.

Sealed Chimney Bypass (Slide #13)

- The red line between the chimney and the metal air barrier is high-temperature caulk, which is required by code.
- The underside of the metal is caulked to the ceiling framing.
- Scrap pieces of drywall complete the air seal from new framing to the existing ceiling.
- The last step is installing a metal dam to keep insulation at least 2" away from the chimney.

An Alternative Method (Slide #14)

Diagram from Maine's DOE WAP Manual

- With an exposed chimney, it is permissible to create the air seal in the living space at the ceiling if (1) it matches the general style and construction quality of the home, and 2) the homeowner agrees.
- The insulation dam is still required in the attic.

In the Basement (Slide #15)

Notice the **spauling** (the white, chalk-like coating on the concrete caused by water picking up salts as it migrates through the concrete, then leaving them on the surface when it evaporates) as well as the high water mark and standing water. The sewer cleanout is plugged with a wood stopper. There is minor mold on the cement blocks and floor stringers.

Q. Square foot for square foot, what evaporates more water vapor into the air: standing water or concrete without a vapor barrier?

A. Concrete, because it has more surface area.

- Without a **vapor retarder** in, on, or below the concrete floor, ground moisture is constantly radiated into the basement.
- Even with a vapor retarder, ground moisture will enter the basement through cracks and holes.
- Soil gasses will enter with the moisture.
- Mechanical appliances can produce airborne pollutants.
- Many things stored in the basement can off-gas. Typically, we find detergents, paint, hobby chemicals, cleaning solvents, etc.
- Dirt floors and crawl spaces are even more problematic.
- Basements are typically well connected to the living space. Whatever is in the basement, occupants breathe in the living space.
- Duct leaks can have many consequences:
 - The heat that leaks out of the ducts warms an area you don't want heated.
 - Cold air is pulled into the heating system from the basement.
 - Heated air is forced out of the home.
 - Basement pollutants are delivered to the living space.
- Remember: Whatever is in the basement, occupants breathe in the living space.

Plumbing and Wire Opening (Slide #16)

- All types of holes give basement air free access into first-floor wall cavities. They will be connected in turn to upper floor cavities and the attic.

Under the Tub (Slide #17)

- This opening under the tub looks innocent enough. It is almost certainly connected to vertical chases behind the tub/shower that are, in turn, connected to upper floor cavities and the attic.

Another Tub (Slide #18)

- This is a similar situation in an older home.

More in the Basement (Slide #19)

- The installer couldn't fit his arm into the space between the plenum and the ceiling so he didn't bother finishing this job.
- This situation pressurizes the basement, forcing air out along the sill. It can "power rot" the basement box sill assembly, while wasting significant energy.
- The "cure" was drywall mesh tape, a good quality duct mastic such as RDC # 6, and a short stick.

More in the Basement: Danger! (Slide #20)

- The picture to the left shows a grille cut into the return plenum to prevent the duct from banging when the air handler started up. The air handler fan now sucks directly on the barometric damper. This house has, in effect, a power vent chimney. All combustion byproducts are being delivered to the occupants to breathe. **THIS IS EXTREMELY DANGEROUS!**
 - Even oil units can produce CO under these conditions. Oil combustion also produces **aldehydes**—toxic byproducts of oil combustion—and other pollutants.
- On the right, we see the top of an atmospheric gas water heater. Because the vent system **backdrafted** repeatedly to the point of burning the paint off the water heater, someone installed thermocouples to shut down the gas flame whenever backdrafting occurred. The real culprit was leaky return ductwork on a warm air furnace (not pictured) sucking on the basement.

In the Garage (Slide #21)

Q. What are some pollutants typically stored in the garage?

Click to reveal selection of pollutants typically found in the garage.

- The garage floor has the same moisture characteristics as the basement floor.
- Garages are even more likely than basements to contain stored "off-gassers," such as automobiles, lawn mowers, and other fossil-fueled machines.
- Catalytic converters in cars emit low levels of CO for approximately four hours after the car is shut off!
- Garages typically have a low "air-feed" (the lower edge of the overhead door) and high "relief" (pipe and wire penetrations near the ceiling). Or they are totally open to the living space attic. Anything breathable in the garage is soon inside the home.
- It is extremely important to isolate the garage from the living space to the greatest degree possible to ensure that our weatherization activities—particularly measures that reduce the natural air change rate in the living space—do not concentrate pollutants that previously escaped. A post-weatherization check of any isolation measures using pressure diagnostics is imperative!

In the Kitchen and Bathroom (Slide #22)

- Showering creates large amounts of airborne moisture.
-as does cooking without using pot lids.
- Existing vent fans are typically underpowered and noisy.
- Often, they're not vented to the exterior.
- When they are, the ducts often leak or restrict airflow.
- Even a good fan does nothing if it isn't used.
- Remember when evaluating homes with gas ranges or cooktops that gas code requires they be vented to the building exterior through a hard-ducted vent hood. Recirculating models do not satisfy the code requirement. Always consider installing good quality CO detectors in homes with gas appliances.

With a properly functioning ventilation system, moisture and other pollutants are kept from entering the home. Any pollutant—and moisture is considered a pollutant for the purposes of this discussion—created in the home is transported safely outside through exhaust ventilation and ductwork. However, in many homes, the fans or ducts are loud, leaky, non-existent or otherwise not up to the job. Moisture created within the home condenses on cool building surfaces, both in the living space and in the attic, and causes mold, mildew, poor IAQ, and structural damage.

Dropped Soffits (Slide #23)

- Ceiling drywall isn't typically extended over cabinet ***dropped soffits***.
- Even if the attic is insulated, attic air has free access to the cavity, cooling the walls and cabinet.

Dropped Soffits (Slide #24)

- If you see soffit-mounted cabinets, remember to investigate during attic inspection.

In the Living Room (Slide #25)

- An “open-burn” fireplace (one without glass doors) pulls so much heated air from the living space it actually may cool the surrounding space.
 - Of interest: Wing chairs and footstools were invented to shield people from the rush of air heading to open fireplaces in castles.

Unvented Space Heaters (Slide #26)

This is a photo of a kerosene wick burner heater, the predecessor of the Kerosun and other unvented space heaters.

- Kerosene wick burner heaters are almost universally illegal because of their unhealthy emissions and because of the likelihood of fire. Vent-free gas fireplaces are illegal in many states because they tend to produce high levels of CO.
- Instructions for vent-free fireplaces usually say to set the gas flame to blue with a yellow tip for low CO production. Further on, the instructions often say to close the air gate down for a more realistic yellow flame. A yellow flame indicates high CO production.

Outside (Slide #27)

The house as a system concept doesn't stop at the walls. Factors outside the home that affect structural integrity and home performance include:

- Roof leaks – Water leaking into the attic damages insulation, reducing the effective R-value and increasing heating and cooling bills.
- Gutters (or lack of) – Poorly installed or clogged gutters can cause moisture to drip down exterior surfaces, infiltrating cracks and crevices. This can cause structural damage and reduce effective R-values of wall insulation.
- Landscaping
 - Ground slope – Any landscaping that guides moisture toward the home, rather than away, is poor landscaping.
 - Vegetation
 - Good design: A deciduous tree planted on the south side of the house can shade it in summer, and allow low winter sun to warm the home during the heating season.
 - Bad design: Trees and bushes of any type that reduce air movement around the building retard drying of building components and can promote building rot.
- Building design
 - Any building design—low slope or flat roof additions, abutting dormers, etc.—that allows water to puddle or channels it toward other building components is a poor design.

Mechanical Ventilation (Slide #28)

- Mechanical ventilation is essential in today's homes to balance good indoor air quality and energy conservation. Homes left loose enough for moisture and odor control without using mechanical ventilation waste energy.
- Types of mechanical ventilation include:
 - Bathroom and kitchen fans.
 - Clothes drier.
 - Central vacuum.
 - Whole-house ventilation.
 - Central heating and cooling systems.
- Mechanical ventilation can pull moist exterior air into wall and ceiling assemblies in cooling environments. It may also cause backdrafting in any environment.

Occupant Behavior (Slide #29)

Occupant behavior is the most arbitrary factor in the IAQ and energy use of all homes. When conducting the final inspection or monitoring interview, find out how the clients use their home, and whether the auditor gave them advice for protecting IAQ.

To protect IAQ, clients should avoid:

- Storing firewood inside (or outdoors right next to the home).
- Air drying clothes inside – even in the basement.
- Having numerous plants.
- Using chemicals indoors without adequate ventilation.
- Using “energy conservation” gadgets such as a drier draft diverter which will dump wash. chemicals into the home along with any reclaimed heat from the drier.

Energy use is affected by lifestyle:

- Sleeping with windows open.
- Under or over dressing.
- Leaving any windows and doors open when the heat or A/C is on.

Typically, it falls to the auditor to assess the impact of occupant behavior on their measure recommendations. It is extremely difficult to get someone to change a habit, and what makes sense to the auditor may not make sense for the client.

What's Going On? (Slide #30)

- Side windows are double glazed; the center window is single glazed.
- Plant watering. All water poured into plant soil eventually evaporates into the room.
- Evaporated water is condensing on the cold, single-paned center window.

What Should Have Been Done? (Slide #31)

- Choices:
 1. Add a storm window – Relatively inexpensive with fair return (improves existing R-1 to R-2).
 2. Replace the window unit – More expensive with better return (R-1 to $\approx$ R-3.5).
 3. Run the ceiling fan – No initial cost and will raise the glass temperature over dew point, but will increase heat loss through windows and use electricity.
 4. Eliminate the plants – Free but interferes with client lifestyle and doesn't reduce space heat consumption.
- Any of the four will work.
- In the private sector, the decision would rest on homeowner resources and motivations. With DOE funding, the auditor must make the best choice for each house, considering 1) the client, 2) the future use of the building, and 3) the SIR. As the inspector or monitor, it falls to you to determine whether the auditor made an appropriate choice.

Something to Think About (Slide #32)

This slide lists the four reasons why John Tooley, a leading building scientist, believes House as a System Science should dominate energy conservation retrofit decisions.

This slide and the next six were created using information from a presentation given by John Tooley in Portland, Maine.

Today's Houses Are Tighter (Slide #33)

- Plywood and drywall vs. boards and plaster.
- Platform vs. balloon framing.
- Concrete vs. granite slabs or rubble stone and brick.
- Concrete vs. dirt floors.
- Vinyl thermo pane windows vs. wood sash and storms.
- Insulated doors vs. wooden doors.
- Modern caulks.

Today's Houses Have More and Bigger Fans (Slide #34)

- More and stronger exhaust appliances.
- 400+ CFM Jenn-air (upper left) vs. 50 CFM kitchen paddle fan hood (right).
- Direct through-the-wall fan (below).
- Clothes driers vs. drying rack or clothes line.
- Central vacuum.
- Air handlers.
- Central AC.
- Stronger furnace fans.
- Whole house ventilation fans.
- Bigger and more powerful fans in general.

Today's Houses Have Weaker Draft Appliances (Slide #35)

Click to reveal the progression of appliances from open fireplaces to fireplaces with glass doors to air tight woodstove to coal boiler to 80% drybase boiler and finally to a 90%+ furnace. Ask students to name an appliance with weaker draft each step of the way.

- Heating efficiency ratings are simply the percentage of consumed energy that goes up the chimney, i.e., as efficiency increases, less heat and air go up the chimney.
- As we increase heating appliance efficiency, we reduce draft, which in turn moves less air through the building, reducing its drying capability.
- The final step in efficiency improvement is a sealed combustion unit, which gets its combustion air from the outside and consequently does nothing to dry the building at all.

Today's Houses Have Less Drying Potential (Slide #36)

- Air moves readily through uninsulated walls and ceilings. Cavities filled with insulation slow or stop air movement.
- Years ago, houses were designed to cycle wet to dry annually. That is, they got wet in humid times and dried out when the humidity dropped.
- Energy savings measures generally interfere with this cycle and require moisture mitigation.
- These circumstances led to the common belief that cellulose rots buildings. When cellulose first gained popularity after the first energy crisis, installers were not aware of the necessity for moisture control. The result was a large number of damaged buildings. We now know that moisture control is essential when insulating and air sealing buildings.
- Modern homes generally spread out rather than up (think “ranch” vs. Victorian”), reducing the stack effect.
- Better caulks and sealants, tighter construction details, and man-made materials all help keep moisture in.

Lifestyle Changes (Slide #37)

- We've transformed from an agrarian society to an industrialized one, and from an active outdoor lifestyle to a sedentary indoor one.
- Daily showers vs. weekly baths.
- Water "sports" include hot tubs, multiple showerheads, saunas, and indoor pools.

Summary (Slide #38)

- We build very differently than we did as little as 40 years ago.
- Economic pressure is driving the move to tighter houses with smaller margins of safety.
- The tighter a house is, the more influence individual components have on the others.
- All pollutants inside the pressure boundary will eventually be dispersed throughout the entire living area.
- Altering a building or its mechanical system can have unexpected consequences.



TECHINICAL MONITOR/INSPECTOR

House as a System

Learning Objectives

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HOUSE AS A SYSTEM

By attending this session, participants will:

- Become aware of the potential for interaction among building components and mechanical systems.
- Understand how air sealing a home can negatively affect indoor air quality.
- Be able to recognize typical air leakage sites and know how to deal with them.

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House as a System

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HOUSE AS A SYSTEM

A house is a system of interdependent parts.

- The operation of one part affects many others.
- When they all work together, the house is comfortable, safe, efficient, and durable.

A house will experience problems when its house parts don't work together properly.

- Some obvious, some invisible.
- Some now, some years down the road.

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A house is a system of interdependent parts: Mechanical and physical components.

- The operation of one part affects many others.
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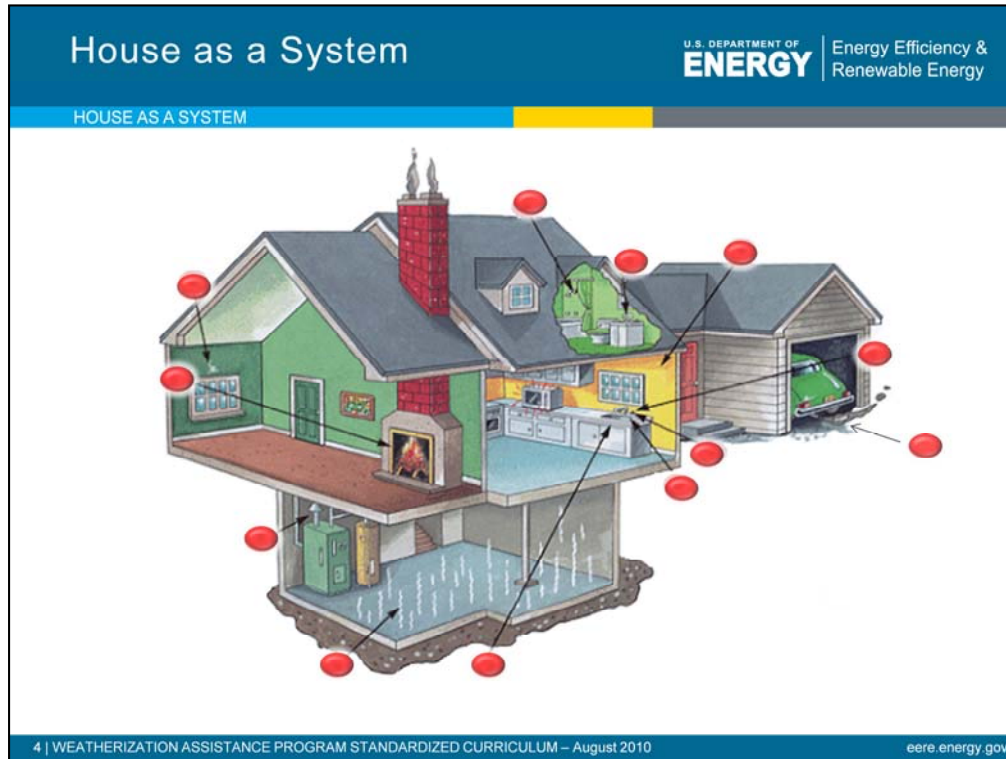
Approaching the house as a system of interactive parts, the savings mount and we avoid creating health and safety issues.

Air sealing and insulating a home reduces the heating and cooling load. A replacement furnace in a sealed and insulated home can be smaller than the existing furnace. The initial price of the smaller unit is lower, and the long-term operating costs will be less.

A house will experience problems when its house parts don't work together properly.

- Some problems are obvious, some invisible.
- Some problems appear now, some years down the road.

Building failures are symptoms of failures in the house as a system. As weatherization workers, we need to find the underlying problem, not just replace the rotted wood.



Click to highlight arrows pointing to various elements, as outlined in list below.

- Buildings are systems. Everything in a building has the potential to interact with everything else:
 - o Moisture through concrete, grading, landscaping, gutters, and downspouts.
 - o Moisture from cooking, showering, and faucet aerators.
 - o Air infiltration at windows and doors.
 - o Air exfiltration at cathedral ceilings and recessed light fixtures, i.e., “can lights” or “pot lights.”
 - o Garages and **carbon monoxide**.
 - o Atmospheric combustion appliances.
 - o Occupants and how they use the home.
- The tighter the building, the stronger the interaction will be.
- Codes that control trades practices were, for the most part, written when this potential was essentially insignificant. Consequently, individual tradesmen performing code-compliant work can create potentially harmful situations without realizing they have done so.
 - o Example: Heating codes commonly ensure sufficient combustion air by requiring so many cubic feet of space per BTU/hr input of the appliance. These codes were established when basements were commonly rubble stone or granite slabs. Concrete is inherently tighter, but the codes haven’t changed to reflect that.
- Energy auditors, and now technical monitors and inspectors, are the only people commonly trained in House as a System Science!

Examples - House as a System

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An uninsulated attic ...



Makes the heating
and cooling system work
harder than necessary.

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- An uninsulated attic or other failure in the thermal boundary or air barrier makes the heating and/or cooling system work harder.

Examples – House as a System

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HOUSE AS A SYSTEM



Leaky recessed
lighting fixtures...



Increases heat loss/gain,
and can cause ice dams.

- Leaky recessed light fixtures increase heat loss and gain, and can cause ice dams and moisture problems.

Examples – House as a System

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HOUSE AS A SYSTEM



This bathroom exhaust fan does not exhaust to outdoors – just to the soffit.



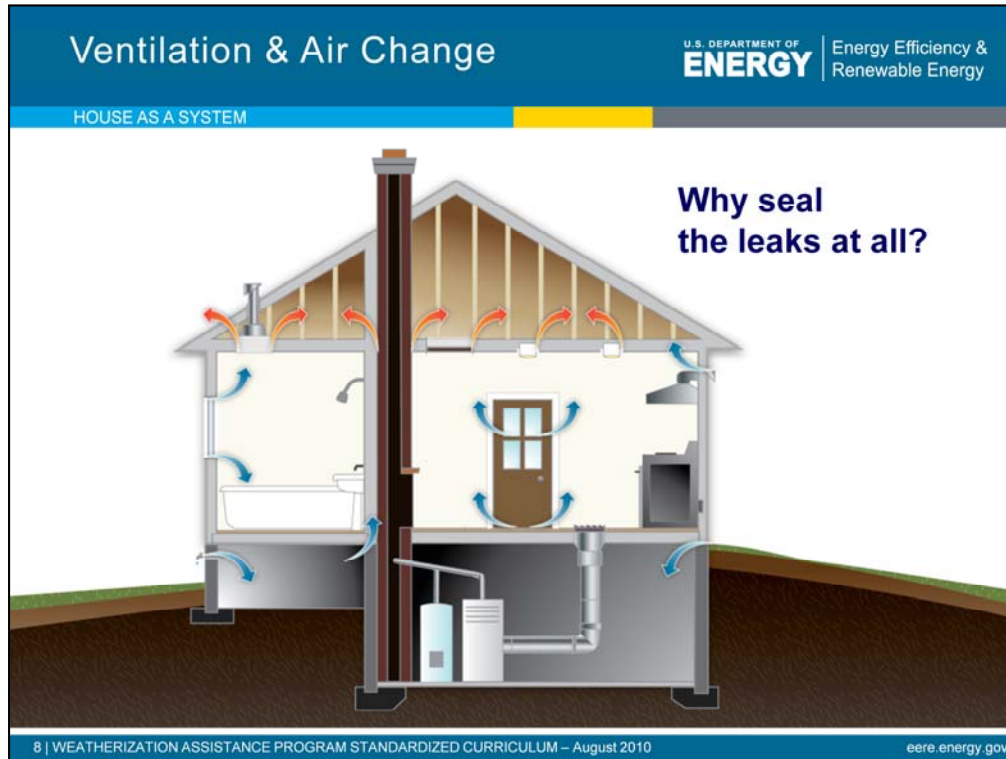
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The moisture condenses on the roof deck and trusses causing damage.

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- Fans that exhaust into the attic or crawl space cause moisture to condense on the roof deck and trusses, weakening the structure. This problem could exist unnoticed for years, causing poor **indoor air quality** and expensive structural damage.



Click to reveal arrows indicating air leaking in, and again to reveal air leaking out.

- Plugging the holes and then putting in fans is counterintuitive to most people.
- The “old-timers” believed that “houses have to breathe,” so left them loose, but leaving houses leaky enough to provide good **indoor air quality** in spring and fall also leaves them drafty, which makes them expensive to heat in the winter and cool in the summer.
- The first energy crisis inspired a wave of insulating without considering moisture build-up or IAQ. The results were odors, rot, and mold.
- A house that is properly air sealed and mechanically vented has the correct amount of air exchange all the time. Heating properly air-sealed homes is also significantly cheaper than “letting the house breathe.”
- The blue arrows represent infiltration, the red arrows, exfiltration. Because holes at the top and bottom are the ones most involved with the **stack effect**, sealing them is the first priority.
- Intermediate-level holes—those around living space windows and doors—are more of a comfort issue than an energy conservation issue simply because the stack effect has little effect on them.
 - Wind-driven air leakage, which can occur at windows and doors, is mostly a function of building exposure. Unless the building is severely exposed to the wind, window and door leakage will have little effect on the air change rate. In homes with normal exposure, it is acceptable to only weatherstrip and air seal the windows and doors the homeowner complains about.

In the Attic...

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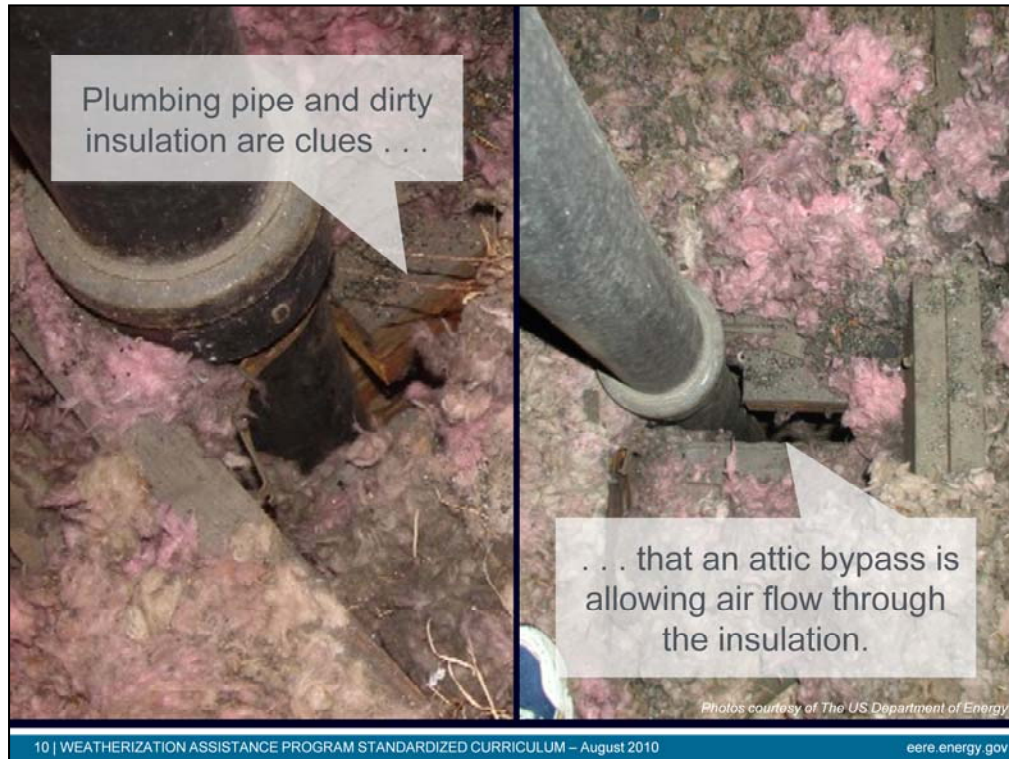
- 2" x 6" rafters with plywood decking.
- White "dots" are frost on nail points.



Photo courtesy of The US Department of Energy

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- Small holes in the attic floor—at pipes, wires, and the ***chimney chase***—allow heated air from the living space to enter the attic.
- The entering air will be relatively warm and wet compared to a cold attic in winter.
- Moisture from the warm-wet air condenses on the first cold surface it contacts—typically, the most northerly walls and the underside of the roof deck.
- The water reacts to gravity, runs down to stain the ceiling, and looks like a roof leak.



Pipe/Wire Bypasses

- Dirty insulation—particularly fiberglass—can help you pinpoint air **bypasses**.

Chimney Chases

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- Chimney chases are almost universally ignored during initial construction. There is little differentiation between new and old construction.
- From an energy perspective, the area around the chimney is absolutely the worst place to have a vertical hole in a house.
 - It is the only hole that's guaranteed to be a bypass between the basement and the attic. The chimney's heat causes the air column around it to suck air from the basement and pressurize the attic.
 - Many a prematurely failed roof in heating climates is solely attributable to an unsealed chimney chase simply because the air pulled from the basement is often very humid. The resulting condensation on the underside of the roof deck can cause it to rot and load the underside of the shingles with moisture, causing them to expand and curl up at the ends. As the sun dries, the shingles contract back to their normal shape. The constant flexing causes premature shingle failure.

Treating the Chimney Chase

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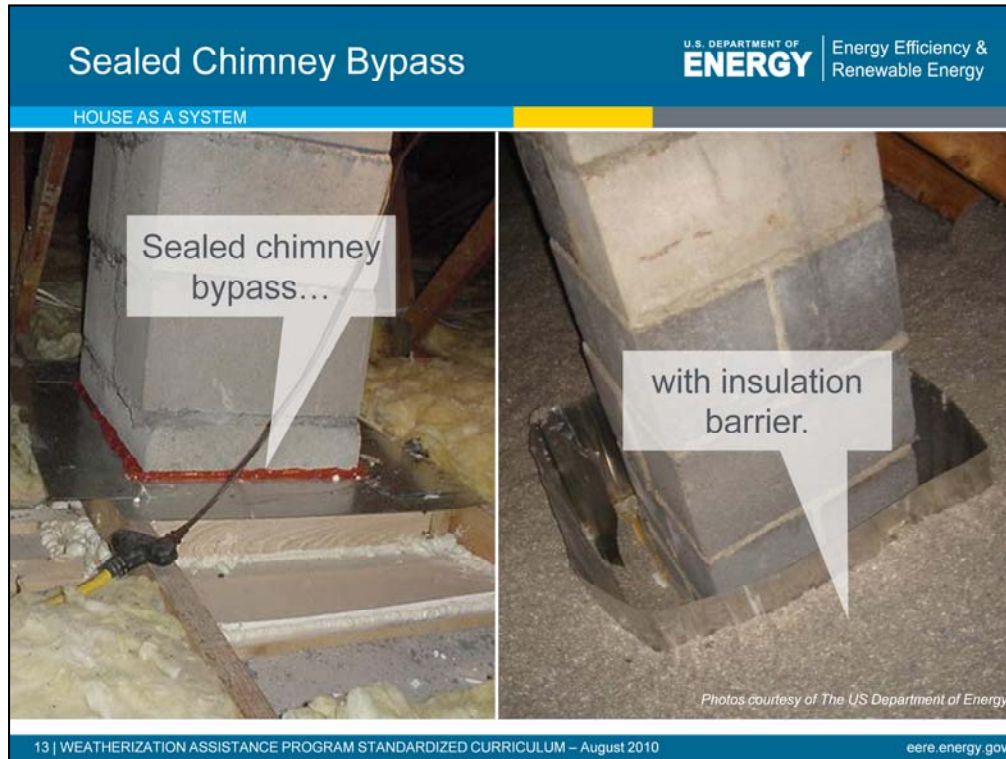


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- Dirty fiberglass around the chimney points to an air leak from below.
- Clearances are important. Fire code requires a 2” clearance from combustibles.
- The air seal from the chimney to the ceiling below must be complete.

Note the “shine” below the tape to the left of the chimney in the upper right of the picture. That’s a light reflecting off the boiler smoke pipe in the basement.



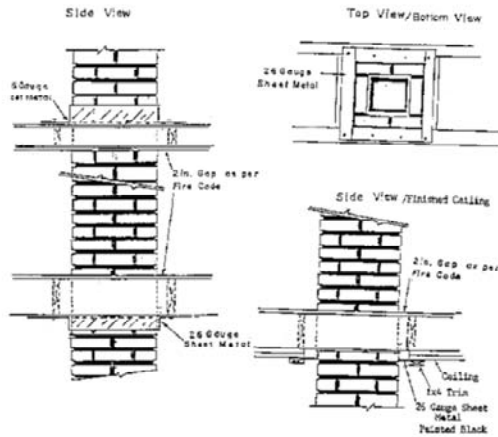
- The red line between the chimney and the metal air barrier is high-temperature caulk, which is required by code.
- The underside of the metal is caulked to the ceiling framing.
- Scrap pieces of drywall complete the air seal from new framing to the existing ceiling.
- The last step is installing a metal dam to keep insulation at least 2” away from the chimney.

An Alternative Method

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HOUSE AS A SYSTEM

Detail for Sealing Thermal Bypass Around Chimney



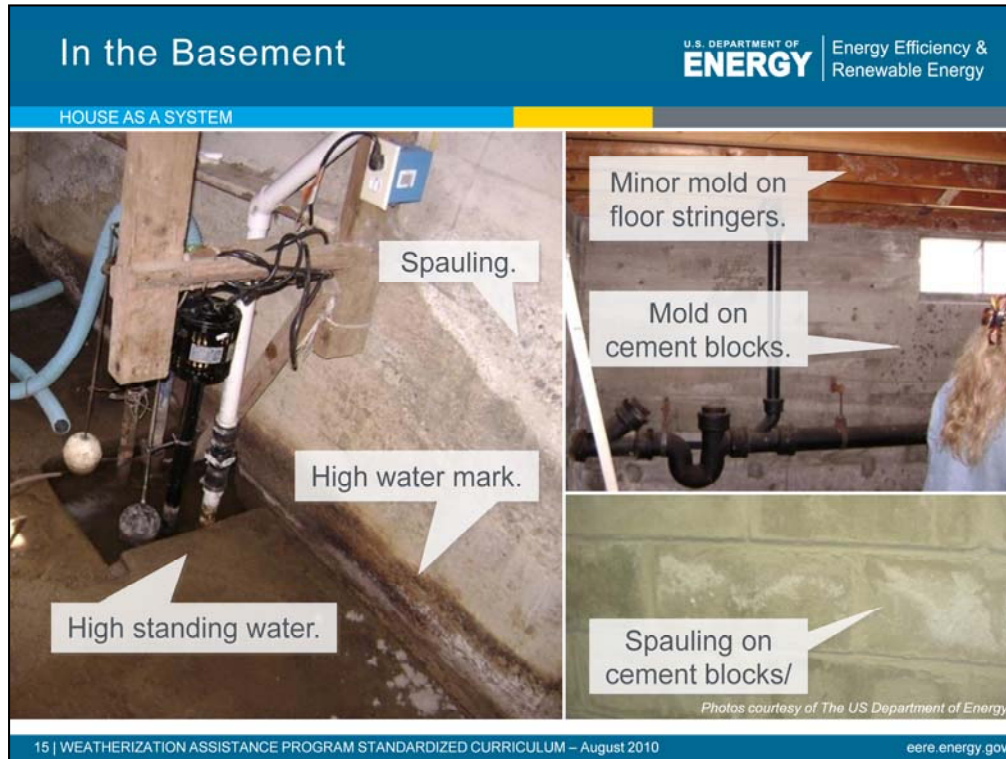
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Diagram from Maine's DOE WAP Manual

- With an exposed chimney, it is permissible to create the air seal in the living space at the ceiling if (1) it matches the general style and construction quality of the home, and (2) the homeowner agrees.
- The insulation dam is still required in the attic.



Notice the **spauling** (the white, chalk-like coating on the concrete caused by water picking up salts as it migrates through the concrete, then leaving them on the surface when it evaporates) as well as the high water mark and standing water. The sewer cleanout is plugged with a wood stopper. There is minor mold on the cement blocks and floor stringers

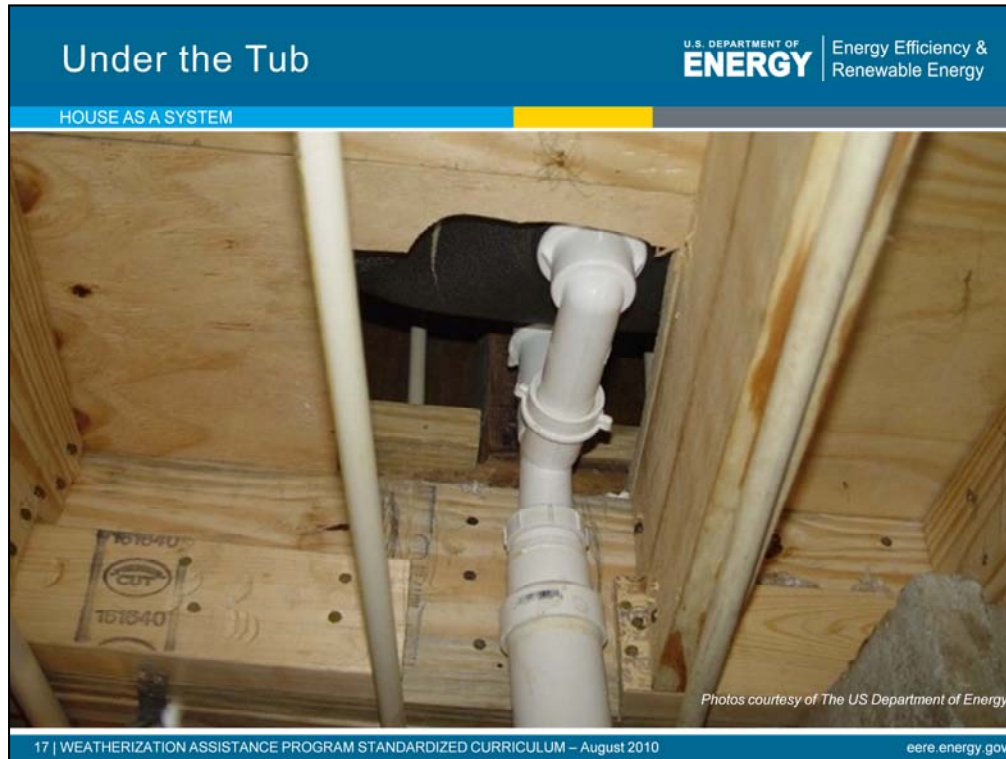
Q. Square foot for square foot, what evaporates more water vapor into the air: standing water or concrete without a vapor barrier?

A. Concrete, because it has more surface area.

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- All types of holes give basement air free access into first-floor wall cavities. They will be connected in turn to upper floor cavities and the attic.



- This opening under the tub looks innocent enough. It is almost certainly connected to vertical chases behind the tub/shower that are, in turn, connected to upper floor cavities and the attic.

Another Tub

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- This is a similar situation in an older home.

More in the Basement

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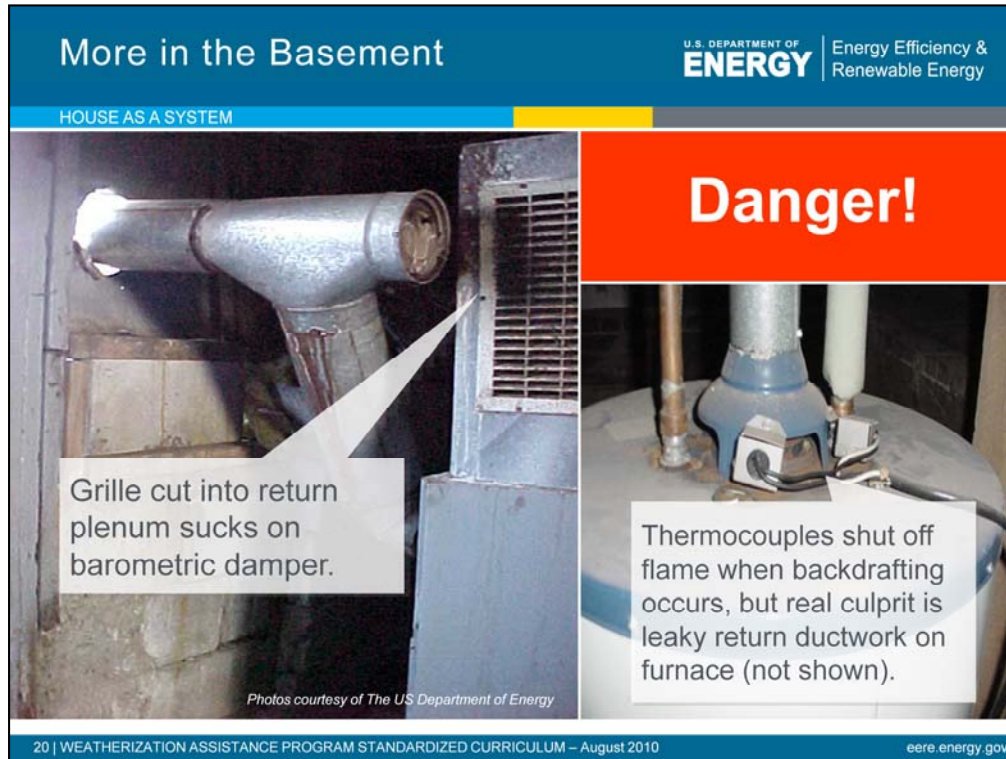
Top of connection between heat delivery plenum and main trunk.



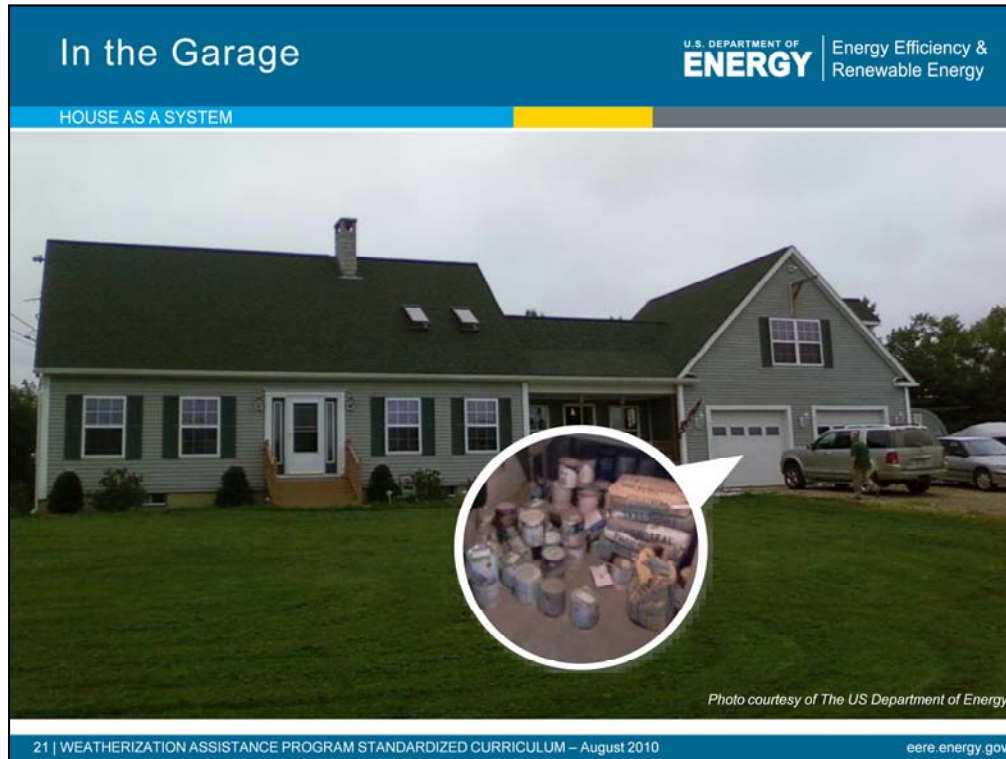
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- The installer couldn't fit his arm into the space between the plenum and the ceiling so he didn't bother finishing this job.
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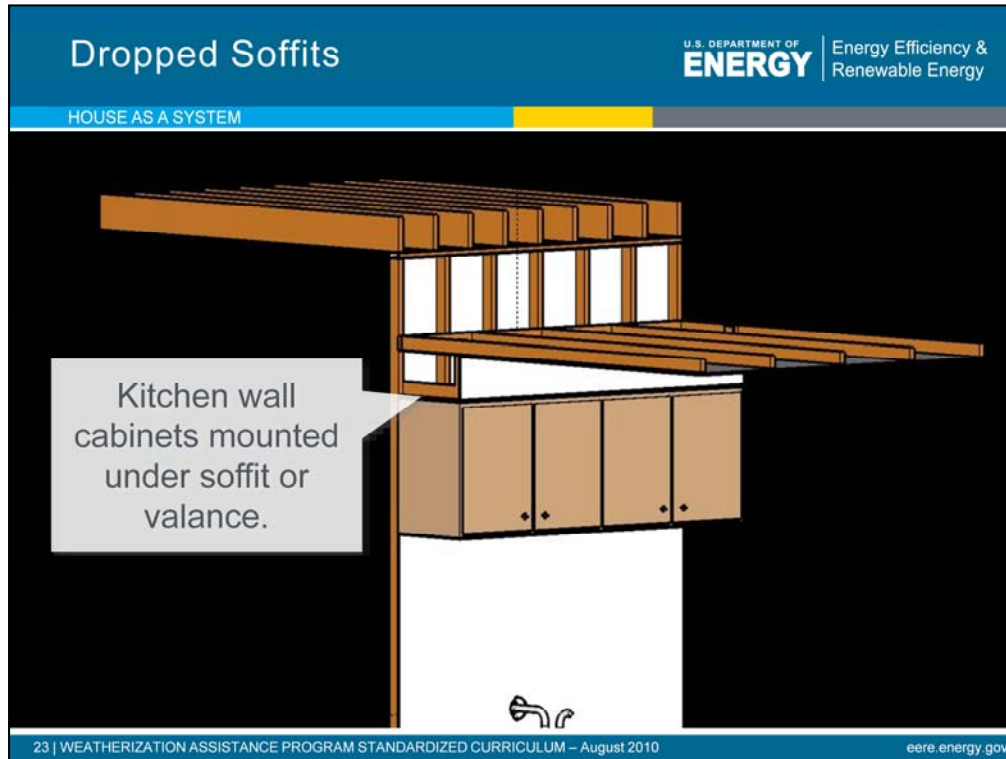
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- Catalytic converters in cars emit low levels of CO for approximately four hours after the car is shut off!
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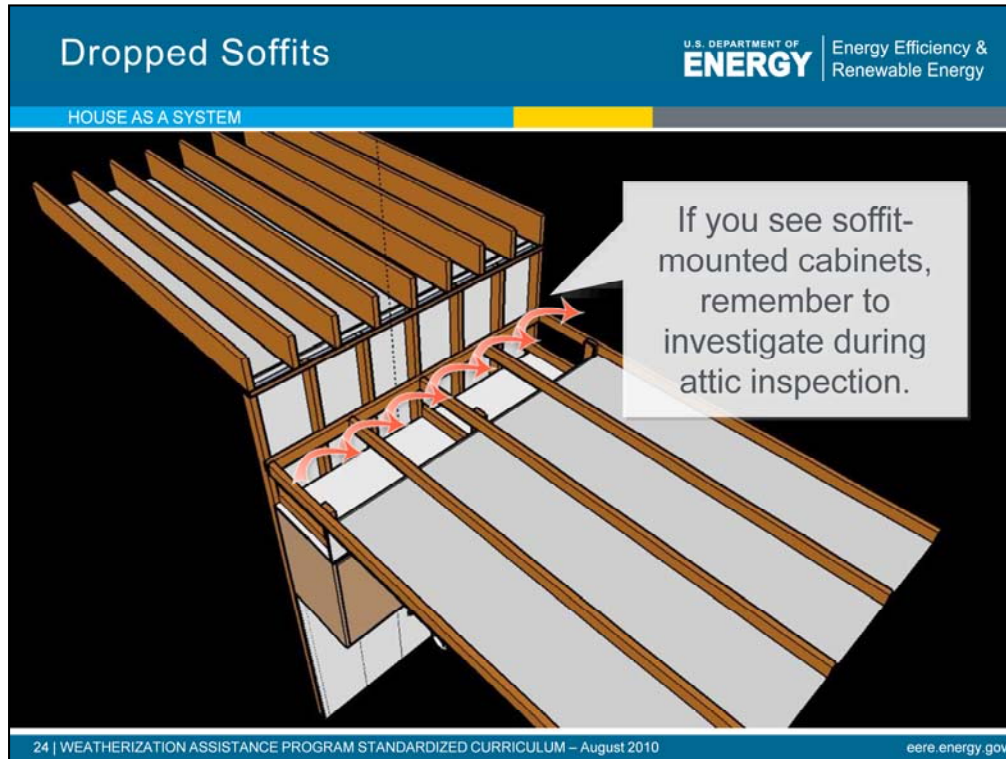


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- Even a good fan does nothing if it isn't used.
- Remember when evaluating homes with gas ranges or cooktops that gas code requires they be vented to the building exterior through a hard-ducted vent hood. Recirculating models do not satisfy the code requirement. Always consider installing good quality CO detectors in homes with gas appliances.

With a properly functioning ventilation system, moisture and other pollutants are kept from entering the home. Any pollutant—and moisture is considered a pollutant for the purposes of this discussion—created in the home is transported safely outside through exhaust ventilation and ductwork. However, in many homes, the fans or ducts are loud, leaky, non-existent or otherwise not up to the job. Moisture created within the home condenses on cool building surfaces, both in the living space and in the attic, and causes mold, mildew, poor IAQ, and structural damage.



- Ceiling drywall isn't typically extended over cabinet ***dropped soffits***.
- Even if the attic is insulated, attic air has free access to the cavity, cooling the walls and cabinet.



- If you see soffit-mounted cabinets, remember to investigate during attic inspection.

In the Living Room

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Energy Efficiency &
Renewable Energy

HOUSE AS A SYSTEM

Fireplaces “net cool” all but the smallest spaces.



Photos courtesy of The US Department of Energy

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- An “open-burn” fireplace (one without glass doors) pulls so much heated air from the living space it actually may cool the surrounding space.
 - o Of interest: Wing chairs and footstools were invented to shield people from the rush of air heading to open fireplaces in castles.

Unvented Space Heaters

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HOUSE AS A SYSTEM



And then there are
VENT FREE fireplaces!
& kerosene heaters
& homemade stuff.

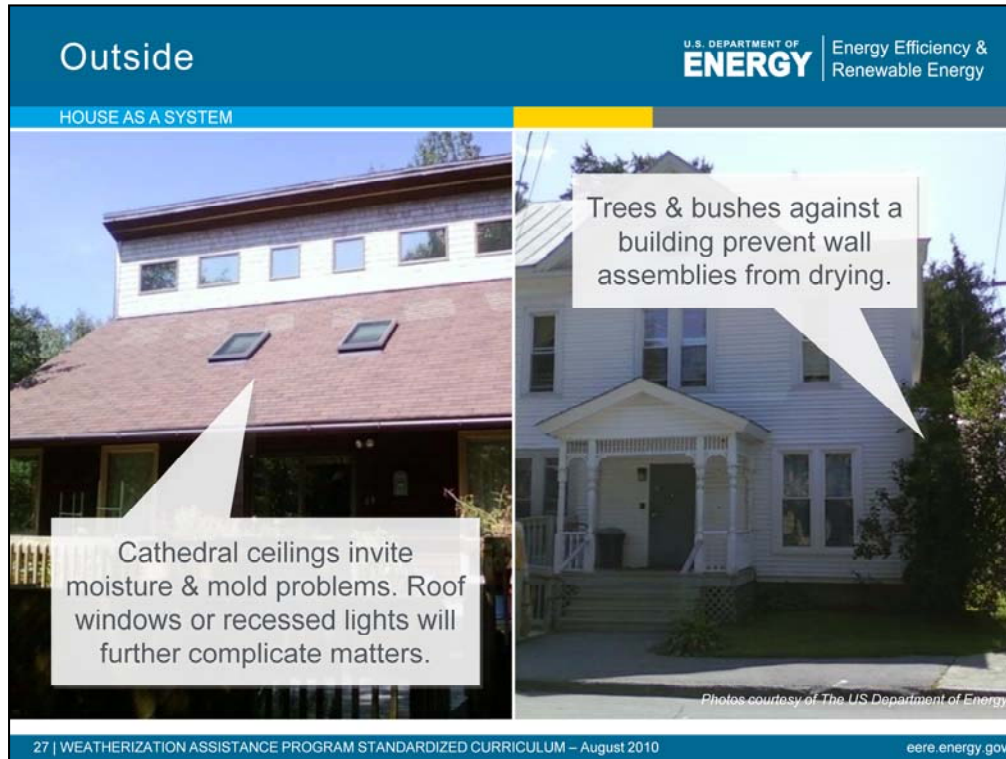
Photo courtesy of The US Department of Energy

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This is a photo of a kerosene wick burner heater, the predecessor of the Kerosun and other unvented space heaters.

- Kerosene wick burner heaters are almost universally illegal because of their unhealthy emissions and because of the likelihood of fire. Vent-free gas fireplaces are illegal in many states because they tend to produce high levels of CO.
- Instructions for vent-free fireplaces usually say to set the gas flame to blue with a yellow tip for low CO production. Further on, the instructions often say to close the air gate down for a more realistic yellow flame. A yellow flame indicates high CO production.



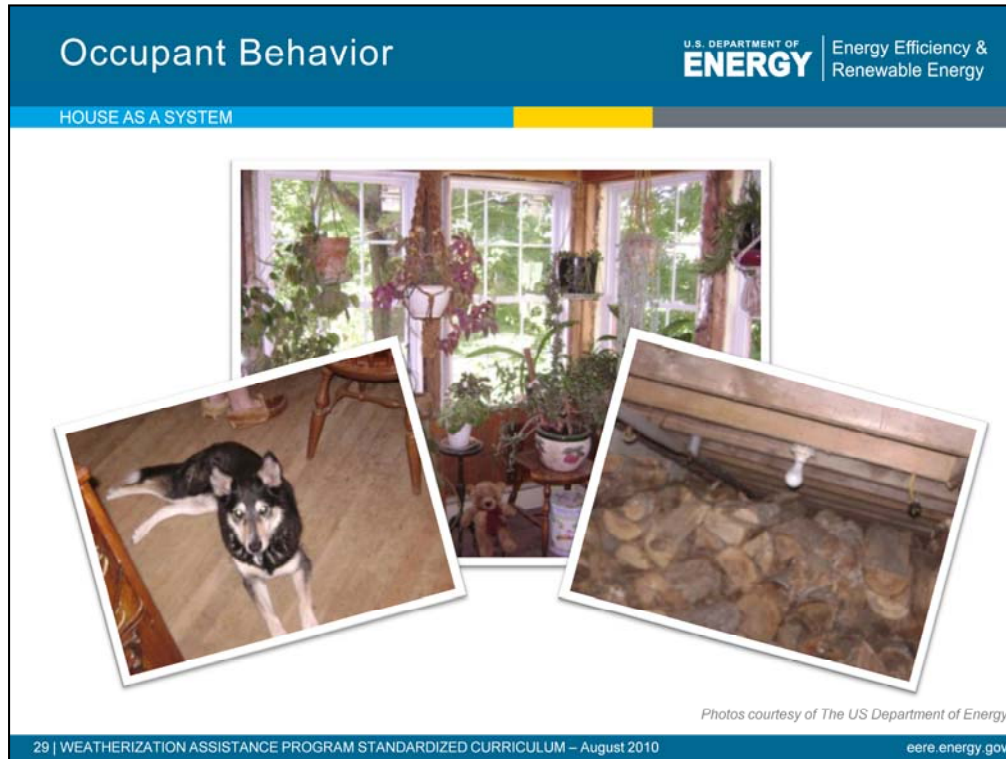
The house as a system concept doesn't stop at the walls. Factors outside the home that affect structural integrity and home performance include:

- Roof leaks – Water leaking into the attic damages insulation, reducing the effective R-value and increasing heating and cooling bills.
- Gutters (or lack of) – Poorly installed or clogged gutters can cause moisture to drip down exterior surfaces, infiltrating cracks and crevices. This can cause structural damage and reduce effective R-values of wall insulation.
- Landscaping
 - Ground slope – Any landscaping that guides moisture toward the home, rather than away, is poor landscaping.
 - Vegetation
 - Good design: A deciduous tree planted on the south side of the house can shade it in summer, and allow low winter sun to warm the home during the heating season.
 - Bad design: Trees and bushes of any type that reduce air movement around the building retard drying of building components and can promote building rot.
- Building design
 - Any building design—low slope or flat roof additions, abutting dormers, etc.—that allows water to puddle or channels it toward other building components is a poor design.

All exhaust appliances “suck” on the house.



- Mechanical ventilation is essential in today’s homes to balance good indoor air quality and energy conservation. Homes left loose enough for moisture and odor control without using mechanical ventilation waste energy.
- Types of mechanical ventilation include:
 - Bathroom and kitchen fans.
 - Clothes drier.
 - Central vacuum.
 - Whole-house ventilation.
 - Central heating and cooling systems.
- Mechanical ventilation can pull moist exterior air into wall and ceiling assemblies in cooling environments. It may also cause backdrafting in any environment.



Occupant behavior is the most arbitrary factor in the IAQ and energy use of all homes. When conducting the final inspection or monitoring interview, find out how the clients use their home, and whether the auditor gave them advice for protecting IAQ.

To protect IAQ, clients should avoid:

- Storing firewood inside (or outdoors right next to the home)
- Air drying clothes inside – even in the basement.
- Having numerous plants
- Using chemicals indoors without adequate ventilation
- Using “energy conservation” gadgets such as a drier draft diverter which will dump wash chemicals into the home along with any reclaimed heat from the drier.

Energy use is affected by lifestyle:

- Sleeping with windows open
- Under or over dressing
- Leaving any windows and doors open when the heat or A/C is on

Typically, it falls to the auditor to assess the impact of occupant behavior on their measure recommendations. It is extremely difficult to get someone to change a habit, and what makes sense to the auditor may not make sense for the client.

What's Going On?

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HOUSE AS A SYSTEM



Heavy condensation on center window.
No condensation on side windows.
Why? What is the most likely moisture source?

Photo courtesy of The US Department of Energy

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- Side windows are double glazed; the center window is single glazed.
- Plant watering. All water poured into plant soil eventually evaporates into the room.
- Evaporated water is condensing on the cold, single-paned center window.

What Should Be Done?

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ENERGY
Energy Efficiency & Renewable Energy

HOUSE AS A SYSTEM

- Add a storm window.
- Replace the entire window unit.
- Advise the homeowner to run the ceiling fan.
- Get rid of the plants.



Photo courtesy of The US Department of Energy

It Depends!

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- Choices:
 - Add a storm window – Relatively inexpensive with fair return (improves existing R-1 to R-2).
 - Replace the window unit – More expensive with better return (R-1 to $\approx$ R-3.5).
 - Run the ceiling fan – No initial cost and will raise the glass temperature over dew point, but will increase heat loss through windows and use electricity.
 - Eliminate the plants – Free but interferes with client lifestyle and doesn't reduce space heat consumption.
- Any of the four will work.
- In the private sector, the decision would rest on homeowner resources and motivations. With DOE funding, the auditor must make the best choice for each house, considering 1) the client, 2) the future use of the building, and 3) the SIR. As the inspector or monitor, it falls to you to determine whether the auditor made an appropriate choice.

Something to Think About

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HOUSE AS A SYSTEM

Houses:

- Are tighter.
- Have more exhaust appliances.
- Have “weaker” natural draft combustion appliances.
- Have less drying potential.

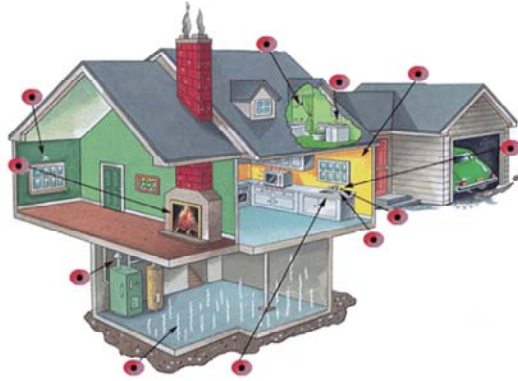


Diagram courtesy of John Tooley

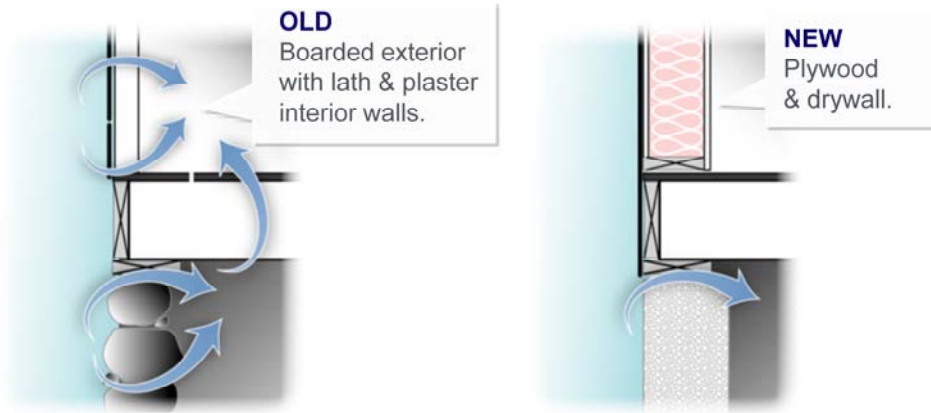
This slide lists the four reasons why John Tooley, a leading building scientist, believes House as a System Science should dominate energy conservation retrofit decisions.

This slide and the next six were created using information from a presentation given by John Tooley in Portland, Maine.

Today's Houses Are Tighter

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HOUSE AS A SYSTEM



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- Plywood and drywall vs. boards and plaster.
- Platform vs. balloon framing.
- Concrete vs. granite slabs or rubble stone and brick.
- Concrete vs. dirt floors.
- Vinyl thermo pane windows vs. wood sash and storms.
- Insulated doors vs. wooden doors.
- Modern caulks.

Today's Houses Have More and Bigger Fans

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HOUSE AS A SYSTEM

Photos courtesy of The US Department of Energy

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- More and stronger exhaust appliances.
- 400+ CFM Jenn-Aire (upper left) vs. 50 CFM kitchen paddle fan hood (right).
- Direct through-the-wall fan (below).
- Clothes driers vs. drying rack or clothes line.
- Central vacuum.
- Air handlers.
- Central AC.
- Stronger furnace fans.
- Whole house ventilation fans.
- Bigger and more powerful fans in general.

Today's Houses Have Weaker Draft Appliances

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ENERGY

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HOUSE AS A SYSTEM

The weaker the draft (i.e., the higher the efficiency), the less air moves through the heating system & therefore the house.



Open fireplaces



Glass doors reduce air loss



Air Tight Wood Stove
Kuma Stoves kumastoves.com



System 2000™ 90+%



High Mass drybase boiler 80%



Converted coal boiler 50%

Photos courtesy of The US Department of Energy

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Click to reveal the progression of appliances from open fireplaces to fireplaces with glass doors to air tight woodstove to coal boiler to 80% drybase boiler and finally to a 90%+ furnace. Ask students to name an appliance with weaker draft each step of the way.

- Heating efficiency ratings are simply the percentage of consumed energy that goes up the chimney, i.e., as efficiency increases, less heat and air go up the chimney.
- As we increase heating appliance efficiency, we reduce draft, which in turn moves less air through the building, reducing its drying capability.
- The final step in efficiency improvement is a sealed combustion unit, which gets its combustion air from the outside and consequently does nothing to dry the building at all.

Today's Houses Have Less Drying Potential

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ENERGY | Energy Efficiency & Renewable Energy

HOUSE AS A SYSTEM

The **old house** got wet in the summer (humid) & dried in the winter (low humidity).



Older Home:

- Balloon-framed two-story home (lots of stack effect).
- Boards, plaster & lathe.
- No insulation.
- Construction style and materials inherently leaky.

The **new house** gets just as wet but can't dry; therefore poor IAQ and mold/mildew.



Newer Home:

- Low (little stack effect).
- Plywood & drywall.
- Construction style and materials inherently tighter than older home.

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- Air moves readily through uninsulated walls and ceilings. Cavities filled with insulation slow or stop air movement.
- Years ago, houses were designed to cycle wet to dry annually. That is, they got wet in humid times and dried out when the humidity dropped.
- Energy savings measures generally interfere with this cycle and require moisture mitigation.
- These circumstances led to the common belief that cellulose rots buildings. When cellulose first gained popularity after the first energy crisis, installers were not aware of the necessity for moisture control. The result was a large number of damaged buildings. We now know that moisture control is essential when insulating and air sealing buildings.
- Modern homes generally spread out rather than up (think “ranch” vs. Victorian”), reducing the stack effect.
- Better caulks and sealants, tighter construction details, and man-made materials all help keep moisture in.

Lifestyle Changes

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HOUSE AS A SYSTEM



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- We've transformed from an agrarian society to an industrialized one, and from an active outdoor lifestyle to a sedentary indoor one.
- Daily showers vs. weekly baths.
- Water "sports" include hot tubs, multiple showerheads, saunas, and indoor pools.

Summary

HOUSE AS A SYSTEM

- We build very differently than we did as little as 40 years ago.
- Economic pressure is driving the move to tighter houses with smaller margins of safety.
- The tighter a house is, the more influence individual components have on the others.
- All pollutants inside the pressure boundary will eventually be dispersed over the entire area.
- Altering a building or its mechanicals can have unexpected consequences.

- We build very differently than we did as little as 40 years ago.
- Economic pressure is driving the move to tighter houses with smaller margins of safety.
- The tighter a house is, the more influence individual components have on the others.
- All pollutants inside the pressure boundary will eventually be dispersed throughout the entire living area.
- Altering a building or its mechanical system can have unexpected consequences.

Regulations and Standards

Technical Monitor/Inspector

Learning Objectives

By attending this session participants will gain an understanding of:

- Selection criteria for weatherization measures.
- Appendix A as a tool for materials selection.
- DOE rules and guidance.
- Definitions and resources for residential building, electrical, and mechanical codes.
- Application of codes in weatherization.
- Definitions and resources for worker safety requirements.
- Benefits of and resources for best weatherization practices.

Key Terminology

American Gas Association (AGA)

American National Standards Institute (ANSI)

Accredited Standards Committee (ASC)

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

Appendix A

ASHRAE 62 - 1989, 62.2 - 2007

Certified Renovator

Cubic Feet per Minute (CFM)

Decommissioning

Discount rate

Fuel escalation rate

Grantee

I-Codes

International Association of Plumbing and
Mechanical Officials (IAPMO)

International Codes Council (ICC)

International Residential Code (IRC)

Knob and tube wiring

Lead Safe Weatherization (LSW)

Manufactured Home Energy Audit (MHEA)

Material Safety Data Sheets (MSDS)

National Electric Code (NEC)

National Energy Audit Tool (NEAT)

National Fire Protection Association (NFPA)

NFPA 31, "Standard for the Installation of Oil-
Burning Equipment"

NFPA 54, "National Fuel Gas Code"

NFPA 211, "Standard for Chimneys,
Fireplaces, Vents, and Solid Fuel-Burning
Appliances"

Occupational Safety and Health Administration
(OSHA)

Personal Protective Equipment (PPE)

Present Value (PV)

Savings-to-Investment Ratio (SIR)

Standards for conformance

Subgrantee

Title 10 CFR Part 440

Uniform Mechanical Code (UMC)

Uniform Plumbing Code (UPC)

Weatherization Program Notices (WPN)

Supplemental Materials

Handouts & Resources

Appendix A

Applicable Codes Handout

Lead Paint Decision Chart. July 12, 2002.

MSDS for two-part foam

Occupational Safety and Health Administration. "Fall Protection Tips QuickCard™." OSHA 3267 – 2005. www.osha.gov/Publications/fall_protection_qc.html.

SIR calculator with PV function

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

U.S. Department of Energy. Memorandum. "Knob-and-Tube Wiring: Revised Policy Superseding Guidance of 7/25/83 and 7/13/88." Oct. 21, 1988.

U.S. Department of Energy, Seattle Regional Office and Energy Out West. *Energy OutWest Weatherization Field Guide*. 2005. Copyright Saturn 2009.
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U.S. Department of Energy, Weatherization Assistance Program, Midwest Regional Field Office. *Midwest Weatherization Best Practices Field Guide*. May 2007.
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U.S. Department of Energy, Weatherization Assistance Program. *Southeast Weatherization Field Guide*. 2002. Copyright Saturn 2002.

U.S. Department of Energy, Weatherization Assistance Program. *WPN 08-4 Space Heater Policy*. March 3, 2008. www.waptac.org.

U.S. Department of Energy, Weatherization Assistance Program. *WPN 09-6: LSW WPN Final*. Jan. 7, 2009. www.waptac.com.

Class Overview

Before beginning the section, ask students what they think the measure selection guidelines for WAP are. Keep a running list.

- Deliver the presentation to the class. This presentation focuses as much on pointing out resources as on providing new content. If you have Wi-Fi access, use the links in the PowerPoint presentation to show the Websites listed. Distribute handouts when prompted in the speaker notes and for the class exercise.
- Use the presentation to introduce the guidelines for selecting and installing measures. Note if certain things mentioned by class are not required or if restrictions apply that students did not mention.

Exercise - Compare Simple Payback and Simple SIR

- Discuss simple payback as it relates to SIR. Simple payback provides auditors with an estimate of whether a measure is close to cost-effective. SIR calculations using present value and fuel escalation rates are more accurate and must be applied within WAP.
- Conduct simple payback calculations on the board for the class to follow along. Assume replacing a refrigerator costs \$300 and saves \$25 dollars per year in electricity. The refrigerator has a simple payback of 12 years. Plugging those same numbers (\$300 cost, \$25 annual savings, and 12-year life) into a simple SIR calculation returns a value of exactly 1.
- Display the SIR Calculator spreadsheet tool. Input a variety of utility rates, installation costs, and estimated savings to illustrate how these factors influence SIR.

Exercise – What is required?

While monitoring or inspecting, students may have to determine whether measures were installed in accordance with local codes. Slides 18 through 23 illustrate common weatherization work order requests. Distribute the Applicable Codes Handout. Divide the class into groups of three or four students. For each slide, give the groups 5 to 10 minutes to decide which codes/rules apply. Have them list any required actions and any needed calculations to size installed measures or equipment. Have each group list its answers on a flip chart. Compare answers and decide as a class on the correct response(s) to each situation.

Suggested responses:

Slide 18: Work order says, “Insulate over knob and tube wiring.”

The NEC requires that all wiring junction boxes, not just knob and tube, be flagged before insulating over them.

NEC 394.12 specifically forbids enveloping knob and tube wiring with thermal insulation.

DOE policy allows insulating around knob and tube wiring if certain conditions are satisfied:

All affected live knob and tube wiring is visually examined to see that it is in good condition and tested to see that the circuit voltage drop is less than 10%.

The circuit breaker or fuse controlling the circuit is matched to the wire gauge.

Correct amperage “S” type fuses are installed if the fuse panel has screw-in fuses.

All affected circuits in walls are evaluated, not just visible wiring in attics or elsewhere.

Slide 19: Work order says, “Add attic venting as necessary.”

The International Residential Code requirement for attic venting is:

1 sq. ft. of net free vent area for every 300 sq. ft. of attic floor area if there is a vapor barrier.

1 sq. ft. of net free vent area for every 150 sq. ft. of attic floor area if there is no vapor barrier (2009 IRC 806.2).

Sloped ceiling area is included in the attic floor area for this calculation.

Existing ventilation:

Three 8-ft. x 26-ft. ceiling sections = 624 sq. ft./300 sq. ft. = 2.08 sq. ft. net free vent area required.

$(12 \text{ in.} \times 18 \text{ in.})/2$ [screening blocks 1/2 of the free vent area] $\times 2$ vents =
 $2 \times (1 \text{ ft.} \times 1.5 \text{ ft.})/2 = 1.5 \text{ sq. ft. net free vent area existing.}$

0.58 sq. ft. additional net free vent area is needed.

Choices faced by auditor and installers:

Add one 8 in. x 10 in. vent to each end = $2 \text{ vents} \times (0.67 \text{ ft.} \times 0.83 \text{ ft.})/2 =$
 0.56 sq. ft. added net free vent area.

Replace existing vents with 12 in. x 24 in. vents = $2 \times (12 \text{ in.} \times 24 \text{ in.})/2 =$
 $2 \times (1 \text{ ft.} \times 2 \text{ ft.})/2 = 2 \text{ sq. ft. net free vent area.}$

Replace existing vents with 14 in. x 24 in. vents = $2 \times (1.17 \text{ ft.} \times 2 \text{ ft.})/2 = 2.34 \text{ sq. ft. net free vent area.}$

Which is correct?

Adding the 8 in. x 10 in. vents is the least expensive way to satisfy the code requirement, but it is usually cosmetically unacceptable.

Replacing the existing vents with 12 in. x 24 in. vents creates a net free vent area that’s slightly under the code, but it’s probably close enough for most authorities.

Replacing the existing vents with 14 in. x 24 in. vents creates a net free vent area that’s slightly over the code. It’s the safe choice.

Slide 20: Work order says, “Replace bedroom window.”

2006 & 2009 IRC 310.1.2 & 3 require a minimum 20-in. wide by 24-in. high, 5.7 sq. ft. clear opening area, or 5.0 sq. ft. with direct grade-level access for upper-story bedroom egress windows, including habitable attics. Note: 24 in. x 20 in. = 3.34 sq. ft., meaning at least one dimension must be greater than the code minimum.

27 in. x 44 in. = 1,188 sq. in./144 sq. in. = 8.25 sq. ft., but the existing window is single hung, allowing only half the opening or 4.125 sq. ft.

Q: Is the replacement window “grandfathered?”

A: No. It must be an egress window.

A casement window is the easy answer, but it won’t match the building style or appearance.

The pictured double-hung unit is acceptable because both sashes tilt in, allowing almost the full sash area to be free of any obstruction.

For a home built before 1978:

Installers must be lead-safe certified by EPA and work must be supervised by a certified firm. This must be documented in the client file.

Lead-safe work practices must be used.

Slide 21: Work order says, “Replace attic hatch.”

2009 IRC 807.1 requires a minimum rough opening of 22 in. x 30 in. if the attic is larger than 30 sq. ft., and requires a minimum of 30 inches of headroom between the hatch opening and roof framing at least at one point.

For a home built before 1978:

Installers must be lead-safe certified by EPA and work must be supervised by a certified firm. This must be documented in the client file.

Lead-safe work practices must be used.

Slides 22, 23: Work order says, “Install new bath fan and control.”

The NEC applies. All wiring must be done by a licensed electrician.

Legally, a resident homeowner can wire his own home. Over the years, some Community Action Agency employees and contractors have convinced homeowners to “twist the screws and wirenuts” to save a few dollars. DO NOT DO THIS! The potential liability risks are too high.

For homes built before 1978:

Installers must be lead-safe certified by EPA and work must be supervised by a certified firm. This must be documented in the client file.

Lead-safe work practices must be used.

How do you determine the fan installed is acceptable? What is the appropriate fan CFM?

ASHRAE 62-1989: Greater of 15 CFM/person (minimum 5 persons) or 0.35 air changes per hour (ACH) (conditioned volume)

$$5 \times 15 = 75 \text{ CFM}$$

$$0.35 \text{ ACH} = \text{volume} \times 0.35 = 9,000 \text{ cu. ft.} \times 0.35 = 3,150 \text{ cu. ft. per hour (CFH)} / 60 \text{ minutes} = 52.5 \text{ CFM}$$

The fan must provide at least 75 CFM.

ASHRAE 62.2-2007: Bath fan must be rated at 100 CFM. If used to satisfy indoor air quality, ventilation must provide 7.5 CFM/person (occupancy determined by number of bedrooms plus 1) plus 1% of the conditioned floor area in sq. ft.

$$[7.5 \text{ CFM} \times (3+1)] + [0.01 \times (12 \text{ ft.} \times 20 \text{ ft.} + 16 \text{ ft.} \times 8 \text{ ft.} + 16 \text{ ft.} \times 26 \text{ ft.} + 16 \text{ ft.} \times 26 \text{ ft.})] = (7.5 \times 4) + [0.01 \times (240 \text{ sq. ft.} + 128 \text{ sq. ft.} + 416 \text{ sq. ft.} + 416 \text{ sq. ft.})] = 30 + 0.01 \times 1,100 \text{ sq. ft.} = 30 + 11 = 41 \text{ CFM}$$

The fan should be set to deliver 41 CFM continuous, 20.5 CFM, ½ hour on, and ½ hour off.

Ask students to volunteer similar situations they regularly encounter, describing what code issues they encounter, what is usually done, and why.

Regulations and Standards

Technical Monitor/Inspector

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Appendix A

ASHRAE 62 - 1989, 62.2 - 2007

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Cubic Feet per Minute (CFM)

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Standards for conformance

Subgrantee

Title 10 CFR Part 440

Uniform Mechanical Code (UMC)

Uniform Plumbing Code (UPC)

Weatherization Program Notices (WPN)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will gain an understanding of:

- Selection criteria for weatherization measures.
- Appendix A as a tool for materials selection.
- DOE rules and guidance.
- Definitions and resources for residential building, electrical, and mechanical codes.
- Application of codes in weatherization.
- Definitions and resources for worker safety requirements.
- Benefits of and resources for best weatherization practices.

Measure Selection Guidelines (Slide #3)

- **Appendix A (Title 10 CFR Part 440)** – Measures must pass cost-effectiveness guidelines and be listed in Appendix A to be installed. Exceptions are made for health and safety measures, which aren't subject to **savings-to-investment ratio (SIR)** calculations.
- $SIR \geq 1$ – The SIR must be at least one based on the approved calculation methods, which include three key components:
 - o A DOE-approved audit – **National Energy Audit Tool (NEAT)**, **Manufactured Home Energy Audit (MHEA)**, or another DOE-approved audit software must be used to generate projected energy savings for the measure. The result is converted to dollar savings based on local utility rates.
 - o The **present value (PV)** of money – PV considers the time value of money: \$10 was worth more 15 years ago than it is today, and the \$10 spent today to install a measure is very likely worth more than \$10 dollars saved 15 years from now.
 - o The **fuel escalation rate** – Fuel prices change. Predicting overall savings includes predicting how much the saved energy will be worth in the future.

If you are using a DOE-approved priority list instead of an individual audit, the SIR will be calculated for a range of housing stock. The priority lists have SIR built in.

Appendix A (Slide #4)

Appendix A provides a framework for materials and equipment selection.

- Appendix A lists all the measures that may be installed. Listed measures include replacing refrigerators, but not chest freezers. Other acceptable measures include adding dense-pack sidewall insulation, window films, and solar water heaters.
- Materials must meet **standards for conformance** based on Appendix A. These standards ensure that safe, code-compliant materials and equipment are installed.

Q. If a measure is listed in Appendix A, can it automatically be installed in any house?

Click to reveal text.

A. No, it must still pass cost-effectiveness guidelines.

- Measures listed here must still meet cost-effectiveness guidelines.
- If a measure passes cost-effectiveness guidelines, but is not listed in Appendix A, DOE funds cannot be used for installation.

SIR Data Needs (Slide #5)

To understand the data needed to calculate SIR, imagine you are considering a refrigerator replacement. You must determine:

- Energy consumption of the existing item – This information can come from a database or actual metered data collected during the audit.
- Energy consumption of the replacement item – Find this information on the Energy Guide label.
- Total cost of replacement:
 - Price and installation costs of the new unit – Determine the price of the new refrigerator, including delivery and any labor costs associated with installation.
 - Cost of removing and **decommissioning** the old unit – This usually includes labor for removal and transportation, as well as the fee the local solid waste/decommissioning facility charges.
- Local utility rates – These are used to translate projected energy savings into dollar savings.
- **Discount rate** – This is the interest rate at which expected future cash flows can be discounted. It includes both the present value and fuel escalation rate, and is used to account for the time value of money and the changing price of fuels.

Both the fuel escalation rate and discount rate are available from the *Annual Supplement to NIST Handbook 135* and *NBS Special Publication 709*. This level of detail won't typically be required of monitors and inspectors, but you should have a clear understanding of the program's cost-effectiveness guidelines in case you ever need to evaluate whether a certain measure is allowable.

SIR Calculations (Slide #6)

- SIR calculations are built into DOE-approved audits – If you use an approved audit updated with accurate current energy prices and installation costs, the SIR is computed automatically.
- Use the spreadsheet “PV” function to calculate present value – Excel and other spreadsheet software have a built-in “PV” function. This function is typically used to calculate loan payments, but can be used to calculate SIR with the discount rate inserted in the place of interest rate.

Using “PV” Function for SIR (Slide #7)

$SIR = -PV (\%, n, \text{savings/year}) \div \text{cost}$

Where:

% = DOE-provided discount rate,
n = lifetime of measure, in years,
savings/year are based on local utility data, and
cost = total cost of installation.

- The discount rate is generally around 3%.
- The lifetime of the measure should be based on industry norms. The accepted lifetime of a refrigerator is 12 years; the accepted lifetime of insulation is 25 years.
- The total cost of installation must include removal and decommissioning of the old appliance if applicable.

Q. How would it affect the SIR calculation if refrigerators only last 7 years in a region due to brownouts and power surges?

A. Since the lifetime would be shortened, there would be less time for the measure to pay for itself in energy savings, so we would either have to find a less expensive refrigerator or one that is more efficient for the same price. The new refrigerator would have to pay for itself in 7 years instead of 12.

Client Acceptance (Slide #8)

Every measure must be listed in Appendix A and have an SIR of 1 or more. The client must also accept the measure because WAP is a voluntary program.

If the client does not want certain measures installed, the auditor has two choices:

- Continue with weatherization, omitting the unwanted measures.
- Defer weatherization services.

For example, clients may not want to give up their old refrigerator and we cannot force them to accept a new one. In this situation, the auditor must determine if weatherization should continue or if services should be deferred.

Where to Set the Bar? (Slide #9)

Monitor or inspect to standards that are consistent with:

- DOE rules and guidance:
 - Appendix A (Title 10 CFR Part 440) – Title 10 CFR Part 440, established by the Energy Conservation in Existing Buildings Act of 1976, directs DOE to provide weatherization assistance to low-income persons. Appendix A identifies and lists the specifications for materials that may be installed on homes.
 - **Weatherization program notices (WPN)** – Program notices released by DOE to **grantees** provide program guidance, policy, or clarifications. Examples include WPN 08-4, “Space Heater Policy,” and WPN 02-6, “Weatherization Activities and Federal Lead-Based Paint Regulations.” The grantee must distribute WPNs to its **subgrantees** and training network.
- State program standards:
 - Mirror DOE rules.
 - Defer to local authority having jurisdiction – Local codes may be more stringent than Federal or State regulations or the **International Residential Code (IRC)**. Agencies must abide by the most stringent applicable code.

Reference Appendix A and WPN 08-4.

Building Codes (Slide #10)

Monitor or inspect to standards that are consistent with the locally enforced codes:

- **International Codes Council (ICC)** codes (**I-Codes**) provide minimum construction safeguards for homes, schools, and the workplace. The I-Codes are comprehensive, coordinated building safety and fire prevention codes. They are available for purchase at www.intlcode.org.
- IRC, one of the I-Codes, is a comprehensive, stand-alone residential code that creates minimum regulations for one- and two-family dwellings of three stories or less. The 09 IRC refers to the code published in 2009.

Electrical and Mechanical Codes (Slide #11)

Monitor or inspect to standards that are consistent with the locally enforced codes:

- The **American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)** (www.ashrae.org) develops standards for refrigeration processes and the design and maintenance of indoor environments.
- The **National Fire Protection Association (NFPA)** develops, publishes, and disseminates codes and standards that minimize the possibility and effects of fire and other risks. Codes are available for purchase at www.nfpa.org. Frequently referenced codes in weatherization are **NFPA 211, “Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances,” NFPA 54, “National Fuel Gas Code,”** and **NFPA 31, “Standard for the Installation of Oil-Burning Equipment.”**
- The **National Electric Code (NEC)**, also known as NFPA 70, is a comprehensive, stand-alone residential code that creates minimum regulations for one- and two-family dwellings of three stories or less. The 09 IRC refers to the code published in 2009. The NEC is available at www.nfpa.org.
- The **International Association of Plumbing and Mechanical Officials (IAPMO)** (www.iapmo.org) works with governments and industry to implement comprehensive plumbing and mechanical systems codes around the world through the **Uniform Mechanical Code (UMC)** and the **Uniform Plumbing Code (UPC)**.
- National Fuel Gas Code – The **American Gas Association (AGA)** promulgates revisions of the National Fuel Gas Code through the **American National Standards Institute’s (ANSI) Accredited Standards Committee**. The ASC Z223 develops and publishes the National Fuel Gas Code, also known as ANSI Z223.1 and NFPA 54. The code is jointly developed with the NFPA 54 Committee. Available at www.nfpa.org.

Weatherization Field Guides (Slide #12)

Regional and State weatherization field guides detail installation standards and best practices. If you will monitor or inspect in a region or State that has a technical field guide, make sure you refer to it. It is fine to share best practices in the field and encourage workers to adopt them, but it isn’t fair to chastise installers for doing less if they are still meeting the local standards.

Regional field guides:

- Weatherization Guidebook for the Mid-Atlantic Region.
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- Energy OutWest Weatherization Field Guide.
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Many States have developed more specific field guides to help resolve technical issues and provide policy guidance. States with field guides include:

- Illinois
- New Mexico
- Oregon
- Pennsylvania
- South Dakota
- Texas
- Utah
- Wisconsin

These guides are often available through state or local offices, or on their respective Web sites. Crews/contractors should have the appropriate field guides at the job site for reference.

Worker Safety #1 (Slide #13)

When monitoring or inspecting in-progress jobs, look at the job site and ask yourself, “Is it safe?”

Q: What’s wrong with the picture on the right?

*A: Ladder scaffolding must be approved by the **Occupational Safety and Health Administration (OSHA)** or it must be free-standing steel scaffolding.*

Q: What’s wrong with the picture on the left?

A: Drinking on the job is absolutely forbidden.

The short piece of lumber being cut should be clamped to the saw horse.

The saw blade is reversed.

Worker Safety #2 (Slide #14)

On in-progress visits, make sure workers are:

- Following safety regulations.
- Wearing **personal protective equipment (PPE)**.

Monitor/Inspector Requirements (Slide #15)

Monitors and inspectors must possess a working knowledge of:

- Weatherization Assistance Program regulations and policies on worker safety.
- U.S. Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards – In homes built before 1978, **lead safe weatherization (LWS)** practices are required to minimize the dangers of lead dust. An EPA **Certified Renovator** must be on site to oversee any work that disturbs lead paint.
- Occupational Safety & Health Act (OSHA) standards ([available at www.osha.gov](http://www.osha.gov)).
- **Material Safety Data Sheets (MSDS)** contain data on the properties of potentially unsafe substances. MSDS provide workers and emergency personnel with procedures for safely handling or working with those substances.

Hand out the MSDS on two-part foam, “OSHA Fall Protection Tips,” and “OSHA Fact Sheet – Outreach Training Program.” Review documents in class, pointing out the important elements.

Best Practices (Slide #16)

As a monitor or inspector, you may visit and evaluate more than one contractor or agency. This puts you in an ideal position to share best practices throughout the network. Use site visits as an opportunity to commend good work and perform impromptu on-the-job training when the opportunity presents itself.

Best practices:

- Explain how to do the right things the right way.
- Go well beyond standards.
- Offer a consistent technical approach.
- Promote quality workmanship.
- Help with quality assurance.

Best practices are guidelines for how work should be performed by auditors, and all workers in the field. Field guides are an effective means of communicating best practices. One example is the “Midwest Weatherization Best Practices Field Guide.” Technical briefs, such as “Combustion Appliance Safety & Efficiency Testing” published as part of the DOE Hot Climate Initiative, are another excellent resource.

Reference the “Midwest Weatherization Best Practices Field Guide” and hand out “Combustion Appliance Safety & Efficiency Testing.”

Exercise — What Is Required? (Slide #17)

While monitoring or inspecting, you may have to determine whether measures were installed in accordance with local codes. The following exercise gives you some practice.

Introduce Exercise #1: What Is Required? (45 minutes). Refer to Lesson Plan for details. Hand out Applicable Codes Table.

Insulate over Knob and Tube Wiring (Slide #18)

Knob and tube wiring is common in homes built before World War II. Properly installed and used as designed, it is safe. Problems typically arise from circuit over-fusing and overloading and from amateur modifications.

Codes and rules govern weatherization measures that come into contact with knob and tube wiring:

- The 2008 NEC 314.29 requires that all wiring junction boxes remain accessible. Flagging all boxes before insulating over them achieves this easily.
- The 2008 NEC 394.12 forbids enveloping knob and tube wiring in thermal insulation. While it is a national code, it is enforced at the State and local levels.
- Usually, one of the national building codes—all of which reference the NEC for electrical requirements—is the basis for State and local codes. Therefore, if a building code is in effect, the NEC knob and tube ban also is in effect, unless the code has been amended locally.
- DOE’s official position on installation of thermal insulation around knob and tube wiring is stated in DOE’s October 21, 1988 memorandum: “...it is the state’s responsibility to ensure that such work be in conformance with the applicable codes in the jurisdiction where the work is being performed.”

DOE policy allows insulating around knob and tube wiring if certain conditions are satisfied:

- All affected live knob and tube wiring is visually examined to see that it is in good condition, and tested to see that the circuit voltage drop is less than 10%.
- The circuit breaker or fuse controlling the circuit is matched to the wire gauge.
 - o #14 wire = 15 amp fuse/circuit breaker
 - o #20 wire = 20 amp fuse/circuit breaker
- Correct amperage “S” type fuses are installed if the fuse panel has screw-in fuses.
- All affected circuits in walls are evaluated, not just visible wiring in attics.

A State weatherization program wishing to take advantage of the DOE policy must say it is doing so in its DOE State Plan, and must also determine that the activity is allowable under any applicable State and local codes.

Applicable codes/rules:

- 2008 National Electric Code 314.29 and 394.12.
- DOE Memorandum.

Attic Venting (Slide #19)

Add attic venting as needed. Attic (and crawl space) venting is extremely controversial. The IRC requirement for attic venting of 1 ft² of net free vent area for every 300 ft² of attic space (1/300) is an arbitrary number dating back to a 1942 document with no citations or references.¹ Refer interested students to DOE's Building America program or www.buildingscience.com. Both have extensive coverage of the pros and cons of attic and crawl space venting, along with code-approved alternatives. Applicable codes/rules:

- IRC 806.1 – 806.4.
- EPA/OSHA lead paint rules and regulations (if house was built before 1978).

Replace Bedroom Window (Slide #20)

Applicable codes/rules:

- National Fire Protection Association egress code, 2006 & 2009 IRC 310.1 - 310.4.

Q: Is the replacement window “grandfathered?”

A: No.

- WPN 09-6 and EPA/OSHA lead paint rules and regulations (if house was built before 1978).

Replace Attic Hatch (Slide #21)

Applicable codes/rules:

- 2009 IRC 807.1.
- WPN 09-6 and EPA/OSHA lead paint rules and regulations (if house was built before 1978).

Install New Bath Fan and Control (Slide #22)

Applicable codes/rules:

- National Electric Code
 - Anyone can disconnect electrical wiring, but only a licensed electrician or the resident homeowner can connect electrical equipment.
- 2009 IRC 1501.1 – Bath fan may not discharge into any part of the attic.
- WPN 09-6 and EPA/OSHA lead paint rules and regulations.
- **ASHRAE 62 -1989 or ASHRAE 62.2 -2007.**

Note: Use Floor Plan slide for volume and square footage of conditioned space.

¹ Rose, William B. *Early History of Attic Ventilation*. Building Research Council – School of Architecture, University of Illinois at Urbana-Champaign. 1995.

Floor Plan (Slide #23)

Use dimensions from this slide to calculate bath fan *cubic feet per minute (CFM)* and run time.

Refer to Lesson Plan for calculations.

Summary (Slide #24)

- Measures must be listed and conform to Appendix A standards.
- Measures must have an SIR ≥ 1 based on local costs and savings.
- Measures may not be installed if the client does not accept them.
- Inspect or monitor to applicable rules and codes. Make sure installers know the applicable standards.
- When monitoring in-progress units, ensure that safe work practices are used.
- Incorporate training into monitoring and inspecting whenever possible by sharing best practices in the field.



TECHNICAL MONITOR/INSPECTOR

Regulations and Standards

Learning Objectives

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By attending this session participants will gain an understanding of:

- Selection criteria for weatherization measures.
- Appendix A as a tool for materials selection.
- DOE rules and guidance.
- Definitions and resources for residential building, electrical and mechanical codes.
- Application of codes in weatherization.
- Definitions and resources for worker safety requirements.
- Benefits of and resources for best weatherization practices.

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- Benefits of and resources for best weatherization practices.

Measure Selection Guidelines

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- Appendix A
- $SIR \geq 1$
 - Based on DOE-approved audit.
 - Present Value of \$.
 - Fuel Escalation Rate.

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- **Appendix A (Title 10 CFR Part 440)** – Measures must pass cost-effectiveness guidelines and be listed in Appendix A to be installed. Exceptions are made for health and safety measures, which aren't subject to **savings-to-investment ratio (SIR)** calculations.
- $SIR \geq 1$ – The SIR must be at least one based on the approved calculation methods, which include three key components:
 - o A DOE-approved audit – **National Energy Audit Tool (NEAT)**, **Manufactured Home Energy Audit (MHEA)**, or another DOE-approved audit software must be used to generate projected energy savings for the measure. The result is converted to dollar savings based on local utility rates.
 - o The **present value (PV)** of money – PV considers the time value of money: \$10 was worth more 15 years ago than it is today, and the \$10 spent today to install a measure is very likely worth more than \$10 dollars saved 15 years from now.
 - o The **fuel escalation rate** – Fuel prices change. Predicting overall savings includes predicting how much the saved energy will be worth in the future.

If you are using a DOE-approved priority list instead of an individual audit, the SIR will be calculated for a range of housing stock. The priority lists have SIR built in.

Appendix A

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- Can only install measures listed in Appendix A.
- Materials must meet standards for conformance based on Appendix A.

Example:

REPLACEMENT WATER HEATERS	Standards for Conformance
Electric (resistance) water heaters	10 CFR1 430 and UL3 174.
Heat pump water heaters	UL 1995, Second Edition, 1995. Electrical components to be listed by UL.

And must have $SIR \geq 1$

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Appendix A provides a framework for materials and equipment selection.

- Appendix A lists all the measures that may be installed. Listed measures include replacing refrigerators, but not chest freezers. Other acceptable measures include adding dense-pack sidewall insulation, window films, and solar water heaters.
- Materials must meet **standards for conformance** based on Appendix A. These standards ensure that safe, code-compliant materials and equipment are installed.

Q. If a measure is listed in Appendix A, can it automatically be installed in any house?

Click to reveal text.

A. No, it must still pass cost-effectiveness guidelines.

- Measures listed here must still meet cost-effectiveness guidelines.
- If a measure passes cost-effectiveness guidelines, but is not listed in Appendix A, DOE funds cannot be used for installation.

SIR Data Needs

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- Energy consumption of existing item.
- Energy consumption of replacement item.
- Total cost of replacement:
 - Price and installation costs of new unit.
 - Cost of removal and decommissioning of old unit.
- Local Utility Rates.
- Discount Rate.
 - Fuel Escalation Rate.
 - Present Value.

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To understand the data needed to calculate SIR, imagine you are considering a refrigerator replacement. You must determine:

- Energy consumption of the existing item – This information can come from a database or actual metered data collected during the audit.
- Energy consumption of the replacement item – Find this information on the Energy Guide label.
- Total cost of replacement:
 - Price and installation costs of the new unit – Determine the price of the new refrigerator, including delivery and any labor costs associated with installation.
 - Cost of removing and **decommissioning** the old unit – This usually includes labor for removal and transportation, as well as the fee the local solid waste/decommissioning facility charges.
- Local utility rates – These are used to translate projected energy savings into dollar savings.
- **Discount rate** – This is the interest rate at which expected future cash flows can be discounted. It includes both the present value and fuel escalation rate, and is used to account for the time value of money and the changing price of fuels.

Both the fuel escalation rate and discount rate are available from the *Annual Supplement to NIST Handbook 135* and *NBS Special Publication 709*. This level of detail won't typically be required of monitors and inspectors, but you should have a clear understanding of the program's cost-effectiveness guidelines in case you ever need to evaluate whether a certain measure is allowable.

SIR Calculations

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Alternately:

- Built into DOE-approved audits.
- Use spreadsheet “PV” function.

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- SIR calculations are built into DOE-approved audits – If you use an approved audit updated with accurate current energy prices and installation costs, the SIR is computed automatically.
- Use the spreadsheet “PV” function to calculate present value – Excel and other spreadsheet software have a built-in “PV” function. This function is typically used to calculate loan payments, but can be used to calculate SIR with the discount rate inserted in the place of interest rate.

Using "PV" Function for SIR

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SIR Equation =

- PV (% , n , Savings/Year) ÷ Cost

Where:

- % = DOE provided Discount Rate
- n = Lifetime of measure, in years
- Savings/Year is based on local utility data
- Cost = Total cost of installation

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$SIR = -PV(\%, n, \text{savings/year}) \div \text{cost}$

Where:

% = DOE-provided discount rate,
 n = lifetime of measure, in years,
 savings/year are based on local utility data, and
 cost = total cost of installation.

- The discount rate is generally around 3%.
- The lifetime of the measure should be based on industry norms. The accepted lifetime of a refrigerator is 12 years; the accepted lifetime of insulation is 25 years.
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A. Since the lifetime would be shortened, there would be less time for the measure to pay for itself in energy savings, so we would either have to find a less expensive refrigerator or one that is more efficient for the same price. The new refrigerator would have to pay for itself in 7 years instead of 12.

Client Acceptance

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REGULATIONS AND STANDARDS

- Appendix A
- $SIR \geq 1$
- Client Acceptance

Ultimately, if the client does not want certain measures installed, then you have two choices:

1. Continue with weatherization, minus the unwanted measures, or
2. Defer weatherization services.

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Every measure must be listed in Appendix A and have an SIR of 1 or more. The client must also accept the measure because WAP is a voluntary program.

If the client does not want certain measures installed, the auditor has two choices:

- Continue with weatherization, omitting the unwanted measures.
- Defer weatherization services.

For example, clients may not want to give up their old refrigerator and we cannot force them to accept a new one. In this situation, the auditor must determine if weatherization should continue or if services should be deferred.

Where to Set the Bar?

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Energy Efficiency & Renewable Energy

REGULATIONS AND STANDARDS

Monitor or inspect to standards that are consistent with:

- **DOE Rules and Guidance:**
 - Appendix A (DOE CFR 440).
 - Weatherization program notices (WPN).
<http://www.waptac.org/>
- **State Program Standards:**
 - Mirror DOE rules.
 - Defer to local authority having jurisdiction.

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Monitor or inspect to standards that are consistent with:

- DOE rules and guidance:
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- State program standards:
 - o Mirror DOE rules.
 - o Defer to local authority having jurisdiction – Local codes may be more stringent than Federal or State regulations or the **International Residential Code (IRC)**. Agencies must abide by the most stringent applicable code.

Reference Appendix A and WPN 08-4.

Building Codes

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- International Codes Council (ICC)
- International Residential Code (IRC)
www.intlcode.org



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Monitor or inspect to standards that are consistent with the locally enforced codes:

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Electrical & Mechanical Codes

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- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
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- National Fire Protection Association (NFPA)
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- National Electric Code (NEC) (NFPA 70)
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- The International Association of Plumbing and Mechanical Officials (IAPMO) www.iapmo.org
 - Uniform Mechanical Code (UMC)
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- National Fuel Gas Code (NFGC)

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Monitor or inspect to standards that are consistent with the locally enforced codes:

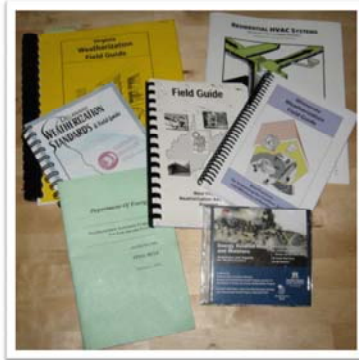
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Weatherization Field Guides

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- Field guides include detailed instructions, best-practices and more.
- Regional Field Guides:
 - Weatherization Guidebook for Mid-Atlantic Region**
 - Northeast Weatherization Field Guide**
 - Southeastern Weatherization Field Guide**
 - Energy OutWest Weatherization Field Guide**
- Many State field guides.



An assortment of State and Regional Field Guides, Regulations, and training resources.

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Regional and State weatherization field guides detail installation standards and best practices. If you will monitor or inspect in a region or State that has a technical field guide, make sure you refer to it. It is fine to share best practices in the field and encourage workers to adopt them, but it isn't fair to chastise installers for doing less if they are still meeting the local standards.

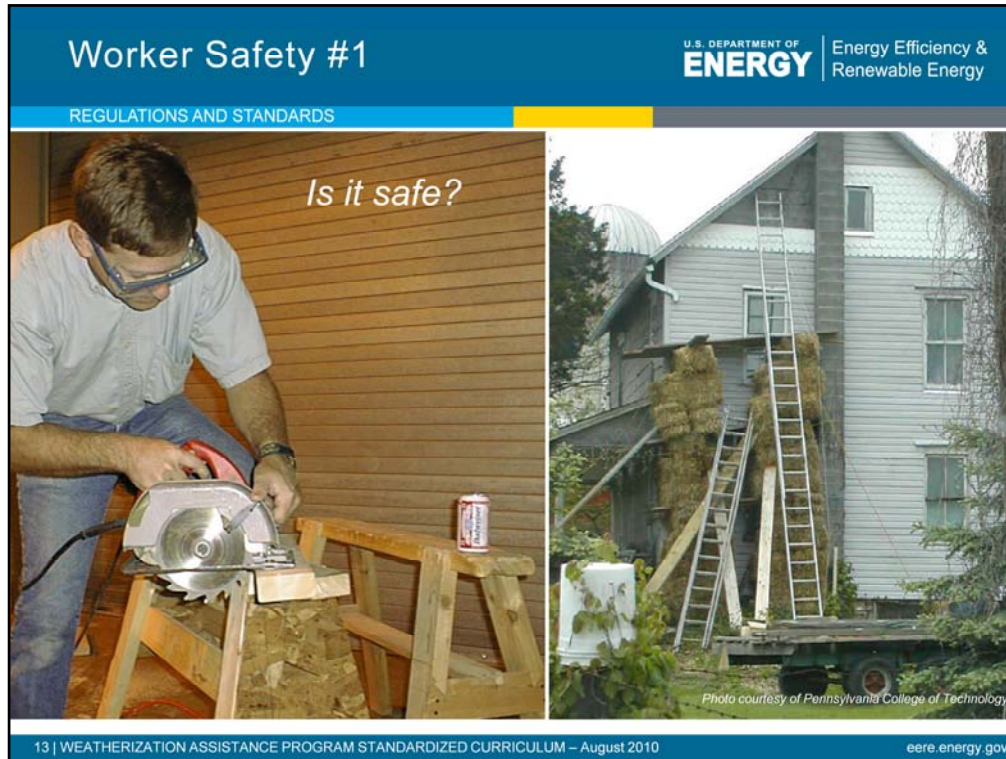
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The short piece of lumber being cut should be clamped to the saw horse.

The saw blade is reversed.

Worker Safety #2

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- On in-progress visits, make sure workers:
- Follow safety regulations.
- Use personal protective equipment.



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On in-progress visits, make sure workers are:

- Following safety regulations.
- Wearing ***personal protective equipment (PPE)***.

Monitor/Inspector Requirements

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Energy Efficiency & Renewable Energy

REGULATIONS AND STANDARDS

Monitors and Inspectors must possess a working knowledge of:

- U.S. Department of Energy (DOE) Weatherization Assistance Program Regulations and Policy.
www.waptac.org
- U.S. Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards.
www.epa.gov
- Occupational Safety & Health Act (OSHA) standards.
www.osha.gov
- Material Safety Data Sheets (MSDS).

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Monitors and inspectors must possess a working knowledge of:

- Weatherization Assistance Program regulations and policies on worker safety.
- U.S. Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards – In homes built before 1978, **lead safe weatherization (LWS)** practices are required to minimize the dangers of lead dust. An EPA **Certified Renovator** must be on site to oversee any work that disturbs lead paint.
- Occupational Safety & Health Act (OSHA) standards ([available at www.osha.gov](http://www.osha.gov)).
- **Material Safety Data Sheets (MSDS)** contain data on the properties of potentially unsafe substances. MSDS provide workers and emergency personnel with procedures for safely handling or working with those substances.

Hand out the MSDS on two-part foam, “OSHA Fall Protection Tips,” and “OSHA Fact Sheet – Outreach Training Program.” Review documents in class, pointing out the important elements.

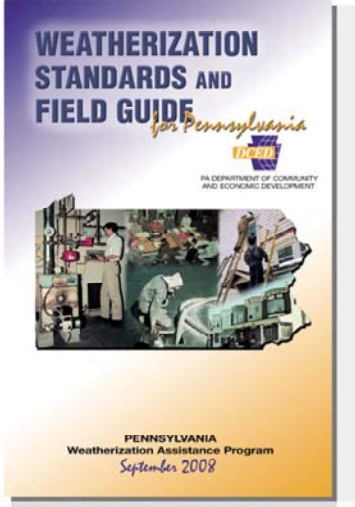
Best Practices

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REGULATIONS AND STANDARDS

Best Practices:

- Explain how to do the right things the right way.
- Go well beyond standards.
- Offer a consistent technical approach.
- Promote quality workmanship.
- Help with quality assurance.



Courtesy of the Pennsylvania College of Technology

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As a monitor or inspector, you may visit and evaluate more than one contractor or agency. This puts you in an ideal position to share best practices throughout the network. Use site visits as an opportunity to commend good work and perform impromptu on-the-job training when the opportunity presents itself.

Best practices:

- Explain how to do the right things the right way.
- Go well beyond standards.
- Offer a consistent technical approach.
- Promote quality workmanship.
- Help with quality assurance.

Best practices are guidelines for how work should be performed by auditors, and all workers in the field. Field guides are an effective means of communicating best practices. One example is the “Midwest Weatherization Best Practices Field Guide.” Technical briefs, such as “Combustion Appliance Safety & Efficiency Testing” published as part of the DOE Hot Climate Initiative, are another excellent resource.

Reference the “Midwest Weatherization Best Practices Field Guide” and hand out “Combustion Appliance Safety & Efficiency Testing.”

What is Required?

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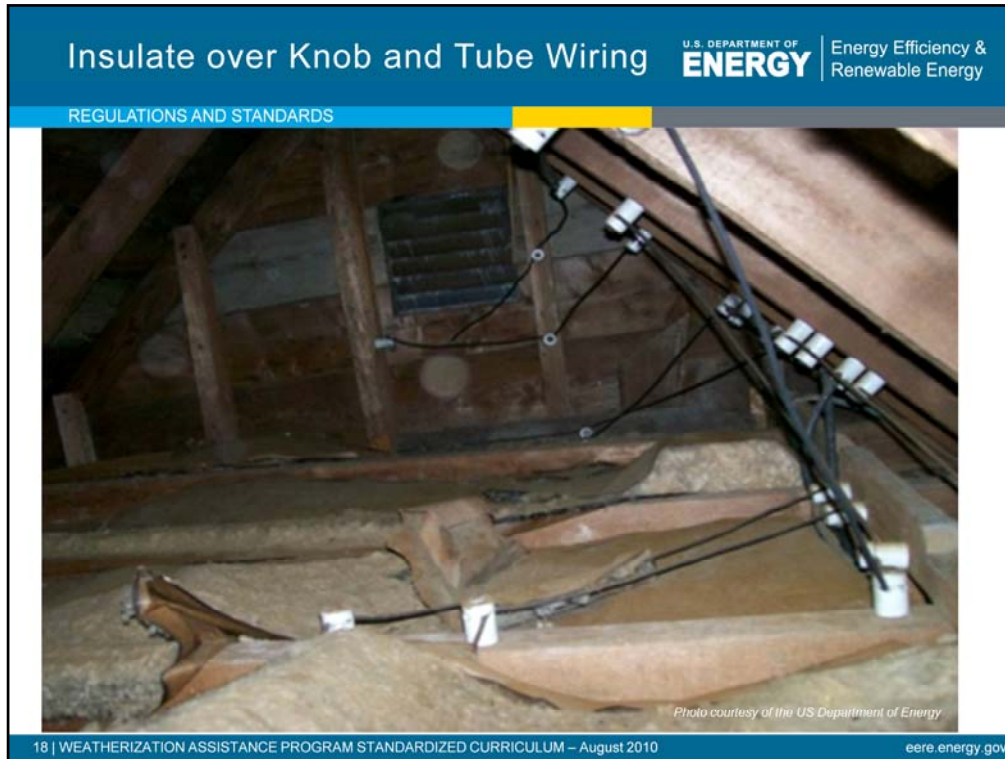
REGULATIONS AND STANDARDS

- Exercise: **What is Required?**
- (45 Minutes)
- Use next 6 slides and refer to Lesson Plan.

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While monitoring or inspecting, you may have to determine whether measures were installed in accordance with local codes. The following exercise gives you some practice.

Introduce Exercise #1: What Is Required? (45 minutes). Refer to Lesson Plan for details. Hand out Applicable Codes Table.



Knob and tube wiring is common in homes built before World War II. Properly installed and used as designed, it is safe. Problems typically arise from circuit over-fusing and overloading and from amateur modifications.

Codes and rules govern weatherization measures that come into contact with knob and tube wiring:

- The 2008 NEC 314.29 requires that all wiring junction boxes remain accessible. Flagging all boxes before insulating over them achieves this easily.
- The 2008 NEC 394.12 forbids enveloping knob and tube wiring in thermal insulation. While it is a national code, it is enforced at the State and local levels.
- Usually, one of the national building codes—all of which reference the NEC for electrical requirements—is the basis for State and local codes. Therefore, if a building code is in effect, the NEC knob and tube ban also is in effect, unless the code has been amended locally.
- DOE's official position on installation of thermal insulation around knob and tube wiring is stated in DOE's October 21, 1988 memorandum: "...it is the state's responsibility to ensure that such work be in conformance with the applicable codes in the jurisdiction where the work is being performed."

DOE policy allows insulating around knob and tube wiring if certain conditions are satisfied:

- All affected live knob and tube wiring is visually examined to see that it is in good condition, and tested to see that the circuit voltage drop is less than 10%.
- The circuit breaker or fuse controlling the circuit is matched to the wire gauge.
 - o #14 wire = 15 amp fuse/circuit breaker
 - o #20 wire = 20 amp fuse/circuit breaker
- Correct amperage "S" type fuses are installed if the fuse panel has screw-in fuses.
- All affected circuits in walls are evaluated, not just visible wiring in attics.

A State weatherization program wishing to take advantage of the DOE policy must say it is doing so in its DOE State Plan, and must also determine that the activity is allowable under any applicable State and local codes.

Applicable codes/rules:

- 2008 National Electric Code 314.29 and 394.12.
- DOE Memorandum.

Attic Venting

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REGULATIONS AND STANDARDS



Add attic venting as necessary

Attic flat: 8' x 26'
Slopes: 8' x 26' x 2
Existing: Two 12" x 18" louvered end vents
No ridge vents; No soffit vents
All ceilings coated with vapor barrier paint

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Add attic venting as needed. Attic (and crawl space) venting is extremely controversial. The IRC requirement for attic venting of 1 ft² of net free vent area for every 300 ft² of attic space (1/300) is an arbitrary number dating back to a 1942 document with no citations or references. Refer interested students to DOE's Building America program or www.buildingscience.com. Both have extensive coverage of the pros and cons of attic and crawl space venting, along with code-approved alternatives.

Applicable codes/rules:

- IRC 806.1 – 806.4.
- EPA/OSHA lead paint rules and regulations (if house was built before 1978).

Rose, William B. *Early History of Attic Ventilation*. Building Research Council – School of Architecture, University of Illinois at Urbana-Champaign. 1995.

Replace Bedroom Window

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REGULATIONS AND STANDARDS

- House built in 1900.
- 2nd floor bedroom has only one window.
- Sash area is 27" x 44".
- Existing window is single hung.



Photo courtesy of the US Department of Energy

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Applicable codes/rules:

- National Fire Protection Association egress code, 2006 & 2009 IRC 310.1 - 310.4.

Q: Is the replacement window “grandfathered?”

A: No.

- WPN 09-6 and EPA/OSHA lead paint rules and regulations (if house was built before 1978).



Applicable codes/rules:

- 2009 IRC 807.1.
- WPN 09-6 and EPA/OSHA lead paint rules and regulations (if house was built before 1978).

Install New Bath Fan & Control

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REGULATIONS AND STANDARDS



1. How many CFM?
2. How controlled?

Photo courtesy of the US Department of Energy

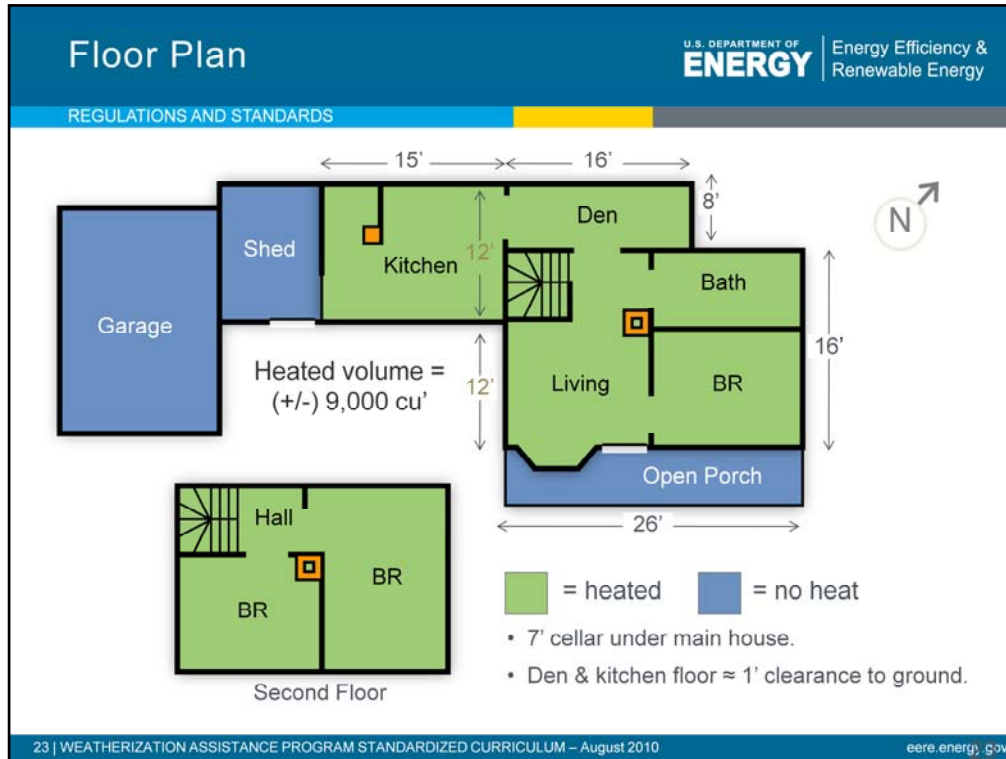
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Applicable codes/rules:

- National Electric Code
 - o Anyone can disconnect electrical wiring, but only a licensed electrician or the resident homeowner can connect electrical equipment.
- 2009 IRC 1501.1 – Bath fan may not discharge into any part of the attic.
- WPN 09-6 and EPA/OSHA lead paint rules and regulations.
- **ASHRAE 62 -1989 or ASHRAE 62.2 -2007.**

Note: Use Floor Plan slide for volume and square footage of conditioned space.



Use dimensions from this slide to calculate bath fan *cubic feet per minute (CFM)* and run time.

Refer to Lesson Plan for calculations.

Summary

REGULATIONS AND STANDARDS

- Measures must be listed and conform to Appendix A standards.
- Measures must have $SIR \geq 1$ based on local costs and savings.
- Client must accept measures.
- Inspect or monitor to applicable rules and codes.
- When monitoring in-progress units, ensure that safe work practices are used.
- Incorporate training into monitoring and inspecting whenever possible by sharing best practices in the field.

- Measures must be listed and conform to Appendix A standards.
- Measures must have an $SIR \geq 1$ based on local costs and savings.
- Measures may not be installed if the client does not accept them.
- Inspect or monitor to applicable rules and codes. Make sure installers know the applicable standards.
- When monitoring in-progress units, ensure that safe work practices are used.
- Incorporate training into monitoring and inspecting whenever possible by sharing best practices in the field.

Incidental Repairs and Health & Safety Measures

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will gain an understanding of:

- The differences between incidental repairs and health and safety (H&S) measures.
- DOE rules as they apply to incidental repairs and H&S measures.

Key Terminology

Carbon Monoxide (CO)

Incidental repairs

Energy Conservation Measure (ECM)

Knob and tube wiring

Ground Fault Circuit Interrupter (GFCI)

Savings-to-Investment Ratio (SIR)

Grantee

Subgrantee

Health and Safety (H&S)

Weatherization Program Notice (WPN)

Supplemental Materials

Handouts & Resources

US Department of Energy, Weatherization Assistance Program, *WPN 11-6. Health and Safety Guidance*. January 12, 2011. www.waptac.org.

US Department of Energy, Weatherization Assistance Program, *WPN 11-1. Program Year 2011 Weatherization Grant Guidance*. December 28, 2010. www.waptac.org.

Class Overview

Reference weatherization program notices that define or explain health and safety measures and incidental repairs. Discuss how those should be incorporated into a weatherization project. Lead a class discussion using slides 11-18 on whether the pictured scenarios qualify as incidental repairs or health and safety measures, or could possibly be classified as either.

Incidental Repairs and Health & Safety Measures

Technical Monitor/Inspector

Key Terminology

Carbon Monoxide (CO)

Energy Conservation Measure (ECM)

Ground Fault Circuit Interrupter (GFCI)

Grantee

Health and Safety (H&S)

Incidental repairs

Knob and tube wiring

Savings-to-Investment Ratio (SIR)

Subgrantee

Weatherization Program Notice (WPN)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will gain an understanding of:

- The differences between incidental repairs and health and safety (H&S) measures.
- DOE rules as they apply to incidental repairs and H&S measures.

Incidental Repairs Defined (Slide #3)

Incidental repairs are those repairs necessary for the effective performance or preservation of weatherization materials. Incidental repairs are different from the regular energy conservation measures installed in homes, and some rules apply:

- Incidental repairs must assist in the performance or protect energy-savings measures – Incidental repairs may be necessary to ensure the lifetime of the energy conservation measures being installed in the home. For example:
 - Lighting fixture replacement – You can replace a hardwired lighting fixture if it is necessary to install energy-efficient lighting.
 - Wiring upgrades – This can be done when it is a component of the measure being installed, such as upgrading wiring to handle the extra load of a cooling system.
- Costs must be included in the **savings-to-investment ratio (SIR)** calculations – Incidental repairs must pass the cost-effectiveness test. While the justification of incidental repair must be tied to a measure or specific group of measures, the price of incidental repairs can be included

in the package of measures. If the SIR is still 1 or higher and the repairs meet the requirements listed above, the incidental repairs may be performed. Because of this rule incidental repairs are self-limiting costs – they can't exceed what will fit into the SIR of the total package of measures.

- Expenditures are sometimes capped by the **grantee** to prevent unreasonable spending on non-energy-saving repairs. Expenditures are typically capped at a certain dollar amount per house (\$500 per home, for example) or at a percentage of the maximum allowable cost per home.

Health & Safety Measures #1 (Slide #4)

- When in doubt, try to relate health & safety (H&S) work to energy. If you can't, it probably isn't allowable.
 - **Carbon monoxide (CO)** detectors are justified because the increased house tightness due to air sealing can potentially cause higher concentrations of CO.
- The grantee sets an average limit for H&S expenditures in the State Plan. Expenditures are typically limited to a percentage of the maximum allowable cost per home. Since some homes don't need any H&S work, providers can install more H&S measures in homes with great need, and still remain within the overall average.
- Examples:
 - Repairing gas leaks – If you find a gas leak in a client's home, it is crucial that it be repaired.
 - Installing smoke/CO alarms – This is a typical H&S measure.
- H&S work is not included in SIR calculations, and therefore not subject to the same SIR requirements as air sealing, insulation, or incidental repairs.

Health and Safety Measures #2 (Slide 5)

- Test and repair leaky fuel lines.
 - Replace unsafe or leaking hot water tanks.
- Q. Name some other big ticket measures under health and safety.*
- A. Some examples:*
- *Replace furnaces found to have cracked heat exchangers.*
 - *Replace non-code-compliant chimney vents.*
 - *Install chimney liners.*
 - *Install kitchen and bath fans.*
 - *Repair and clean cook stoves that produce high levels of CO.*

WPN 11-6 H&S Guidance (Slide #6)

Weatherization Program Notice (WPN) 11-6 - HEALTH AND SAFETY GUIDANCE – will assist states/grantees in their development of a comprehensive approach to health and safety matters through their health and safety plans.

WPN 11-6 addresses:

- Allowability of H&S measures and testing, as well as training and client education requirements.
- Instruction for H&S plan development.

H&S or Energy Conservation Measure? (Slide #7)

Grantees will perform those measure in 11-6 with health and safety funds, unless they can be cost justified as an energy conservation measure. If measures such as furnace or water heater replacement can be cost justified through the audit or priority list, then they must be cost justified. An attempt should be made to achieve an SIR of 1 or greater for all potential energy saving measures. Once it is determined that the measure is not cost effective, it can be considered for health and safety repair or replacement.

H&S or Incidental Repair? #1 (Slide #8)

Grantees will perform those measure in 11-6 with health and safety funds, unless they can be stand alone energy conservation measures, or they are defined as incidental repair in the Grantee Health & Safety Plan, effectively removing them from the health and safety budget category. This practice can help manage health and safety budget limitations, but it must be done consistently across the program. If a grantee does not remove 11-6 health and safety measures and state clearly within their health and safety plan that they will be performed as incidental repair, then they must be performed with health and safety funds.

H&S or Incidental Repair? #2 (Slide #9)

Eligible measures that meet the incidental repair definition but are also allowable H&S expenditures must be clearly identified in the grantee plan as incidental repairs if that is the intended budget source. The default setting for these measures is as part of the H&S budget.

Some of the defined H&S measures do not meet the incidental repair definition and may not be defined as such in the grantee plan. These measures must always be paid for with H&S funds when applied to client homes.

H&S or Incidental Repair? #3 (Slide #10)

Some cases may not be so clear, as when code compliance triggers the installation of a measure. Several questions should be asked:

- Is the measure necessary in order to install weatherization or needed to protect the occupant as a result of weatherization activities?
- Is the measure specific to ensuring the health and safety of the occupant/worker?
- Is the activity a component of an ECM?

- What parts of an ECM would have been conducted anyway, without consideration for the health and safety guidance

Which Is It? #1 (Slide #11)

Now it's time for some fun. Ask the class to determine whether a scenario qualifies as an incidental or health and safety measure. Hint: it can be H&S, incidental, or neither, but sometimes depends on the purpose and justification.

- Wiring on an outdoor fixture is frayed and taped.

Q: Which is it?

A: Incidental repair when installing energy efficient lighting – Correcting this wiring is a component of the energy efficiency measure and installing a new CFL into an unsafe fixture is not recommended.

**If energy efficiency lighting is not being installed, then fixing the wiring issue could be performed as a health and safety measure*

Which Is It? #2 (Slide #12)

- The light fixture in the ceiling is damaged.

Q: Which is it?

A: Incidental repair when installing energy efficient lighting – Replacing the fixture is a component of the energy efficiency measure and installing a new CFL into an unsafe fixture is not recommended.

**If energy efficient lighting is not being installed, then replacing the fixture could be performed as a health and safety measure if necessary to perform weatherization or avoid creating an unsafe condition because of weatherization activity. If the broken fixture will not prevent safe and effective weatherization or the weatherization work will not make the situation worse, then it should be left as is.*

Which Is It? #3 (Slide #13)

- There is mold in the living space.

Q: Which is it?

A: Health and safety – If insulation is being installed, this assumes that the drywall is structurally sound to handle the insulation measure. The most important thing to address is the “mold and moisture creating condition”, which would be a health and safety cost. Mold cleanup and mitigation is not allowed and client education is required.

Which Is It? #4 (Slide #14)

- There is extensive live **knob and tube wiring** in the attic.

Q: Which is it?

A: Health & Safety – Unless the knob-and-tube wiring is a direct component of an energy efficiency measure, such as an electrical upgrade for a cooling system, then it would be performed as health & safety. Grantees have the opportunity to define electrical measures as incidental repair in their health and safety plan, effectively removing them from the H&S budget category. If it is not defined as incidental repair then it must be performed as health and safety. If it is defined as incidental repair then it must be charged to incidental repair and cost justified with the package of measures consistently throughout the service territory.

Which Is It? #5 (Slide #15)

- Water damage is leading to failure of a concrete roof and ceiling.

Q: Which is it?

A: In this case, weatherization work should probably be deferred due to the extent of the structural and water problems.

Which Is It? #6 (Slide #16)

- There is a large hole in the ceiling.

Q: Which is it?

A: Neither. It is an infiltration measure – This repair is part of air leakage reduction, which is an energy saving measure.

Which Is It? #7 (Slide #17)

- There are sagging or water-damaged ceilings.

Q. Which is it?

A. Incidental repair or health and safety – Repair, replace, or reinforce the ceilings to support the weight of insulation as an incidental repair. Repair of the moisture damage could also be health and safety depending on the justification in the client file. This is a gray area that can be decided in the field but must be justified in the client file. Repairing the roof leak and/or providing mechanical bathroom ventilation is a health and safety measure – in other words correcting the “moisture creating condition”. Grantees have the opportunity to define correcting moisture creating conditions as incidental repair in their health and safety plan, effectively removing it from the H&S budget category. If it is defined as incidental repair then it must be charged to incidental repair and cost justified with the package of measures consistently throughout the service territory.

Which Is It? #8 (Slide #18)

- The roof leaks into the bedroom.

Q: Which is it?

A. In the bedroom, it could be billed as health and safety.

Click to reveal the porch.

A: But actually it's neither! The leak is located on a porch that is outside the scope of weatherization.

Which is it? #9

A door sill is rotted and prevents weather stripping.

Q. Which is it?

- *Incidental repair – a rotted sill is a direct component of air sealing the door with weather stripping and door sweeps. However, this is not a justification for replacing the door.*

Summary (Slide #19)

- Incidental repairs ensure longevity of weatherization measures and are included in the SIR.
- Health and safety repairs must be energy-related, but aren't included in the SIR.
- Determination should first be made with reference to the grantee plan, but also relies largely on your professional judgment.
- Situations vary by case, but consistency is critical.
 - Health and safety and incidental repairs are often gray areas. The decision often comes down to a judgment call by the auditor. Auditors are empowered to make these kinds of decisions as long as they provide a strong justification in the client file and follow consistent logic from case to case.



TECHNICAL MONITOR/INSPECTOR

Incidental Repairs and Health and Safety Measures

Learning Objectives

U.S. DEPARTMENT OF
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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

By attending this session, participants will gain an understanding of:

- The differences between incidental repairs and health and safety (H&S) measures.
- DOE rules as they apply to incidental repairs and H&S measures.

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By attending this session, participants will gain an understanding of:

- The differences between incidental repairs and health and safety (H&S) measures.
- DOE rules as they apply to incidental repairs and H&S measures.

Incidental Repairs Defined

INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

Necessary for the effective performance or preservation of weatherization materials.

Examples:

- Lighting fixture replacement when installing CFLs.
- Flooring repair for water heater installation.
- Included in SIR of the unit.
- Expenditures often capped by the grantee.



Incidental repairs are those repairs necessary for the effective performance or preservation of weatherization materials. Incidental repairs are different from the regular **energy conservation measures (ECMs)** installed in homes, and some rules apply:

- Incidental repairs must assist in the performance or protect energy-savings measures – Incidental repairs may be necessary to ensure the lifetime of the energy conservation measures being installed in the home. For example:
 - Lighting fixture replacement – You can replace a hardwired lighting fixture if it is necessary to install energy-efficient lighting.
 - Wiring upgrades – This can be done when it is a component of the measure being installed, such as upgrading wiring to handle the extra load of a cooling system.
- Costs must be included in the **savings-to-investment ratio (SIR)** calculations – Incidental repairs must pass the cost-effectiveness test. While the justification of incidental repair must be tied to a measure or specific group of measures, the price of incidental repairs can be included in the package of measures. If the SIR is still 1 or higher and the repairs meet the requirements listed above, the incidental repairs may be performed. Because of this rule, incidental repairs are self-limiting costs – they can't exceed what will fit into the SIR of the total package of measures.
- Expenditures are sometimes capped by the **grantee** to prevent unreasonable spending on non-energy-saving repairs. Expenditures are typically capped at a certain dollar amount per house (\$500 per home, for example) or at a percentage of the maximum allowable cost per home.

Health & Safety Measures #1

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

- **Energy-related** health and safety.
- Expenditures often capped by the grantee.
- Examples:
 - Repairing gas leak
 - Installing smoke/CO alarms
- Not included in SIR calculations.



Installing smoke and CO detectors is a common health and safety measure.

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- When in doubt, try to relate health & safety (H&S) work to energy. If you can't, it probably isn't allowable.
 - o **Carbon monoxide (CO)** detectors are justified because the increased house tightness due to air sealing can potentially cause higher concentrations of CO.
- The grantee sets an average limit for H&S expenditures in the State Plan. Expenditures are typically limited to a percentage of the maximum allowable cost per home. Since some homes don't need any H&S work, providers can install more H&S measures in homes with greatest need, and still remain within the overall average.
- Examples:
 - o Repairing gas leaks – If you find a gas leak in a client's home, it is crucial that it be repaired.
 - o Installing smoke/CO alarms – This is a typical H&S measure.
- H&S work is not included in SIR calculations, and therefore not subject to the same SIR requirements as air sealing, insulation, or incidental repairs.
- You must be performing energy conservation measures in the home to conduct any H&S repairs.

Health & Safety Measures #2

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES



**Test and repair leaky
fuel lines.**



**Replace unsafe or leaking
hot water tanks.**

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- Test and repair leaky fuel lines.
- Replace unsafe or leaking hot water tanks.

Q. Name some other big ticket measures under health and safety.

A. Some examples:

- *Replace furnaces found to have cracked heat exchangers.*
- *Replace non-code-compliant chimney vents.*
- *Install chimney liners.*
- *Install kitchen and bath fans.*
- *Repair and clean cook stoves that produce high levels of CO.*

WPN 11-6 H&S Guidance

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

- Drafted in 2011 to put all relevant H&S guidance in one place.
- Describes most common issues encountered during weatherization, what is allowed, what is required, and what is prohibited in terms of dealing with these issues.
- Outlines how grantees must address H&S in their grantee plan, and where more guidance may be needed at the local level.

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Weatherization Program Notice (WPN) 11-6 - HEALTH AND SAFETY GUIDANCE – will assist states/grantees in their development of a comprehensive approach to health and safety matters through their health and safety plans.

WPN 11-6 addresses:

- Allowability of H&S measures and testing, as well as training and client education requirements.
- Instruction for H&S plan development.

WPN 11-6 - HEALTH AND SAFETY GUIDANCE

“There are some instances where, depending on circumstances, the measure can be considered either a health and safety measure OR an energy conservation measure (e.g., furnaces). In those instances where the measure has a cost-effective savings-to-investment ratio (SIR) of one (1) or greater, the measure should be treated as a weatherization efficiency measure.”

Grantees will perform those measure in 11-6 with health and safety funds, unless they can be stand alone energy conservation measures, or they are defined as incidental repair in the Grantee Health & Safety Plan, effectively removing them from the health and safety budget category. If measures such as furnace or water heater replacement can be cost justified through the audit or priority list, then they must be cost justified. An attempt should be made to achieve an SIR of 1 or greater for all potential energy saving measures. Once it is determined that the measure is not cost effective, it can be considered for health and safety repair or replacement.

WPN 11-6 - HEALTH AND SAFETY GUIDANCE

“Grantees should carefully consider the approach to be taken when they draft their health and safety procedures. While ease of accounting is an important consideration, Grantees should keep in mind that activities assigned to the health and safety budget category do not have to be cost-justified by the energy audit. The same items assigned to incidental repair, weatherization material, or installation cost categories must be cost-justified.”

When defining those measures in 11-6 as incidental repair in the Grantee Health & Safety Plan it removes them from the health and safety budget category. This practice can help manage health and safety budget limitations, but it must be done consistently across the program. If a grantee does not remove any health and safety measures identified in 11-6 and state clearly within their health and safety plan that they will be performed as incidental repair, then they must be performed with health and safety funds.

H&S or Incidental Repair? #2

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

Eligible measures that meet the incidental repair definition (must be defined in grantee plan):

- Correcting moisture creating conditions
- Repairing moisture damaged areas as necessary to perform weatherization
- Roofing repair
- Electrical repair

Ineligible measures that do not meet the incidental repair definition:

- Lead Safe work and testing
- Asbestos testing, encapsulation, mitigation
- Removing pollutants
- Radon testing

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Eligible measures that meet the incidental repair definition but are also allowable H&S expenditures must be clearly identified in the grantee plan as incidental repairs if that is the intended budget source. The default setting for these measures is as part of the H&S budget.

Some of the defined H&S measures do not meet the incidental repair definition and may not be defined as such in the grantee plan. These measures must always be paid for with H&S funds when applied to client homes.

H&S or Incidental Repair? #3

INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

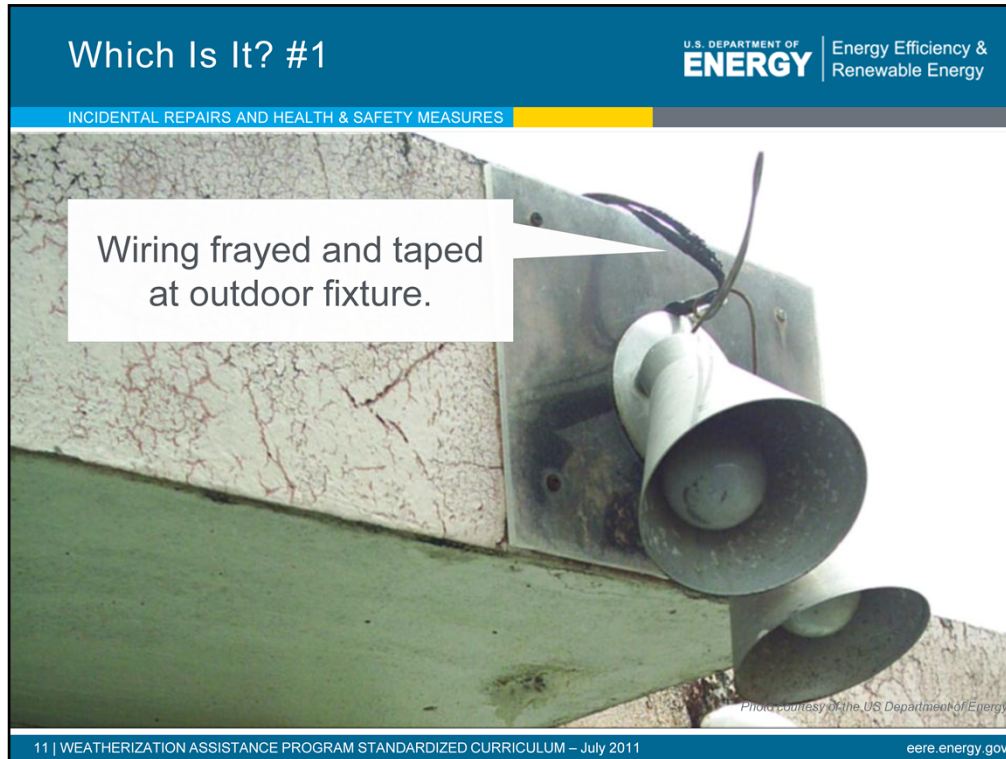
Some cases may not be so clear, as when code compliance triggers the installation of a measure. Several questions should be asked:

- Necessary for installation of ECMs or protection of client?
- Specific to ensuring H&S of worker/occupant?
- Part of an ECM?
- What aspects of ECM are separate from H&S?

*The following Q&A does not consider the grantee's ability to remove certain health and safety measures and define them as incidental repair in their health and safety plan.

Some cases may not be so clear, as when code compliance triggers the installation of a measure. Several questions should be asked:

- Is the measure necessary in order to install weatherization or needed to protect the occupant as a result of weatherization activities?
- Is the measure specific to ensuring the health and safety of the occupant/worker?
- Is the activity a component of an ECM?
- What parts of an ECM would have been conducted anyway, without consideration for the health and safety guidance



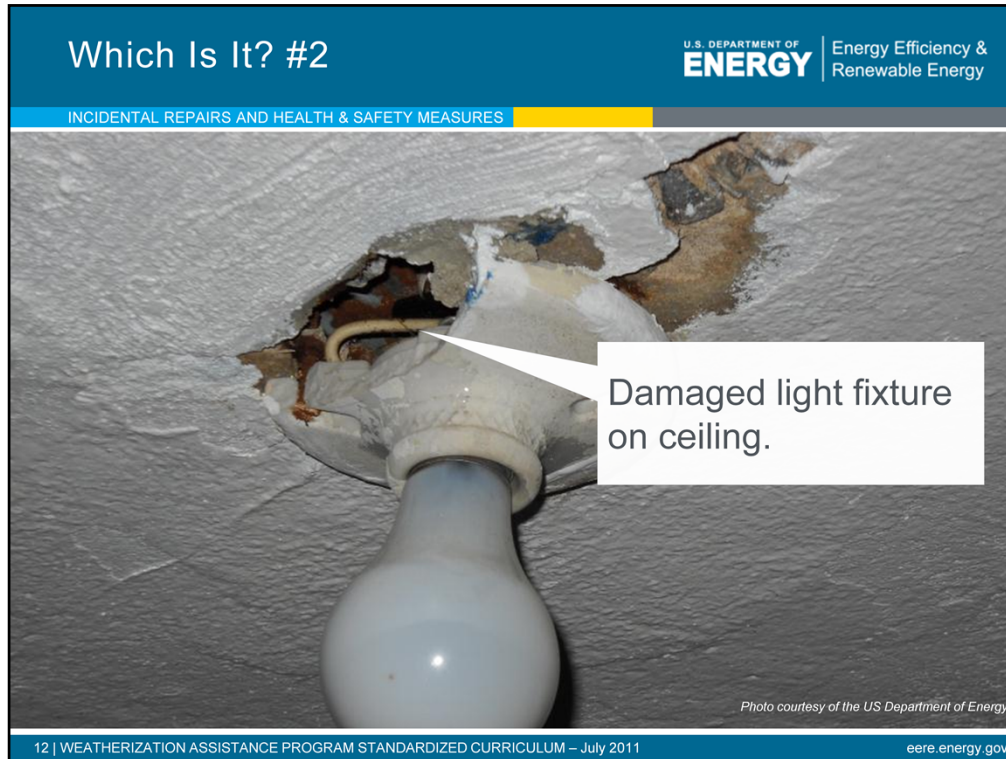
Now it's time for some fun. Determine whether a scenario qualifies as an incidental repair or health and safety measure. Hint: it can be H&S, incidental, or neither, but sometimes depends on the purpose and justification.

- Wiring on an outdoor fixture is frayed and taped, audit calls installing energy efficient lighting.

Q: Which is it?

A: Incidental repair when installing energy efficient lighting – Correcting this wiring is a component of the energy efficiency measure and installing a new CFL into an unsafe fixture is not recommended.

**If energy efficiency lighting is not being installed, then fixing the wiring issue could be performed as a health and safety measure.*

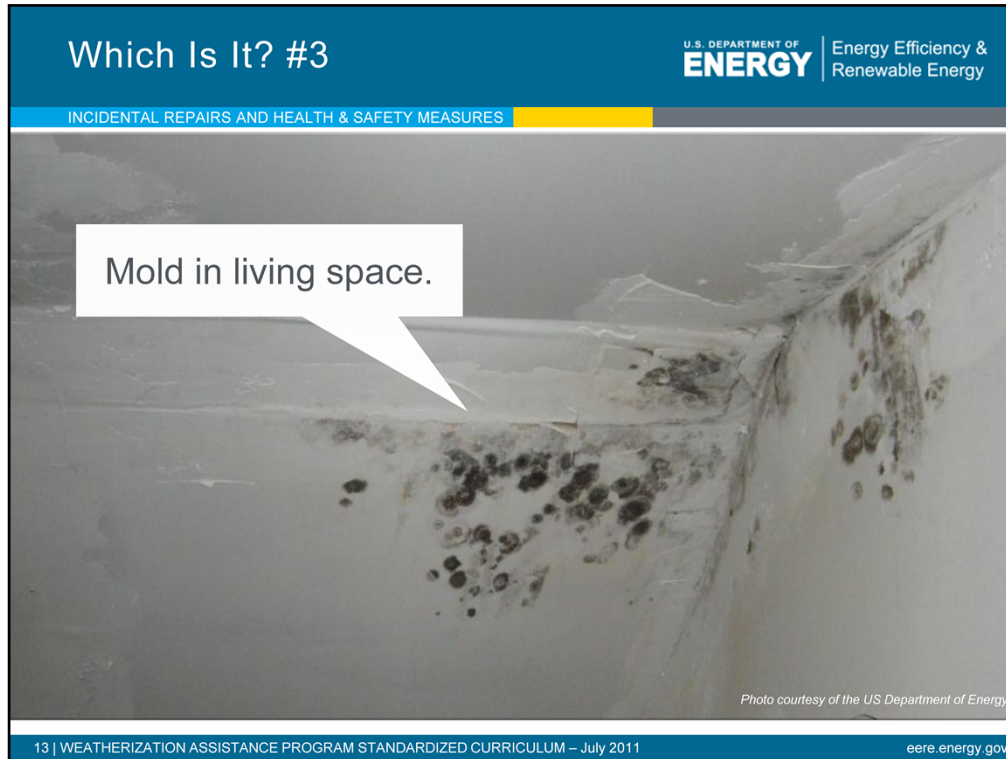


- The light fixture in the ceiling is damaged.

Q: Which is it?

A: Incidental repair when installing energy efficient lighting – Replacing the fixture is a component of the energy efficiency measure and installing a new CFL into an unsafe fixture is not recommended.

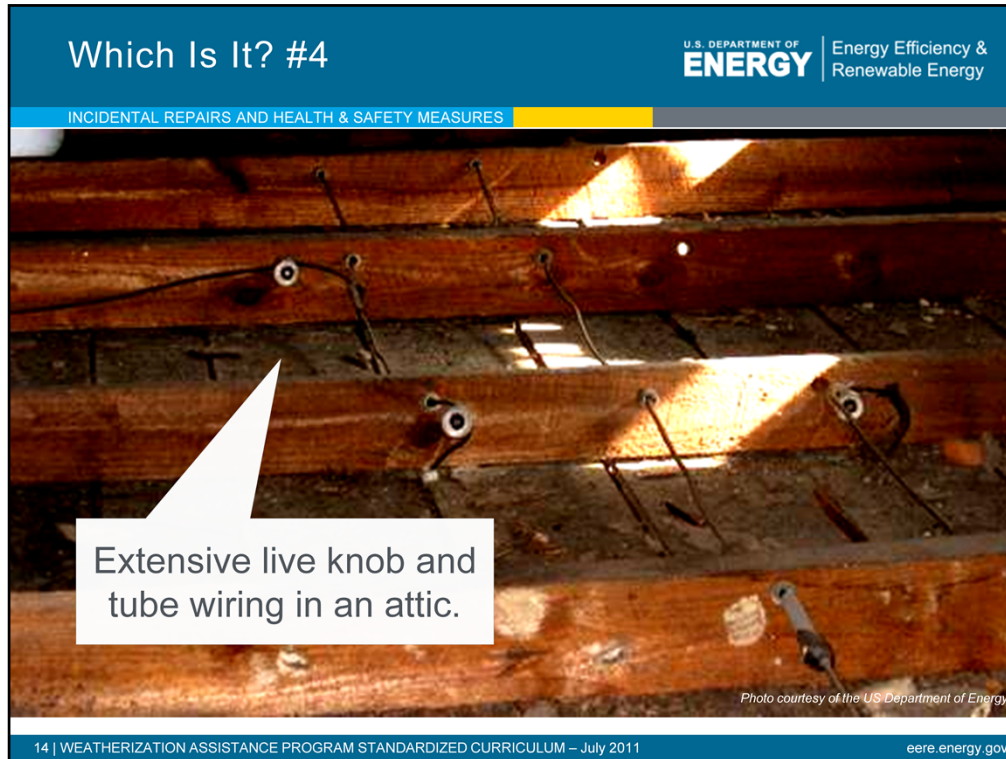
**If energy efficient lighting is not being installed, then replacing the fixture could be performed as a health and safety measure if necessary to perform weatherization or avoid creating an unsafe condition because of weatherization activity. If the broken fixture will not prevent safe and effective weatherization or the weatherization work will not make the situation worse, then it should be left as is.*



- There is mold in the living space.

Q: Which is it?

A: Health & Safety – If insulation is being installed, assuming that the drywall is structurally sound to handle the insulation measure. The most important thing to address is the “mold and moisture creating condition”, which would be a health and safety cost. Mold cleanup and mitigation is not allowed and client education is required.



- There is extensive live **knob and tube wiring** in the attic.

Q: Which is it?

A: Health & Safety – Unless the knob-and-tube wiring is a direct component of an energy efficiency measure, such as an electrical upgrade for a cooling system, then it would be performed as health & safety. Grantees have the opportunity to define electrical measures as incidental repair in their health and safety plan, effectively removing them from the H&S budget category. If it is not defined as incidental repair then it must be performed as health and safety. If it is defined as incidental repair then it must be charged to incidental repair and cost justified with the package of measures consistently throughout the service territory.

Which Is It? #5

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES



Water damage leading to failure of concrete roof/ceiling.

Photos courtesy of the US Department of Energy

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- Water damage is leading to failure of a concrete roof and ceiling.

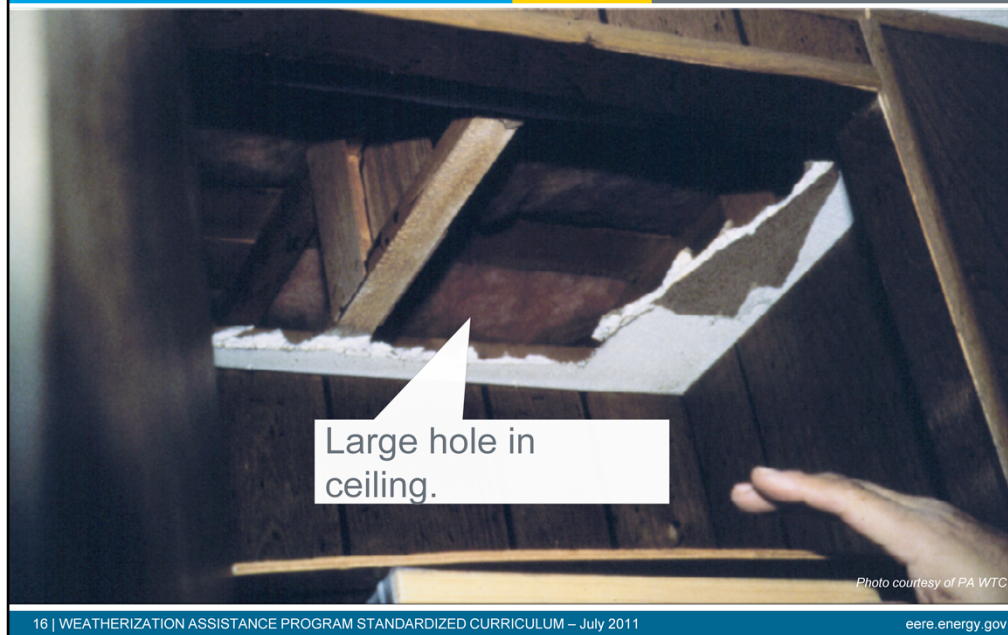
Q: Which is it?

A: This would fall under the health and safety category. But most likely, weatherization work would be deferred due to the extent of the structural and water problems.

Which Is It? #6

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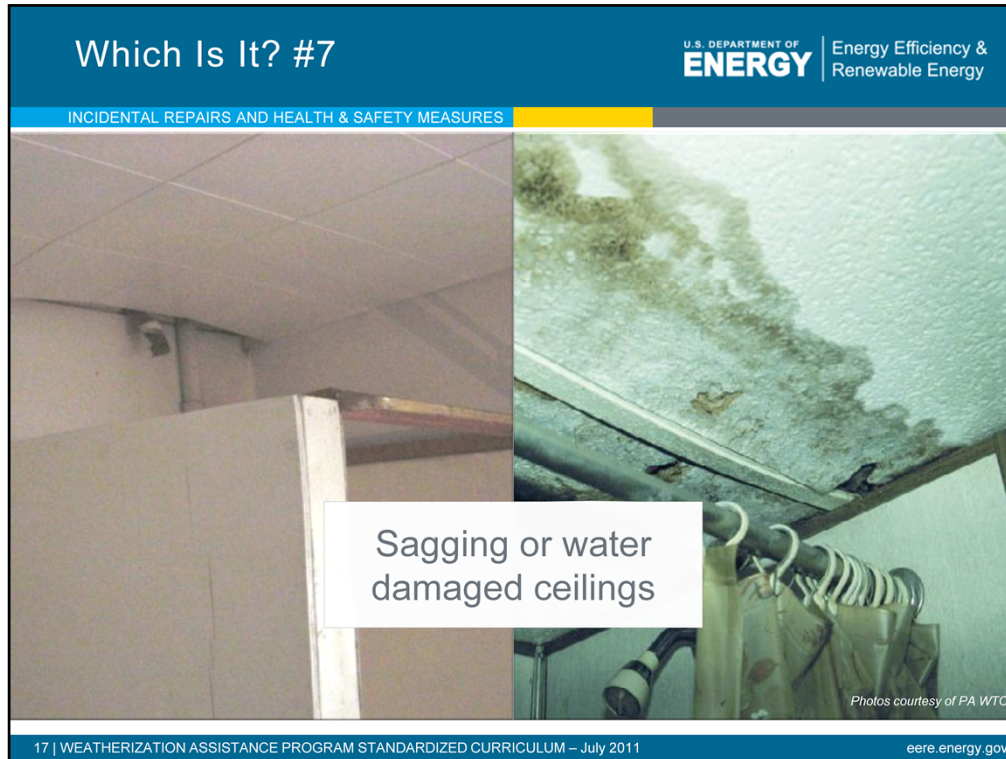
INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES



- There is a large hole in the ceiling.

Q: Which is it?

A: Neither. It is an infiltration measure – This repair is part of air leakage reduction, which is an energy saving measure.



- There are sagging or water-damaged ceilings.

Q. Which is it?

A. Incidental repair or health and safety – Repair, replace, or reinforce the ceiling to support the weight of insulation as an incidental repair. Repair of the moisture damage could also be health and safety depending on the justification in the client file. This is a gray area that can be decided in the field but must be justified in the client file. Repairing the roof leak and/or providing mechanical bathroom ventilation is a health and safety measure – in other words correcting the “moisture creating condition”. Grantees have the opportunity to define correcting moisture creating conditions as incidental repair in their health and safety plan, effectively removing it from the H&S budget category. If it is defined as incidental repair then it must be charged to incidental repair and cost justified with the package of measures consistently throughout the service territory.

Which Is It? #8

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES



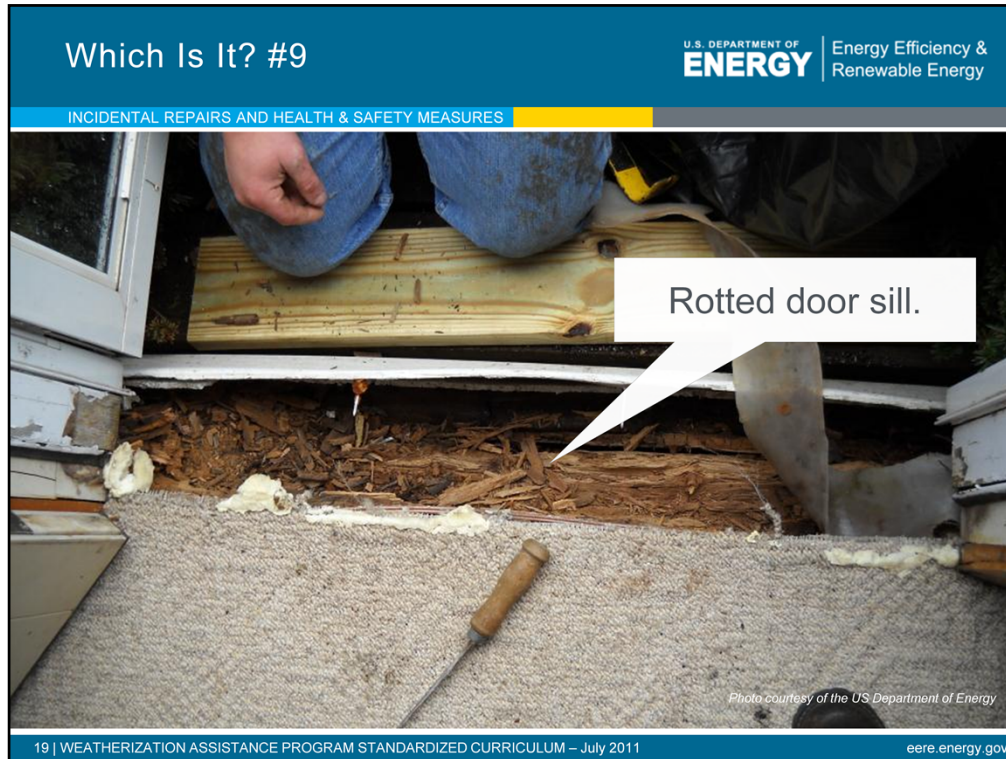
- The roof leaks into the bedroom.

Q: Which is it?

A. In the bedroom, it could be billed as health and safety.

Click to reveal the porch.

A: But actually it's neither! The leak is located on a porch that is outside the scope of weatherization.



A door sill is rotted and prevents weatherstripping.

Q. Which is it?

A. *Incidental repair – a rotted sill is a direct component of air sealing the door with weatherstripping and door sweeps. However, this is not a justification for replacing the door.*

Summary

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INCIDENTAL REPAIRS AND HEALTH & SAFETY MEASURES

- Incidental repairs ensure the performance or longevity of measures and are included in SIR.
- Health and safety repairs must be energy-related, but aren't included in SIR.
- Determination should first be made with reference to the grantee plan but also relies largely on your professional judgment.
- Situations vary case-by-case, but consistency is critical.

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- Incidental repairs ensure the performance or longevity of measures and are included in SIR.
- Health and safety repairs must be energy-related, but aren't included in SIR.
- Determination should first be made with reference to the grantee plan but also relies largely on your professional judgment.
- Situations vary by case, but consistency is critical.
 - Health and safety and incidental repairs are sometimes gray areas. The decision often comes down to a judgment call by the auditor. Auditors are empowered to make these kinds of decisions as long as they first follow the grantee plan and when a judgment must be made, provide a strong justification in the client file with consistent logic from case to case.

Purpose of Monitoring and Inspecting

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Gain an understanding of the purpose and importance of monitoring and inspecting weatherized units as part of the Weatherization Assistance Program.
- Learn about the U.S. Department of Energy's monitoring requirements.
- Learn about the different types of monitoring.
- Understand the different levels of technical proficiency that a monitor/inspector gains through training and experience.

Key Terminology

American Recovery and Reinvestment Act (ARRA)

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

Appendix A

ASHRAE 62.1

ASHRAE 62.2

Building Performance Institute (BPI)

Building tightness limits

Call-back

Carbon Monoxide (CO)

Cubic Feet per Minute (CFM)

Energy Audit using the Queens Information Package (EA-QUIP)

Grantee

Health and Safety (H&S)

Indoor Air Quality (IAQ)

Infrared thermography

Inspecting

Kilowatt hours (kWh)

Manufactured Home Energy Audit (MHEA)

Monitoring

National Energy Audit Tool (NEAT)

National Fire Protection Association (NFPA)

Parts per million (ppm)

Project officer

Priority list

Subgrantee

Technical monitoring

Technical Monitoring Checklists

U.S. Department of Energy (DOE)

Weatherization Program Notice (WPN)

Zonal pressure diagnostics (ZPD)

Supplemental Materials

Handouts & Resources

U.S. Department of Energy. Weatherization Assistance Program. *WPN 01-6 Updated Weatherization Assistance Program Monitoring Policy*. January 3, 2001. www.waptac.org.

U.S. Department of Energy. Weatherization Assistance Program. *WPN 02-5 Health and Safety Guidance*. July 12, 2002. www.waptac.org

U.S. Department of Energy. Weatherization Assistance Program. WPN 10-9 Amendment to Weatherization Program Notice 09-1B to Clarify Monitoring Requirements (Section 4.0) of the Grant Guidance to Administer the American Recovery and Reinvestment Act of 2009 Funding. January 15, 2010. www.waptac.org

U.S. Department of Energy. Weatherization Assistance Program. *WPN 10-1 Program Year 2010 Weatherization Grant Guidance*. December 18, 2009. www.waptac.org

Code of Federal Regulations, Title 10 – Energy, Part 440 – Weatherization Assistance for Low-Income Persons (10 CFR 440)

Appendix A to 10 CFR 440 – Standards for Weatherization Materials

Weatherization Assistance Program Monitoring Plan

Technical Monitoring Tools for the Weatherization Assistance Program, including the following Technical Monitoring Checklists:

- Simplified
- Standard
- Comprehensive

Purpose of Monitoring & Inspecting Pre-Training Quiz and Key

Class Overview

- Begin the training session by asking if anyone is a monitor or inspector or training to become one.
- Give the 10-question multiple choice quiz about the purpose of monitoring. Have attendees complete the quiz before you begin the PowerPoint presentation.
- Start the PowerPoint presentation by emphasizing the learning objectives of this training. For each section of the presentation (technical performance, accountability, and consistency):
 - Read the definition.
 - Solicit initial thoughts about each section from the group and write them on the board.
 - Show the slides for each sub-section, noting the examples listed on the slides.
- Discuss the Technical Monitoring Checklists. Use the Technical Monitoring Tools handout to review the levels from beginner to expert.
- Review the quiz from the beginning of the session to show trainees how much they learned.

Purpose of Monitoring and Inspecting

Technical Monitor/Inspector

Key Terminology

American Recovery and Reinvestment Act (ARRA)

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

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Technical Monitoring Checklists

U.S. Department of Energy (DOE)

Weatherization Program Notice (WPN)

Zonal pressure diagnostics (ZPD)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will:

- Gain an understanding of the purpose and importance of monitoring and inspecting weatherized units as part of the Weatherization Assistance Program.
- Learn about the U.S. Department of Energy's monitoring requirements.
- Learn about the different types of monitoring.
- Learn the key difference between monitoring and inspecting.

Regulatory Monitoring Requirements (Slide #3)

Federal regulations require **monitoring** of federally funded weatherization projects. According to 10 CFR, Part 440.23 (a):

- The **U.S. Department of Energy (DOE)** “shall monitor and evaluate [**grantees**]...through on-site inspections, or through other means.”
 - Other means can include desk monitoring, phone conversations, file reviews, on-site visits to grantee and **subgrantees**, and attending trainings or other public events.
- “The Secretary of Energy, DOE Inspector General, [and others] shall have access to any books, documents, papers, information, and records of any weatherization project...for the purpose of audit and examination.”

According to **Weatherization Program Notice (WPN) 10-1**, “Program Year 2010 Weatherization Grant Guidance,” the grantee must conduct comprehensive monitoring of each subgrantee at least once a year. Failure to comply with this requirement is sufficient cause to require special conditions to the grant under 10 CFR 600.212.

Monitoring Requirements Program Guidance (Slide #4)

- Grantees are monitored by DOE **project officers** to ensure compliance with current, approved annual plans.
- Project Management Center (PMC) project officers periodically accompany grantees to observe their monitoring and oversight of subgrantees. There are two DOE PMCs: the PMC in Pittsburgh, PA/Morgantown, WV is part of the National Energy Technology Laboratory, and the PMC in Golden, CO is part of the National Renewable Energy Laboratory.
- There are three phases of monitoring a grantee:
 - Pre-monitoring tasks – Notifying the grantee in writing, scheduling, etc.
 - On-site monitoring tasks – Following the checklists in the Technical Monitoring Tools for the Weatherization Assistance Program (hereafter Technical Monitoring Tool).
 - Post-monitoring tasks – Providing a written report to the grantee and following up on action items.
- The Weatherization Assistance Program Monitoring Plan specifies timelines for pre-visit notification and post-visit report.

Monitoring/Inspecting Flowchart (Slide #5)

- Federal staff monitor the grantee.
- Grantee staff monitor the subgrantee.
- Subgrantee inspects the work of the crews or contractors.

Monitoring Levels (Slide #6)

- DOE project officers are tasked with monitoring 5% of the grantee's total completed, monitored units. For example, if a grantee (state) weatherizes 100,000 units, the grantee is tasked with monitoring 5% of the subgrantees' total completed units, or 5,000 units. DOE monitors then visit a total of 250 completed units, 5% of the units monitored by the grantee.
 - Under ***American Recovery and Reinvestment Act (ARRA)***, DOE monitors must visit 5% of the total completed units. In the example above, the DOE monitors and contracted quality assessment staff need to monitor 5,000 units weatherized with ARRA funding.
- Subgrantee (local agency) inspectors inspect all completed units.
- Grantees must conduct an annual monitoring visit of each subgrantee.¹
- Before a unit can be considered weatherized, a final inspector **MUST** inspect the dwelling and sign off that the work is complete.

Purpose of Monitoring (Slide #7)

Monitoring ensures technical performance, accountability, and consistency.

Technical Performance (Slide #8)

Monitoring technical performance means ensuring that:

- Testing and work performed on dwelling units is accurate, high quality, and durable.
- Field staff are properly trained and the grantee provides appropriate training opportunities to maintain the staff's technical proficiency.
- Appropriate measures were installed according to State policy and procedure manuals and weatherization best practices.
- Appropriate tests were properly conducted on the dwelling before, during, and after weatherization.

Accountability (Slide #9)

Monitoring accountability means ensuring that:

- Grantees are operating their Weatherization Assistance Program (WAP) according to program regulations (10 CFR, Part 440) and guidelines (yearly Weatherization Program Notices).
- Grantees and subgrantees are spending program funds for their intended purposes and within proper limits, attaining production goals, and performing due diligence to ensure quality control
 - Measures that were billed were in fact installed.
 - Measures installed meet the savings-to-investment ratio (SIR) requirements of the WAP.
 - The average cost per unit complies with program guidance.

¹ WPN 01-6, "Updated Weatherization Assistance Program Monitoring Policy," January 3, 2001.

Consistency (Slide #10)

Monitoring consistency means ensuring that:

- A grantee is operating its WAP in a uniform manner so that all of its subgrantees maintain a similar quality of auditing, **inspecting**, and installing materials.
 - No measures are favored over other measures in a grantee or subgrantee's service territory, unless based on superior SIR.
 - Contractors follow the audit recommendations or the **priority list** measures.
 - Field staff is properly trained to perform all necessary aspects of their jobs.

Types of Monitoring & Inspecting (Slide #11)

There are three types of monitoring:

- Program monitoring.
- Fiscal monitoring.
- Technical (field) monitoring.

Technical monitoring and unit inspections are done in the field; program and fiscal monitoring are conducted in the office.

The Need for Technical Monitoring #1 (Slide #12)

Regulatory and policy monitoring do not assess how well a State or local agency achieves its core mission, which is to:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons.
- Reduce clients' total residential energy costs.
- Improve client **health and safety (H&S)**.
- Achieve a stated goal for completed weatherized units based on the State plan.

Technical monitoring helps to ensure the program is being properly implemented in a weatherized unit from the auditor's first visit to the inspector's final visit.

Technical monitoring offers a gauge to identify:

- Program statistics such as units weatherized and energy actually saved compared to what is outlined in the annual plan.
- Areas where there are deficiencies and training and technical assistance is warranted.
- Areas of success worthy of replication elsewhere.

The Need for Technical Monitoring #2 (Slide #13)

Photo: A weatherization technician installs a bathroom fan that will be vented through the attic and the roof to the outside of the dwelling.

- Technical monitoring includes verifying that work was done right.
- Sometimes a monitor needs to get his/her head into the nitty gritty of a house to ensure work is high quality. In this case, a final inspector or monitor should go into the attic to confirm that the fan was vented through the roof. It might involve some climbing in the rafters!

What Is Technical Monitoring? (Slide #14)

Technical monitoring assesses how the delivery of the program functions, including:

- Energy audit and/or priority list procedures.
 - Diagnostic testing.
 - Measure selection.
- H&S protocols.
- Installation standards.
- Client education.
- Quality control efforts.
- Evaluation/feedback mechanisms.

Technical monitoring confirms whether:

- Appropriate measures are being installed, based on SIR from an approved energy audit and/or priority list.
- Materials are properly installed and listed in **Appendix A**, found in 10 CFR, Part 440.
- Service delivery could be improved to:
 - Increase savings.
 - Lower costs.
 - Raise production and reduce **call-backs**.
 - Better ensure client health and safety.

Monitors have the unique opportunity to compare work practices across agencies and States, and offer recommendations for improvement or different methods of implementation.

Questions a monitor should always address during a monitoring visit:

- Did the auditor perform the appropriate tests and recommend the proper measures to be installed?
- Did the auditor identify all H&S issues in the unit? Did the installers practice proper H&S protocols while on-site?
- Did the installers follow installation standards as described in the local field guide? Field guides offer a comprehensive roadmap of weatherization installation practices.
- Did the auditor provide client education while on site?
- Did the inspector provide adequate and appropriate quality control before signing off on the unit?
- Is feedback from clients collected to improve the program?

A Case for Technical Monitoring (Slide #15)

Photo of poor insulation

- Post-weatherization homes should not look like this home.
 - Snow indicates a sloped section where there is insulation.
 - No snow indicates a sloped section where there is no insulation. (The warm roof has melted the snow.)
- This particular home may not have been eligible for weatherization. It was taken by a state monitor driving by who thought it made a good training photo.

Important, but Difficult (Slide #16)

- Technical monitoring is particularly important in light of ARRA funding requirements.
- Effective monitoring requires monitors to master both the programmatic and technical components of the program. Monitor training is essential.
 - The new Technical Monitoring Tool outlines the skills achieved as a monitor progresses from beginner to expert.
 - Technical proficiency is necessary for effective technical monitoring. Unfortunately, constrained grantee budgets force staff with non-technical backgrounds to monitor an increasingly technical program.
- Monitoring is not about sleuthing for infractions and fault finding; it is about assisting the grantee to make the program the best that it can be.
 - On-site monitoring can serve to train grantee staff and identify future training needs. For example, noting that air sealing practices in a grantee's jurisdiction routinely miss attic bypasses could lead to attic bypass and air sealing training.
 - Monitoring allows issues to be identified and addressed before they become problematic. For example, subgrantees are not checking gas appliances for carbon monoxide readings, and corrective training is conducted before a tragic accident occurs.

Inspecting (Slide #17)

- Inspectors perform nearly the same tasks as monitors.
- Inspectors, in essence, are monitoring the work of crews/contractors.
- When inspectors find sub-standard work, they will call back the contractor to bring the work up to local standards and re-inspect before signing off on the job.
- Inspectors are the first to note trends that might indicate training opportunities.

The key difference between inspectors and monitors:

- Inspectors focus on selection and quality of installed measures, and proper billing by field staff.
- Monitors evaluate the entire weatherization process.

Monitoring Initiatives (Slide #18)

There are tools available to help monitors/inspectors chart their skill levels at the job. WAP developed three levels of technical monitoring checklists to assist new and experienced monitors:

- Simplified.
- Standard.
- Comprehensive.

The checklists, which are part of the Technical Monitoring Tool, help monitors gather information to ensure that topic areas are addressed during the monitoring visit. The checklists also help create a structure for conducting the monitoring visit.

Technical Monitoring Checklists (Slide #19)

A new monitor with little technical expertise should move from the “Simplified” checklist to the “Standard” checklist to the “Comprehensive” checklist as soon as possible.

Monitors will progress through the checklists through a combination of field experience and training. Monitors can evaluate their own abilities based on four levels of technical knowledge:

- Beginner.
- Intermediate.
- Advanced.
- Expert.

Using the checklists helps a monitor evaluate his/her skills. A monitor can choose a checklist based on his/her abilities.

Summary (Slide #20)

- Monitoring at all levels is the key to maintaining consistent workmanship and identifying inferior workmanship.
- By reviewing the work performed by new hires, monitors can assess whether existing training is sufficient and plan for future training.
- Monitoring is critical to identifying waste, fraud, and abuse in the program.
- DOE Monitoring Plan determines how many units must be weatherized, and when the reports are due.



TECHNICAL MONITOR/INSPECTOR

Purpose of Monitoring & Inspecting

Learning Objectives

By attending this session, participants will:

- Gain an understanding of the purpose and importance of monitoring and inspecting weatherized units as part of the Weatherization Assistance Program.
- Learn about the U.S. Department of Energy's monitoring requirements.
- Learn about the different types of monitoring.
- Learn the key difference between monitoring and inspecting.

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Regulatory Monitoring Requirements

U.S. DEPARTMENT OF

ENERGY

Energy Efficiency & Renewable Energy

PURPOSE OF MONITORING AND INSPECTING

DOE “*shall monitor and evaluate [Grantees] . . . through on-site inspections, or through other means.*”

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Monitoring Requirements Program Guidance

U.S. DEPARTMENT OF
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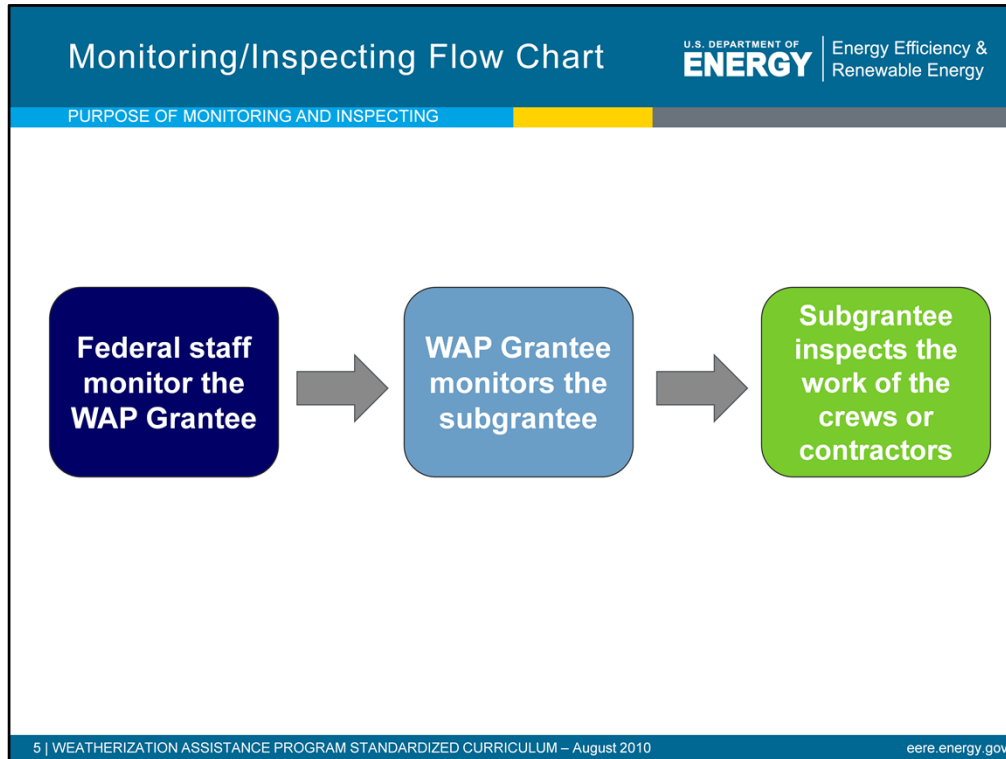
PURPOSE OF MONITORING AND INSPECTING

- Grantees are monitored by DOE PMC Project Officers against the current, approved annual plans.
- PMC Project Officers periodically accompany Grantees to observe their monitoring and oversight of subgrantees.
- Written notice of planned visit by PMC Project Officer provided 30 days in advance.
- Written monitoring report due to Grantee within 45 days after site visit.

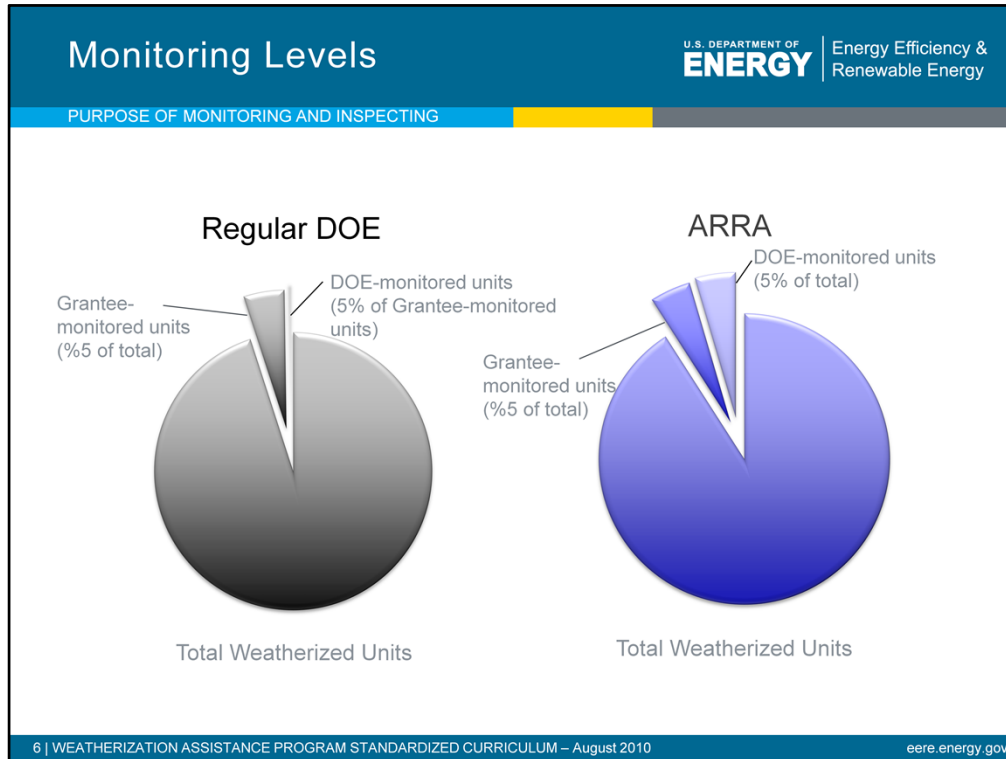
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 - o Pre-monitoring tasks – Notifying the grantee in writing, scheduling, etc.
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- WPN 01-6, "Updated Weatherization Assistance Program Monitoring Policy," January 3, 2001.

Purpose of Monitoring

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PURPOSE OF MONITORING AND INSPECTING



- Technical Performance
- Accountability
- Consistency

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Monitoring ensures technical performance, accountability, and consistency.

Technical Performance

PURPOSE OF MONITORING AND INSPECTING

Monitoring technical performance means ensuring that:

- Testing and work is accurate, high quality, and durable.
- Proper training opportunities.
- Measures installed are appropriate to home and local policy.
- Proper testing - before, during and after the work.



At it's simplest, monitoring tells us if the right measures were installed properly.

Monitoring technical performance means ensuring that:

- Testing and work performed on dwelling units is accurate, high quality, and durable.
- Field staff are properly trained and the grantee provides appropriate training opportunities to maintain the staff's technical proficiency.
- Appropriate measures were installed according to State policy and procedure manuals and weatherization best practices.
- Appropriate tests were properly conducted on the dwelling before, during, and after weatherization.

Accountability

PURPOSE OF MONITORING AND INSPECTING

- Measures billed as being installed were in fact installed in a dwelling.
- Measures installed meet the SIR requirements of the WAP.
- The average cost per unit is maintained per the program guidance.



Monitoring accountability means ensuring that:

- Grantees are operating their Weatherization Assistance Program (WAP) according to program regulations (10 CFR, Part 440) and guidelines (yearly Weatherization Program Notices).
- Grantees and subgrantees are spending program funds for their intended purposes and within proper limits, attaining production goals, and performing due diligence to ensure quality control
 - o Measures that were billed were in fact installed.
 - o Measures installed meet the savings-to-investment ratio (SIR) requirements of the WAP.
 - o The average cost per unit complies with program guidance.

Consistency

PURPOSE OF MONITORING AND INSPECTING

Monitoring consistency means ensuring that:

- Measures are favored only in terms of SIR.
- Contractors are following the audit recommendations or the priority list measures.
- Field staff are properly trained in all areas of weatherization to be able to perform all necessary aspects of their jobs.

Monitoring consistency means ensuring that:

- A grantee is operating its WAP in a uniform manner so that all of its subgrantees maintain a similar quality of auditing, **inspecting**, and installing materials.
 - o No measures are favored over other measures in a grantee or subgrantee's service territory, unless based on superior SIR.
 - o Contractors follow the audit recommendations or the **priority list** measures.
 - o Field staff is properly trained to perform all necessary aspects of their jobs.

Monitoring:

- Program monitoring
- Fiscal monitoring
- Technical (field) monitoring/inspecting



There are three types of monitoring:

- Program monitoring.
- Fiscal monitoring.
- Technical (field) monitoring.

Technical monitoring and unit inspections are done in the field; program and fiscal monitoring are conducted in the office.

The Need for Technical Monitoring #1

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

PURPOSE OF MONITORING AND INSPECTING

Regulatory and policy monitoring largely do not assess how well a State or local agency achieves its core mission, which is to:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons.
- Reduce client's total residential expenditures.
- Improve client health and safety.
- Achieve a stated goal for DOE completed weatherized units.

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Regulatory and policy monitoring do not assess how well a State or local agency achieves its core mission, which is to:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons.
- Reduce clients' total residential energy costs.
- Improve client **health and safety (H&S)**.
- Achieve a stated goal for completed weatherized units based on the State plan.

Technical monitoring helps to ensure the program is being properly implemented in a weatherized unit from the auditor's first visit to the inspector's final visit.

Technical monitoring offers a gauge to identify:

- Program statistics such as units weatherized and energy actually saved compared to what is outlined in the annual plan.
- Areas where there are deficiencies and training and technical assistance is warranted.
- Areas of success worthy of replication elsewhere.

The Need for Technical Monitoring #2

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

PURPOSE OF MONITORING AND INSPECTING

- Was it done right?
- To find out, monitors/inspectors sometimes need to crawl into crawl spaces and climb in the rafters!



Photo Source: US Department of Energy

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Photo: A weatherization technician installs a bathroom fan that will be vented through the attic and the roof to the outside of the dwelling.

- Technical monitoring includes verifying that work was done right.
- Sometimes a monitor needs to get his/her head into the nitty gritty of a house to ensure work is high quality. In this case, a final inspector or monitor should go into the attic to confirm that the fan was vented through the roof. It might involve some climbing in the rafters!

What is Technical Monitoring?

PURPOSE OF MONITORING AND INSPECTING

Technical monitoring:

- Assesses the delivery of services through WAP.
- Evaluates the selection and installation of measures.
- Looks for program delivery improvement opportunities.
- Shares best practices throughout service territories being monitored.

Technical monitoring assesses how the delivery of the program functions, including:

- Energy audit and/or priority list procedures.
 - o Diagnostic testing.
 - o Measure selection.
- H&S protocols.
- Installation standards.
- Client education.
- Quality control efforts.
- Evaluation/feedback mechanisms.

Technical monitoring confirms whether:

- Appropriate measures are being installed, based on SIR from an approved energy audit and/or priority list.
- Materials are properly installed and listed in **Appendix A**, found in 10 CFR, Part 440.
- Service delivery could be improved to:
 - o Increase savings.
 - o Lower costs.
 - o Raise production and reduce **call-backs**.
 - o Better ensure client health and safety.

Monitors have the unique opportunity to compare work practices across agencies and States, and offer recommendations for improvement or different methods of implementation.

Questions a monitor should always address during a monitoring visit:

- Did the auditor perform the appropriate tests and recommend the proper measures to be installed?
- Did the auditor identify all H&S issues in the unit? Did the installers practice proper H&S protocols while on-site?
- Did the installers follow installation standards as described in the local field guide? Field guides offer a comprehensive roadmap of weatherization installation practices.
- Did the auditor provide client education while on site?
- Did the inspector provide adequate and appropriate quality control before signing off on the unit?
- Is feedback from clients collected to improve the program?

A Case for Technical Monitoring

PURPOSE OF MONITORING AND INSPECTING

- Post-weatherization homes should not look like this home.
- Snow indicates slope section where there is insulation.
- No snow indicates slope section where there is no insulation (warm roof has melted the snow).



Photo of poor insulation

- Post-weatherization homes should not look like this home.
 - Snow indicates a sloped section where there is insulation.
 - No snow indicates a sloped section where there is no insulation. (The warm roof has melted the snow.)
- This particular home may not have been eligible for weatherization. It was taken by a state monitor driving by who thought it made a good training photo.

Important, But Difficult

PURPOSE OF MONITORING AND INSPECTING

- Technical monitoring is particularly important in light of ARRA funding requirements.
- Programmatic and technical expertise is required!
- No monitoring with a “Gotcha!” attitude: it is about assisting the grantee to make the program the best that it can be.
- On-site monitoring can serve training function.
- Catch problems before they grow!

- Technical monitoring is particularly important in light of ARRA funding requirements.
- Effective monitoring requires monitors to master both the programmatic and technical components of the program. Monitor training is essential.
 - The new Technical Monitoring Tool outlines the skills achieved as a monitor progresses from beginner to expert.
 - Technical proficiency is necessary for effective technical monitoring. Unfortunately, constrained grantee budgets force staff with non-technical backgrounds to monitor an increasingly technical program.
- Monitoring is not about sleuthing for infractions and fault finding; it is about assisting the grantee to make the program the best that it can be.
 - On-site monitoring can serve to train grantee staff and identify future training needs. For example, noting that air sealing practices in a grantee’s jurisdiction routinely miss attic bypasses could lead to attic bypass and air sealing training.
 - Monitoring allows issues to be identified and addressed before they become problematic. For example, subgrantees are not checking gas appliances for carbon monoxide readings, and corrective training is conducted before a tragic accident occurs.

Inspecting

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PURPOSE OF MONITORING AND INSPECTING



Inspectors:

- Monitor the work of crews/contractors.
- Initiate call-backs to repair sub-standard work.
- Are first to note trends/training opportunities.

The key difference between inspectors and monitors:

- Inspectors focus on selection and quality of installed measures, and proper billing by field staff.
- Monitors evaluate the entire weatherization process.

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- Inspectors perform nearly the same tasks as monitors.
- Inspectors, in essence, are monitoring the work of crews/contractors.
- When inspectors find sub-standard work, they will call back the contractor to bring the work up to local standards and re-inspect before signing off on the job.
- Inspectors are the first to note trends that might indicate training opportunities.

The key difference between inspectors and monitors:

- Inspectors focus on selection and quality of installed measures, and proper billing by field staff.
- Monitors evaluate the entire weatherization process.

Monitoring Initiatives

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PURPOSE OF MONITORING AND INSPECTING

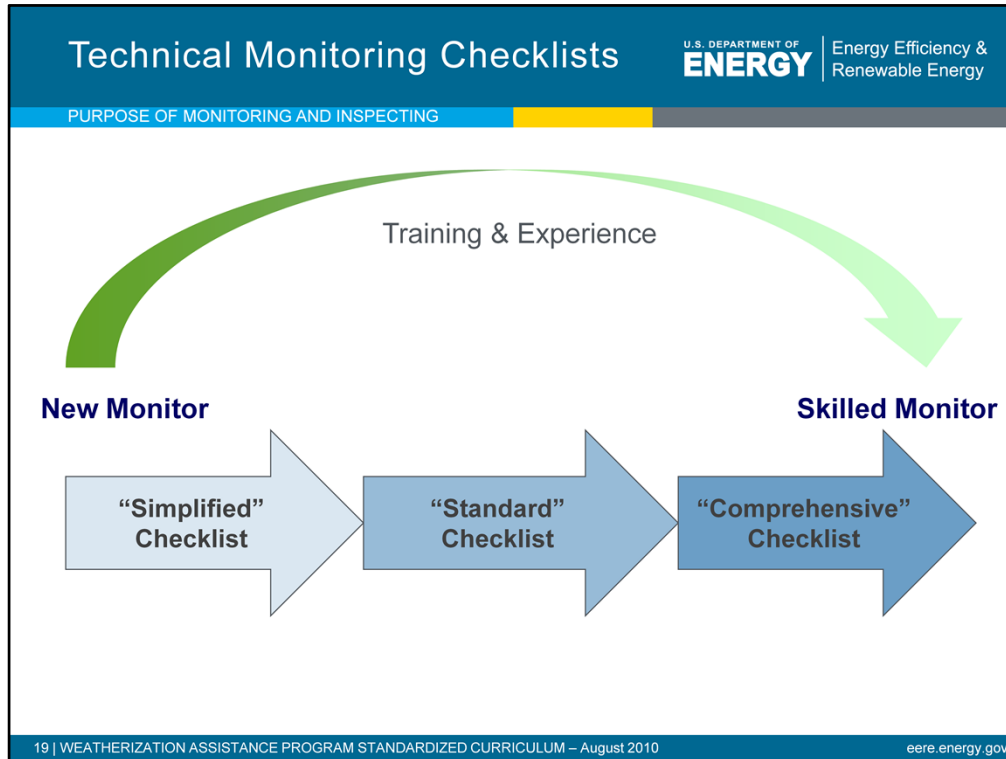
- Three levels of monitoring checklists developed to assist new and existing monitors:
 - Simplified
 - Standard
 - Comprehensive
- Checklists are designed for monitors with varying degrees of technical proficiency.

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There are tools available to help monitors/inspectors chart their skill levels at the job. WAP developed three levels of technical monitoring checklists to assist new and experienced monitors:

- Simplified.
- Standard.
- Comprehensive.

The checklists, which are part of the Technical Monitoring Tool, help monitors gather information to ensure that topic areas are addressed during the monitoring visit. The checklists also help create a structure for conducting the monitoring visit.



A new monitor with little technical expertise should move from the “Simplified” checklist to the “Standard” checklist to the “Comprehensive” checklist as soon as possible.

Monitors will progress through the checklists through a combination of field experience and training.

Monitors can evaluate their own abilities based on four levels of technical knowledge:

- Beginner.
- Intermediate.
- Advanced.
- Expert.

Using the checklists helps a monitor evaluate his/her skills. A monitor can choose a checklist based on his/her abilities.

Summary

PURPOSE OF MONITORING AND INSPECTING

- Monitoring at all levels is the key to maintaining consistent workmanship and identifying inferior workmanship.
- By reviewing the work performed by new hires, monitors can assess whether existing training is sufficient and plan for future training.
- Monitoring is critical to identifying waste, fraud, and abuse in the program.
- DOE Monitoring Plan determines how many units must be weatherized, and when the reports are due.

- Monitoring at all levels is the key to maintaining consistent workmanship and identifying inferior workmanship.
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Desk Monitoring

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Become aware of applicable DOE regulations.
- Learn about basic fiscal requirements:
 - Procurement.
 - Purchase order to final inspection paper trail.
- Be exposed to the typical file structure.
- Learn to recognize anomalies to know what to flag for site visits.
- Practice completing typical file review forms.

Key Terminology

10 CFR 440

Desk monitoring

10 CFR 600

Lead Safe Weatherization (LSW)

Community Action Agency (CAA)

On-site monitoring

Supplemental Materials

Handouts & Resources

Abridged, highlighted 10 CFR 440 handout

Sample client file(s)

Blank file review forms

Class Overview

Field staff members can grow restless in a lecture setting. Make the class as interactive as possible by encouraging trainees to share relevant “war stories” during the presentation. Expand on any that offer an opportunity to illustrate how file review discoveries led to improvements (e.g., more training, better recordkeeping).

While projecting the slide entitled “10 CFR 440,” distribute the abridged, highlighted 10 CFR 440 handout.

Exercise – Sample File Review

Distribute the sample client files and the file review form. Have students review files and fill in the forms. Do everyone’s answers match? What is missing? Lead a discussion about what works and what doesn’t in those client files.

Desk Monitoring

Technical Monitor/Inspector

Key Terminology

10 CFR 440

Desk monitoring

10 CFR 600

Lead Safe Weatherization

Community Action Agency (CAA)

On-site monitoring

Section Transition

Learning Objectives (Slide #2)

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- Practice completing typical file review forms.

Weatherization's Mission (Slide #3)

- Monitoring by the Weatherization Assistance Program (WAP) is mandated by 10 CFR 440.
- Monitoring—desk or on-site—need not be adversarial.
 - **Desk monitoring** typically consists of a file review of fiscal and programmatic requirements. The review has two goals: (1) verifying that procurement rules were followed; and (2) checking that the file is self-explanatory—that is, any competent reviewer can tell what was done to the home and why.
 - **On-site monitoring** also includes a client home visit to verify that (1) the billed materials were properly installed, (2) the chosen measures were the most cost-effective possible for the particular home, and (3) the client and home were treated with respect.
 - Use monitoring as a tool for determining training needs.
- Always remember WAP's goal of serving the client while fulfilling the Congressional mandate to save energy.

Legislation: 10 CFR 440 (Slide #4)

- The legislation authorizing WAP is known as 10 CFR 440.
- DOE rules are intended to guarantee that the taxpayers' money is well spent.
- The complete document is available on WAPTAC.

The legislation implements a weatherization assistance program to:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons or to provide such persons renewable energy systems or technologies.
- Reduce their total residential expenditures.
- Improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden.

Fiscal Requirements (Slide #5)

- **10 CFR 600** covers procurement (§600.144 Procurement Procedures).
- Weatherization files must show:
 - Method of selecting a contractor.
 - Bid process for any item not on the regular bid list.
 - Three bids for individual items such as heating systems.
 - Justification for any sole source item.
- As part of the file review process, check that:
 - The price charged for any material or labor matches the bid.
 - Measures listed on the final inspection report match the contractor invoice and/or crew job report.
 - Measures listed on the client sign-off match the contractor invoice and/or crew job report.

File Organization (Slide #6)

- **Community Action Agency (CAA)** files will range from highly organized—count in six sheets and you will find a specific form every time—to totally chaotic.
 - Multiple copies of the same form.
 - Notes on scrap paper.
 - Blank or incomplete forms.
 - Missing forms.
 - Unreadable scrawls for signatures.
 - Undated and/or unsigned forms.
- Read through the whole file to familiarize yourself with the CAA's "style" before making any entries on the review form. Knowing what the CAA requires before you start can avoid a lot of erasing!

Minimum Contents for Client Files (Slide #7)

Most client files will contain a great deal of duplicative material. Look for the essentials:

- Verification of client eligibility.
- Client permission form.
- Documentation of building age, which may then require:
 - Lead paint notification form (if building was constructed before 1978).
 - **Lead-safe weatherization** documentation (if building was constructed before 1978).
 - State historic preservation documentation (if building is more than 45 years old).
- Mold/moisture form.
- Audit report.
- Work order.
- Invoices and/or materials list.
- Final inspection report, including reworks.
- Client satisfaction and sign-off form.

File Review Essentials (Slide #8)

- All forms required by DOE are present.
- All forms are legibly signed and dated.
- Any explanatory notes and change orders are signed and dated.
- Unusual activities are justified:
 - Door or window replacement – These measures don't typically result in SIR of one or greater at today's prices. File should contain a valid SIR, or justification for replacement for reasons other than energy savings, and be charged accordingly.
 - Skipped priorities – If attic insulation is number two on the audit report, but was skipped while items with lower SIR were installed, the reason should be evident in the file.
 - Large expense charged to incidental purchases.
 - Blower door or other test results not recorded – Why not?

File Review Procedure (Slide #9)

- Acquaint yourself with the file review form. What information is being requested?
- Read through the file and note:
 - Is it organized?
 - Are all the necessary forms present?
 - Are all the forms signed and dated?
- Put something in every blank. (If it's filled in, you know you've evaluated it!) Empty spaces indicate further searching is needed. If a field is not applicable, write N/A. Filling in the blanks in order is usually most efficient.
- Use the notes sections to alert others to possible deficiencies in activities in the client's home. The notes also provide useful information for your summary report.
- When you're done, sign and date the file review form.
- The file should accurately reflect what was done to the home.

Remember: A weatherization file should be able to stand on its own; that is, any reasonably competent person should be able to determine from the file what was done to the dwelling and why.

What's Weird? (Slide #10)

- In time, you will know immediately what should and shouldn't be in a file.
- Familiarize yourself with the State Plan, Weatherization Manual, priority list (if used), and audit system.
- Note anything you see that doesn't seem to fit.
- The following items are worth noting:
 - Replacement windows—any number.
 - Replacement doors.
 - Expensive incidental repairs.
 - Blower door numbers that are similar among files.
 - Repeated instances of incomplete testing.
 - A pattern of not doing certain measures – Note if wall or attic insulation is rare, ground covers are never installed, few refrigerators replaced, etc. This may be valid, but it may also be a sign that technical support (training and other resources) is needed.
 - Repeated instances of missing or incomplete forms.

Visit Report (Slide #11)

- Organize your report by strengths and weaknesses.
- Suggest any training you feel is appropriate. With any criticism, offer a remedy.
- Be positive: Always keep the goal of better serving the client through program improvement foremost in your mind.

Summary (Slide #12)

- Monitoring is a necessary part of the weatherization process.
- Desk monitoring can provide important information to indicate that training is needed or to target site visit investigations.
- Use the notes sections to alert on-site monitors to possible issues in the client's home.
- Be alert for anomalies.
- Include positive reinforcement in your report.



TECHNICAL MONITOR/INSPECTOR

Desk Monitoring

By attending this session, participants will:

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 - Procurement.
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Practice completing typical file review forms.

Weatherization's Mission

U.S. DEPARTMENT OF

ENERGY

Energy Efficiency & Renewable Energy

DESK MONITORING

Mission of the Weatherization Assistance Program

To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their health and safety.

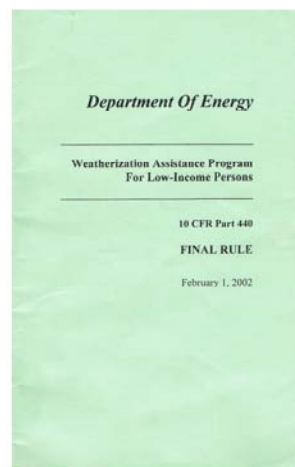
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 - **On-site monitoring** also includes a client home visit to verify that (1) the billed materials were properly installed, (2) the chosen measures were the most cost-effective possible for the particular home, and (3) the client and home were treated with respect.
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Always remember WAP's goal of serving the client while fulfilling the Congressional mandate to save energy.

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- Reduce their total residential expenditures.
- Improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden.

Fiscal Requirements

U.S. DEPARTMENT OF
ENERGY
Energy Efficiency & Renewable Energy

DESK MONITORING

10 CFR 600 covers procurement.

Weatherization files must show:

- Method of selecting a contractor.
- Bid process.
- Three bids.
- Justification for sole sourcing.

During file review check that:

- Charges match bids.
- Measures on final inspection match invoices.
- Measures listed on client sign-off are consistent.

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- **10 CFR 600** covers procurement (§600.144 Procurement Procedures).
- Weatherization files must show:
 - o Method of selecting a contractor.
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 - o Three bids for individual items such as heating systems.
 - o Justification for any sole source item.
- As part of the file review process, check that:
 - o The price charged for any material or labor matches the bid.
 - o Measures listed on the final inspection report match the contractor invoice and/or crew job report.
 - o Measures listed on the client sign-off match the contractor invoice and/or crew job report.

File Organization

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

DESK MONITORING



From organized to chaotic!

- Community Action Agency (CAA) files will range from highly organized to totally chaotic.
- Read through the whole file to familiarize yourself with the CAA's "style" before making any entries on the review form.

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- **Community Action Agency (CAA)** files will range from highly organized—count in six sheets and you will find a specific form every time—to totally chaotic.
 - o Multiple copies of the same form.
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 - o Missing forms.
 - o Unreadable scrawls for signatures.
 - o Undated and/or unsigned forms.

Read through the whole file to familiarize yourself with the CAA's "style" before making any entries on the review form. Knowing what the CAA requires before you start can avoid a lot of erasing!

Minimum Contents for Client Files		U.S. DEPARTMENT OF ENERGY	Energy Efficiency & Renewable Energy
DESK MONITORING			
✓	Verification of client eligibility		
✓	Client permission form		
✓	Building age documentation which keys:		
✓	Lead paint notification form (constructed prior to 1978)		
✓	Lead Safe Weatherization documentation (constructed prior to 1978)		
✓	State Historic Preservation documentation (building more than 45 years old)		
✓	Mold/moisture form		
✓	Audit report		
✓	Work order aka Building Weatherization Report (BWR) or Building Job Order Sheet (BJOS)		
✓	Contractor invoice or crew materials list and hours worked		
✓	Final inspection report including any rework documentation		
✓	Client satisfaction and sign-off form		

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Most client files will contain a great deal of duplicative material. Look for the essentials:

- Verification of client eligibility.
- Client permission form.
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- Mold/moisture form.
- Audit report.
- Work order.
- Invoices and/or materials list.
- Final inspection report, including reworks.
- Client satisfaction and sign-off form.

File Review Essentials

DESK MONITORING

- DOE required forms present.
- All forms legibly signed and dated.
- Any explanatory notes, change orders, other, signed & dated.
- **Unusual activities are justified:**
 - Door or window replacement.
 - Skipped priorities.
 - Large expense charged to incidental purchases.
 - Blower door or other test results not recorded.

- All forms required by DOE are present.
- All forms are legibly signed and dated.
- Any explanatory notes and change orders are signed and dated.
- Unusual activities are justified:
 - o Door or window replacement – These measures don't typically result in SIR of one or greater at today's prices. File should contain a valid SIR, or justification for replacement for reasons other than energy savings, and be charged accordingly.
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File Review Procedure

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

DESK MONITORING

- Acquaint yourself with your file review form.
- Read through the file and note:
 - Organization.
 - Presence of necessary forms.
 - Signed and dated.
- Ask CAA representative to clarify any questions.
- Don't leave blanks. If something doesn't apply, enter "N/A".
- Use the notes sections to record anything unusual to alert the onsite reviewer.
- Complete, sign and date the file review form.

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- Acquaint yourself with the file review form. What information is being requested?
- Read through the file and note:
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- Put something in every blank. (If it's filled in, you know you've evaluated it!) Empty spaces indicate further searching is needed. If a field is not applicable, write N/A. Filling in the blanks in order is usually most efficient.
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Remember: A weatherization file should be able to stand on its own; that is, any reasonably competent person should be able to determine from the file what was done to the dwelling and why.

What's Weird?

DESK MONITORING

- Replacement windows – any number.
 - Replacement doors (to a lesser degree).
- Expensive incidental repairs.
- Blower door numbers that are similar, file to file.
- Repeated instances of incomplete testing.
- A pattern of not doing certain measures (wall or attic insulation rare, ground covers never installed, few refrigerators replaced).
- Repeated instances of missing or incomplete forms.

- In time, you will know immediately what should and shouldn't be in a file.
- Familiarize yourself with the State Plan, Weatherization Manual, priority list (if used), and audit system.
- Note anything you see that doesn't seem to fit.
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 - Repeated instances of missing or incomplete forms.

Within the written report:

- Organize report by strengths and weaknesses.
- Suggest appropriate training.

Be positive: Always keep the goal of better serving the client through program improvement foremost in your mind.

- Organize your report by strengths and weaknesses.
- Suggest any training you feel is appropriate. With any criticism, offer a remedy.
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Summary

DESK MONITORING

- Monitoring is a necessary part of the weatherization process.
- Desk monitoring can provide important information to indicate that training is needed or to target site visit investigations.
- Use the notes sections to alert on-site monitors to possible issues in the client's home.
- Be alert for anomalies.
- Include positive reinforcement in your report.

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Site Monitoring: Inspector's Toolbox

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Be familiarized with typical inspecting tools.
- Gain an understanding of basic test procedures.
- Be exposed to more advanced test procedures.

Key Terminology

Blower door

Boroscope

British Thermal Unit (BTU)

Carbon Monoxide (CO)

Combustion Appliance Zone (CAZ)

Depressurization Tightness Limit (DTL)

Infrared (IR) camera

Knob and tube wiring

Manometer

Net Free Area (NFA)

Pascal (Pa)

Pressure pan

Psychrometer

Relative Humidity (RH)

Supplemental Materials

Handouts & Resources

Whole House Weatherization Equipment List

Classroom Props & Activities

- Blower door with manometer
- Exhaust Fan Flow Meter
- Telescoping ladder
- Boroscope
- Infrared camera
- Moisture meter
- Sling psychrometer or electronic RH meter
- Smoke generator (Wizard Stick™)

Class Overview

Demonstrate use of as many test instruments as possible. Pass instruments around so students can handle and use them. If feasible, set up blower door in classroom and get CFM50. Show smoke. Run infrared and blower door together to demonstrate how blower door affects IR pattern. If technical capacity is present, show real-time IR scan of classroom on screen. Offer possible explanations of what is seen with methods to resolve any questionable interpretations.

Site Monitoring: Inspector's Toolbox

Technical Monitor/Inspector

Key Terminology

Blower door	Knob and tube wiring
Boroscope	Manometer
British Thermal Unit (BTU)	Net Free Area (NFA)
Carbon Monoxide (CO)	Pascal (Pa)
Combustion Appliance Zone (CAZ)	Pressure pan
Depressurization Tightness Limit (DTL)	Psychrometer
Infrared (IR) camera	Relative Humidity (RH)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will:

- Become familiar with typical inspecting tools.
- Gain an understanding of basic test procedures.
- Be exposed to more advanced test procedures.

Basic Inspection Tools (Slide #3)

A monitor or inspector needs to be skilled at using the same diagnostic testing equipment as is used by the auditor to evaluate the home initially. The following slides provide an overview of all the tools required to perform a thorough inspection of a weatherized home.

- A blower door (for locating air leakage sites) with a **manometer** (to check the relative leakage in each zone) is absolutely essential for quantifying air leakage.
- Conduct a blower door test to verify air sealing efforts were successful.
- There are several blower door manufacturers. The pictured unit is from the Energy Conservatory. All consist of:
 - Fan and controls.
 - Shroud and frame.
 - Pressure gauges or manometer.

- It is also a good idea to carry an assortment of hand tools. Assorted hand tools (clockwise from lower left):
 - Telescoping ladder – lightweight and convenient; easy to maneuver in tight quarters.
 - Phillips head screwdriver.
 - Cutting pliers.
 - Slotted screwdriver.
 - Adjustable wrench.
 - Razor knife.
 - 25' tape measure.
 - A good flashlight.
 - Digital camera.
 - Pen and paper.
 - A plastic crochet hook (for fishing insulation samples through small openings).

Tool Case (Slide #4)

- An organized case with a place for everything makes your tools easy to find. It also reduces the chance of leaving a tool behind.

Specialized Tools (Slide #5)

Some situations call for a specific tool (clockwise from upper left):

- Pry bars and nail pullers.
- Cordless drill motor with assorted drivers.
- Drill index.
- Nippers with the face ground flat – used to pull nails from cement board siding.
- Hammer.
- Locking pliers.
- Long reach flat blade screwdriver.
- Long reach pliers.
- Reamer – to enlarge the smoke pipe hole when testing heating appliance efficiency.
- Square bit driver – used for mobile home siding.
- Star bit driver – used for mobile home siding.

Vision Enhancers (Slide #6)

Sometimes we can't see everything we need to with the naked eye (clockwise from upper left):

- Digital camera – A digital camera is like an eye on the end of your arm. Any place your hand will fit you can see into.
- **Boroscope** – The boroscope was designed to inspect the inside of diesel engines. The tube can be inserted through a 3/8" hole to view wall and ceiling cavities, etc.
- Testo Video Pro – The Testo Video Pro is a boroscope with a flexible tube for viewing inside cavities. It produces a video picture on the 3.5" screen.
- **Infrared camera** – The infrared camera converts surface temperature patterns into a visible picture. It can't see through anything; it simply reads surface temperatures. Properly used, it can speed the inspection process considerably. It can be a definite asset to an inspector. Its chief drawback is that absent good training and experience, it can be very misleading.

Refer to the "Interpreting Infrared" section of this curriculum for more details.

Combustion Appliance Testing (Slide #7)

Picture on the left, left to right:

- Thermometer.
- Draft gauge.
- Inspection mirror.

Picture on the right, counter-clockwise from lower left:

- Pipe wrenches.
- Long lighter.
- Gas leak detector.
- Inspection mirror.
- Gas leak detection bubbles.
- Smoke pump and smoke test filter paper.
- Combustion analyzer.

Combustion Appliance Test Kit (Slide #8)

Pictured: Combustion test equipment stored in case

Keep one case just for combustion testing. Pictured in this case:

- Smoke pump and filter paper.
- Lighter.
- Combustion analyzer and manual.
- High-temp sealant.
- Appropriate drill bits for test holes.
- Organization makes the job of auditing efficient and enjoyable.

As with all hand tools, it is better to have an assigned slot for each item so it is obvious when something is missing or out of place.

Blower Door (Slide #9)

- The blower door is a calibrated fan connected to a manometer. It has two basic functions: to quickly quantify house leakiness and locate specific leaks.
- Testing is usually done by depressurizing the house to -50 **Pascals (Pa)** with reference to the outdoors.
- Openings in the fan housing connected to the manometer allow it to measure the volume of air being pumped out by the fan during the test. With volume and pressure known, hole size can be determined. Walking around the house with the blower door running at 30 Pa will pinpoint leaks.
- Older units, which are equipped with gauges, required considerable operator expertise to arrive at accurate results. The newer units are equipped with digital manometers, which eliminate most of the interpretation previously needed.

Manometers & Gauges (Slide #10)

- Magnahelic gauges – The triple gauge unit pictured on the left consists of two pressure gauges and a flow gauge. The pressure gauges display the pressure between inside and out created by the fan. The flow gauge shows the amount of air moving through the fan housing.
- The center picture is a digitalized manometer with pressure readings on the left and flow on the right.
- The right picture is a combined fan control, pressure gauge and flow gauge by a different manufacturer.
- All use pressure and flow readings to arrive at a CFM₅₀ number. Dividing that number by 10 gives the approximate total envelope hole size in square inches.

Blower Door with Infrared (Slide #11)

The testing discussed to this point should be done in every home inspected. Tests described from this point forward should only be done when you believe you will learn something valuable by doing them.

- On the left is an infrared picture of kitchen cabinets taken on a cold day. The dark, vertical lines are the framing behind the drywall covering the dropped soffit over the cabinets and the first wall bay to the left of them. (Infrared is typically set to show cold as dark. This pattern indicates the framing is cooler than the drywall.)
- The picture on the right is the same view with the blower door operating. The framing now appears warmer than the drywall. The blower door is pulling cold outside air into the soffit area, rapidly cooling the drywall. The framing—having more mass—is slower to react. From this, we can tell the soffit area is open to the attic above.
- Note: The temperature of the framing didn't change but the color went from black to white. Be very careful when interpreting infrared. It can easily deceive you!

“Feathering” at a Dropped Soffit (Slide #12)

- This is infrared with the blower door running.
- The feathery edged areas extending across the ceiling are caused by cold outside air being pulled in through a crack between the dropped box soffit and the ceiling.

Smoke (Slide #13)

- A smoke test is performed by pressurizing the house to 30 Pa and then walking from room to room, creating smoke. The smoke will stream to any opening connected to the outside.
- The pictured Wizard Stick—actually a child's toy—produces totally non-toxic smoke. While the smoke is not heat neutral, as is the frequently used chemical titanium tetrachloride smoke, it won't harm anyone. Notice how the smoke is moving toward the ceiling opening in the picture in the upper right of the slide.
- It is possible to find attic bypasses from the attic side by depressurizing the house and then creating smoke in the attic. Again, the smoke will stream to any openings connected to the living space.

Pressure Pan (Slide #14)

- A **pressure pan** is a gasketed pan with a pressure tap used in connection with the blower door. One can be constructed from a shallow cake pan with a stick-on foam gasket and a tap purchased from an aquarium supply store. That's how the prototype was constructed.
- To operate a pressure pan, connect the pan tap to the upper manometer tap and leave the lower tap open to the house interior. Placing the pan over any envelope opening with the house depressurized will measure the degree of "connectivity" to the exterior.
- Example: If placing the pan over an interior wall outlet with the house at 50 Pa produces a reading of 25 Pa, the sum of the holes between the wall cavity and the interior equals the sum of the holes between the wall cavity and the exterior. The common way to express this is to say, "The wall cavity is ½ outside."

Inspecting Duct Sealing (Slide #15)

- The most common use of the pressure pan is in duct evaluation. The pictured pressure pan is an Energy Conservatory product. With the house depressurized to -50 Pa, take a reading at each grille and sum the results. Do not seal off any duct openings. A total of over 3 Pa indicates poor duct sealing.
- Obviously, this method will allow a single leak to be read at more than one register, but this is intended.
- Duct leaks to the exterior are extremely costly and relatively easy to treat.

Duct Blaster (Slide #16)

- The pictured Energy Conservatory Duct Blaster is really a miniature blower door.

Conducting a Duct Blaster test:¹

- Connect the Duct Blaster fan to the duct system at the air handler cabinet, or a return grille. Temporarily seal all remaining registers and grills and turn on the Duct Blaster fan to force air through all holes and cracks in the ductwork.
- Increase fan speed until a standard test pressure (typically 25 Pa) is achieved in the duct system. A precise leakage measurement is then made using an airflow and pressure gauge connected to the Duct Blaster system.
- Estimates of efficiency losses from duct leakage can then be made from the leakage measurements.
- A theatrical fog machine can be used along with the Duct Blaster to inject a non-toxic fog into the duct system to visually demonstrate the location and extent of leakage in the ductwork.

¹ The Energy Conservatory, www.energyconservatory.com

Pressure Diagnostics (Slide #17)

- A pressure diagnostics test is accomplished by first establishing a CFM₅₀ for the conditioned space and the pressure across the boundary between the conditioned space and whatever adjacent zone is in question. Changing the size of the opening in the barrier between the conditioned space and zone will establish a new CFM₅₀ and pressure.
- Comparing the two sets of results, either with charts or a computer program, produces two estimates: one of the total hole in the barrier between the zone and the interior, and another of the total hole between the zone and the exterior. It also estimates the CFM₅₀ attributable to the house/zone/exterior path.
- This test is best used when the inspector either needs to quantify the specific amount of opening between two spaces—say a garage and the living space, or an attic and the rooms below—or the degree of connectedness between, say, a cellar and attic. The test can also be used to determine the square inches of net free attic ventilation that is actually present.
- The test is useful for evaluating air sealing attempts by determining the degree of leakiness remaining between the attic and living space.
- A blower door, a manometer, and the ability to change the opening in the barrier are necessary. The colored hoses are helpful:
 - Run green to the exterior.
 - Run blue to the attic.
 - Run red to the CAZ or garage.
 - Run the clear hose to anything else.
- With 50-foot hoses running to various zones between his/her fingers, the auditor can operate the blower door, moving the tap from zone to zone as needed to get the necessary pressures.
- A blower door equipped with a cruise control frees the auditor to move around the house while testing.

Measuring Exhaust Fan CFM (Slide #18)

- The Exhaust Fan Flow Meter (the one shown here is manufactured by the Energy Conservatory) is really a calibrated pressure pan. It requires a DG-700 pressure and flow gauge. It is an inexpensive tool to accurately measure exhaust fan flow as required by ASHRAE 62.2, but it will measure exhaust intake only. It will not work by placing it over a fan discharge.
- Note: Having both a pressure pan and an Exhaust Fan Flow Meter isn't necessary. The Flow Meter adjustable opening can be closed so the Flow Meter will function as a pressure pan if desired.
- To use, set the DG-700 to pressure/flow and connect the flow meter tap to the upper left manometer tap. Place the meter pan over the (running) fan intake. Adjust the meter opening until a pressure reading between 1 and 8 on the left hand DG-700 screen is achieved. Move the meter hose to the flow tap on the upper right, and read the fan CFM on the screen above.

Moisture Assessment (Slide #19)

Inspectors typically assess moisture by visual observation only, but more accurate information is sometimes required (pictured left to right):

- Pin meter, also called “Non-contact moisture meter” – This works by reading electrical “connectivity” between the two pin points, much like a lie detector, when the points are pressed into a hard surface, such as wood. It has two sets of probes, long and short. The long probes are used to measure surfaces behind insulation without removing the insulation².
- The black and yellow unit has the short probes only. It is smaller and less expensive³.
- The black “L” shaped tool is a sling **psychrometer**. It has two tube thermometers side by side. One has a wetted sock over it; the other is bare. Spinning it in the air produces wet and dry temperatures. Plotting the temperatures on a psychometric chart produces not only the **relative humidity(RH)**, but also a host of other valuable information.
- The indoor/outdoor thermometer on the right also has an electronic RH output.⁴ It’s sufficiently accurate for all but research and much less fragile than a sling psychrometer.

Circuit Testing & Tracing (Slide #20)

Pictured from right to left:

- The tip of the live wire tester turns red whenever it is placed near a live wire. It is most useful to determine if wiring—particularly **knob and tube wiring**—is still live.
- The circuit tracer on the left is a two-part tool. It is used to determine which fuse/breaker controls a circuit that may have been affected by installing insulation. Plug the lower unit into an outlet on the circuit in question. When moved past circuit breakers or fuses in the entrance box, the upper unit will indicate which breaker/fuse serves the outlet.⁵
- When plugged into an outlet, the SureTest Pro will provide a number of outputs. The one of interest to inspectors is the percent of overload on the circuit, used to determine if insulation has been placed around a possibly overloaded circuit.

² Pictured model manufactured by Delmhorst.

³ Pictured model manufactured by General.

⁴ Pictured model found at Radio Shack.

⁵ Pictured model found at Radio Shack.

Summary (Slide #21)

- A blower door is essential.
- Infrared is convenient but can lead to false conclusions.
- Good tools pay for themselves.
- There are many specialized tools and tests available. Testing can be fun, but it's time consuming. Only test when you will learn something.
- Don't test simply for the purpose of testing. Test only when the results will give usable information. On the other hand, final inspectors should always do a blower door test. You can't "eyeball" a house accurately!



TECHNICAL MONITOR/INSPECTOR

Inspector's Toolbox

WEATHERIZATION ASSISTANCE PROGRAM STANDARDIZED CURRICULUM – August 2010

Learning Objectives

U.S. DEPARTMENT OF
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Energy Efficiency &
Renewable Energy

INSPECTOR'S TOOLBOX

By attending this session, participants will:

- Be familiar with typical inspecting tools.
- Gain an understanding of basic test procedures.
- Be exposed to more advanced test procedures.

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 - Cutting pliers.
 - Slotted screwdriver.
 - Adjustable wrench.
 - Razor knife.
 - 25' tape measure.
 - A good flashlight.
 - Digital camera.
 - Pen and paper.
 - A plastic crochet hook (for fishing insulation samples through small openings).

Tool Case

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Renewable Energy

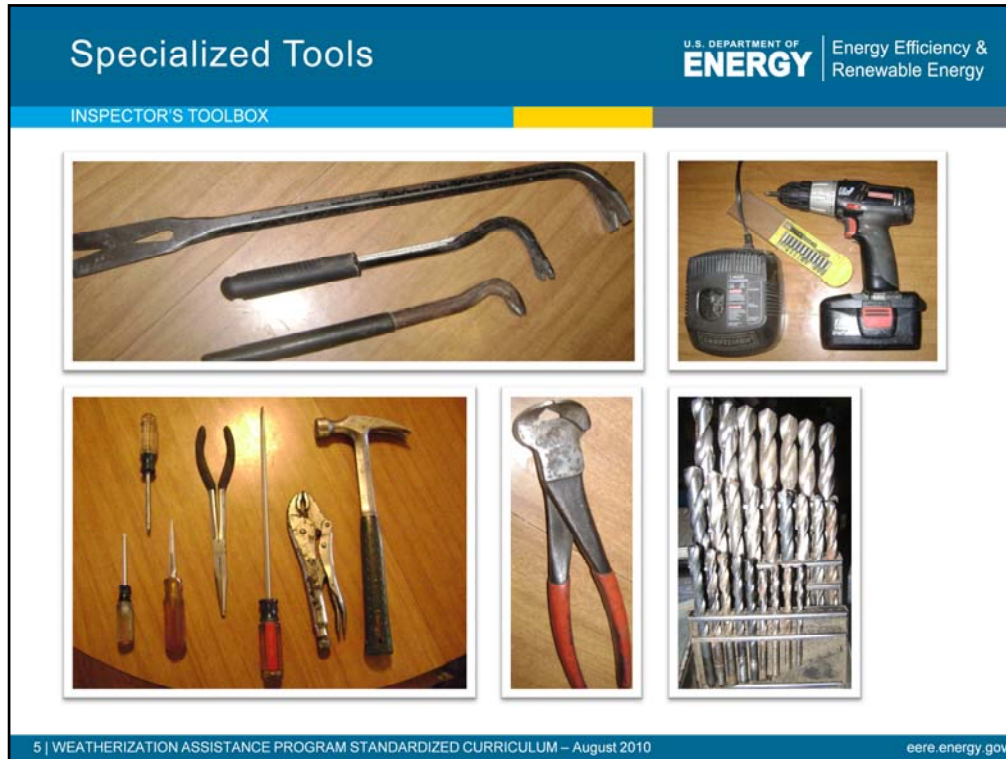
INSPECTOR'S TOOLBOX



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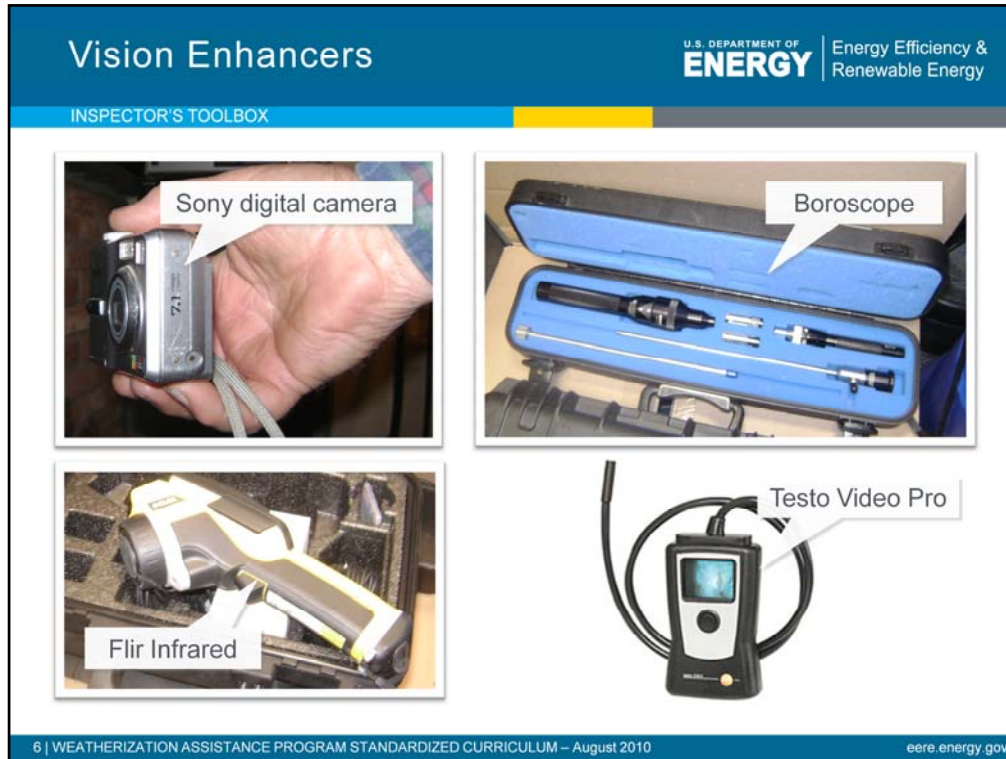
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- Pry bars and nail pullers.
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Combustion Appliance Testing

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INSPECTOR'S TOOLBOX



Above left to right:

- Thermometer
- Draft Gauge
- Inspection mirror



Above counter-clockwise from lower left:

- Pipe wrenches
- Long lighter
- Gas leak detector
- Inspection mirror
- Gas leak detection bubbles
- Smoke pump and smoke test filter paper
- Combustion analyzer

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Picture on the left, left to right:

- Thermometer.
- Draft gauge.
- Inspection mirror.

Picture on the right, counter-clockwise from lower left:

- Pipe wrenches.
- Long lighter.
- Gas leak detector.
- Inspection mirror.
- Gas leak detection bubbles.
- Smoke pump and smoke test filter paper.
- Combustion analyzer.

Combustion Appliance Test Kit

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ENERGY | Energy Efficiency & Renewable Energy

INSPECTOR'S TOOLBOX

Keep one case just for combustion testing:

- Smoke pump and filter paper.
- Lighter.
- Combustion analyzer and manual.
- High-temp sealant.
- Appropriate drill bits for test holes.
- Organization!



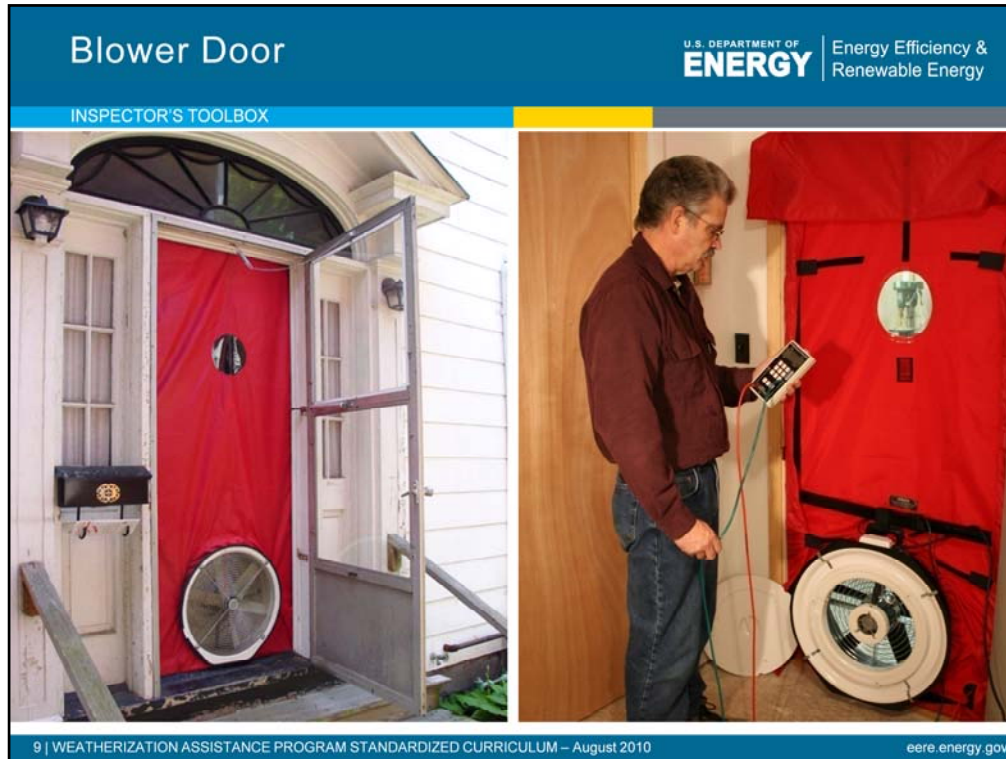
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Pictured: Combustion test equipment stored in case

Keep one case just for combustion testing. Pictured in this case:

- Smoke pump and filter paper.
- Lighter.
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- Organization makes the job of auditing efficient and enjoyable.

As with all hand tools, it is better to have an assigned slot for each item so it is obvious when something is missing or out of place.



- The blower door is a calibrated fan connected to a manometer. It has two basic functions: to quickly quantify house leakiness and locate specific leaks.
- Testing is usually done by depressurizing the house to -50 **Pascals (Pa)** with reference to the outdoors.
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- Older units, which are equipped with gauges, required considerable operator expertise to arrive at accurate results. The newer units are equipped with digital manometers, which eliminate most of the interpretation previously needed.

Manometers & Gauges

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INSPECTOR'S TOOLBOX



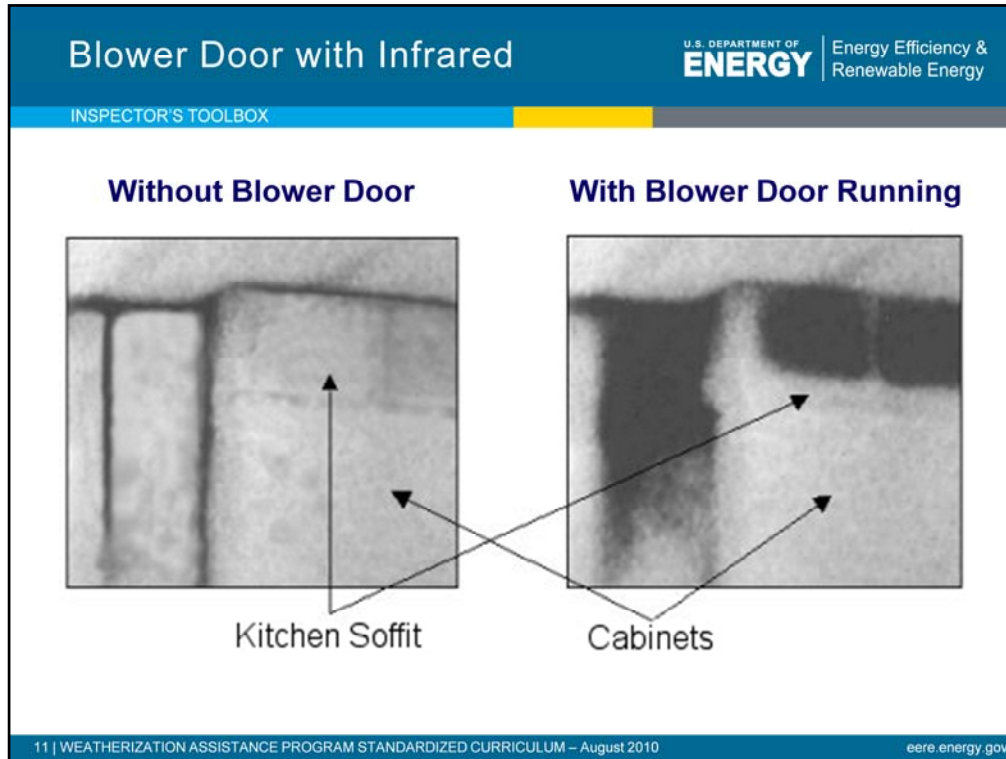
**Magnahelic
Gauges**

**DG-700
(Energy Conservatory)**

**DM-2
(Retrotec)**

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- Magnahelic gauges – The triple gauge unit pictured on the left consists of two pressure gauges and a flow gauge. The pressure gauges display the pressure between inside and out created by the fan. The flow gauge shows the amount of air moving through the fan housing.
- The center picture is a digitalized manometer with pressure readings on the left and flow on the right.
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- All use pressure and flow readings to arrive at a CFM₅₀ number. Dividing that number by 10 gives the approximate total envelope hole size in square inches.



The testing discussed to this point should be done in every home inspected. Tests described from this point forward should only be done when you believe you will learn something valuable by doing them.

- On the left is an infrared picture of kitchen cabinets taken on a cold day. The dark, vertical lines are the framing behind the drywall covering the dropped soffit over the cabinets and the first wall bay to the left of them. (Infrared is typically set to show cold as dark. This pattern indicates the framing is cooler than the drywall.)
- The picture on the right is the same view with the blower door operating. The framing now appears warmer than the drywall. The blower door is pulling cold outside air into the soffit area, rapidly cooling the drywall. The framing—having more mass—is slower to react. From this, we can tell the soffit area is open to the attic above.
- Note: The temperature of the framing didn't change but the color went from black to white. Be very careful when interpreting infrared. It can easily deceive you!

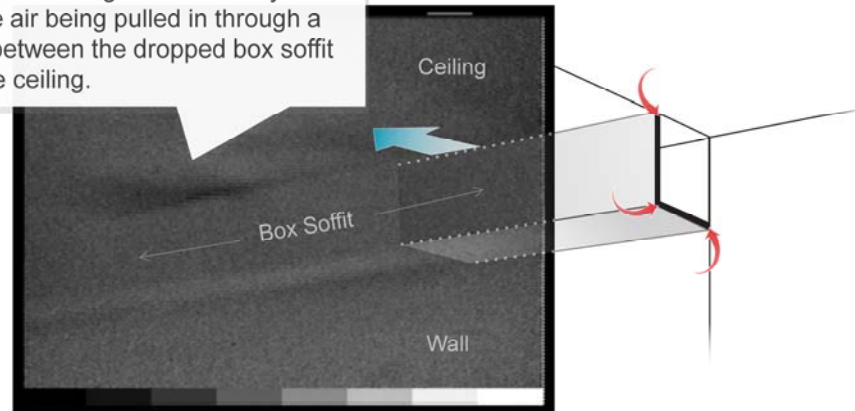
“Feathering” at a Dropped Soffit

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INSPECTOR'S TOOLBOX

The feathery edged areas extending across the ceiling are caused by cold outside air being pulled in through a crack between the dropped box soffit and the ceiling.



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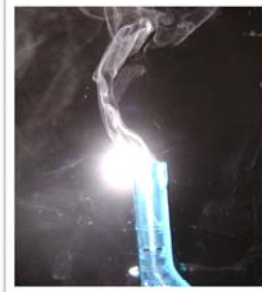
- This is infrared with the blower door running.
- The feathery edged areas extending across the ceiling are caused by cold outside air being pulled in through a crack between the dropped box soffit and the ceiling.

Smoke

INSPECTOR'S TOOLBOX



Wizard Stick



- A smoke test is performed by pressurizing the house to 30 Pa and then walking from room to room, creating smoke. The smoke will stream to any opening connected to the outside.
- The pictured Wizard Stick—actually a child's toy—produces totally non-toxic smoke. While the smoke is not heat neutral, as is the frequently used chemical titanium tetrachloride smoke, it won't harm anyone. Notice how the smoke is moving toward the ceiling opening in the picture in the upper right of the slide.
- It is possible to find attic bypasses from the attic side by depressurizing the house and then creating smoke in the attic. Again, the smoke will stream to any openings connected to the living space.



- A **pressure pan** is a gasketed pan with a pressure tap used in connection with the blower door. One can be constructed from a shallow cake pan with a stick-on foam gasket and a tap purchased from an aquarium supply store. That's how the prototype was constructed.
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- Example: If placing the pan over an interior wall outlet with the house at 50 Pa produces a reading of 25 Pa, the sum of the holes between the wall cavity and the interior equals the sum of the holes between the wall cavity and the exterior. The common way to express this is to say, "The wall cavity is $\frac{1}{2}$ outside."

Inspecting Duct Sealing

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INSPECTOR'S TOOLBOX



Common mobile home duct pattern

Bedroom	0.8 Pa
Bedroom	1.2 Pa
Bath	2.4 Pa
Furnace Closet (living rm)	2.6 Pa
Living Room	2.0 Pa
Kitchen	1.2 Pa
Kitchen	0.5 Pa

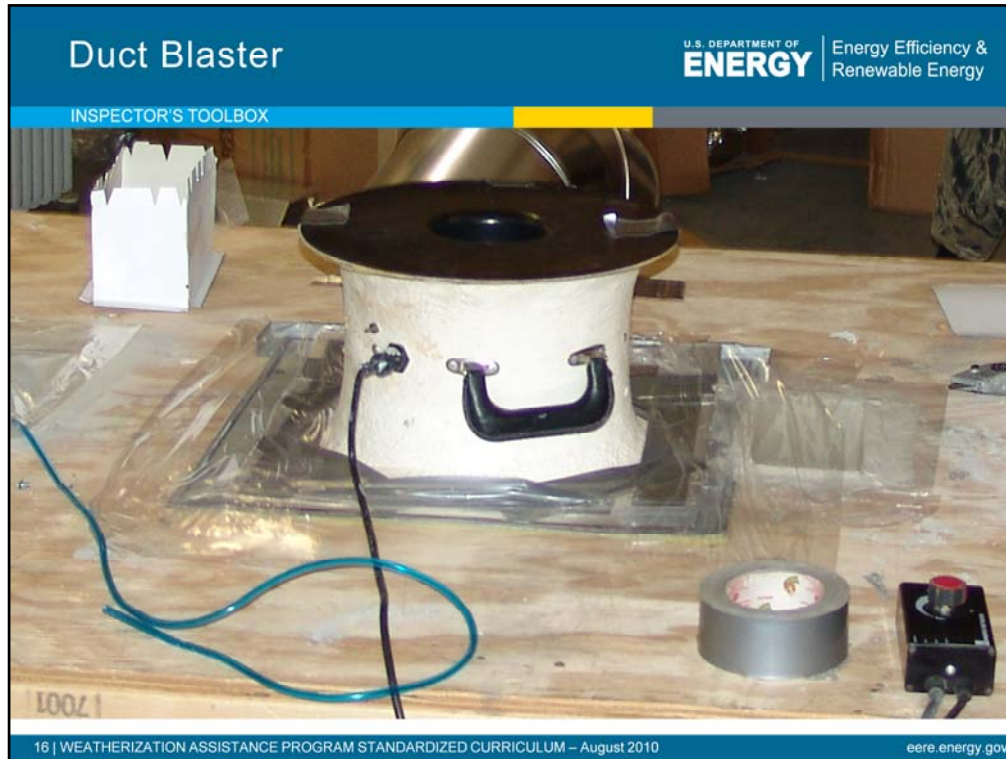
Total: **10.7 Pa**

= seal ducts

2.4 Pa at bath register & 2.6 Pa at living room register indicate a large leak between them, most probably at the furnace plenum.

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eere.energy.gov

- The most common use of the pressure pan is in duct evaluation. The pictured pressure pan is an Energy Conservatory product. With the house depressurized to -50 Pa, take a reading at each grille and sum the results. Do not seal off any duct openings. A total of over 3 Pa indicates poor duct sealing.
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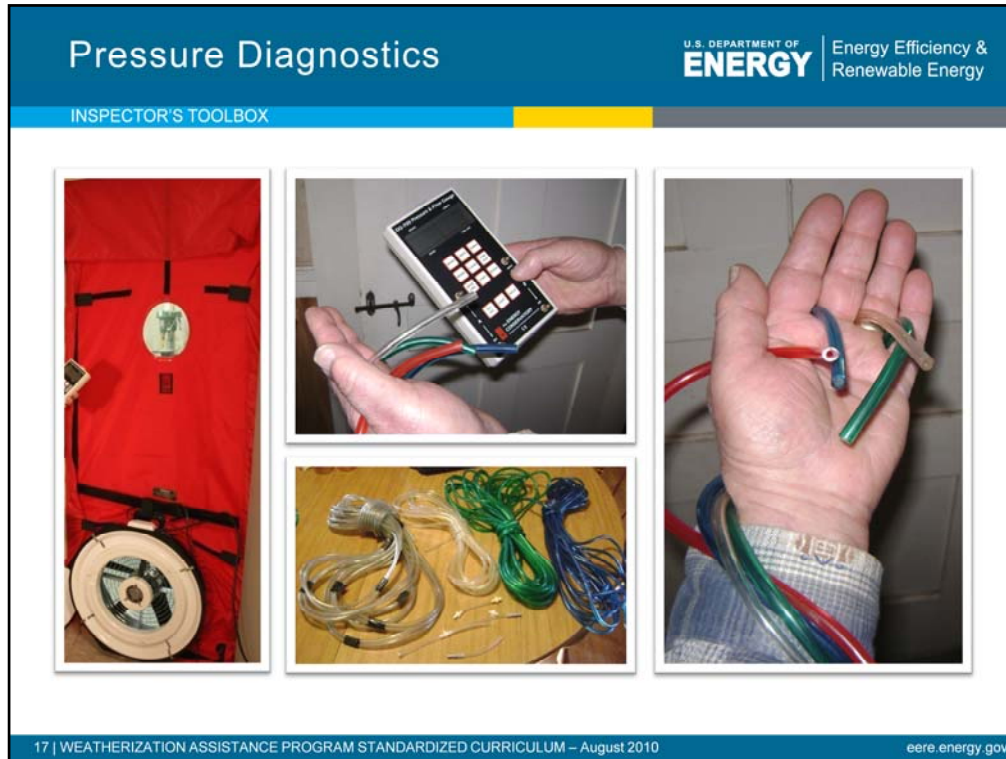


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 - Run green to the exterior.
 - Run blue to the attic.
 - Run red to the CAZ or garage.
 - Run the clear hose to anything else.
- With 50-foot hoses running to various zones between his/her fingers, the auditor can operate the blower door, moving the tap from zone to zone as needed to get the necessary pressures.
- A blower door equipped with a cruise control frees the auditor to move around the house while testing.

Energy Conservatory Exhaust Fan Flow Meter with DG-700 Pressure & Flow Gauge



- The Exhaust Fan Flow Meter (the one shown here is manufactured by the Energy Conservatory) is really a calibrated pressure pan. It requires a DG-700 pressure and flow gauge. It is an inexpensive tool to accurately measure exhaust fan flow as required by ASHRAE 62.2, but it will measure exhaust intake only. It will not work by placing it over a fan discharge.
- Note: Having both a pressure pan and an Exhaust Fan Flow Meter isn't necessary. The Flow Meter adjustable opening can be closed so the Flow Meter will function as a pressure pan if desired.
- To use, set the DG-700 to pressure/flow and connect the flow meter tap to the upper left manometer tap. Place the meter pan over the (running) fan intake. Adjust the meter opening until a pressure reading between 1 and 8 on the left hand DG-700 screen is achieved. Move the meter hose to the flow tap on the upper right, and read the fan CFM on the screen above.

Moisture Assessment
U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

INSPECTOR'S TOOLBOX

“Pin” or “Non contact” moisture meters



Delmhorst



GENERAL



Indoor/outdoor
reads RH



Sling psychrometer

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Inspectors typically assess moisture by visual observation only, but more accurate information is sometimes required (pictured left to right):

- Pin meter, also called “Non-contact moisture meter” – This works by reading electrical “connectivity” between the two pin points, much like a lie detector, when the points are pressed into a hard surface, such as wood. It has two sets of probes, long and short. The long probes are used to measure surfaces behind insulation without removing the insulation.
- The black and yellow unit has the short probes only. It is smaller and less expensive.
- The black “L” shaped tool is a sling **psychrometer**. It has two tube thermometers side by side. One has a wetted sock over it; the other is bare. Spinning it in the air produces wet and dry temperatures. Plotting the temperatures on a psychrometric chart produces not only the **relative humidity(RH)**, but also a host of other valuable information.
- The indoor/outdoor thermometer on the right also has an electronic RH output. It’s sufficiently accurate for all but research and much less fragile than a sling psychrometer.

Pictured model manufactured by Delmhorst.

Pictured model manufactured by General.

Pictured model found at Radio Shack.

Circuit Testing & Tracing

U.S. DEPARTMENT OF
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INSPECTOR'S TOOLBOX



Live wire tester, especially useful for determining if knob & tube wiring is still live.

Circuit tracer determines which fuse/breaker controls which circuit.

Tells percent overload on circuit, among other outputs.



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Pictured from right to left:

- The tip of the live wire tester turns red whenever it is placed near a live wire. It is most useful to determine if wiring—particularly **knob and tube wiring**—is still live.
- The circuit tracer on the left is a two-part tool. It is used to determine which fuse/breaker controls a circuit that may have been affected by installing insulation. Plug the lower unit into an outlet on the circuit in question. When moved past circuit breakers or fuses in the entrance box, the upper unit will indicate which breaker/fuse serves the outlet.
- When plugged into an outlet, the SureTest Pro will provide a number of outputs. The one of interest to inspectors is the percent of overload on the circuit, used to determine if insulation has been placed around a possibly overloaded circuit.

Pictured model found at Radio Shack.

Summary

INSPECTOR'S TOOLBOX

- A blower door is essential.
- Infrared is convenient but can lead to false conclusions.
- Good tools pay for themselves.
- There are many specialized tools and tests available. Testing can be fun, but it's time consuming. Only test when you will learn something.
- Don't test simply for the purpose of testing. Test only when the results will give usable information. On the other hand, final inspectors should always do a blower door test. You can't "eyeball" a house accurately!

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Site Monitoring: Building Assessment

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will be introduced to evaluating whether:

- Appropriate energy savings measures were installed.
- The thermal boundary was appropriately treated.
- Opportunities for air sealing or insulating were missed.
- Energy-related repairs and health and safety (H&S) measures were justified.
- Installed measures match the audit and work order.
- Measures were installed as billed.
- Installed measures meet weatherization standards for quality workmanship.

Key Terminology

Action levels	Indoor Air Quality (IAQ)
Air barrier	Infrared (IR)
Balloon framing	Infrared imaging
Band joist	Infrared thermography
Base load	Knee wall
Cantilever	Knob and tube wiring
Carbon Monoxide (CO)	Loose-fill insulation
Combustion Appliance Zone (CAZ)	Manual J
Compact Fluorescent Light (CFL)	Mud sill
Condensation	National Electrical Code (NEC)
Conductive heat loss	National Fire Protection Association (NFPA)
Cubic Feet per Minute (CFM)	Net Free Area (NFA)
Decommission	Parts per million (ppm)
Dense-pack insulation	Pascals (Pa)
Dropped soffit	Pull-down staircase
Health and Safety (H&S)	R-value

Savings-to-Investment Ratio (SIR)	U-value
Shading Coefficient (SC)	Vapor retarder
Solar absorption	Vent
Solar exposure	Vermiculite
Solar film	Weatherization Program Notice (WPN)
Solar gain	Window film
Solar reflectance	With Reference To (WRT)
Thermal boundary	WPN 08-4, "Space Heater Policy"
Tuck-under garage	Zonal Pressure Diagnostics (ZPD)

Supplemental Materials

Handouts & Resources

Attic air sealing video

DOE Hot Climate Initiative. *Air Sealing*.

DOE Hot Climate Initiative. *Combustion Appliance Safety & Efficiency Testing*.

DOE Hot Climate Initiative. *Dense-pack Sidewall Insulation*.

NFPA Combustion Clearance Tables

Refrigerator Info Toolkit

Sample attic insulation certificate

Sample Technical Field Rating Sheet

Sample insulation coverage chart

Sample Quality Assurance Form

Water Heater Info Toolkit

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Classroom Props & Activities

Sample Site Monitoring Quality Assurance Form

- Acquaint students with the QA form they will be using during a planned field trip.
- Focus on the information being requested.
- Tell students that filling in the blanks in order is usually most efficient.
- Instruct students to fill the appropriate check box or blank. (If it's filled in, you know you've evaluated it!) Empty spaces indicate further searching is needed. If a field is not applicable, write N/A.
- Use the notes sections to provide more detail on what was done, or not done, in the home.
- The completed form should accurately reflect what was done to the home.

Remember: A completed QA form should be able to stand on its own; that is, any reasonably competent person should be able to determine from the form what was done to the dwelling.

Hands-On Field Activities – Class Field Trip

Plan to take the class to a home that has been completed by a local weatherization agency. The purpose is to conduct a full quality assurance assessment. Work with the local agency to identify a homeowner who is willing to have an inspection performed by a group of students under the direction of a knowledgeable instructor.

The agency may not be able to provide you with detailed information from the client file such as client information, inventory records, or measure justification. It will, however, be likely to give you a summary of the measures installed. Focus attention on whether measures appear to have been installed according to specifications and that quality workmanship was employed. If the agency can provide the individual audit report or priority list and other measure-related documents from the client file, consider using it for the “Desk Monitoring” section of this curriculum.

The house should be a typical single-family home, ideally with an operating forced-air furnace, an attic, and a basement or crawl space. Other features, such as an attached garage or additions, are desirable. Visiting a completed mobile home would also be interesting.

Before the visit, spend about 45 minutes to an hour in the classroom reviewing the sample QA form to make sure everyone understands how to use it.

Plan to spend 2 to 3 hours in the home conducting a visual assessment and diagnostic tests.

Provide students with QA forms, flashlights, measuring tapes, and clipboards with paper and pencils. Plan to take digital pictures. Allow students to disperse into small groups and regroup periodically to assess their progress, discuss findings, and watch or take part in activities such as blower door testing or zonal pressure diagnostics. Remind students that they should be discreet when discussing possible negative findings on site.

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

Divide the class into groups to reach consensus about major categories of weatherization measures, including heating system improvements, attic measures, and health and safety measures. Have each group designate one person to report its findings to the class. Allow 10 minutes per group for reporting, then discuss as a whole. To enhance the discussion, project digital images onto a screen showing weatherization details or special features of the home.

Class Overview

Deliver the PowerPoint presentation. Focus on a systematic approach for performing inspections on homes and what inspectors should be looking for when conducting a building assessment.

The PowerPoint presentation follows the sequence of categories on the sample QA form. These are associated with specific slides and are queued up in the speaker notes. Have students keep the QA form handy throughout the presentation.

There are infinitely more possible scenarios that will manifest themselves in the field than those discussed in this presentation. Feel free to insert additional pictures and encourage students to share their experiences.

Introduce students to the key elements of a complete QA building assessment, including:

- Inspection protocol.
- Installed measures.
- Insulation levels.
- Selection of materials.
- Accounting for materials.
- Health and safety issues.

Use the presentation to introduce the concept of air barriers and thermal boundaries, reinforcing what's inside and what's outside the boundaries.

Site Monitoring: Building Assessment

Technical Monitor/Inspector

Key Terminology

Action levels	National Electrical Code (NEC)
Air barrier	National Fire Protection Association (NFPA)
Balloon framing	Net Free Area (NFA)
Band joist	Parts per million (ppm)
Base load	Pascals (Pa)
Cantilever	Pull-down staircase
Carbon Monoxide (CO)	R-value
Combustion Appliance Zone (CAZ)	Savings-to-Investment Ratio (SIR)
Compact Fluorescent Light (CFL)	Shading Coefficient (SC)
Condensation	Solar absorption
Conductive heat loss	Solar exposure
Cubic Feet per Minute (CFM)	Solar film
Decommission	Solar gain
Dense-pack insulation	Solar reflectance
Dropped soffit	Thermal boundary
Health and Safety (H&S)	Tuck-under garage
Indoor Air Quality (IAQ)	U-value
Infrared (IR)	Vapor retarder
Infrared imaging	Vent
Infrared thermography	Vermiculite
Knee wall	Weatherization Program Notice (WPN)
Knob and tube wiring	Window film
Loose-fill insulation	With Reference To (WRT)
Manual J	WPN 08-4, "Space Heater Policy"
Mud sill	Zonal Pressure Diagnostics (ZPD)

Section Transition

Learning Objectives (Slide #2)

This session will introduce participants to evaluating whether:

- Appropriate energy savings measures were installed.
- The **thermal boundary** was appropriately treated.
- Opportunities for air sealing or insulating were missed.
- Energy-related repairs and **health and safety (H&S)** measures were justified.
- Installed measures match the audit and work order.
- Measures were installed as billed.
- Installed measures meet weatherization standards for quality workmanship.

Building Assessment – Protocol (Slide #3)

Develop a site visit protocol and follow it at each dwelling.

- Snap a picture of the front of the house. Include the street number.
- Walk around the outside, noting any conspicuous features such as **cantilevers** or **tuck-under garages**.
- Upon entering, introduce yourself to the occupant(s) and explain why you are there. Ask how they were treated by the weatherization crew, if they are satisfied with the work, and if they have any questions.
- Use the same walk-through pattern in every house: e.g., top down and clockwise or bottom up and counterclockwise, whichever is most comfortable for you. Following the same pattern every time reduces the chance you'll miss something.
- Take pictures of everything! Multiple houses soon run together in your mind. Pictures will help jog your memory.

Measure Assessment (Slide #4)

Assessing the measures installed in a home includes evaluating not only whether the measures were installed correctly, but also whether they should have been called for in the first place. The inspector/monitor is looking at the home much like an auditor would, determining what should have been installed.

Note the following in the inspection report for each measure that could have been considered for the home:

- Was the item on the work order?
 - If it was not on the work order, note whether the site visit indicates that it should have been.

- If the measure was on the work order, note the quality of the installation. For example:
 - Work appears to have been performed to standards.
 - Work appears to have been performed, but cannot verify (no access to area).
 - Work appears to have been performed to standards, but does not reflect good workmanship.
 - Some work was performed, but not to standards.
 - Work does not appear to have been performed, but cannot verify (no access to area).
 - Item was on the work order but not installed.

Thermal Boundary (Slide #5)

The thermal boundary is the insulation.

- The thermal boundary limits heat flow.
- It is usually easy to identify by the presence of insulation.
- The location of insulation in relation to other building components is critical to its effectiveness. Air passing through insulation takes heat and moisture with it.
- Even small areas of missing insulation are critical to address. Voids of 7% can reduce the effective **R-value** by almost 50%.
 - The effective R-value in the attic of a 1,000-square-foot single-story rambler insulated to R-38 falls to an effective R-value of only 19 when 70 square feet of insulation is pushed aside. This would be the case if the installer didn't blow cellulose insulation right up to the edges, instead of installing soffit baffles and chimney dams and blowing to the proper depth throughout the attic.

Common insulation materials include fiberglass batts and blown-in cellulose. **Vermiculite** is a naturally occurring mineral that was commonly used for loose-fill insulation in the walls and attics of older homes until fiberglass and cellulose insulation gained more widespread use in the 1950s and '60s.

If the **thermal boundary** and **air barrier** are continuous and in contact with each other, air will not pass through the insulation.

It is common for cold air to bypass the insulation, not just in low-income homes, but in large, new homes as well.

Q. What materials serve as both a thermal boundary and air barrier?

A. Foam board.

Spray foam.

Dense-pack insulation, properly installed, greatly reduces air flow.

The thermal boundary is obvious (Slide #6)

Photo of an insulated attic.

Q. Where is the thermal boundary?

*A. In this case, the thermal boundary is the insulated ceiling that separates the unconditioned attic from the conditioned space below. The thermal boundary cannot always be determined through visual inspection. **Zonal pressure diagnostics (ZPD)** is one of the best ways to determine the location and condition of the thermal boundary and air barrier.*

A Case of Mistaken Identity (Slide #7)

- Here's a case in which the installers misidentified the location of the thermal boundary. The installers wrapped the gable end wall of an attic with bubble wrap, which is like insulating a cold space (the attic) from another cold space (outside). The ceiling floor adjacent to the living space below is the thermal boundary.

Thermal Boundary & Air Barrier (Slide #8)

- Again, for maximum efficiency and comfort, the thermal boundary and air barriers must be continuous and in contact with each other.
- Successful evaluation of building shell measures such as air sealing and insulation is tied to an inspector's ability to identify the thermal boundary and determine whether the thermal boundary and air barriers are in alignment.

Air Barrier (Slide #9)

- The air barrier:
 - Limits air flow between inside and outside, and the heat and moisture carried by that air.
 - Is more difficult to identify than the thermal boundary, because it can be hard to see.
 - Is not always where you think it is.
- Pressure readings taken with the blower door running are used to locate air leakage and the air barrier.

Q. What is the air barrier in most homes?

A. Usually it's the interior drywall.

Gap in Thermal Boundary (Slide #10)

An uninsulated attic hatch is a gap in the attic's thermal boundary.

Q. What are some examples of gaps in the thermal boundary?

A. Insulation voids in exterior walls, uninsulated door to an unheated garage.

Attic Spaces (Slide #11)

Note the following in attic spaces:

- Components of the thermal boundary.
- Physical features (floored or open framed ceiling, condition of ceiling, attic hatches and doors).
- Installed insulation levels.
- Air bypass sealing.
- Insulation level of duct systems if present.
- Evidence of **condensation**-based moisture problems or roof leaks.
- Attic ventilation.
- Whether mechanical and plumbing terminations are vented to the outside.
- **Knob and tube wiring** and other electrical hazards.
- Properly dammed heat-producing devices, accesses, and eave chutes.

Refer to the Attic Insulation section of the Installer Intermediate curriculum for more details on attic insulation protocols.

Some Attic Inspection Points (Slide #12)

Point out some attic inspection points:

Chimney

B-vent

Gable vent

Floored attic

Pull-down staircase

Ceiling joist cavities

Attic Air Sealing (Slide #13)

Photo on the left: Large unsealed void.

Photo on the right: Unsealed plumbing chase.

- An inspector can usually observe attic air sealing deficiencies by pulling back some insulation to see if attic air sealing was performed. Trace wiring and plumbing penetrations.
- In the inspection report, for each installed measure note the appropriateness of the measure and the quality of the workmanship, addressing the issues in the sample site inspection QA form.

Hand out the Sample Site Inspection QA form. Refer to it as each new measure is presented for the remainder of the presentation. Have students determine which box they would check for each photo shown.

Attic Air Sealing (Slide #14)

Photo on the left: Properly sealed partition wall before insulation.

Photo on the right: Top of marriage wall in a modular home left unsealed before insulating attic.

Was attic air sealing performed?

- It is often difficult to determine the extent of air sealing work once an attic has been insulated. Inspectors can spot check in obvious places, such as around chimneys or above **dropped soffits**.

Attic Air Sealing (Slide #15)

Photo on the left: Heat-producing chimney sealed with high-temperature caulk.

Photo on the right: One- or two-part foam used to seal common attic leaks.

Was attic air sealing performed?

- It is important to determine the correct application of materials.

Attic Insulation (Slide #16)

Photo: Here's a nice even blanket of insulation at sufficient depth.

Was attic insulation installed?

- Accurate bag counts can help assure that the material claimed matches the quantity of insulation installed.
- For example: Assuming that one bag of cellulose insulation will cover approximately 18.3 ft² of attic space to achieve R-40, a 1,000 ft² attic would require approximately 55 bags of cellulose to achieve R-40 throughout (1,000/18.3), assuming there was no existing insulation.

Refer to the Math Basics section of the Energy Auditor – Single Family curriculum for guidance on estimating material quantity.

Attic Insulation (Slide #17)

Photo on the left: Uneven coverage.

Photo on the right: Insufficient depth of insulation.

- A state priority list or approved audit determines the desired final R-value. In most northern climates, the goal is R-38, or about 10.5" of blown-in cellulose. Uneven coverage results in variable R-values throughout the attic.

Attic Insulation (Slide #18)

Floored attics are closed cavities and must be dense packed. Pull up a floor board and test the density with your hand. If you can move your hand through the material with ease, air can get through it. It should be so dense that it's difficult to poke your fingers through it and it springs back after you touch it.

Questionable Roof Application (Slide #19)

Here's a beautifully installed insulated rubber roof system, but...

- This insulated EPDM¹ rubber roof system was not modeled in the building audit and therefore not cost justified. The nearly \$3,000 installed cost included sheets of 2" R-12 extruded polystyrene insulation, which accounted for only 15% of the cost. In addition, the rubber roof membrane is black, which has no reflective (cooling) value.

An important function of an inspector is to determine whether a U.S. Department of Energy (DOE)-approved priority list or audit confirmed that measures installed under the Weatherization Assistance Program (WAP) were cost-effective.

Attic Insulation Certificate (Slide #20)

Photo: Insulation certificate completed and posted in a convenient location.

Was an insulation certificate completed and posted?

- The insulation certificate should note the company name, R value, number of bags, square footage of coverage, date of installation, ASTM standard and be posted so that it is visible from the attic access.
- Note the stout insulation dam constructed of dimensional lumber. Fiberglass batts or insulation board are not typically acceptable access dams. Refer to local field guides for local standards.

¹ Ethylene Propylene Diene Monomer

Depth and Electrical Markers (Slide #21)

Photo: Electrical junctions should be clearly marked to enable an electrician to reach them in the event of an electrical problem.

- One insulation depth marker should be placed at every 300 ft² of attic space.

Heat Sources and Vent Damming (Slide #22)

Photo on the left: Insulation dams must be properly applied around heat-producing devices such as chimneys.

Photo on the right: Insulation blown tight against an active chimney could cause a fire.

Q. Name another heat source that must be dammed.

A. Non-IC-rated recessed can lights must be covered with a non-combustible dam such as drywall and have a 3" clearance around the sides and top of the fixture.

Attic Access Insulated and Secured (Slide #23)

Photo on the left: Insulated, weatherstripped, and secured – good job.

Photo on the right: Uninsulated, not weatherstripped, no insulation dam.

Was the attic access properly insulated, weatherstripped, and secured?

Q. Give an example of another type of attic access and how it should be treated.

A. Another type of access is a full-sized standard door leading to an attic walk-up staircase. If the stairway is considered outside space, e.g., the top of the stairway wasn't topped with an insulated tent, then you would hope to see weatherstripping and a door sweep, the same way an exterior door would be treated. In this situation, the cold side of the door should be insulated with rigid insulation, and the walls of the stairway dense-packed.

Attic Access Insulated and Secured (Slide #24)

Photo: Pull-down staircase cover insulated and sealed with a commercially available or fabricated lid.

- In all cases, insulation on top of an attic hatch should be the same R-value as the rest of the attic.

Attic Hatch Specifications (Slide #25)

Illustration on the left: Scuttle hole cover.

Illustration on the right: Pull-down staircase.

- Attic hatches must be weatherstripped and insulated to the same R-value as the rest of the attic.
- Pull-down staircases present a special challenge since they protrude into the attic when folded up. You should see a fabricated or commercially available insulated cover.
- Insulation dams around attic hatches should be constructed of lumber in a way that can hold the weight of people entering and exiting the attic. Structurally weak materials such as fiberglass batts, metal coil stock, or rigid insulation are typically unacceptable. Refer to local field guides for local standards.

Health and Safety-Related Attic Repairs (Slide #26)

Photo on the left: Uncovered electrical junction.

Photo on the right: Disconnected vent fan.

Were H&S repairs performed and documented?

- Determine if all electrical junctions are covered and vented appliances are vented to the outside.

Knob and Tube Wiring (Slide #27)

- Knob and tube wiring must not be encapsulated with insulation, per the ***National Electrical Code (NEC)***.
- Knob and tube wiring may be brought up to code as an energy-related repair, but the cost must be rolled into the total project cost. The whole job must maintain a ***savings-to-investment ratio (SIR)*** of greater than or equal to 1.

Sidewall Insulation (Slide #28)

Photo on the left: Uniform light color without dark areas indicate complete insulation coverage.

Photo on the right: Dark areas indicate insulation voids.

Was sidewall insulation installed?

- **Infrared (IR) thermography** is an excellent tool for evaluating hidden sidewall insulation coverage. With the camera set up as shown here, when interpreting **infrared images** on a cold day, light is good and dark is bad. It's just the opposite on a warm day.
- Accurate bag counts can help assure that material claimed matches the quantity of installed insulation. Claimed bag counts can usually be verified by looking at a contractor's invoice or a daily in-out inventory sheet as recorded by a crew supervisor.
- For example, a 4" thick, 1,000 ft.² wall, blown with cellulose at a density of 3.5 lbs per ft.³, should contain approximately 11 thirty-pound bags of insulation.

Refer to the Dense-Pack Sidewall Insulation section of the Installer Intermediate curriculum for more details on sidewall insulation protocols. Refer to the Math Basics section of the Energy Auditor – Single Family curriculum for guidance on estimating material quantity.

Sidewall Insulation (Slide #29)

Photo: Walk-up staircase.

What about walk-up attic staircases?

Yes, they should absolutely be insulated!

- If the top of them isn't treated, walk-up attic staircases should be treated like exterior sidewalls because these surfaces separate conditioned from unconditioned areas.
- The staircase walls and stair risers should be dense packed with **loose-fill insulation** where possible.

Q. Can you think of any other sidewalls that should be insulated?

A. A wall between a kitchen and an attached garage or between an unheated porch and a living room.

Walk-Up Attics (Slide #30)

Q. Where is the thermal boundary? Where should it be?

A. It should enclose the conditioned space and nothing else. If occupants use the attic often, the thermal boundary might encompass the stairwell leading up to the attic, effectively putting the staircase outside.

The thermal boundary can be tricky to determine. It depends on how the occupant uses the house and what's considered conditioned space.

- In this illustration, the staircase and the door leading to the unheated attic are part of the thermal boundary. The auditor may opt to improve the existing thermal boundary by air sealing the attic staircase and access door, as illustrated on the left.
- Alternatively, if the occupants don't use the attic often, the auditor may decide to create a new thermal boundary by calling for a removable lid that is air sealed and insulated, as pictured on the right.
- The staircase then becomes part of the conditioned space by default. That space must be conditioned to prevent condensation problems. Thinking about these issues helps the inspector evaluate the location of the thermal boundary.

Knee Wall Insulation in a Cape Attic (Slide #31)

Photo on the left: **Knee wall** insulated and covered (good).

Photo on the right: Knee wall insulated but not covered (bad).

Was knee-wall insulation installed?

- For exposed fiberglass wall insulation to be effective, it must be enclosed with air-impermeable plastic or house wrap.

Q. What are other insulation options for knee walls?

A. Spray foam insulation, which must be enclosed if it is in a living space; blown-in insulation held in place with webbing stapled to studs.

Cape Attic (Slide #32)

Illustration of how the air barrier and insulation should be aligned in a 1.5-story house with a knee wall attic.

- Note that the critical junctions in this picture have been air sealed.

An inspector/monitor would hope to find the following:

- Dense-pack insulation in the roof rafter bays.
- Appropriate R-value insulation on the knee walls – This can be batts or blown-in insulation covered with house wrap, spray foam, etc.
- Loose-fill insulation of appropriate R-value on the knee wall attic floor and in the small triangular-shaped attic above the second-floor ceiling.

Plugs, Patches, and Painting (Slide #33)

Photos of acceptable and unacceptable work.

- In the inspection report, note the appropriateness of each installed measure and the quality of the workmanship.

General Air Sealing of the Building Envelope (Slide #34)

Illustration on the left: Cantilevered floor detail.

Photo on the right: Arrows pointing to floor cantilevers that need to be sealed and insulated.

Were other special features of the building envelope adequately sealed and insulated?

- Besides basements, walls, and attics, there are many special architectural features in single-family homes that may contribute to heat loss. The sequence of slides that follows will cover some of the ones that must be treated.

Refer to the Building Shell Retrofit Strategies section of the Energy Auditor – Single Family curriculum for recommended treatments of specialized building features.

Wall Repair (Slide #35)

Photo on the left: Piece of hardboard foamed in place as drywall repair is messy and borderline acceptable. Unused dryer vent pipe was left open and untreated.

Photo on the right: Good job air sealing in stairwell ceiling. Relatively neat tape coat should not need excessive sanding to finish.

- Standard minimum requirements are one (tape bedding) coat of compound for drywall patching. The quality of workmanship should be such that any reasonably competent drywall taper can finish the wall without extra correction time and effort (no excessive sanding needed). Refer to local field guides for local standards.

Porch Roof Connections (Slide #36)

Photo of a two-story house with **balloon framing** where the porch framing could be open to the wall cavities of the house.

- The porch roof cavity may be open to wall cavities. This could be one of the largest hidden air leaks in the house, making it a good candidate for air sealing with dense-pack insulation. This should have been sealed and insulated, as blower door and IR tests would have indicated.

Tuck-Under Garage (Slide #37)

Photo of a tuck-under garage on a platform-framed house.

- Significant **conductive heat loss** is associated with a floor cavity that separates an unconditioned garage and the conditioned space above.
- If the enclosed floor cavity wasn't insulated, dense-pack insulation should have been specified and installed.

Q. What are other problems associated with tuck-under garages and what should be done about them?

*A: Air leakage between the house and garage can bring pollutants like **carbon monoxide (CO)** into the living space, creating poor and potentially deadly **indoor air quality (IAQ)**. All penetrations from the garage to the living space should be sealed.*

Exposed Floors (Slide #38)

Photo of a very unprofessional job in which an exposed floor was insulated with bubble wrap and spray foam.

Q. What could have been done differently here for a more effective job?

A. Plywood or insulated sheathing could have been attached to the bottom of the floor joists, holes drilled, and joist cavities filled with dense-pack insulation.

Dropped Ceilings (Slide #39)

Photo: Untreated air leak above a dropped ceiling.

- Air leakage problems are often hidden above dropped ceilings. If post-weatherization blower door numbers indicate that air sealing was ineffective, look above tiles for hidden air leaks. Remove panels in several locations to check whether they were sealed.

Plumbing Access (Slide #40)

Check access doors, closets and cabinets for interior leakage paths.

This opening within the plumbing wall was discovered behind an access door.

The opening is a major source of air leakage.

Dropped Soffits (Slide #41)

Dropped soffits, like the one shown here, are common sources of significant air leakage.

The open framing is a direct connection from the soffit to the attic above. The cavity should be sealed before insulating, as shown.

Conditioned Space Inspection Points (Slide #42)

Check the following:

- Wall insulation.
- Windows and doors.
- Leakage around outlets and fixtures (with blower door running).
- Thermostat, smoke detectors, CO alarms.
- Fireplace.
- Air registers.
- Window air-conditioning units.
- Recessed light fixtures.
- Stored chemicals that might affect IAQ.

Heating System Replacement (Slide #43)

Photo on the left: New boiler.

Photo on the right: New mobile home furnace.

- Furnace replacement is generally cost-effective only in extremely cold climates and areas with high fuel costs where the existing unit is below 80% efficient. Replacements will most likely be part of H&S expenditures.
- Check with the occupants about their comfort and whether the heating system is operating as it should.

Q. Identify some conditions in which a furnace or boiler may or should be replaced as a health and safety measure.

A. Not serviceable despite all attempts to repair.

Cracked heat exchanger (furnace).

Leaking water jacket (boiler).

Cost of repairs greater than cost of a replacement (Note: some Grantees state that if cost of repair is 40% or more of cost of replacement, unit should be replaced with more efficient model.

Age and general condition.

Clean/Tune Up/Replace Cooling Systems (Slide #44)

Photo: One sad-looking AC unit.

- Remove obstructions to airflow.
- Clean condenser coils.
- Clean evaporator if accessible.
- Clean/replace filters.
- Insulate coolant line.
- Level unit.
- Test/adjust coolant charge. (This requires an EPA-licensed refrigeration technician).
- If the unit was replaced, it should have been properly sized.
 - Room air conditioners can be easily sized using the ENERGY STAR sizing chart found later in this presentation and online at www.energystar.gov.
 - **Manual J** is the accepted standard for sizing whole-home (single-family) air-conditioning systems. Over-sizing systems beyond Manual J is unnecessary, since Manual J calculations already over-predict the design load.²
 - An oversized system will be less effective at removing moisture from the air, which can leave a house feeling damp and lead to mold.

Check with the occupants about their comfort and whether they think the air-conditioning system is operating the way it should.

Refer to the Cooling Measures section of the Energy Auditor – Single Family curriculum for more details on air-conditioner protocols.

Heating System Tune-Up (Slide #45)

Photo: Oil furnace with a single-wall flue graduated to a double-wall flue to maintain clearance to combustibles.

- Note the test hole where samples of flue gases will be taken and draft measured.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety and efficiency protocols.

² Proctor, John, and Peggy Albright. "Sizing Air Conditioners: If Bigger is Not Better, What Is?" *Home Energy* Sept./Oct. 1996. www.homeenergy.org.

Unvented Gas Heaters (Slide #46)

Photos: Three mounted and unvented gas heaters.

- DOE does not allow air sealing measures on homes with permanently mounted unvented space heaters. See ***Weatherization Program Notice (WPN) 08-4, Space Heater Policy***.
- Under very limited conditions, DOE will allow an unvented space heater to remain in a weatherized unit as a back-up in case of a power failure. DOE funds may not be used to repair or replace these unvented secondary heating sources.
- DOE funds may be used to repair or purchase and install a working CO detector, which should always be installed near such a unit before completing weatherization work.

Open Returns (Slide #47)

Photo of a dangerous combination of a disconnected draft hood and open return register on the furnace return air plenum.

Q. Why is this a problem?

*A. Flue gases spill into the **combustion appliance zone (CAZ)** and are drawn into the conditioned house air by the furnace blower through the open return air register. Open returns in the CAZ should always be sealed.*

Venting Systems (Slide #48)

A venting system should:

- Carry all combustion byproducts to the outdoors.
- Establish draft quickly.
- Be properly sized with minimal restrictions.
- Have long durability (corrosion resistance).
- Not overheat surrounding materials.
- Have adequate make-up air.

Heating System Safety Issues (Slide #49)

This flue pipe is not in compliance with code.

The photo on the left shows the flue exit from the boiler, with a nearly horizontal route toward the chimney.

The photo on the right shows a long horizontal run with an elbow into the chimney; the elbow indicated by the red circle is rusted through.

The photo on the bottom right zooms in on an area that is rusted through.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety protocols.

Chimneys and Vents (Slide #50)

Photo of vent and chimney connection.

- The vent connects the combustion appliance to a vertical masonry or metal chimney, and is also referred to in the heating trade as a smoke pipe.

Q. Is anything wrong with this picture?

A. The excessive elbows on the large vent to the furnace restrict the flow of flue gases.

Clearance to Combustibles (Slide #51)

Photos of a flue through a ceiling penetration.

Proper clearances of heat-producing chimney vents to combustible materials must be maintained to prevent fires.

Refer to the National Fire Protection Association (NFPA) combustion clearance tables.

- Seal the chimney opening with metal coil stock and high-temperature silicone caulk.

Filter Replacement (Slide #52)

- Air filters are often so clogged that airflow is drastically reduced. The reduced airflow may cause heat exchangers to overheat and fail over time.
- Educate clients to check the condition of their filter every month during the heating season and replace it if necessary. Show them a replacement filter and compare it to the old, dirty filter.

Duct Sealing and Insulation (Slide #53)

Photo on the left: Mastic used to seal ducts.

Photo on the right: Two-part foam used for sealing ducts.

- Sealing and insulating ducts in unconditioned spaces is an extremely important part of reducing duct losses. Check for the appropriate use of materials and thoroughness of the application.

Heating System Duct (Slide #54)

The existing heating system return used a floor joist cavity as the duct. Weatherization workers did a very good job of sealing this with caulk.

Q. Is this OK?

*A. This is not ideal, but it is acceptable. Duct mastic would have been a better choice for sealing. The best practice would be to pan the floor joist with sheet metal, to protect the building components from potential moisture issues. Building cavities are best **not** used as ducts.*

Mobile Home Ducts (Slide #55)

- Upper and lower photos on the left: Insert a flashlight through the duct opening and lay it flat in the duct run. A mirror will reveal many problems, including holes, obstructions, and collapsed sections.
- Upper and lower photos on the right: These mobile home ducts were repaired and sealed with mastic during weatherization.

Refer to the Duct Diagnostics and Repair section of the Mobile Home Installer curriculum for more details on duct sealing in mobile homes.

Distribution System Modification (Slide #56)

Photo on the upper left: Seal belly return grilles in the furnace closet.

Photo on the lower left: A variety of materials, including plywood and duct board, may be used to permanently seal return air grilles.

Photo on the lower right: A louver in the furnace closet door is part of a hallway return system.

- Modify a mobile home belly return system and convert to a hallway return system.
- Install a return louver in the furnace closet door. A commercially available louvered door would actually be a better option. Its installation is less labor-intensive than cutting and fitting grilles into the existing door and it will look better.
- Leave 2 in² of **net free area (NFA)** per 1,000 BTU of furnace input.

Q: How much FVA is required for a furnace closet return louver for a furnace with a 50,000 BTU input?

A: $2 \text{ in}^2 \times (50,000/1,000) = 100 \text{ in}^2$

Refer to the Duct Diagnostics and Repair section of the Mobile Home Installer curriculum for more details on duct sealing.

- In the inspection report, note the appropriateness of each installed measure and the quality of the workmanship.

Set Back Thermostat (Slide #57)

Photo: An ENERGY STAR qualified programmable thermostat.

Did someone explain to the homeowner how to operate the new smart thermostat?

Does it seem to work?

Does the client use its features?

Did the client receive education on use, and did s/he get the instruction booklet?

Subspace (Slide #58)

- Evaluate the subspace for weatherization measures, too. Subspaces include full basements and crawl spaces.
- Determine whether the subspace is conditioned or unconditioned, because this will indicate which measures should have been installed.
- Inspection points in a subspace:
 - Hot water tank thermostat set point.
 - Insulation on tank and piping.
 - Furnace.
 - Windows.
 - Foundation walls.
 - **Band joist** and **mud sill** – Are they sealed or insulated?
 - Bypasses through the floor.
 - Ducts.
 - Interior and exterior doors.

Q. Is this basement conditioned or unconditioned?

A. It appears to be conditioned:

No duct insulation.

No thermal boundary (insulation) in basement ceiling.

Presence of washer and dryer indicates occupants use the space.

Refer to the Basements and Crawl Spaces section of the Installer Intermediate curriculum for more details on subspace protocols.

Conditioned or Unconditioned? (Slide #59)

Conditioned

- More than 50% below grade.
- Relatively tight or unvented foundation.
- A living space.
- Intentional or unintentional space conditioning.

Unconditioned

- Less than 50% below grade.
- Leaky, vented, or severely degraded foundation.
- Not a living space.
- No intentional or unintentional space conditioning.

Retrofit strategies in subspaces should be defined by an auditor, based on whether the space is conditioned or unconditioned.

The guidelines above are somewhat subjective but a decision one way or the other drives the retrofit strategies.

- Above- or below-grade considerations are less critical than establishing whether the basement is intentionally or unintentionally conditioned.
- The presence of a washer and dryer or stored items indicates at least limited activity and could therefore qualify that area as a conditioned space.

Unconditioned Basement Retrofit Options (Slide #60)

The following measures are typically specified for unconditioned basements:

- Air seal all bypasses between the basement and house.
- Seal all return and supply ducts.
- Insulate all duct work to the recommended R-value. Insulation levels are based on cost-effectiveness criteria determined through a DOE-approved audit or priority list.
- Insulate open floor joists to the recommended R-value with insulation batts supported by wire supports, putting the **vapor retarder** to the heated side.
- Insulate closed floor cavities with dense-pack insulation.

Conditioned Basement Retrofit Options (Slide #61)

The following measures are typically specified for conditioned basements:

- Air seal the perimeter mud sill, the band joist, and all air pathways between the basement and the house.
- Seal off portions of the basement that are in unconditioned areas, such as coal bins or vented crawl spaces.
- Seal the return plenum and all return ducts for safety.
- Mechanically reconnect boots to register transitions, and repair broken trunk lines and branch ducts.
- Insulate the band joist area to the recommended R-value with polystyrene board or two-part spray foam.
- Consider insulating above-grade basement walls with two-part spray foam or batt insulation wrapped in vapor barrier.
- Use ZPD to verify that the conditioned crawl space **with reference to (WRT)** the house is close to 0 **pascals (Pa)**.

Q. If the basement is conditioned, should the entire height of the basement walls be insulated?

A. No. Insulate above-grade walls and no more than 2 feet below grade. This depth roughly corresponds to the average frost depth in cold climates. The soil becomes increasingly warmer with increasing depth, making it no longer cost-effective to insulate.

Refer to the Basements and Crawl Spaces section of the Installer Intermediate curriculum for more details on basement weatherization.

Unconditioned Crawl Space Options (Slide #62)

In some cases, it may be more cost-effective to leave the crawl space outside the conditioned space by air sealing and insulating the floor between the crawl space and the house and leaving the space unconditioned.

The following measures are typically specified for unconditioned crawl spaces:

- Remove debris and resolve moisture issues.
- Air seal the perimeter mud sill, band joist, and all air pathways between the subspace and the house.
- Seal all returns and supply ducts.
- Install a ground vapor retarder (6-mil plastic). This will help prevent ground-source moisture vapor from entering the crawl space.
- Seal foundation vents. This will prevent moisture-laden air from entering the crawl space, where it can condense on cold surfaces.
- Insulate ductwork to the recommended R-value.
- Insulate floor joists to the recommended R-value.

The floor becomes the pressure and thermal boundary.

Bulk moisture problems such as standing water in the subspace caused by poor drainage around the foundation must also be resolved.

Although the floor is now the primary air barrier, some programs also air seal the perimeter mud sill and band joist to prevent outside air from washing underneath or penetrating the floor insulation.

Conditioned Crawl Space Options (Slide #63)

- Many building scientists have found that creating a conditioned crawl space is beneficial for maintaining the building's integrity. Crawl space conditioning also increases surface temperatures of pipes and ducts, thereby preventing condensation problems.
- Several WAP programs have embraced crawl space conditioning and have the methods and techniques in place to do it.
- The following measures would typically be specified for conditioned crawl spaces:
 - Moisture issues resolved.
 - Ground vapor retarder (6-mil plastic) installed.
 - Foundation vents sealed.
 - Band joist, cracks in the foundation, access door, etc. sealed.
 - All air bypasses through floor of house sealed.
 - All returns and supplies sealed.
 - Foundation walls insulated with two-part foam or fiberglass insulation wrapped in vapor barrier.
- Duct runs may be left uninsulated.

Subspace Air Sealing (Slide #64)

Photo on the left: Unsealed plumbing penetration.

Photo on the right: Sealed plumbing penetration.

Subspace Air Sealing (Slide #65)

Photo on the left: Great air sealing job on the old basement stairwell.

Photo on the right: Mobile home belly penetration sealed but note the poor quality workmanship.

Were major air leakage sites sealed?

Subspace Foundation and Perimeter Insulation (Slide #66)

Photo on the left: Untreated band joist and mud sill.

Photo on the right: Perimeter air sealing and insulation with two-part foam.

Was the above-grade perimeter sealed and insulated?

Subspace Foundation and Perimeter Insulation (Slide #67)

Photo: Perimeter is only partially insulated with big air chases between masonry and furred-out walls.

Subspace: Under Floor Insulation (Slide #68)

Photo on the left: Collapsed insulation on a mobile home belly left untreated.

Photo on the right: Missing floor insulation.

Was the space under the floor insulated where applicable?

Basement and Crawl Space Sidewall Insulation (Slide #69)

Photo on the left: Two-part foam insulation on basement wall.

- In cold climates, insulation should not extend more than 2 feet below grade.

Photo on the right: Insulation on crawl space foundation.

Were foundation walls insulated where applicable?

Vapor Retarder Added (Slide #70)

Photos: Properly applied vapor retarders should overlap and have 100% coverage.

Was a ground vapor retarder installed?

Where's the Ground Cover? (Slide #71)

Photo: Picture of a crawl space

- If there's enough room to insulate the floor, there's enough room to install a ground cover (vapor retarder). If vapor retarders/ground covers are required by the local field guides, and there is no valid reason in the file for not installing this measure, send the weatherization team back!
- Note that the quality of the floor insulation work is poor. The report should indicate this.

Health-and-Safety-Related Subspace Repairs (Slide #72)

Photo on the left: A badly crimped flex vent

Photo on the right: Smooth metal vent

Were H&S repairs performed and documented?

- The crimped flex vent at the back of the dryer should be replaced with a smooth metal vent and terminated outdoors.

Q. Other than dryer vents, what are some subspace repairs that may be allowable under health and safety?

A. Sump pump repairs, water pump repairs, dehumidifiers.

Refer to the Dryer Vents section of the Installer Intermediate curriculum for more details on dryer exhaust protocols.

Window Replacement (Slide #73)

Photo on the left: Severely degraded windows may be candidates for replacement.

Photo on the right: A large combination unit with a **U-value** (rate of heat loss) of 0.20 replaces a fixed unit of multiple single-pane sections.

Were window replacements performed?

- Count the replacement windows to verify the number claimed vs. the number installed.
- Refer to the auditor's house diagram to be sure the correct windows were replaced.

Refer to the Windows and Doors section of the Installer Intermediate curriculum for more details on window and door protocols.

Storm Windows (Slide #74)

Photo: Exterior storm windows were installed as an alternative to primary window replacement.

Were storm windows installed?

Doors (Slide #75)

Photo on the left: The door qualifies for replacement because it is deteriorated and beyond repair.

Center photo: New ENERGY STAR door with R-6 rating

Photo on the right: Mobile home door replacement.

Were doors replaced?

- Door replacements are not often cost-effective because of their high cost and relatively low impact on energy savings.
- Best practice for the local agency is to include photo documentation of the original door in the client file. This provides proof that the existing door was beyond repair.

A+ for Workmanship! (Slide #76)

Photo: Combination door and window unit was built on site to replace a defective sliding glass door.

- This labor-intensive retrofit done as an incidental repair is an example of high-quality workmanship in WAP.

Door Weatherstripping/Thresholds/Sweeps (Slide #77)

Photo on the left: Door seals effectively and latches correctly (good).

Center photo: Weatherstrip is pulled away (bad).

Photo on the right: Great example of a built-up, sealed, and insulated bulkhead door to the conditioned basement.

Were door weatherstrips, sweeps, or thresholds installed?

- Leaky doors can be the cause of significant air leakage and comfort issues due to operational problems and poor seals.

Sunscreens/Films (Slide #78)

- Shading or applying **solar film** (also known as **window film**) to certain windows and doors can drastically reduce home solar gain during the cooling season. Solar film is sometimes recommended for:
 - South-, west-, and east-facing windows not shaded during the cooling season.
 - Rooms overheated by **solar gain**, causing an increase in air-conditioner use.
- The window in the photo is already shaded by a nearby tree. The auditor should have evaluated **solar exposure** to determine cost-effectiveness of window shades or solar films.

Refer to the Cooling Measures section of the Energy Auditor – Single Family curriculum for more details on sunscreens and shading.

Window Film Guidelines (Slide #79)

Photo: Film is applied to the cleaned interior of eligible windows and doors and smoothed.

- Standards vary by climate region. The following window characteristics were found to be cost-effective in Pennsylvania:
 - The **shading coefficient (SC)** is 0.40 or less.
 - The shading coefficient is a decimal describing how much solar energy is transmitted through a window opening compared to clear single glass, which has an SC of 1.0. For example, reflective glass has an SC of 0.20 to 0.45.
 - The U-value of the window is 1.0 or lower.
 - Total solar energy rejected is at least 65%.
 - The percent of solar energy rejected equals **solar reflectance** plus the part of **solar absorption** that is reradiated outward. Solar reflectance and absorption are expressed as percents of the total solar energy falling on the surface (in this case, the solar film).
 - The film is approved by the manufacturer for use on insulated glass and insulated panels.

Water Heater Replacement (Slide #80)

Photo on the left: Leaking, rusty original tank.

Photo on the right: Single-family home water heater installation.

Domestic water heaters are usually replaced under health and safety.

Q. What conditions may justify a water heater replacement?

A. Leaking or severely corroded tank, tank clogged by mineral deposits, inoperable water heater, unsafe operation due to flame roll-out or high CO production.

Tank Wrap (Slide #81)

The photo on the left shows a good installation in which the wrap has been properly secured with straps. Clearance to the flue pipe is maintained by not wrapping the top.

The photo on the right shows an installation of poor-quality workmanship. The wrap is unsecured and sagging.

Pipe Insulation (Slide #82)

The photo on the left shows proper clearance of the pipe insulation from the heat source of the flue and use of non-combustible fiberglass pipe wrap near the flue. Clearance should be a minimum of 6" from the heat source.

The photo on the right shows the foam pipe wrap too close to the flue pipe, causing it to melt. The insulation installed on these pipes should be at least 6" away from the flue pipe. Immediate action should be taken because this is a health and safety hazard. Also, the insulation is incomplete and poorly installed, leaving gaps.

Water Heater Safety Issues (Slide #83)

Photo on the left: Burn marks above the burner compartment are evidence of flame roll-out.

Photo on the right: Spillage of flue gases or insufficient draft is often a result of an improper installation such as this.

- Evidence of flame roll-out indicates a problem when ignition of the appliance is delayed, causing a sudden mini-explosion of unburned natural gas in the burner compartment at the bottom of the tank.

Q. What might be some reasons for this?

A: Obstruction in the flue running up through the center of the tank, improper mix of fuel and oxygen, and/or dirty burner ports.

Q. Let's say the hot water tank pictured on the right was found to have a spillage problem. Based on what you see in the picture, what might be the reason for this?

A. Improper slope of the vent to the chimney.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on hot water tanks and combustion safety protocols.

Lighting (Slide #84)

- Count the **compact fluorescent lights (CFLs)** installed.
- CFLs should be installed by the agency and not left for the client to install.
- At a minimum, bulbs that are used more than 2 hours per day should be replaced.

Refer to the Base Load Measures section of the Energy Auditor – Single Family curriculum for more details on lighting upgrades.

Refrigerator Replacement (Slide #85)

- Refrigerator replacement should be considered if it meets the minimum use threshold to replace by metering or by using a DOE-approved refrigerator database.
- Only one refrigerator per home may be replaced.
- Old refrigerator/freezer units must be removed and **decommissioned**.

Refer to the Base Load Measures section of the Energy Auditor – Single Family curriculum for more details on refrigerator testing and upgrades.

Refer to the Refrigerator Info Toolkit for DOE protocols.

Smoke/Carbon Monoxide Detectors (Slide #86)

Where combustion appliances are present, one CO detector should be placed on every level of the house (conditioned spaces only).

Smoke and CO detectors are energy-related health and safety measures.

Q. Do you see anything wrong with the placement of the smoke detector?

A. The smoke detector is mounted too low. It should be at least 6” from the meeting of the ceiling and wall. This is a health and safety issue that needs to be corrected.

Other H&S Measures – Moisture and Mold (Slide #87)

Photo on the left: Damaged ceilings may indicate moisture issues.

Photo on the right: Mold on walls indicates serious moisture issues in the home. These should have been resolved before weatherization work began.

Q: Should air sealing have been performed in a home where these kinds of conditions were observed?

A: Not until the underlying causes have been resolved and the mold has been cleaned up.

Refer to the IAQ section of the Energy Auditor – Single Family curriculum for more details on moisture and mold issues.

Cook Stove Testing (Slide #88)

Photo of dirty burners on a typical gas cook stove.

- Dirty burners can impede a proper flame, causing carbon monoxide to form.

Why test gas cook stoves?

- People sometimes use them as a heat source, and elevated levels of CO from gas stoves are common.
- CO kills.
- Knowledge implies action.
- Gas- and propane-fired cook stoves release combustion byproducts into the air. They must be repaired if CO exceeds suggested **action levels**:
 - o Range-top burner – 25 **parts per million (ppm)**, as measured.
 - o Oven – 100 ppm, as measured.
- Corrective actions can include repair, cleaning, or adding mechanical ventilation.
- Stove testing should be documented in the client file.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on stove testing and combustion safety protocols.

Mechanical Ventilation – Kitchens (Slide #89)

Photo on the left: CO levels were reported at 72 ppm.

- Pre- and post-weatherization blower door tests showed a house-wide reduction from 4,178 **cubic feet per minute (CFM)₅₀** to 1,978 CFM₅₀. This lowered dilution rate could result in higher ambient concentrations of CO from the cook stove. Installation of a kitchen exhaust fan vented to the outdoors is therefore recommended.

Photo on the right: New range hood installed over a previously unvented cook stove.

- When there are no mechanical exhaust fans in the bathroom and kitchen, or the ones installed can't be serviced, new ones should be installed. This is especially true in a kitchen where a gas cook stove is served by an unvented recirculating range hood fan.

Refer to the Mechanical Ventilation section of the Installer Intermediate curriculum for more details on mechanical venting protocols.

Mechanical Ventilation – Bathrooms (Slide #90)

Photo on the left: Non-functional bath fan.

Photo on the right: Installation of a new bath fan.

- Bathrooms are typically high moisture areas. Programs should replace non-functioning fans and install new ones where none exist.
- Tightening a home lowers the dilution rate and additional mechanical ventilation may be necessary to prevent moisture and mold problems.

Refer to the Mechanical Ventilation section of the Installer Intermediate curriculum for more details on mechanical ventilation protocols.

Worst-Case Combustion Safety Testing (Slide #91)

- CAZ testing on vented combustion appliances helps determine if combustion appliances will vent under worst-case conditions, protecting the occupant from the hazards of draft reversal.
- The agency should have performed the following three tests under worst-case conditions during the audit and final inspection of all vented combustion appliances:
 - Spillage test.
 - Draft test.
 - CO test.
- Unsafe appliances should have been deactivated until hazards were mitigated.
- The results of these tests must be documented in the client file.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety protocols.

Summary (Slide #92)

Technical monitors and inspectors should:

- Understand the concept of the air barrier and thermal boundary.
- Recognize whether appropriate energy-savings measures were installed.
- Determine whether there were missed opportunities.
- Evaluate whether energy-related repairs and health and safety measures were justified.
- Decide whether measures installed match the audit and work order and were installed as billed.
- Judge whether installed measures meet weatherization program specifications and standards for quality workmanship.



TECHNICAL MONITOR/INSPECTOR

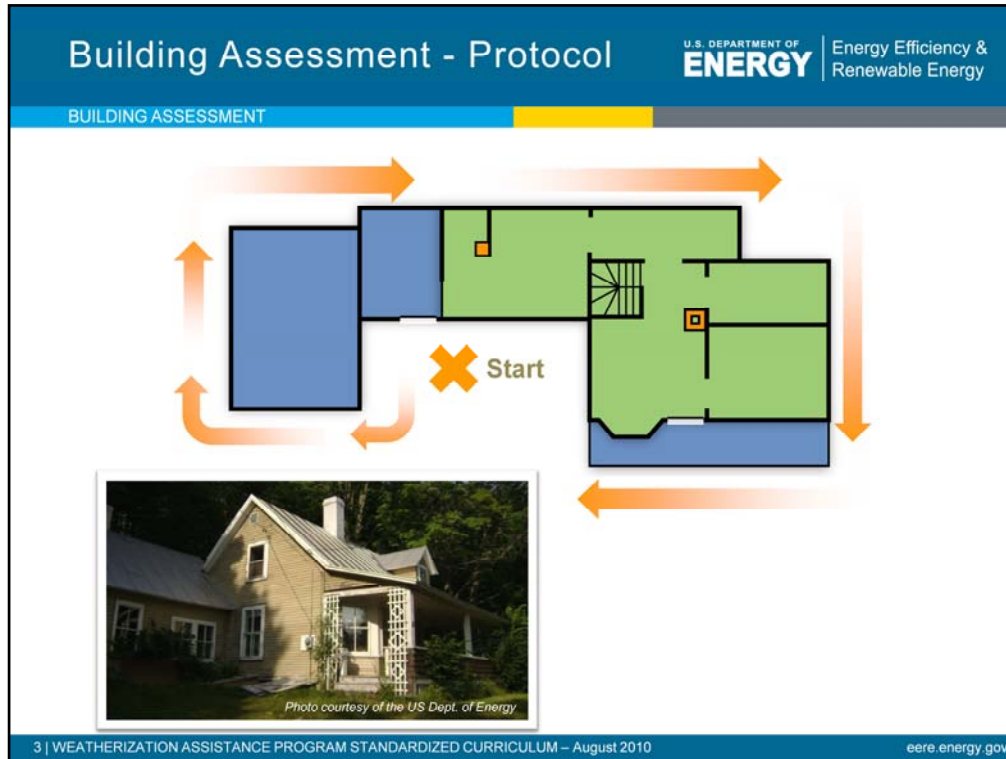
Building Assessment

This session will introduce participants to evaluating whether:

- Appropriate energy savings measures were installed.
- The thermal boundary was appropriately treated.
- Opportunities for air sealing or insulating were missed.
- Energy-related repairs and health and safety measures were justified.
- Installed measures match the audit and work order.
- Measures were installed as billed.
- Installed measures meet standards for quality workmanship.

This session will introduce participants to evaluating whether:

- Appropriate energy savings measures were installed.
- The ***thermal boundary*** was appropriately treated.
- Opportunities for air sealing or insulating were missed.
- Energy-related repairs and ***health and safety (H&S)*** measures were justified.
- Installed measures match the audit and work order.
- Measures were installed as billed.
- Installed measures meet weatherization standards for quality workmanship.



Develop a site visit protocol and follow it at each dwelling.

- Snap a picture of the front of the house. Include the street number.
- Walk around the outside, noting any conspicuous features such as ***cantilevers*** or ***tuck-under garages***.
- Upon entering, introduce yourself to the occupant(s) and explain why you are there. Ask how they were treated by the weatherization crew, if they are satisfied with the work, and if they have any questions.
- Use the same walk-through pattern in every house: e.g., top down and clockwise or bottom up and counterclockwise, whichever is most comfortable for you. Following the same pattern every time reduces the chance you'll miss something.

Take pictures of everything! Multiple houses soon run together in your mind. Pictures will help jog your memory.

Measure Assessment		U.S. DEPARTMENT OF ENERGY	Energy Efficiency & Renewable Energy
BUILDING ASSESSMENT			
Note the following in the inspection report for each measure that could have been considered for the home: ☐ Item was on the work order. • If it was not on the work order, note whether the site visit indicates that it should have been. • If the measure was on the work order, note the quality of the installation. For example: ☐ Work appears to have been performed to standards. ☐ Work appears to have been performed, but cannot verify (no access to area). ☐ Work appears to have been performed to standards, but does not reflect good workmanship. ☐ Some work was performed, but not to standards. ☐ Work does not appear to have been performed, but cannot verify (no access to area). ☐ Item was on the work order but not installed.			
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Assessing the measures installed in a home includes evaluating not only whether the measures were installed correctly, but also whether they should have been called for in the first place. The inspector/monitor is looking at the home much like an auditor would, determining what should have been installed.

Note the following in the inspection report for each measure that could have been considered for the home:

- Was the item on the work order?
 - o If it was not on the work order, note whether the site visit indicates that it should have been.
- If the measure was on the work order, note the quality of the installation. For example:
 - o Work appears to have been performed to standards.
 - o Work appears to have been performed, but cannot verify (no access to area).
 - o Work appears to have been performed to standards, but does not reflect good workmanship.
 - o Some work was performed, but not to standards.
 - o Work does not appear to have been performed, but cannot verify (no access to area).
 - o Item was on the work order but not installed.

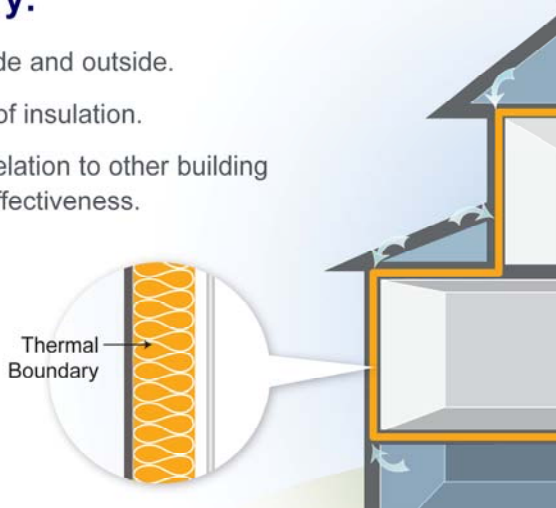
Thermal Boundary

U.S. DEPARTMENT OF
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BUILDING ASSESSMENT

The Thermal Boundary:

- Limits heat flow between inside and outside.
- Easy to identify by presence of insulation.
- The location of insulation in relation to other building components is critical to its effectiveness.
- Even small areas of missing insulation are very important.
- Voids of 7% can reduce effective R-value by almost 50%.



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The thermal boundary is the insulation.

- The thermal boundary limits heat flow.
- It is usually easy to identify by the presence of insulation.
- The location of insulation in relation to other building components is critical to its effectiveness. Air passing through insulation takes heat and moisture with it.
- Even small areas of missing insulation are critical to address. Voids of 7% can reduce the effective **R-value** by almost 50%.
 - o The effective R-value in the attic of a 1,000-square-foot single-story rambler insulated to R-38 falls to an effective R-value of only 19 when 70 square feet of insulation is pushed aside. This would be the case if the installer didn't blow cellulose insulation right up to the edges, instead of installing soffit baffles and chimney dams and blowing to the proper depth throughout the attic.

Common insulation materials include fiberglass batts and blown-in cellulose. **Vermiculite** is a naturally occurring mineral that was commonly used for loose-fill insulation in the walls and attics of older homes until fiberglass and cellulose insulation gained more widespread use in the 1950s and '60s.

If the **thermal boundary** and **air barrier** are continuous and in contact with each other, air will not pass through the insulation.

It is common for cold air to bypass the insulation, not just in low-income homes, but in large, new homes as well.

Q. What materials serve as both a thermal boundary and air barrier?

A. Foam board.

Spray foam.

Dense-pack insulation, properly installed, greatly reduces air flow.

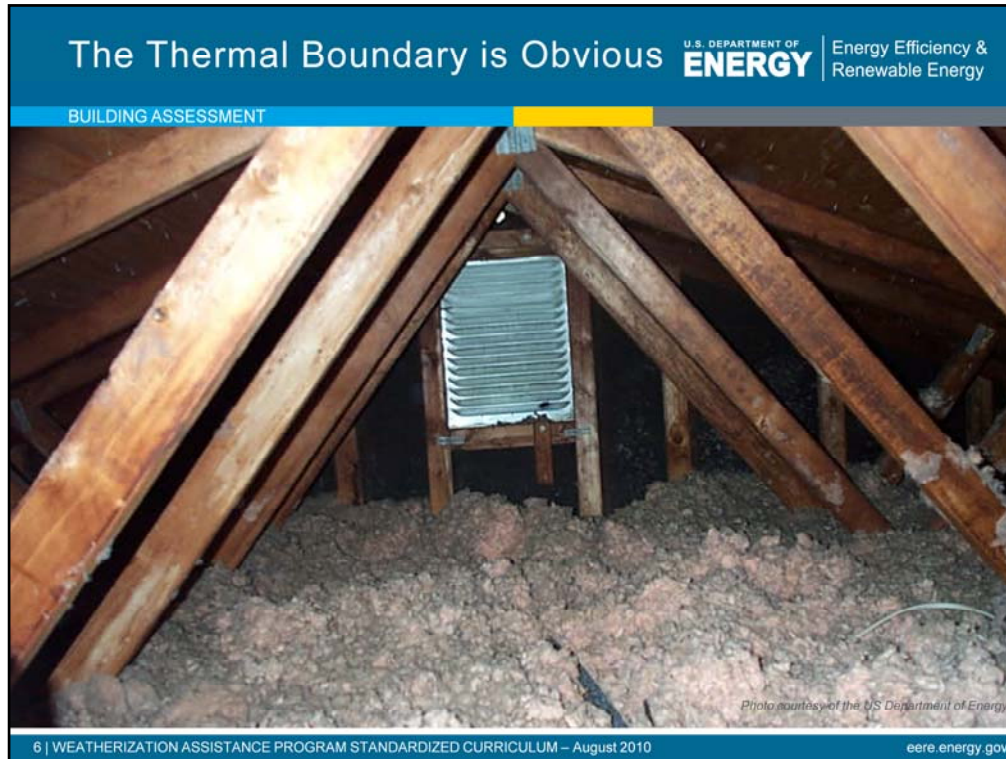


Photo of an insulated attic.

Q. Where is the thermal boundary?

*A. In this case, the thermal boundary is the insulated ceiling that separates the unconditioned attic from the conditioned space below. The thermal boundary cannot always be determined through visual inspection. **Zonal pressure diagnostics (ZPD)** is one of the best ways to determine the location and condition of the thermal boundary and air barrier.*



- Here's a case in which the installers misidentified the location of the thermal boundary. The installers wrapped the gable end wall of an attic with bubble wrap, which is like insulating a cold space (the attic) from another cold space (outside). The ceiling floor adjacent to the living space below is the thermal boundary.

Thermal Boundary & Air Barriers

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

BUILDING ASSESSMENT

For maximum efficiency and comfort, the thermal and air barriers must be continuous and in contact with each other.

Thermal Boundary

Air Barrier

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- Again, for maximum efficiency and comfort, the thermal boundary and air barriers must be continuous and in contact with each other.
- Successful evaluation of building shell measures such as air sealing and insulation is tied to an inspector's ability to identify the thermal boundary and determine whether the thermal boundary and air barriers are in alignment.

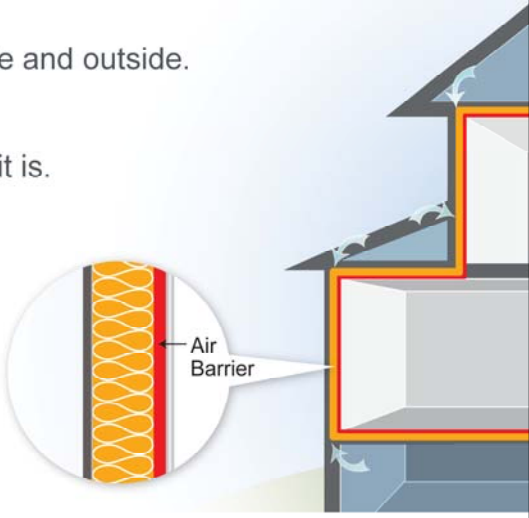
Air Barrier

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency & Renewable Energy

BUILDING ASSESSMENT

The Air Barrier:

- Limits air flow between inside and outside.
- More difficult to identify.
- Not always where you think it is.
- Blower door is used to locate air barrier.

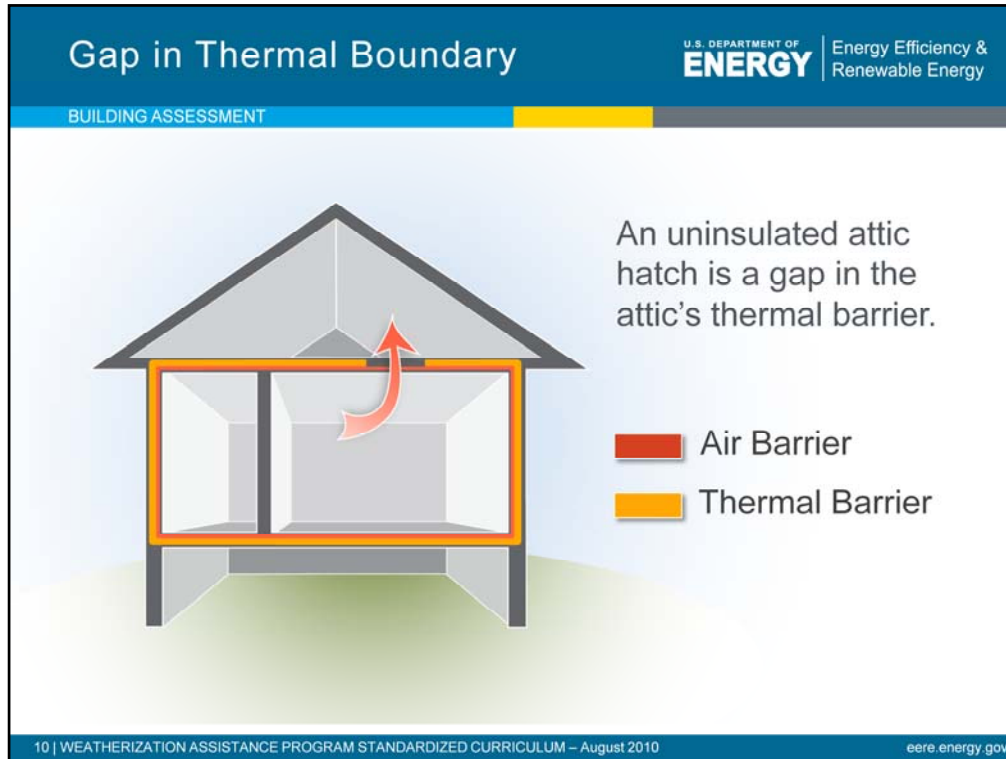


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- The air barrier:
 - Limits air flow between inside and outside, and the heat and moisture carried by that air.
 - Is more difficult to identify than the thermal boundary, because it can be hard to see.
 - Is not always where you think it is.
- Pressure readings taken with the blower door running are used to locate air leakage and the air barrier.

Q. What is the air barrier in most homes?

A. Usually it's the interior drywall.



An uninsulated attic hatch is a gap in the attic's thermal boundary.

Q. What are some examples of gaps in the thermal boundary?

A. Insulation voids in exterior walls, uninsulated door to an unheated garage.

Attic Spaces

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BUILDING ASSESSMENT

Note the following in attic spaces:

- Components of the thermal boundary.
- Physical features (floored or open-framed ceiling, condition of ceiling, attic hatches and doors).
- Installed insulation levels.
- Air bypass sealing.
- Insulation level of duct systems if present.
- Evidence of condensation-based moisture problems or roof leaks.
- Attic ventilation.
- Whether mechanical and plumbing terminations are vented to outside.
- Knob-and-tube wiring and other electrical hazards.
- Properly dammed heat producing devices, accesses, and eave chutes.

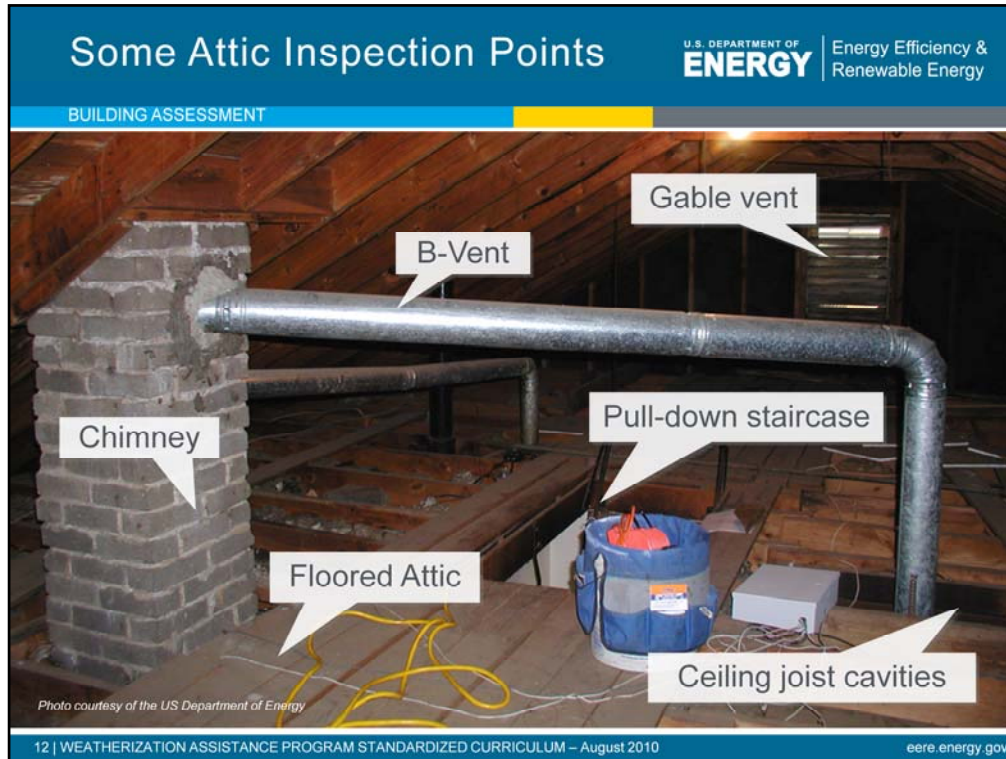
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Note the following in attic spaces:

- Components of the thermal boundary.
- Physical features (floored or open framed ceiling, condition of ceiling, attic hatches and doors).
- Installed insulation levels.
- Air bypass sealing.
- Insulation level of duct systems if present.
- Evidence of **condensation**-based moisture problems or roof leaks.
- Attic ventilation.
- Whether mechanical and plumbing terminations are vented to the outside.
- **Knob and tube wiring** and other electrical hazards.
- Properly dammed heat-producing devices, accesses, and eave chutes.

Refer to the Attic Insulation section of the Installer Intermediate curriculum for more details on attic insulation protocols.



Point out some attic inspection points:

Chimney

B-vent

Gable vent

Floored attic

Pull-down staircase

Ceiling joist cavities

Attic Air Sealing

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BUILDING ASSESSMENT

Was attic air sealing performed?



Unsealed plumbing chase.



Large unsealed void.

Photos courtesy of the US Department of Energy

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Photo on the left: Large unsealed void.

Photo on the right: Unsealed plumbing chase.

- An inspector can usually observe attic air sealing deficiencies by pulling back some insulation to see if attic air sealing was performed. Trace wiring and plumbing penetrations.
- In the inspection report, for each installed measure note the appropriateness of the measure and the quality of the workmanship, addressing the issues in the sample site inspection QA form.

Hand out the Sample Site Inspection QA form. Refer to it as each new measure is presented for the remainder of the presentation. Have students determine which box they would check for each photo shown.

Was attic air sealing performed?



Properly sealed partition wall prior to insulation.



Entire length of top of marriage wall in a modular home was left unsealed prior to insulating attic.

Photos courtesy of the US Department of Energy

Photo on the left: Properly sealed partition wall before insulation.

Photo on the right: Top of marriage wall in a modular home left unsealed before insulating attic.

Was attic air sealing performed?

- It is often difficult to determine the extent of air sealing work once an attic has been insulated. Inspectors can spot check in obvious places, such as around chimneys or above ***dropped soffits***.

Attic Air Sealing

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BUILDING ASSESSMENT

Was attic air sealing performed?



Heat producing chimney
sealed with high temp caulk.



One or two part foam used
to seal common attic leaks.

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Photo on the left: Heat-producing chimney sealed with high-temperature caulk.

Photo on the right: One- or two-part foam used to seal common attic leaks.

Was attic air sealing performed?

- It is important to determine the correct application of materials.

Attic Insulation

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BUILDING ASSESSMENT

Was attic insulation installed?



Photo courtesy of the US Department of Energy

Nice even blanket of insulation of sufficient depth.

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Photo: Here's a nice even blanket of insulation at sufficient depth.

Was attic insulation installed?

- Accurate bag counts can help assure that the material claimed matches the quantity of insulation installed.
- For example: Assuming that one bag of cellulose insulation will cover approximately 18.3 ft² of attic space to achieve R-40, a 1,000 ft² attic would require approximately 55 bags of cellulose to achieve R-40 throughout (1,000/18.3), assuming there was no existing insulation.

Refer to the Math Basics section of the Energy Auditor – Single Family curriculum for guidance on estimating material quantity.

Attic Insulation

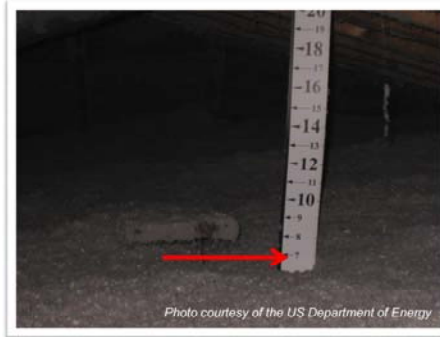
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BUILDING ASSESSMENT

Was attic insulation installed?



Uneven coverage.



Insufficient depth of
insulation.

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Photo on the left: Uneven coverage.

Photo on the right: Insufficient depth of insulation.

- A state priority list or approved audit determines the desired final R-value. In most northern climates, the goal is R-38, or about 10.5” of blown-in cellulose. Uneven coverage results in variable R-values throughout the attic.

Attic Insulation

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BUILDING ASSESSMENT



Photo courtesy of the US Department of Energy

Insufficient density of insulation in floored attic.

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Floored attics are closed cavities and must be dense packed. Pull up a floor board and test the density with your hand. If you can move your hand through the material with ease, air can get through it. It should be so dense that it's difficult to poke your fingers through it and it springs back after you touch it.

Questionable Roof Application

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BUILDING ASSESSMENT



A beautifully done insulated rubber roof system....but!

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Here's a beautifully installed insulated rubber roof system, but...

- This insulated EPDM rubber roof system was not modeled in the building audit and therefore not cost justified. The nearly \$3,000 installed cost included sheets of 2" R-12 extruded polystyrene insulation, which accounted for only 15% of the cost. In addition, the rubber roof membrane is black, which has no reflective (cooling) value.

An important function of an inspector is to determine whether a U.S. Department of Energy (DOE)-approved priority list or audit confirmed that measures installed under the Weatherization Assistance Program (WAP) were cost-effective.

Ethylene Propylene Diene Monomer

Attic Insulation Certificate

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BUILDING ASSESSMENT

Was an insulation certificate completed and posted?

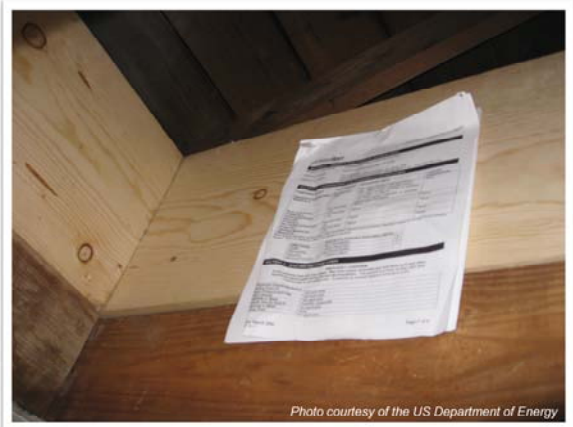


Photo courtesy of the US Department of Energy

Insulation certificate completed and posted in a convenient location.

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Photo: Insulation certificate completed and posted in a convenient location.

Was an insulation certificate completed and posted?

- The insulation certificate should note the company name, R value, number of bags, square footage of coverage, date of installation, ASTM standard and be posted so that it is visible from the attic access.
- Note the stout insulation dam constructed of dimensional lumber. Fiberglass batts or insulation board are not typically acceptable access dams. Refer to local field guides for local standards.

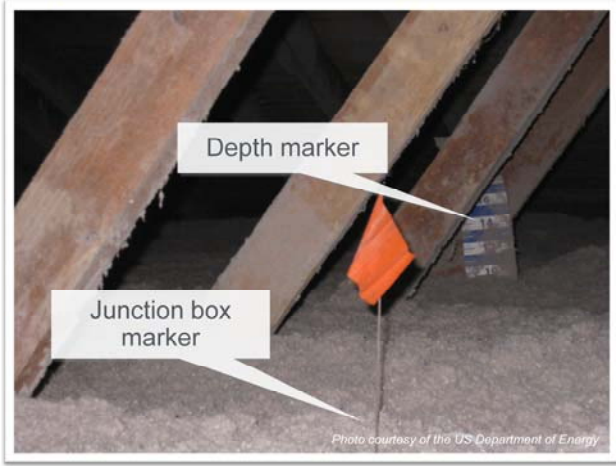
Depth and Electrical Markers

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BUILDING ASSESSMENT

Were insulation depth markers and electrical junction box markers present?



Depth marker

Junction box marker

Photo courtesy of the US Department of Energy

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Photo: Electrical junctions should be clearly marked to enable an electrician to reach them in the event of an electrical problem.

- One insulation depth marker should be placed at every 300 ft² of attic space.

Heat Sources & Vent Damming

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BUILDING ASSESSMENT

Were heat sources and vents properly dammed?



Good

Properly applied dam around a chimney.



Bad

Lack of a code approved dam could cause a fire.

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Photo on the left: Insulation dams must be properly applied around heat-producing devices such as chimneys.

Photo on the right: Insulation blown tight against an active chimney could cause a fire.

Q. Name another heat source that must be dammed.

A. Non-IC-rated recessed can lights must be covered with a non-combustible dam such as drywall and have a 3" clearance around the sides and top of the fixture.

Attic Access Insulated & Secured

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BUILDING ASSESSMENT

Was attic access properly insulated, weatherstripped and secured?



Weatherstripped, insulated and secured. Good job.



Uninsulated, not weatherstripped, no insulation dam.

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Photo on the left: Insulated, weatherstripped, and secured – good job.

Photo on the right: Uninsulated, not weatherstripped, no insulation dam.

Was the attic access properly insulated, weatherstripped, and secured?

Q. Give an example of another type of attic access and how it should be treated.

A. Another type of access is a full-sized standard door leading to an attic walk-up staircase. If the stairway is considered outside space, e.g., the top of the stairway wasn't topped with an insulated tent, then you would hope to see weatherstripping and a door sweep, the same way an exterior door would be treated. In this situation, the cold side of the door should be insulated with rigid insulation, and the walls of the stairway dense-packed.

Pull down staircase cover

- Pull down staircase cover insulated and sealed with a commercially available or fabricated lid.
- Should be the same R- value as the rest of the attic.



Photo: Pull-down staircase cover insulated and sealed with a commercially available or fabricated lid.

- In all cases, insulation on top of an attic hatch should be the same R-value as the rest of the attic.

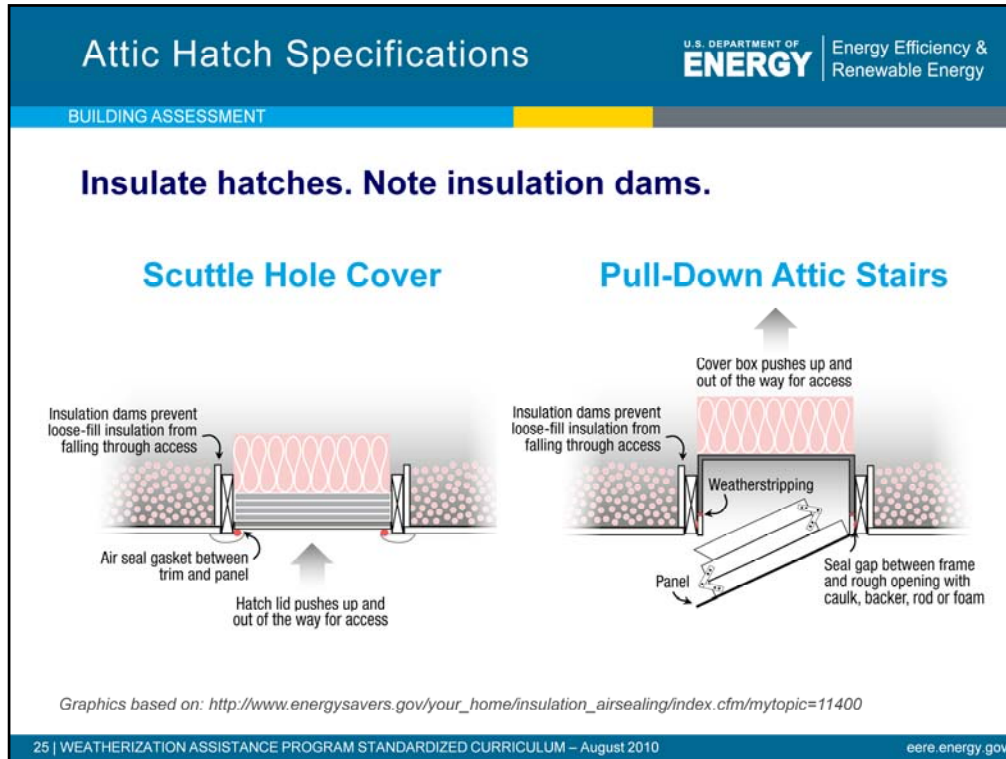


Illustration on the left: Scuttle hole cover.

Illustration on the right: Pull-down staircase.

- Attic hatches must be weatherstripped and insulated to the same R-value as the rest of the attic.
- Pull-down staircases present a special challenge since they protrude into the attic when folded up. You should see a fabricated or commercially available insulated cover.
- Insulation dams around attic hatches should be constructed of lumber in a way that can hold the weight of people entering and exiting the attic. Structurally weak materials such as fiberglass batts, metal coil stock, or rigid insulation are typically unacceptable. Refer to local field guides for local standards.

Health & Safety Related Attic Repairs

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BUILDING ASSESSMENT

Were health and safety repairs performed and documented?



Uncovered electrical junction



Disconnected vent fan

Photo courtesy of the US Department of Energy

Determine if all electrical junctions and vented appliances are vented to the outside.

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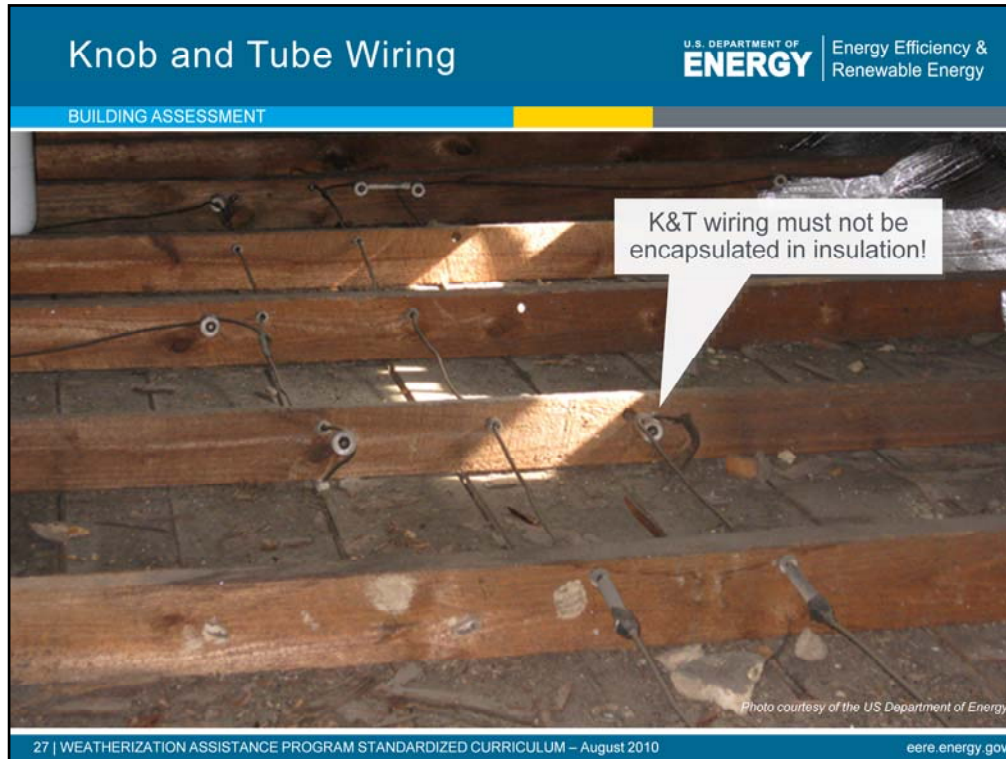
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Photo on the left: Uncovered electrical junction.

Photo on the right: Disconnected vent fan.

Were H&S repairs performed and documented?

- Determine if all electrical junctions are covered and vented appliances are vented to the outside.



- Knob and tube wiring must not be encapsulated with insulation, per the ***National Electrical Code (NEC)***.
- Knob and tube wiring may be brought up to code as an energy-related repair, but the cost must be rolled into the total project cost. The whole job must maintain a ***savings-to-investment ratio (SIR)*** of greater than or equal to 1.

Sidewall Insulation

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BUILDING ASSESSMENT

Was sidewall insulation installed?

Uniform light color without dark areas indicate complete insulation coverage.



11/28/07 6:42:52 p e=0.99

Dark areas indicate insulation voids.



11/30/07 4:22:53 p e=0.99

When IR imaging on a cold day, with the camera set up as this one is, light is good and dark is bad. It's just the opposite on a warm day.

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Photo on the left: Uniform light color without dark areas indicate complete insulation coverage.

Photo on the right: Dark areas indicate insulation voids.

Was sidewall insulation installed?

- **Infrared (IR) thermography** is an excellent tool for evaluating hidden sidewall insulation coverage. With the camera set up as shown here, when interpreting **infrared images** on a cold day, light is good and dark is bad. It's just the opposite on a warm day.
- Accurate bag counts can help assure that material claimed matches the quantity of installed insulation. Claimed bag counts can usually be verified by looking at a contractor's invoice or a daily in-out inventory sheet as recorded by a crew supervisor.
- For example, a 4" thick, 1,000 ft.² wall, blown with cellulose at a density of 3.5 lbs per ft.³, should contain approximately 11 thirty-pound bags of insulation.

Refer to the Dense-Pack Sidewall Insulation section of the Installer Intermediate curriculum for more details on sidewall insulation protocols. Refer to the Math Basics section of the Energy Auditor – Single Family curriculum for guidance on estimating material quantity.

Sidewall Insulation

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BUILDING ASSESSMENT

What about walk up attic stair cases?



Photo courtesy of the US Department of Energy

Yes, they should be addressed!

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Photo: Walk-up staircase.

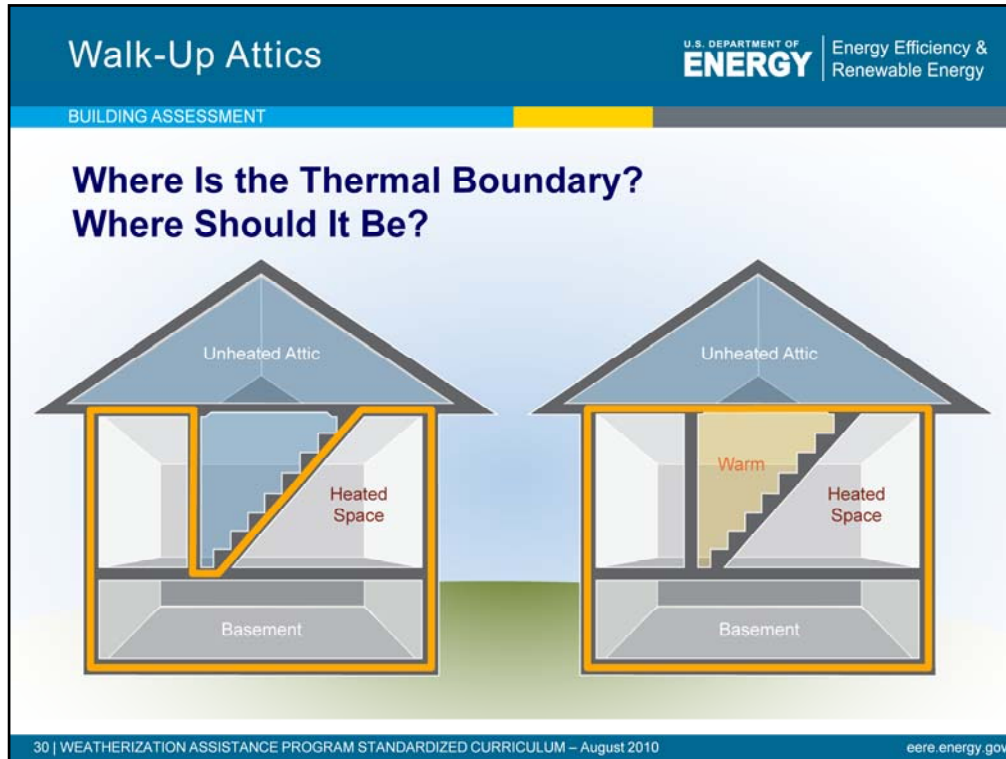
What about walk-up attic staircases?

Yes, they should absolutely be insulated!

- If the top of them isn't treated, walk-up attic staircases should be treated like exterior sidewalls because these surfaces separate conditioned from unconditioned areas.
- The staircase walls and stair risers should be dense packed with **loose-fill insulation** where possible.

Q. Can you think of any other sidewalls that should be insulated?

A. A wall between a kitchen and an attached garage or between an unheated porch and a living room.



Q. Where is the thermal boundary? Where should it be?

A. It should enclose the conditioned space and nothing else. If occupants use the attic often, the thermal boundary might encompass the stairwell leading up to the attic, effectively putting the staircase outside.

The thermal boundary can be tricky to determine. It depends on how the occupant uses the house and what's considered conditioned space.

- In this illustration, the staircase and the door leading to the unheated attic are part of the thermal boundary. The auditor may opt to improve the existing thermal boundary by air sealing the attic staircase and access door, as illustrated on the left.
- Alternatively, if the occupants don't use the attic often, the auditor may decide to create a new thermal boundary by calling for a removable lid that is air sealed and insulated, as pictured on the right.
- The staircase then becomes part of the conditioned space by default. That space must be conditioned to prevent condensation problems. Thinking about these issues helps the inspector evaluate the location of the thermal boundary.

Kneewall Insulation in a Cape Attic

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BUILDING ASSESSMENT

Was knee wall insulation installed?



Kneewall insulated and covered (good).



Kneewall insulated but not covered (bad).

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Photo on the left: ***Knee wall*** insulated and covered (good).

Photo on the right: Knee wall insulated but not covered (bad).

Was knee-wall insulation installed?

- For exposed fiberglass wall insulation to be effective, it must be enclosed with air-impermeable plastic or house wrap.

Q. What are other insulation options for knee walls?

A. Spray foam insulation, which must be enclosed if it is in a living space; blown-in insulation held in place with webbing stapled to studs.

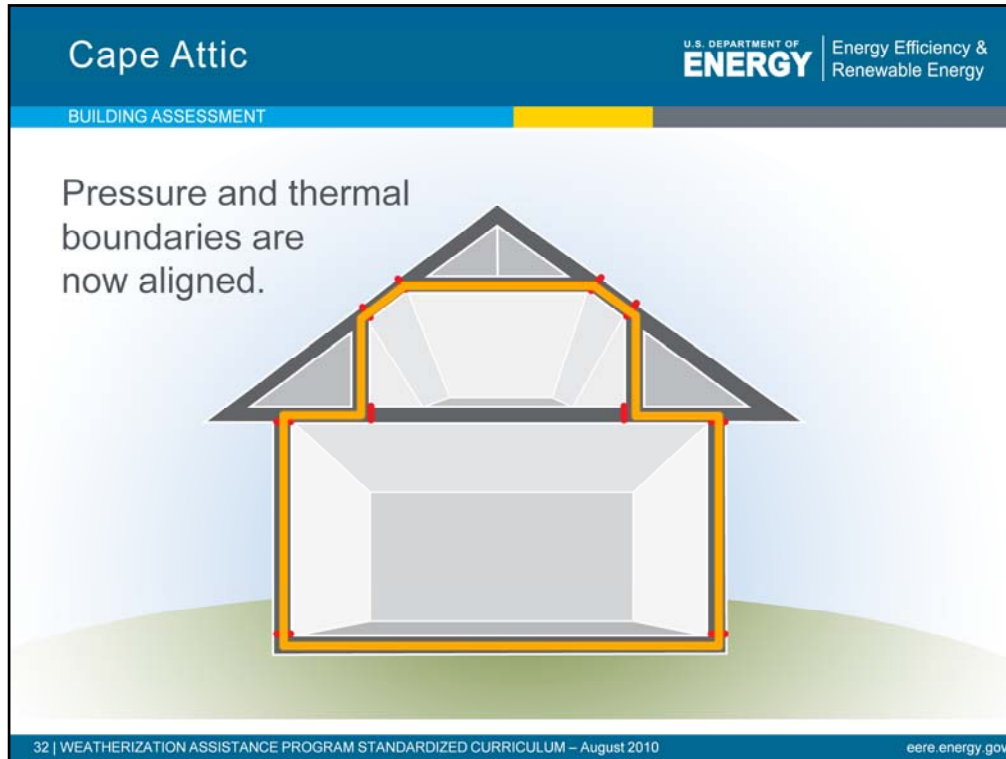


Illustration of how the air barrier and insulation should be aligned in a 1.5-story house with a knee wall attic.

- Note that the critical junctions in this picture have been air sealed.

An inspector/monitor would hope to find the following:

- Dense-pack insulation in the roof rafter bays.
- Appropriate R-value insulation on the knee walls – This can be batts or blown-in insulation covered with house wrap, spray foam, etc.
- Loose-fill insulation of appropriate R-value on the knee wall attic floor and in the small triangular-shaped attic above the second-floor ceiling.

Plugs, Patches and Painting

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BUILDING ASSESSMENT

Was the finished work acceptable?



Plugs painted to match (nice touch).



Stretched and distorted siding.



Siding not properly overlapped.

Photos courtesy of the US Department of Energy

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Photos of acceptable and unacceptable work.

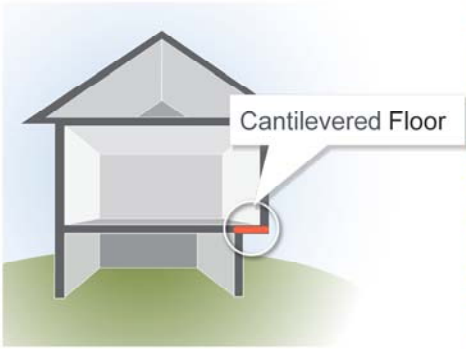
- In the inspection report, note the appropriateness of each installed measure and the quality of the workmanship.

General Air Sealing of the Building Envelope

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BUILDING ASSESSMENT

Were other special features of the building envelope adequately sealed and insulated?




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Illustration on the left: Cantilevered floor detail.

Photo on the right: Arrows pointing to floor cantilevers that need to be sealed and insulated.

Were other special features of the building envelope adequately sealed and insulated?

- Besides basements, walls, and attics, there are many special architectural features in single-family homes that may contribute to heat loss. The sequence of slides that follows will cover some of the ones that must be treated.

Refer to the Building Shell Retrofit Strategies section of the Energy Auditor – Single Family curriculum for recommended treatments of specialized building features.

Wall Repair

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BUILDING ASSESSMENT



Photos courtesy of the US Department of Energy

Poor workmanship.



Well done.

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Photo on the left: Piece of hardboard foamed in place as drywall repair is messy and borderline acceptable. Unused dryer vent pipe was left open and untreated.

Photo on the right: Good job air sealing in stairwell ceiling. Relatively neat tape coat should not need excessive sanding to finish.

- Standard minimum requirements are one (tape bedding) coat of compound for drywall patching. The quality of workmanship should be such that any reasonably competent drywall tapper can finish the wall without extra correction time and effort (no excessive sanding needed). Refer to local field guides for local standards.

Porch Roof Connections

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BUILDING ASSESSMENT

Porch roof cavity may be open to wall cavities.

Arrows indicate air escaping from back of porch roof to adjoining wall cavities.

Photo Source: U.S. Department of Energy.

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Photo of a two-story house with **balloon framing** where the porch framing could be open to the wall cavities of the house.

- The porch roof cavity may be open to wall cavities. This could be one of the largest hidden air leaks in the house, making it a good candidate for air sealing with dense-pack insulation. This should have been sealed and insulated, as blower door and IR tests would have indicated.

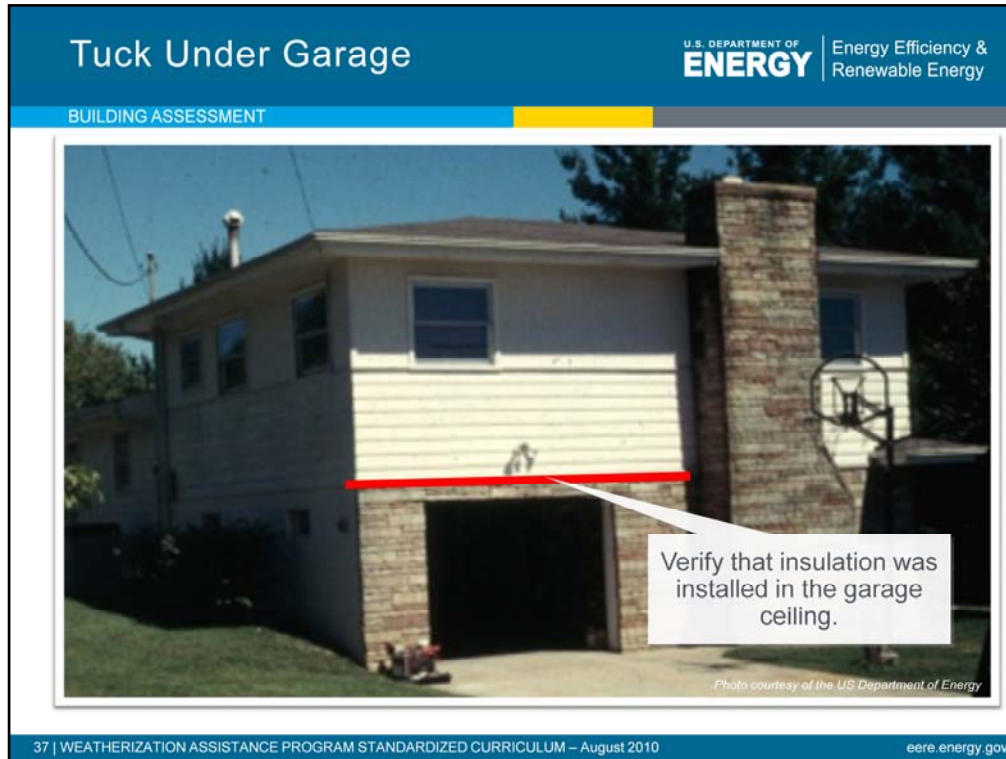


Photo of a tuck-under garage on a platform-framed house.

- Significant **conductive heat loss** is associated with a floor cavity that separates an unconditioned garage and the conditioned space above.
- If the enclosed floor cavity wasn't insulated, dense-pack insulation should have been specified and installed.

Q. What are other problems associated with tuck-under garages and what should be done about them?

*A: Air leakage between the house and garage can bring pollutants like **carbon monoxide (CO)** into the living space, creating poor and potentially deadly **indoor air quality (IAQ)**. All penetrations from the garage to the living space should be sealed.*

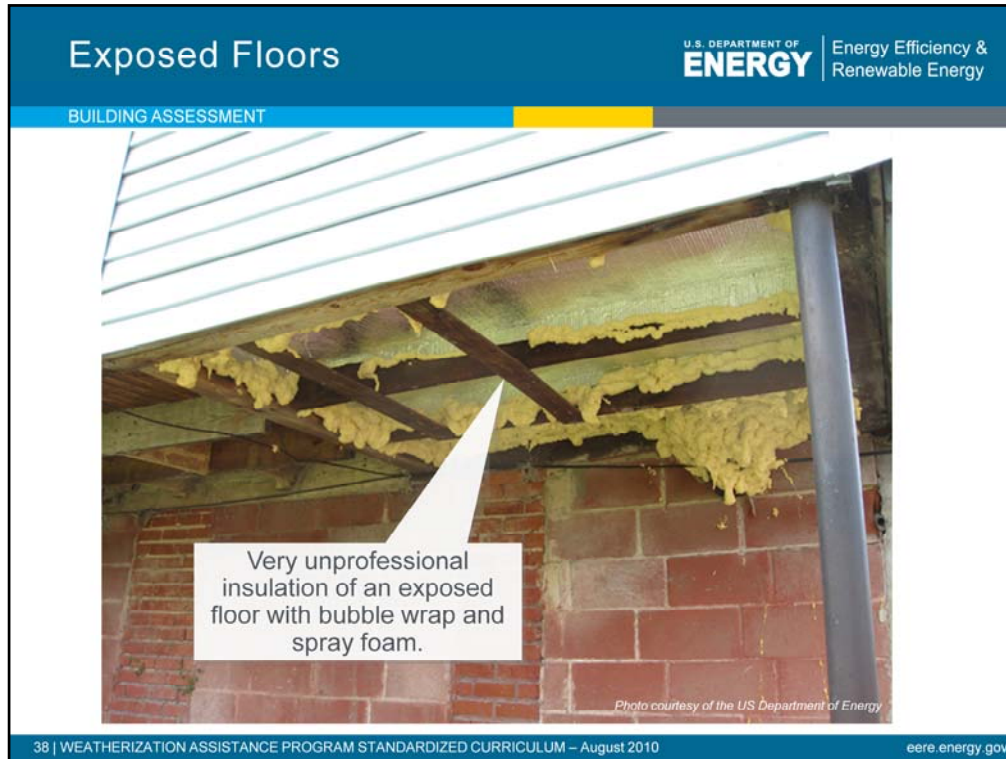


Photo of a very unprofessional job in which an exposed floor was insulated with bubble wrap and spray foam.

Q. What could have been done differently here for a more effective job?

A. Plywood or insulated sheeting could have been attached to the bottom of the floor joists, holes drilled, and joist cavities filled with dense-pack insulation.

Dropped Ceilings

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Look above tiles for hidden air leaks.



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Photo: Untreated air leak above a dropped ceiling.

- Air leakage problems are often hidden above dropped ceilings. If post-weatherization blower door numbers indicate that air sealing was ineffective, look above tiles for hidden air leaks. Remove panels in several locations to check whether they were sealed.

Check access doors, closets and cabinets for interior leakage paths.

- This opening within the plumbing wall was discovered behind an access door.
- The opening is a major source of air leakage.



Check access doors, closets and cabinets for interior leakage paths.

This opening within the plumbing wall was discovered behind an access door.

The opening is a major source of air leakage.



Dropped soffits, like the one shown here, are common sources of significant air leakage.

The open framing is a direct connection from the soffit to the attic above. The cavity should be sealed before insulating, as shown.

Conditioned Space Inspection Points

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Check the following:

- Wall insulation.
- Windows and doors.
- With the blower door running, check for leakage around outlets and fixtures.
- Thermostat, smoke detectors, CO alarms.
- Fireplace.
- Air Registers.
- Window A/C unit.
- Recessed light fixtures.
- Stored chemicals that might effect IAQ.



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Check the following:

- Wall insulation.
- Windows and doors.
- Leakage around outlets and fixtures (with blower door running).
- Thermostat, smoke detectors, CO alarms.
- Fireplace.
- Air registers.
- Window air-conditioning units.
- Recessed light fixtures.
- Stored chemicals that might affect IAQ.

Heating System Replacement

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New boiler



New mobile home furnace

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Photo on the left: New boiler.

Photo on the right: New mobile home furnace.

- Furnace replacement is generally cost-effective only in extremely cold climates and areas with high fuel costs where the existing unit is below 80% efficient. Replacements will most likely be part of H&S expenditures.
- Check with the occupants about their comfort and whether the heating system is operating as it should.

Q. Identify some conditions in which a furnace or boiler may or should be replaced as a health and safety measure.

A. Not serviceable despite all attempts to repair.

Cracked heat exchanger (furnace).

Leaking water jacket (boiler).

Cost of repairs greater than cost of a replacement (Note: some Grantees state that if cost of repair is 40% or more of cost of replacement, unit should be replaced with more efficient model.

Age and general condition.

Clean/Tune Up/Replacing Cooling Systems

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- Remove obstructions to airflow.
- Clean condenser coils.
- Clean evaporator if accessible.
- Clean/Replace filters.
- Insulate coolant line.
- Level unit.
- Test/adjust coolant charge (Requires EPA licensed refrigeration technician).
- If replacing, properly size replacement.



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Photo: One sad-looking AC unit.

- Remove obstructions to airflow.
- Clean condenser coils.
- Clean evaporator if accessible.
- Clean/replace filters.
- Insulate coolant line.
- Level unit.
- Test/adjust coolant charge. (This requires an EPA-licensed refrigeration technician).
- If the unit was replaced, it should have been properly sized.
 - Room air conditioners can be easily sized using the ENERGY STAR sizing chart found later in this presentation and online at www.energystar.gov.
 - Manual J** is the accepted standard for sizing whole-home (single-family) air-conditioning systems. Over-sizing systems beyond Manual J is unnecessary, since Manual J calculations already over-predict the design load.
 - An oversized system will be less effective at removing moisture from the air, which can leave a house feeling damp and lead to mold.

Check with the occupants about their comfort and whether they think the air-conditioning system is operating the way it should.

Refer to the Cooling Measures section of the Energy Auditor – Single Family curriculum for more details on air-conditioner protocols.

Proctor, John, and Peggy Albright. “Sizing Air Conditioners: If Bigger is Not Better, What Is?” *Home Energy* Sept./Oct. 1996. www.homeenergy.org.

Heating System Tune-up

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Furnace tests must be performed and work documented to assess:

- Safety (fuel leaks, clearances, etc.).
- Combustion Efficiency.
- Carbon Monoxide (CO) levels.
- Draft.
- Condition of the heat exchanger.

Single wall flue for oil heat.

Test hole

Photo courtesy of EPA, 2010

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Photo: Oil furnace with a single-wall flue graduated to a double-wall flue to maintain clearance to combustibles.

- Note the test hole where samples of flue gases will be taken and draft measured.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety and efficiency protocols.

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Unvented Gas Heaters

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DOE does not allow air sealing measures where permanently mounted unvented space heaters exist.

Photos courtesy of the US Department of Energy

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Photos: Three mounted and unvented gas heaters.

- DOE does not allow air sealing measures on homes with permanently mounted unvented space heaters. See ***Weatherization Program Notice (WPN) 08-4, Space Heater Policy***.
- Under very limited conditions, DOE will allow an unvented space heater to remain in a weatherized unit as a back-up in case of a power failure. DOE funds may not be used to repair or replace these unvented secondary heating sources.
- DOE funds may be used to repair or purchase and install a working CO detector, which should always be installed near such a unit before completing weatherization work.



Photo of a dangerous combination of a disconnected draft hood and open return register on the furnace return air plenum.

Q. Why is this a problem?

*A. Flue gases spill into the **combustion appliance zone (CAZ)** and are drawn into the conditioned house air by the furnace blower through the open return air register. Open returns in the CAZ should always be sealed.*

A Venting System should:

- Carry all combustion byproducts to outdoors.
- Establish draft quickly.
- Be properly sized with minimal restrictions.
- Have long durability (corrosion resistance).
- Not overheat surrounding materials.
- Have adequate make up air.

A venting system should:

- Carry all combustion byproducts to the outdoors.
- Establish draft quickly.
- Be properly sized with minimal restrictions.
- Have long durability (corrosion resistance).
- Not overheat surrounding materials.
- Have adequate make-up air.

Heating System Safety Issues

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Photos courtesy of the US Department of Energy

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This flue pipe is not in compliance with code.

The photo on the left shows the flue exit from the boiler, with a nearly horizontal route toward the chimney.

The photo on the right shows a long horizontal run with an elbow into the chimney; the elbow indicated by the red circle is rusted through.

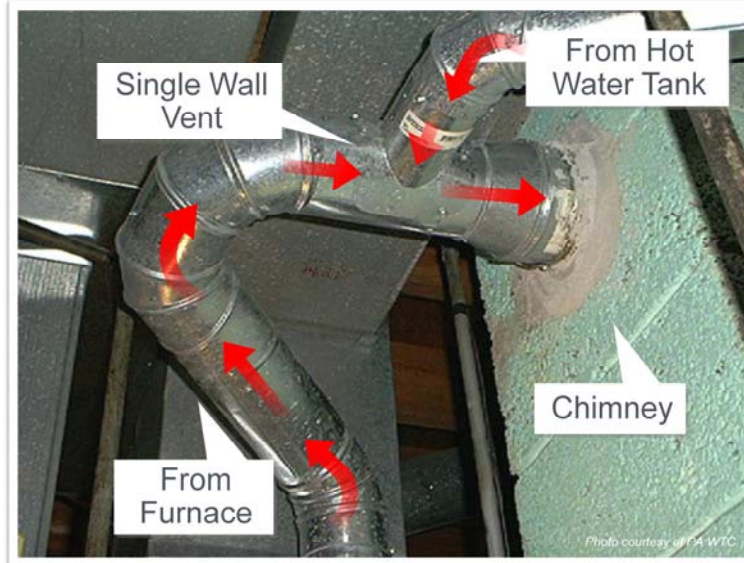
The photo on the bottom right zooms in on an area that is rusted through.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety protocols.

Chimneys and Vents

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Photo of vent and chimney connection.

- The vent connects the combustion appliance to a vertical masonry or metal chimney, and is also referred to in the heating trade as a smoke pipe.

Q. Is anything wrong with this picture?

A. The excessive elbows on the large vent to the furnace restrict the flow of flue gases.

Clearance to Combustibles

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Check clearance to combustibles.

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Photos of a flue through a ceiling penetration.

Proper clearances of heat-producing chimney vents to combustible materials must be maintained to prevent fires.

Refer to the National Fire Protection Association (NFPA) combustion clearance tables.

- Seal the chimney opening with metal coil stock and high-temperature silicone caulk.

Filter Replacement

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Change out the furnace filter and educate the client.

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- Air filters are often so clogged that airflow is drastically reduced. The reduced airflow may cause heat exchangers to overheat and fail over time.
- Educate clients to check the condition of their filter every month during the heating season and replace it if necessary. Show them a replacement filter and compare it to the old, dirty filter.

Duct Sealing and Insulation

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Sealing ducts with mastic. Mastic and mesh tape is typically specified in best practices and field guides.



Photos courtesy of the US Department of Energy

Two-part spray foam can be used to seal and insulate ducts. If insulation was goal, this application is incomplete.

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Photo on the left: Mastic used to seal ducts.

Photo on the right: Two-part foam used for sealing ducts.

- Sealing and insulating ducts in unconditioned spaces is an extremely important part of reducing duct losses. Check for the appropriate use of materials and thoroughness of the application.

Heating System Duct

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Photo courtesy of the US Department of Energy

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The existing heating system return used a floor joist cavity as the duct. Weatherization workers did a very good job of sealing this with caulk.

Q. Is this OK?

*A. This is not ideal, but it is acceptable. Duct mastic would have been a better choice for sealing. The best practice would be to pan the floor joist with sheet metal, to protect the building components from potential moisture issues. Building cavities are best **not** used as ducts.*

Mobile Home Ducts

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Photo courtesy of the US Department of Energy

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- Upper and lower photos on the left: Insert a flashlight through the duct opening and lay it flat in the duct run. A mirror will reveal many problems, including holes, obstructions, and collapsed sections.
- Upper and lower photos on the right: These mobile home ducts were repaired and sealed with mastic during weatherization.

Refer to the Duct Diagnostics and Repair section of the Mobile Home Installer curriculum for more details on duct sealing in mobile homes.

Distribution System Modification

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Seal belly return grilles in the furnace closet.

Leave 2 square inches of net free area per 1,000 BTUs of furnace input.

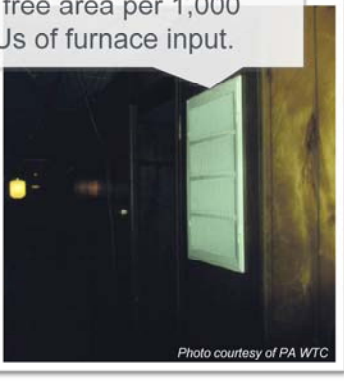


Photo courtesy of PA WTC

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Photo on the upper left: Seal belly return grilles in the furnace closet.

Photo on the lower left: A variety of materials, including plywood and duct board, may be used to permanently seal return air grilles.

Photo on the lower right: A louver in the furnace closet door is part of a hallway return system.

- Modify a mobile home belly return system and convert to a hallway return system.
- Install a return louver in the furnace closet door. A commercially available louvered door would actually be a better option. Its installation is less labor-intensive than cutting and fitting grilles into the existing door and it will look better.
- Leave 2 in² of **net free area (NFA)** per 1,000 BTU of furnace input.

Q: How much FVA is required for a furnace closet return louver for a furnace with a 50,000 BTU input?

A: $2 \text{ in}^2 \times (50,000/1,000) = 100 \text{ in}^2$

Refer to the Duct Diagnostics and Repair section of the Mobile Home Installer curriculum for more details on duct sealing.

- In the inspection report, note the appropriateness of each installed measure and the quality of the workmanship.

Set Back Thermostat

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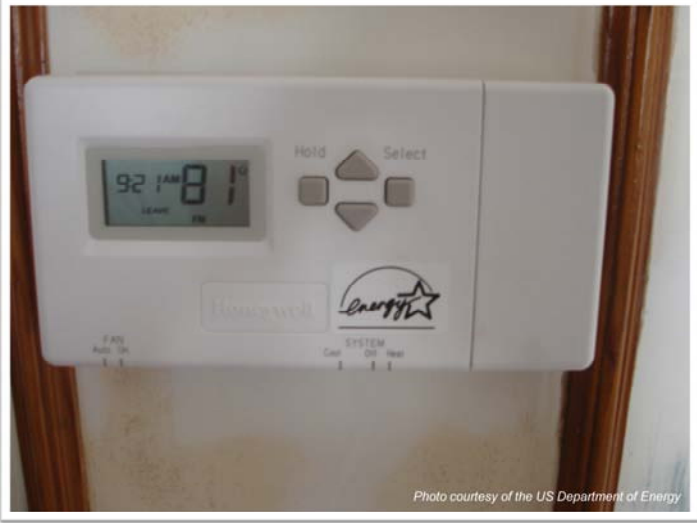


Photo courtesy of the US Department of Energy

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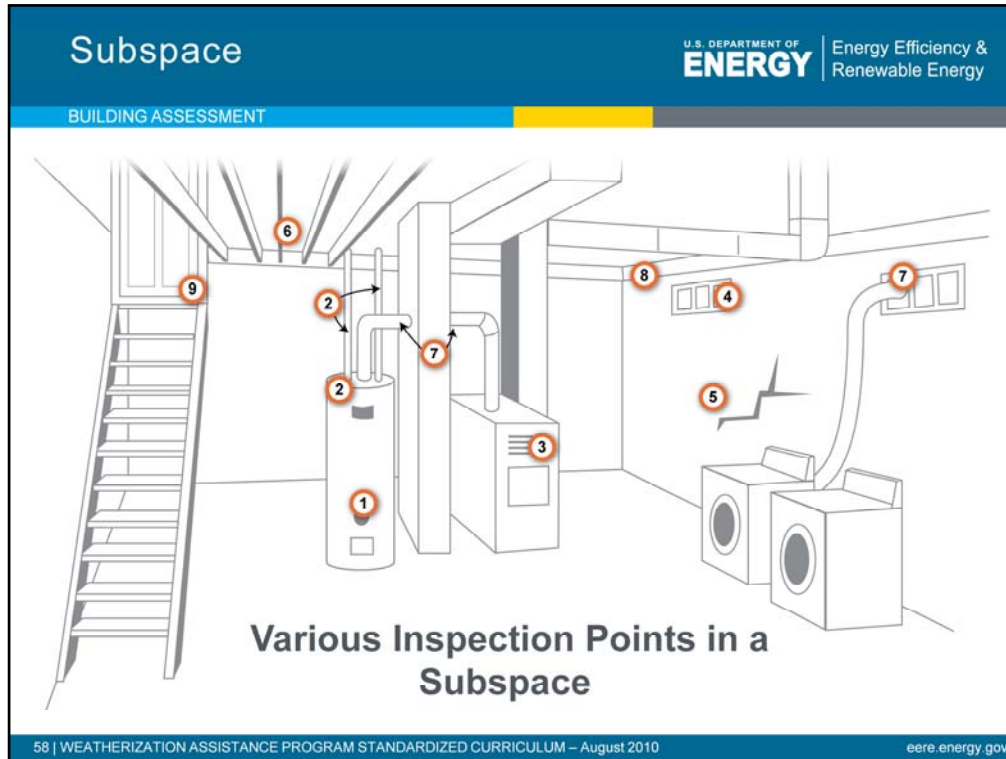
Photo: An ENERGY STAR qualified programmable thermostat.

Did someone explain to the homeowner how to operate the new smart thermostat?

Does it seem to work?

Does the client use its features?

Did the client receive education on use, and did s/he get the instruction booklet?



- Evaluate the subspace for weatherization measures, too. Subspaces include full basements and crawl spaces.
- Determine whether the subspace is conditioned or unconditioned, because this will indicate which measures should have been installed.
- Inspection points in a subspace:
 - Hot water tank thermostat set point.
 - Insulation on tank and piping.
 - Furnace.
 - Windows.
 - Foundation walls.
 - **Band joist** and **mud sill** – Are they sealed or insulated?
 - Bypasses through the floor.
 - Ducts.
 - Interior and exterior doors.

Q. Is this basement conditioned or unconditioned?

A. It appears to be conditioned:

No duct insulation.

No thermal boundary (insulation) in basement ceiling.

Presence of washer and dryer indicates occupants use the space.

Refer to the Basements and Crawl Spaces section of the Installer Intermediate curriculum for more details on subspace protocols.

Conditioned or Unconditioned?

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Guidelines

Conditioned

- More than 50% below grade.
- Relatively tight or unvented foundation.
- A living space.
- Intentional or unintentional space conditioning.

Unconditioned

- Less than 50% below grade.
- Leaky, vented, or severely degraded foundation.
- Not a living space.
- No intentional or unintentional space conditioning.

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Conditioned

- More than 50% below grade.
- Relatively tight or unvented foundation.
- A living space.
- Intentional or unintentional space conditioning.

Unconditioned

- Less than 50% below grade.
- Leaky, vented, or severely degraded foundation.
- Not a living space.
- No intentional or unintentional space conditioning.

Retrofit strategies in subspaces should be defined by an auditor, based on whether the space is conditioned or unconditioned.

The guidelines above are somewhat subjective but a decision one way or the other drives the retrofit strategies.

- Above- or below-grade considerations are less critical than establishing whether the basement is intentionally or unintentionally conditioned.
- The presence of a washer and dryer or stored items indicates at least limited activity and could therefore qualify that area as a conditioned space.

Unconditioned Basement Retrofit Options

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The following measures are typically specified for unconditioned basements:

- Air seal all bypasses between the basement and house.
- Seal all return and supply ducts.
- Insulate all duct work to the recommended R-value. Insulation levels are based on cost-effectiveness criteria determined through a DOE-approved audit or priority list.
- Insulate open floor joists to the recommended R-value with insulation batts supported by wire supports, putting the vapor retarder to the heated side.
- Insulate closed floor cavities with dense-pack insulation.

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The following measures are typically specified for unconditioned basements:

- Air seal all bypasses between the basement and house.
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- Insulate all duct work to the recommended R-value. Insulation levels are based on cost-effectiveness criteria determined through a DOE-approved audit or priority list.
- Insulate open floor joists to the recommended R-value with insulation batts supported by wire supports, putting the **vapor retarder** to the heated side.
- Insulate closed floor cavities with dense-pack insulation.

Conditioned Basement Retrofit Options

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The following measures are typically specified for conditioned basements:

- Air seal the perimeter mud sill, the band joist, and all air pathways between the basement and the house.
- Seal off portions of the basement that are in unconditioned areas, such as coal bins or vented crawl spaces.
- Seal the return plenum and all return ducts for safety.
- Mechanically reconnect boots to register transitions, and repair broken trunk lines and branch ducts.
- Insulate the band joist area to the recommended R-value with polystyrene board or two-part spray foam.
- Consider insulating above-grade basement walls with two-part spray foam or batt insulation wrapped in vapor barrier.

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The following measures are typically specified for conditioned basements:

- Air seal the perimeter mud sill, the band joist, and all air pathways between the basement and the house.
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- Seal the return plenum and all return ducts for safety.
- Mechanically reconnect boots to register transitions, and repair broken trunk lines and branch ducts.
- Insulate the band joist area to the recommended R-value with polystyrene board or two-part spray foam.
- Consider insulating above-grade basement walls with two-part spray foam or batt insulation wrapped in vapor barrier.
- Use ZPD to verify that the conditioned crawl space **with reference to (WRT)** the house is close to 0 **pascals (Pa)**.

Q. If the basement is conditioned, should the entire height of the basement walls be insulated?

A. No. Insulate above-grade walls and no more than 2 feet below grade. This depth roughly corresponds to the average frost depth in cold climates. The soil becomes increasingly warmer with increasing depth, making it no longer cost-effective to insulate.

Refer to the Basements and Crawl Spaces section of the Installer Intermediate curriculum for more details on basement weatherization.

Unconditioned Crawl Space Options

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- Any moisture issues resolved.
- Perimeter mud sill, band joist, and all air pathways between the basement and the house sealed.
- All return and supply ducts sealed.
- Ground vapor retarder (6-mil plastic) installed.
- Foundation vents sealed.
- All duct work insulated to recommended R-Value.
- Floor joists insulated to recommended R-Value.
- Floor becomes the pressure and thermal boundary.

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In some cases, it may be more cost-effective to leave the crawl space outside the conditioned space by air sealing and insulating the floor between the crawl space and the house and leaving the space unconditioned.

The following measures are typically specified for unconditioned crawl spaces:

- Remove debris and resolve moisture issues.
- Air seal the perimeter mud sill, band joist, and all air pathways between the subspace and the house.
- Seal all returns and supply ducts.
- Install a ground vapor retarder (6-mil plastic). This will help prevent ground-source moisture vapor from entering the crawl space.
- Seal foundation vents. This will prevent moisture-laden air from entering the crawl space, where it can condense on cold surfaces.
- Insulate ductwork to the recommended R-value.
- Insulate floor joists to the recommended R-value.

The floor becomes the pressure and thermal boundary.

Bulk moisture problems such as standing water in the subspace caused by poor drainage around the foundation must also be resolved.

Although the floor is now the primary air barrier, some programs also air seal the perimeter mud sill and band joist to prevent outside air from washing underneath or penetrating the floor insulation.

Conditioned Crawl Space Options

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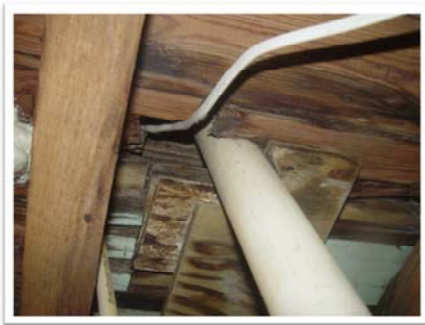
- Moisture issues resolved.
- Ground vapor retarder (6-mil plastic) installed.
- Foundation vents sealed.
- Band joist, cracks in the foundation, access door, etc sealed.
- All air bypasses through floor of house sealed.
- Duct runs may be left uninsulated.
- All returns and supplies sealed.
- Foundation walls insulated with two-part foam or fiberglass insulation.

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- Many building scientists have found that creating a conditioned crawl space is beneficial for maintaining the building's integrity. Crawl space conditioning also increases surface temperatures of pipes and ducts, thereby preventing condensation problems.
- Several WAP programs have embraced crawl space conditioning and have the methods and techniques in place to do it.
- The following measures would typically be specified for conditioned crawl spaces:
 - Moisture issues resolved.
 - Ground vapor retarder (6-mil plastic) installed.
 - Foundation vents sealed.
 - Band joist, cracks in the foundation, access door, etc. sealed.
 - All air bypasses through floor of house sealed.
 - All returns and supplies sealed.
 - Foundation walls insulated with two-part foam or fiberglass insulation wrapped in vapor barrier.
- Duct runs may be left uninsulated.

Were major air leakage sites sealed?



Unsealed plumbing penetration.



Sealed plumbing penetration.

Photo on the left: Unsealed plumbing penetration.

Photo on the right: Sealed plumbing penetration.

Were air leakage sites leaks sealed?



Great air sealing job on old basement stairwell.



Mobile home belly penetration sealed but poor quality workmanship.

Photo on the left: Great air sealing job on the old basement stairwell.

Photo on the right: Mobile home belly penetration sealed but note the poor quality workmanship.

Were major air leakage sites sealed?

Was the above grade perimeter sealed and insulated?



Perimeter air sealing and insulation with two part foam.

Photo on the left: Untreated band joist and mud sill.

Photo on the right: Perimeter air sealing and insulation with two-part foam.

Was the above-grade perimeter sealed and insulated?

Subspace Foundation and Perimeter Insulation

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Perimeter is only partially insulated with big air chases between masonry and furred-out walls.

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Photo: Perimeter is only partially insulated with big air chases between masonry and furred-out walls.

Was under-floor insulated where applicable?



Collapsed insulation on a mobile home belly left untreated.



Missing floor insulation.

Photo on the left: Collapsed insulation on a mobile home belly left untreated.

Photo on the right: Missing floor insulation.

Was the space under the floor insulated where applicable?

Basement and Crawl Space Sidewall Insulation

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Were foundation walls insulated where applicable?



Two part foam insulation on basement wall.



Insulation on crawlspace foundation.

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Photo on the left: Two-part foam insulation on basement wall.

- In cold climates, insulation should not extend more than 2 feet below grade.

Photo on the right: Insulation on crawl space foundation.

Were foundation walls insulated where applicable?

Vapor Retarder Added

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Was a ground cover/vapor retarder installed?



Properly applied vapor retarders should overlap
at all joints and achieve 100% coverage.

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Photos: Properly applied vapor retarders should overlap and have 100% coverage.

Was a ground vapor retarder installed?

Where's the Ground Cover?

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Photo courtesy of the US Department of Energy

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Photo: Picture of a crawl space

- If there's enough room to insulate the floor, there's enough room to install a ground cover (vapor retarder). If vapor retarders/ground covers are required by the local field guides, and there is no valid reason in the file for not installing this measure, send the weatherization team back!
- Note that the quality of the floor insulation work is poor. The report should indicate this.

Health and Safety Related Subspace Repairs

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Were health and safety repairs performed and documented?




Photo courtesy of the US Department of Energy

Crimped flex vent at the back of a dryer should be replaced with smooth metal vent and terminated outdoors.

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Photo on the left: A badly crimped flex vent

Photo on the right: Smooth metal vent

Were H&S repairs performed and documented?

- The crimped flex vent at the back of the dryer should be replaced with a smooth metal vent and terminated outdoors.

Q. Other than dryer vents, what are some subspace repairs that may be allowable under health and safety?

A. Sump pump repairs, water pump repairs, dehumidifiers.

Refer to the Dryer Vents section of the Installer Intermediate curriculum for more details on dryer exhaust protocols.

Window Replacement Performed

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Were window replacements performed?



Severely degraded windows may be considered for replacement.



A large combination unit with a U value of .20 replaces a fixed unit of multiple single pane sections.

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Photo on the left: Severely degraded windows may be candidates for replacement.

Photo on the right: A large combination unit with a ***U-value*** (rate of heat loss) of 0.20 replaces a fixed unit of multiple single-pane sections.

Were window replacements performed?

- Count the replacement windows to verify the number claimed vs. the number installed.
- Refer to the auditor's house diagram to be sure the correct windows were replaced.

Refer to the Windows and Doors section of the Installer Intermediate curriculum for more details on window and door protocols.

Storm Windows

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Were storm windows installed?



Exterior storm windows installed as an alternative to primary window replacement.

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Photo: Exterior storm windows were installed as an alternative to primary window replacement.

Were storm windows installed?

Doors

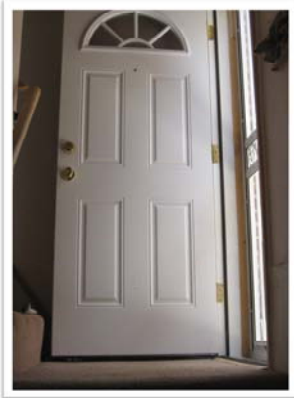
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BUILDING ASSESSMENT

Were door replacements performed?



Qualifies for replacement.



New ENERGY STAR qualified door (R-6).



Mobile home replacement.

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Photo on the left: The door qualifies for replacement because it is deteriorated and beyond repair.

Center photo: New ENERGY STAR door with R-6 rating

Photo on the right: Mobile home door replacement.

Were doors replaced?

- Door replacements are not often cost-effective because of their high cost and relatively low impact on energy savings.
- Best practice for the local agency is to include photo documentation of the original door in the client file. This provides proof that the existing door was beyond repair.



Photo: Combination door and window unit was built on site to replace a defective sliding glass door.

- This labor-intensive retrofit done as an incidental repair is an example of high-quality workmanship in WAP.

Door
Weatherstripping/Thresholds/Sweeps

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Were door weatherstrips, sweeps or thresholds installed?

Door seals and latches (good)

Weatherstrip is pulled away (bad)

Built-up, sealed and insulated bulkhead door to conditioned basement

Potentially significant air leakage and comfort issues due to operational problems and poor seals.

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Photo on the left: Door seals effectively and latches correctly (good).

Center photo: Weatherstrip is pulled away (bad).

Photo on the right: Great example of a built-up, sealed, and insulated bulkhead door to the conditioned basement.

Were door weatherstrips, sweeps, or thresholds installed?

- Leaky doors can be the cause of significant air leakage and comfort issues due to operational problems and poor seals.

Sunscreens/Films

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Recommended for:

- South-, west- and east-facing windows not shaded during summer months.
- When solar gain overheats room causing increase in A/C use.



Photo courtesy of the US Department of Energy

This window is already shaded by a nearby tree. Evaluate cooling-season exposure to determine cost effectiveness of window shades or solar films.

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- Shading or applying **solar film** (also known as **window film**) to certain windows and doors can drastically reduce home solar gain during the cooling season. Solar film is sometimes recommended for:
 - South-, west-, and east-facing windows not shaded during the cooling season.
 - Rooms overheated by **solar gain**, causing an increase in air-conditioner use.
- The window in the photo is already shaded by a nearby tree. The auditor should have evaluated **solar exposure** to determine cost-effectiveness of window shades or solar films.

Refer to the Cooling Measures section of the Energy Auditor – Single Family curriculum for more details on sunscreens and shading.

Window Film Guidelines

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- Shading coefficient of 0.40 or lower.
- U-factor of 1.0 or lower.
- "Total solar energy rejected" is at least 65%.
- Film is approved by manufacturer for use on insulated glass and insulated panels.



Film is applied to the cleaned interior of eligible windows and doors and smoothed.

Source: A. Tamasin Sterner, Chapter 10 "Cooling Measures," PPL Electric Utility Winter Relief Asset Program Standards, 2007

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Photo: Film is applied to the cleaned interior of eligible windows and doors and smoothed.

- Standards vary by climate region. The following window characteristics were found to be cost-effective in Pennsylvania:
 - o The **shading coefficient (SC)** is 0.40 or less.
 - The shading coefficient is a decimal describing how much solar energy is transmitted through a window opening compared to clear single glass, which has an SC of 1.0. For example, reflective glass has an SC of 0.20 to 0.45.
 - o The U-value of the window is 1.0 or lower.
 - o Total solar energy rejected is at least 65%.
 - o The percent of solar energy rejected equals **solar reflectance** plus the part of **solar absorption** that is reradiated outward. Solar reflectance and absorption are expressed as percents of the total solar energy falling on the surface (in this case, the solar film).
 - o The film is approved by the manufacturer for use on insulated glass and insulated panels.

Water Heater Replacement

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Leaking, rusty original tank.



Single family home installation.

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On the left: Leaking, rusty original tank.

Photo on the right: Single-family home water heater installation.

Domestic water heaters are usually replaced under health and safety.

Q. What conditions may justify a water heater replacement?

A. Leaking or severely corroded tank, tank clogged by mineral deposits, inoperable water heater, unsafe operation due to flame roll-out or high CO production.

Tank Wrap

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Good



Bad

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The photo on the left shows a good installation in which the wrap has been properly secured with straps. Clearance to the flue pipe is maintained by not wrapping the top.

The photo on the right shows an installation of poor-quality workmanship. The wrap is unsecured and sagging.

Pipe Insulation

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The right way and the
wrong way.

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The photo on the left shows proper clearance of the pipe insulation from the heat source of the flue and use of non-combustible fiberglass pipe wrap near the flue. Clearance should be a minimum of 6" from the heat source.

The photo on the right shows the foam pipe wrap too close to the flue pipe, causing it to melt. The insulation installed on these pipes should be at least 6" away from the flue pipe. Immediate action should be taken because this is a health and safety hazard. Also, the insulation is incomplete and poorly installed, leaving gaps.

Water Heater Safety Issues

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Photo courtesy of PA WTC

Burn marks above the burner compartment are evidence of flame roll out.



Photo courtesy of NRCERT

Spillage of flue gases or insufficient draft is often a result of an improper installation such as this.

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Photo on the left: Burn marks above the burner compartment are evidence of flame roll-out.

Photo on the right: Spillage of flue gases or insufficient draft is often a result of an improper installation such as this.

- Evidence of flame roll-out indicates a problem when ignition of the appliance is delayed, causing a sudden mini-explosion of unburned natural gas in the burner compartment at the bottom of the tank.

Q. What might be some reasons for this?

A: Obstruction in the flue running up through the center of the tank, improper mix of fuel and oxygen, and/or dirty burner ports.

Q. Let's say the hot water tank pictured on the right was found to have a spillage problem. Based on what you see in the picture, what might be the reason for this?

A. Improper slope of the vent to the chimney.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on hot water tanks and combustion safety protocols.

Lighting

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- Count the **compact fluorescent lights (CFLs)** installed.
- CFLs should be installed by the agency and not left for the client to install.
- At a minimum, bulbs that are used more than 2 hours per day should be replaced.

*Refer to the **Base Load** Measures section of the Energy Auditor – Single Family curriculum for more details on lighting upgrades.*

Refrigerator Replacement

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Refrigerator replacement should be considered if existing unit meets the minimum threshold to replace based on:

- Metering, or
- DOE approved refrigerator database.

Only one refrigerator may be replaced per home.



Photo courtesy of the US Department of Energy

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- Refrigerator replacement should be considered if it meets the minimum use threshold to replace by metering or by using a DOE-approved refrigerator database.
- Only one refrigerator per home may be replaced.
- Old refrigerator/freezer units must be removed and **decommissioned**.

Refer to the Base Load Measures section of the Energy Auditor – Single Family curriculum for more details on refrigerator testing and upgrades.

Refer to the Refrigerator Info Toolkit for DOE protocols.

Smoke/Carbon Monoxide Detectors

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Where combustion appliances are present, one CO detector should be placed on every level of the house (conditioned spaces only).

Smoke and CO detectors are energy-related health and safety measures.

Q. Do you see anything wrong with the placement of the smoke detector?

A. The smoke detector is mounted too low. It should be at least 6" from the meeting of the ceiling and wall. This is a health and safety issue that needs to be corrected.

Other H&S Measures – Moisture and Mold

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Is there any evidence of mold in the home?
Was it noted in the file? Was it caused by weatherization work?



Photo courtesy of PA WTC

Damaged ceilings may
indicate moisture issues.



Photo courtesy of the US Department of Energy

Mold on walls indicates serious
moisture issues in the home; Should
have been resolved prior to
weatherization work.

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Photo on the left: Damaged ceilings may indicate moisture issues.

Photo on the right: Mold on walls indicates serious moisture issues in the home. These should have been resolved before weatherization work began.

Q: Should air sealing have been performed in a home where these kinds of conditions were observed?

A: Not until the underlying causes have been resolved and the mold has been cleaned up.

Refer to the IAQ section of the Energy Auditor – Single Family curriculum for more details on moisture and mold issues.

Cook Stove Testing

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Why Test Gas Cook Stoves?

- Elevated levels of CO are common.
- People often use them as a heat source.
- CO Kills.
- Knowledge implies action.



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Photo of dirty burners on a typical gas cook stove.

- Dirty burners can impede a proper flame, causing carbon monoxide to form.

Why test gas cook stoves?

- People sometimes use them as a heat source, and elevated levels of CO from gas stoves are common.
- CO kills.
- Knowledge implies action.
- Gas- and propane-fired cook stoves release combustion byproducts into the air. They must be repaired if CO exceeds suggested **action levels**:
 - o Range-top burner – 25 **parts per million (ppm)**, as measured.
 - o Oven – 100 ppm, as measured.
- Corrective actions can include repair, cleaning, or adding mechanical ventilation.
- Stove testing should be documented in the client file.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on stove testing and combustion safety protocols.

Mechanical Ventilation - Kitchens

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Unvented range hood over a gas cook stove.



New range hood fan vented to outside.

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Photo on the left: CO levels were reported at 72 ppm.

- Pre- and post-weatherization blower door tests showed a house-wide reduction from 4,178 **cubic feet per minute (CFM)₅₀** to 1,978 CFM₅₀. This lowered dilution rate could result in higher ambient concentrations of CO from the cook stove. Installation of a kitchen exhaust fan vented to the outdoors is therefore recommended.

Photo on the right: New range hood installed over a previously unvented cook stove.

- When there are no mechanical exhaust fans in the bathroom and kitchen, or the ones installed can't be serviced, new ones should be installed. This is especially true in a kitchen where a gas cook stove is served by an unvented recirculating range hood fan.

Refer to the Mechanical Ventilation section of the Installer Intermediate curriculum for more details on mechanical venting protocols.

Mechanical Ventilation - Bathrooms

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Completely non-functional
bath fan.



Brand new installation of
a bath fan.

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Photo on the left: Non-functional bath fan.

Photo on the right: Installation of a new bath fan.

- Bathrooms are typically high moisture areas. Programs should replace non-functioning fans and install new ones where none exist.
- Tightening a home lowers the dilution rate and additional mechanical ventilation may be necessary to prevent moisture and mold problems.

Refer to the Mechanical Ventilation section of the Installer Intermediate curriculum for more details on mechanical ventilation protocols.

Worst Case Combustion Safety Testing

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- Under worst case conditions the agency should have conducted:
 - Spillage Test.
 - Draft Test.
 - CO Test.
- Should have been performed at the time of the audit and final inspection on all vented combustion appliances.
- Unsafe appliances should have been deactivated until hazards were fixed.

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- CAZ testing on vented combustion appliances helps determine if combustion appliances will vent under worst-case conditions, protecting the occupant from the hazards of draft reversal.
- The agency should have performed the following three tests under worst-case conditions during the audit and final inspection of all vented combustion appliances:
 - o Spillage test.
 - o Draft test.
 - o CO test.
- Unsafe appliances should have been deactivated until hazards were mitigated.
- The results of these tests must be documented in the client file.

Refer to the Combustion Appliances section of the Energy Auditor – Single Family curriculum for more details on combustion safety protocols.

Summary

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BUILDING ASSESSMENT

Technical Monitors and Inspectors should:

- Understand the concepts of the air barrier and thermal boundary.
- Recognize whether appropriate energy-savings measures were installed.
- Determine whether there were missed opportunities.
- Evaluate whether energy-related repairs and health and safety measures were justified.
- Decide whether measures installed match the audit and work order and were installed as billed.
- Judge whether installed measures meet weatherization program specifications and standards for quality workmanship.

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Technical monitors and inspectors should:

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Site Monitoring: Interpreting Infrared

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will:

- Gain an understanding of the powers and limitations of infrared (IR) thermography.
- Learn to interpret IR images as they relate to weatherization opportunities.
- Gain practice using IR images to assess the quality of weatherization measure installation.
- Learn to use IR imaging in concert with the blower door to track infiltration and guide air sealing activities.

Key Terminology

Infrared (IR)

Supplemental Materials

Handouts & Resources

Collins, Maureen. "IR – Worth a Thousand Words." *Home Energy* Sept./Oct. 2008.
www.homeenergy.org.

Snell, John. "Breakthroughs in Infrared Cameras." *Home Energy* Jan./Feb. 2006.
www.homeenergy.org.

Snell, John. "Infrared Thermography: (Nearly) A Daily Tool." *Home Energy* Mar./Apr. 2008.
www.homeenergy.org.

Snell, John. "Infrared Thermography: What Works, What Doesn't Work." *Home Energy* May/Jun. 2010. www.homeenergy.org.

Classroom Props & Activities

Infrared camera set up with live feed to a monitor or projector (light box).

Class Overview

Demonstrate use of as many test instruments as possible. Pass instruments around so students can handle and use them. If feasible, set up blower door in classroom and get CFM50. Show smoke. Run infrared and blower door together to demonstrate how blower door affects IR pattern. If technical capacity is present, show real-time IR scan of classroom on screen. Offer possible explanations of what is seen with methods to resolve any questionable interpretations.

Site Monitoring: Interpreting Infrared

Technical Monitor/Inspector

Key Terminology

Infrared (IR)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will:

- Gain an understanding of the powers and limitations of infrared (IR) thermography.
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- Learn to use IR imaging in concert with the blower door to track infiltration and guide air sealing activities.

Infrared Capability (Slide #3)

- There are many myths about ***infrared (IR)***, but here's the truth:
 - IR cannot see through anything.
 - IR sees surface temperatures only.
 - IR does not see color – color is created by an integral computer chip.
 - IR cannot see air – it sees solid objects only.
- IR cameras are usually set to show cold as dark and warm as light.
- Shades of grey are “in between” temperatures.
- Some high-end cameras include a temperature scale superimposed on the image.
- The date/time stamp on saved images will indicate exterior temperature conditions, allowing the viewer to better interpret what is depicted. For example, an interior image of a wall taken in August would appear warm where it is poorly insulated. The same poorly insulated area would appear cold in January.
- The camera can be set to show a color image.
 - Color can be a good sales tool because it is so dramatic, but because the color is computer generated, it lacks the sharp definition seen in grey scale.
 - Grey scale is clearest and easiest to interpret, and therefore best for audits and inspections.
 - Practice one mode or the other and use it consistently.
- The slide shows a typical IR image of a wall with a door (blue outline).

Click to show door with window outline.

- The upper left area is settling or has a void caused by poor blowing.
Click to highlight that area.
- A blower door will accentuate air leakage – more on that later.

Insulation Settled in End Wall Bays (Slide #4)

Picture shows a bedroom with sloped ceiling to the right; bedpost is in the foreground.

Q: Why does the bedpost appear warmer than the wall?

A: It is the same temperature as the room air, which is warmer than the wall. IR cannot “see” air; it only sees objects warmed or cooled by air contacting the object.

Click to highlight wall voids.

Solid dark areas indicate no insulation in the cavities.

Q: What would we see if it were a warm summer day?

A: Black and white would be reversed; that is, the insulation void would appear warm and the bedpost and sloped ceiling would appear cold.

Missed Bay, Low-Density Bays, and Infiltration (Slide #5)

The picture shows an end wall with a window. There is a sloped ceiling to the left. Drywall was installed over the original plaster and lathe on the ceiling flat and upper part of the sloped ceiling.

The darkest area indicates an empty wall bay.

Click to highlight empty wall bay.

The lighter shade indicates partially insulated bays along the slope and over the window.

Click to remove red highlight and show green highlight of partially insulated bays.

The dark stripes extending down the sloped ceiling from the lower edge of the drywall indicate wind-driven infiltration. Air from the attic is cooling the surface of the plaster.

Click to remove green highlights and show yellow arrows.

Poorly Blown Cellulose in a Sloped Ceiling (Slide #6)

The picture shows a sloped ceiling and knee wall with a window below it.

Point out window outline in lower portion of photo. Click to highlight partially insulated bays above window.

This is a post and beam (timber frame) house. The heavy dark lines are the main roof support timbers.

Click to highlight timbers.

The narrow dark lines parallel to the timbers are the spaces between the ceiling lathes.

A properly blown ceiling would appear as a solid shade with no variation as in the end wall.

Click to highlight the end wall area. Click again to remove outline.

Wind-Driven Infiltration at Dropped Soffit (Slide #7)

The picture shows outside air cooling a ceiling.

Click to highlight dark areas.

The feathery edges are a typical air infiltration pattern.

Click to point out the direction of the air movement. Click again to remove arrows.

The size and intensity of the dark areas indicates relative importance.

Wind-Driven Infiltration (Slide #8)

Photo: Wind-driven infiltration over ceiling at the eaves side of the house.

The dark streaks are caused by outside air blowing over a ceiling from soffit vents at the eaves.

IR and the Blower Door – Dropped Soffit (Slide #9)

The pictures show an exterior wall with a dropped soffit over kitchen cabinets. The left picture is under natural conditions; the right is with a blower door operating. The blower door is pulling cold air from the attic into the dropped soffit and closest wall bay.

IR and the Blower Door – Tongue-and-Groove Wall (Slide #10)

Right: Picture of a typical tongue-and-groove pine paneled wall.

Left: IR image of the same wall with a blower door operating.

Note how air is infiltrating every board.

Q: Is the weatherstrip on the door effective?

A: No. There is significant infiltration along the strike edge and the top of the door.

Blower Door-Driven Infiltration #1 (Slide #11)

Note the time and date of the blower door test: mid-day on August 1.

The white streaks at the wall/ceiling junction are caused by hot exterior air being pulled into the attic at the soffit venting by a blower door.

The large white area at the right end of the knee wall is an insulation void.

The streaks radiating from the ceiling light fixture are caused by hot attic air being pulled into the room around the fixture by the blower door.

Q: What should be done?

A: (1) Install blocking and vent chutes between rafter tails to direct soffit vent air up the underside of the roof. (2) Seal the wire penetrations in the ceiling drywall.

Blower Door-Driven Infiltration #2 (Slide #12)

Note the date and time of the blower door test recorded on the picture: 8/1/07 @ 1:54 PM. This is the hottest part of the day. The attic above the pictured ceiling will be extremely hot.

- Intense heat at the fan/light unit—106°F—shows that the unit housing has not been sealed to the ceiling. Air that hot has to be coming from the attic and not directly from the outdoors. (The picture was taken in northern Maine.) It is probably not caused by a faulty back draft damper in the fan unit.

Summary (Slide #13)

- IR imaging sees surface temperatures only.
- Interpreting IR requires putting images in context – what's on the other side of the surface being inspected? Be careful not to jump to conclusions.
- IR imaging cannot see through anything.
- Images are easiest to interpret when there is a large temperature difference, but always require a trained technician for accurate interpretation.
- In conjunction with a blower door, IR imaging is a powerful tool for diagnosing infiltration and targeting air sealing activities. Using IR with a blower door gives far superior results to using either tool alone.



TECHNICAL MONITOR/INSPECTOR

Site Monitoring: Interpreting Infrared

Learning Objectives

U.S. DEPARTMENT OF
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INTERPRETING INFRARED

By attending this session, participants will:

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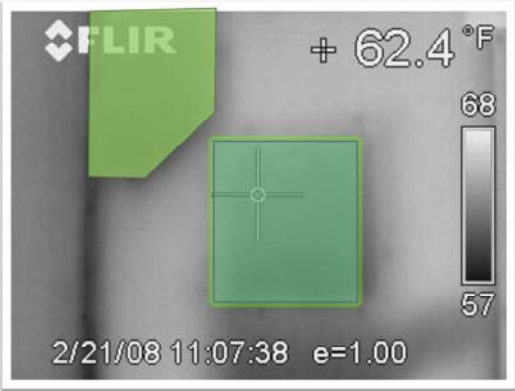
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Infrared Capability

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INTERPRETING INFRARED

- IR cannot see through anything.
- Sees surface temperatures only.
- Cannot see color.
- Cannot see air.



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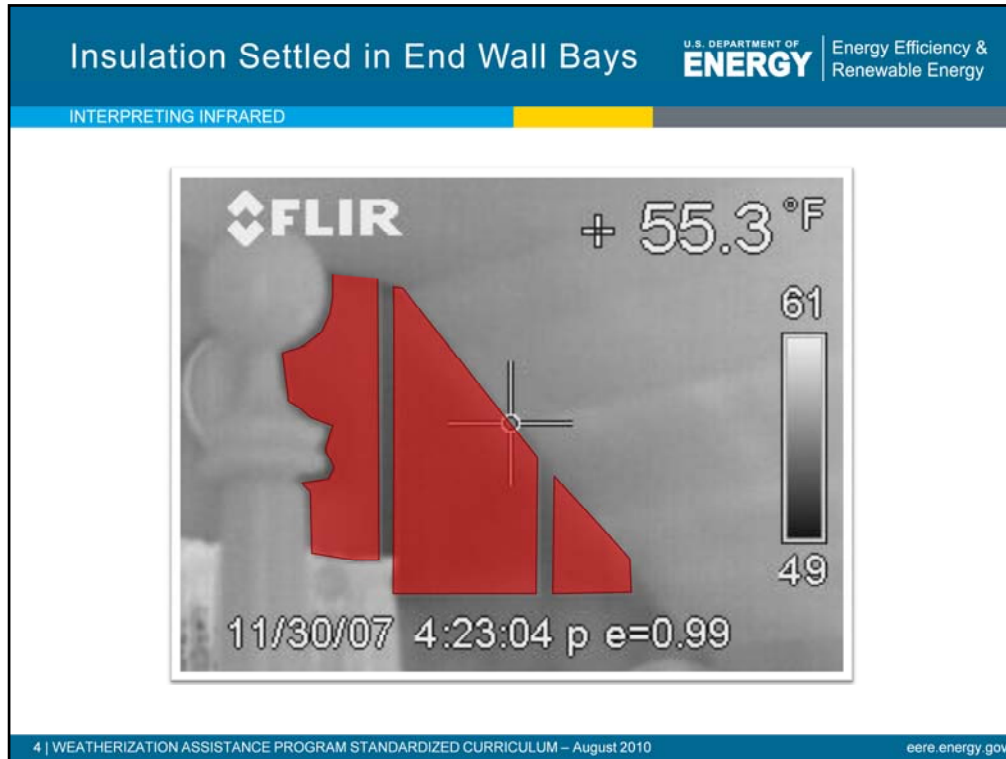
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Click to highlight that area.

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Picture shows a bedroom with sloped ceiling to the right; bedpost is in the foreground.

Q: Why does the bedpost appear warmer than the wall?

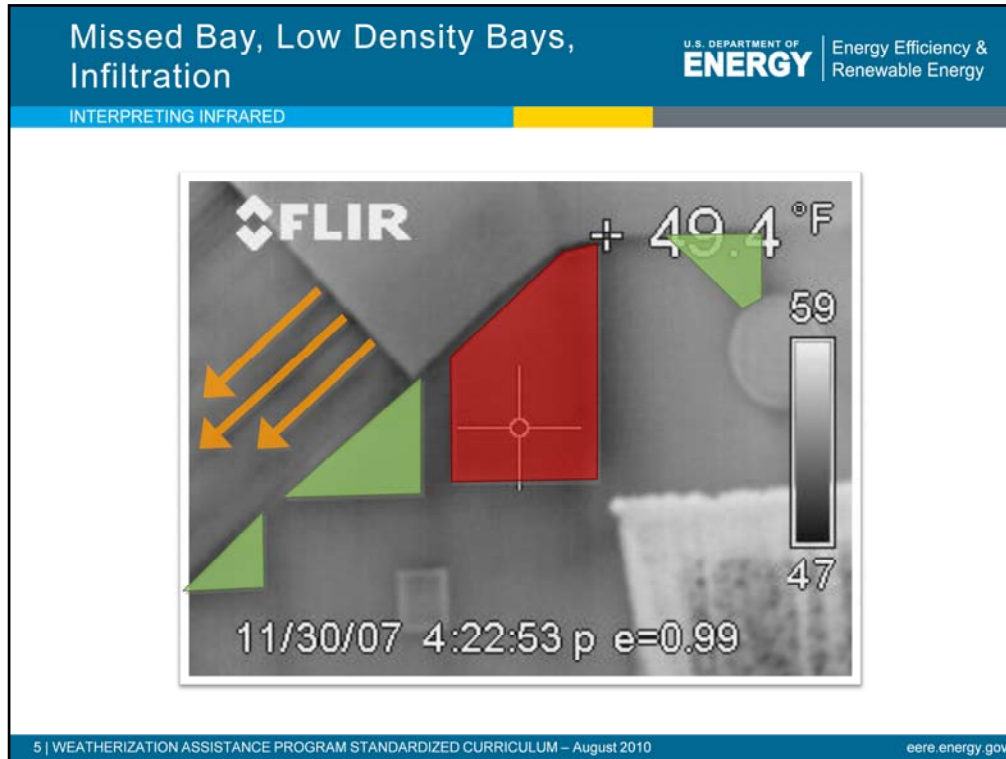
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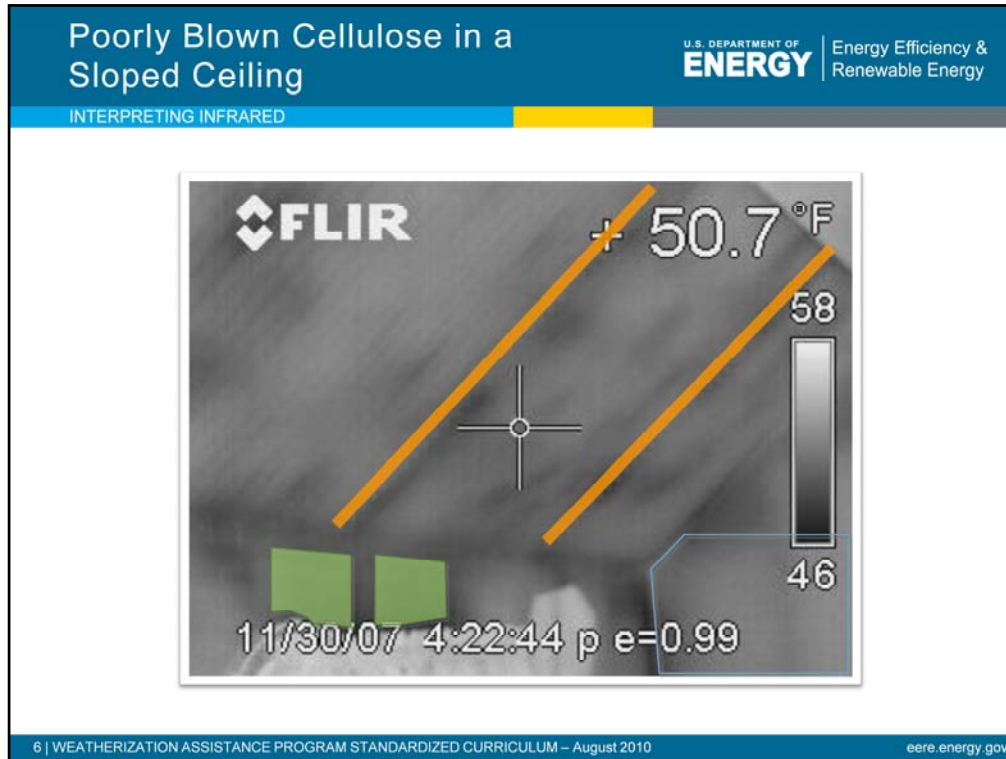
Click to highlight empty wall bay.

The lighter shade indicates partially insulated bays along the slope and over the window.

Click to remove red highlight and show green highlight of partially insulated bays.

The dark stripes extending down the sloped ceiling from the lower edge of the drywall indicate wind-driven infiltration. Air from the attic is cooling the surface of the plaster.

Click to remove green highlights and show yellow arrows.



The picture shows a sloped ceiling and knee wall with a window below it.

Point out window outline in lower portion of photo. Click to highlight partially insulated bays above window.

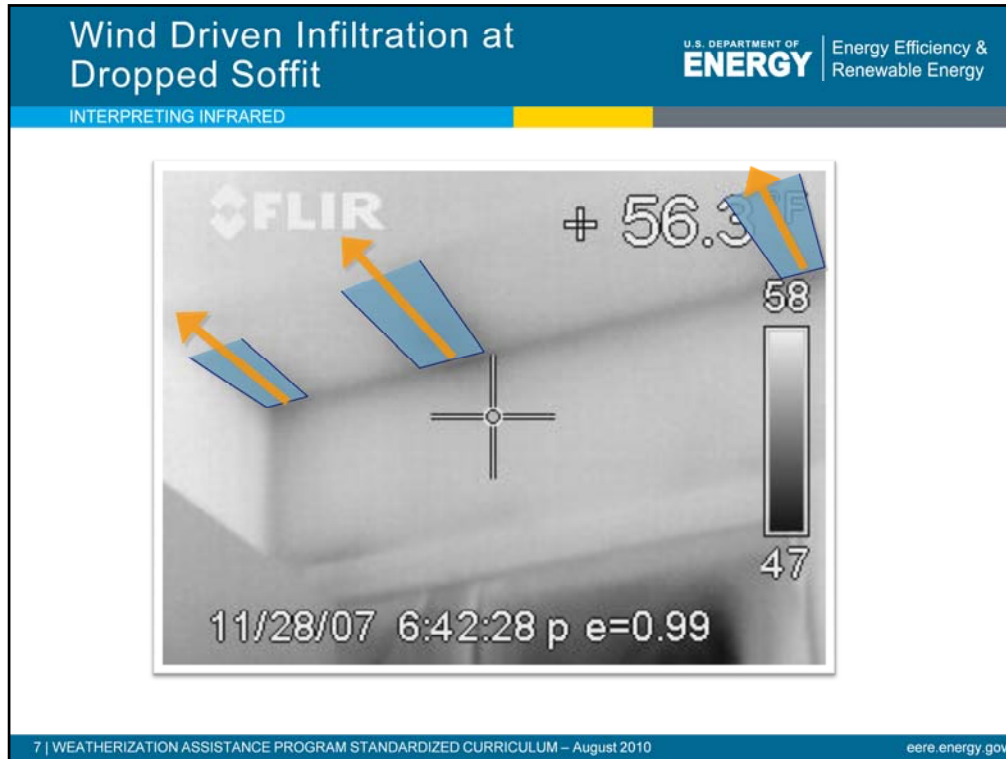
This is a post and beam (timber frame) house. The heavy dark lines are the main roof support timbers.

Click to highlight timbers.

The narrow dark lines parallel to the timbers are the spaces between the ceiling lathes.

A properly blown ceiling would appear as a solid shade with no variation as in the end wall.

Click to highlight the end wall area. Click again to remove outline.



The picture shows outside air cooling a ceiling.

Click to highlight dark areas.

The feathery edges are a typical air infiltration pattern.

Click to point out the direction of the air movement. Click again to remove arrows.

The size and intensity of the dark areas indicates relative importance.

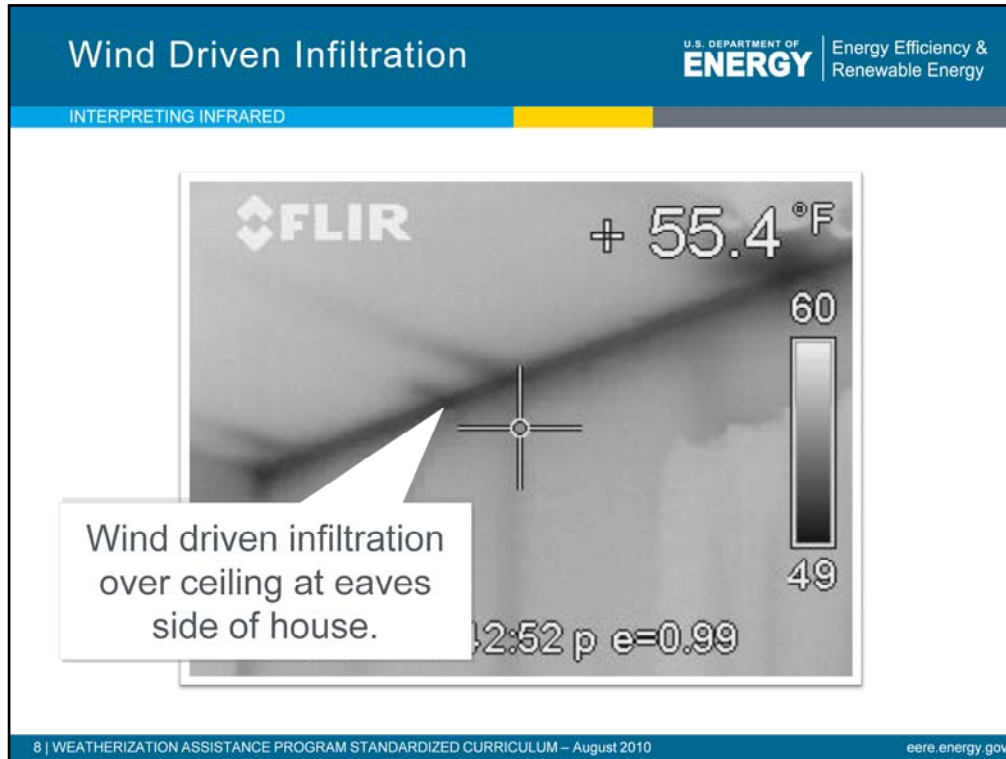
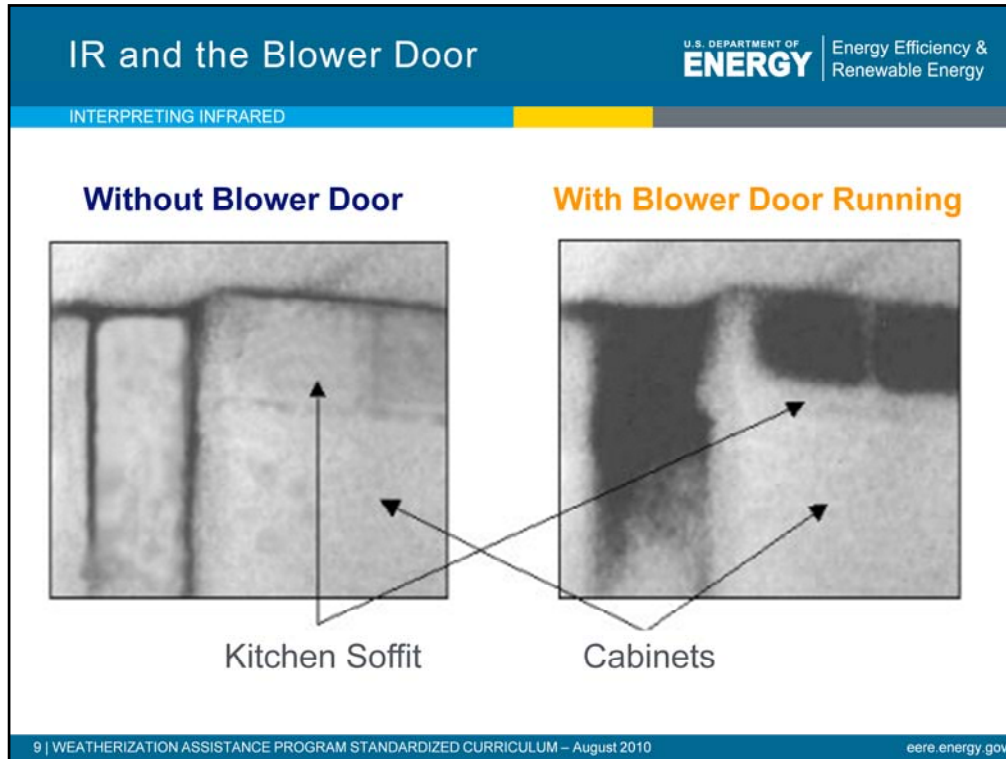
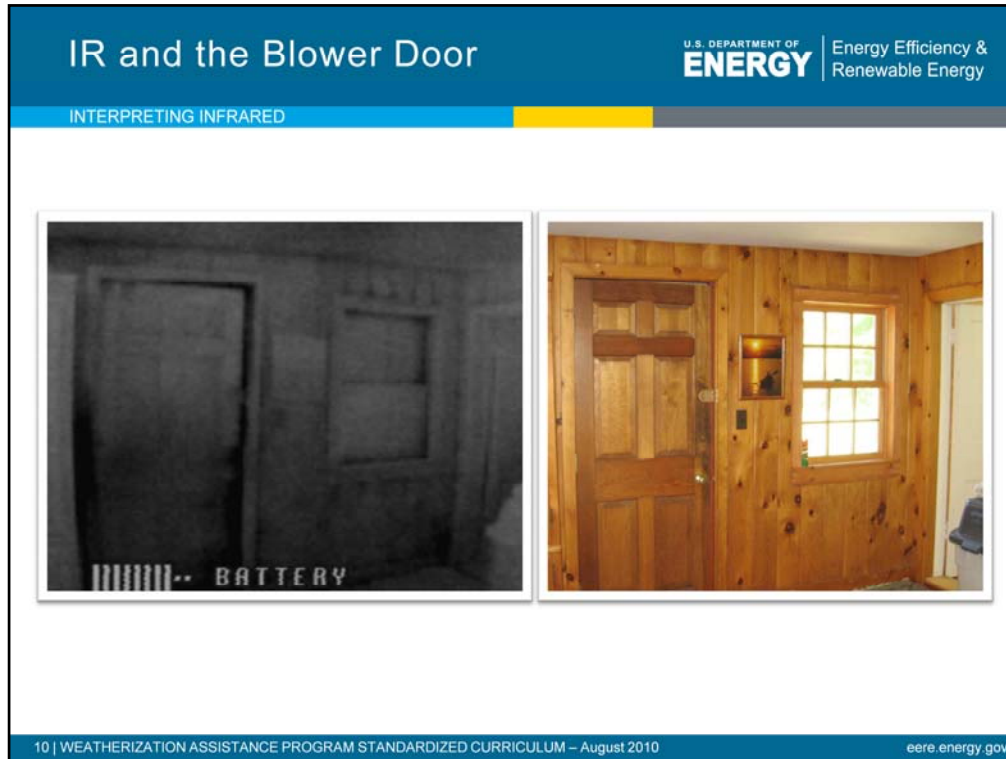


Photo: Wind-driven infiltration over ceiling at the eaves side of the house.

The dark streaks are caused by outside air blowing over a ceiling from soffit vents at the eaves.



The pictures show an exterior wall with a dropped soffit over kitchen cabinets. The left picture is under natural conditions; the right is with a blower door operating. The blower door is pulling cold air from the attic into the dropped soffit and closest wall bay.



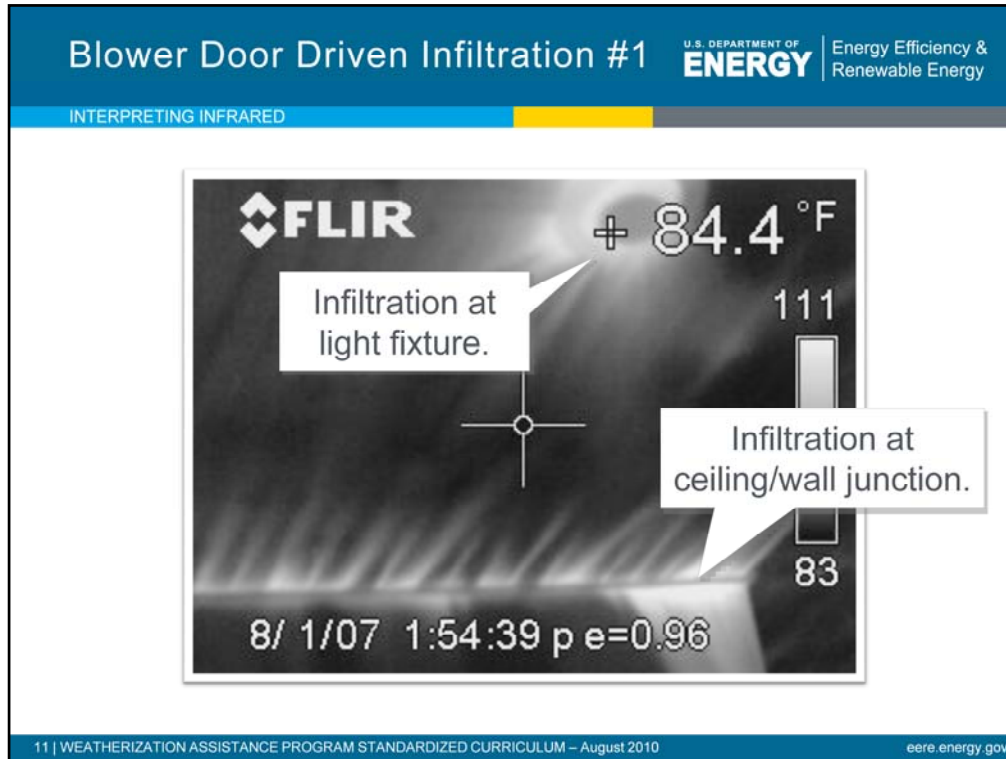
Right: Picture of a typical tongue-and-groove pine paneled wall.

Left: IR image of the same wall with a blower door operating.

Note how air is infiltrating every board.

Q: Is the weatherstrip on the door effective?

A: No. There is significant infiltration along the strike edge and the top of the door



Note the time and date of the blower door test: mid-day on August 1.

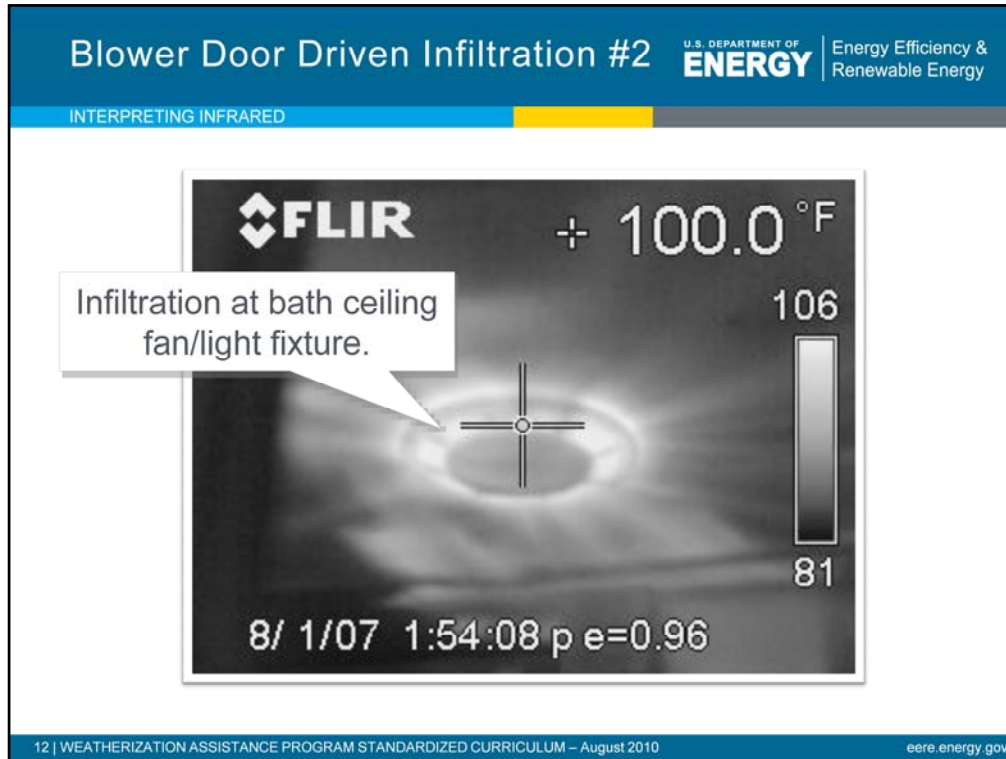
The white streaks at the wall/ceiling junction are caused by hot exterior air being pulled into the attic at the soffit venting by a blower door.

The large white area at the right end of the knee wall is an insulation void.

The streaks radiating from the ceiling light fixture are caused by hot attic air being pulled into the room around the fixture by the blower door.

Q: What should be done?

A: (1) Install blocking and vent chutes between rafter tails to direct soffit vent air up the underside of the roof. (2) Seal the wire penetrations in the ceiling drywall.



Note the date and time of the blower door test recorded on the picture: 8/1/07 @ 1:54 PM. This is the hottest part of the day. The attic above the pictured ceiling will be extremely hot.

- Intense heat at the fan/light unit—106°F—shows that the unit housing has not been sealed to the ceiling. Air that hot has to be coming from the attic and not directly from the outdoors. (The picture was taken in northern Maine.) It is probably not caused by a faulty back draft damper in the fan unit.

Summary

INTERPRETING INFRARED

- IR imaging sees surface temperature only.
- Interpreting IR requires putting images in context
- IR imaging cannot see through anything
- Images are easiest to interpret when there is a large temperature difference, but always require a trained technician for accurate interpretation.
- In conjunction with the blower door, IR imaging is a powerful tool for diagnosing infiltration and targeting air sealing activities.

- IR imaging sees surface temperatures only.
- Interpreting IR requires putting images in context – what's on the other side of the surface being inspected? Be careful not to jump to conclusions.
- IR imaging cannot see through anything.
- Images are easiest to interpret when there is a large temperature difference, but always require a trained technician for accurate interpretation.
- In conjunction with a blower door, IR imaging is a powerful tool for diagnosing infiltration and targeting air sealing activities. Using IR with a blower door gives far superior results to using either tool alone.

Site Monitoring: In-Progress Monitoring and Inspecting

Technical Monitor/Inspector

Learning Objectives

After attending this session, participants will gain an understanding of:

- Who should visit in-progress WAP units.
- The reasons for monitoring and inspecting in-progress WAP units.
- The areas of examination during an in-progress inspection.

Key Terminology

American Recovery and Reinvestment Act (ARRA)

Call-backs

Grantee

Health and safety

In-progress units

Inspector

Lead-Safe Weatherization (LSW)

Material Safety Data Sheet (MSDS)

Monitor

Occupational Safety and Health Administration (OSHA)

Personal Protective Equipment (PPE)

Subgrantee

Weatherization Program Notice (WPN)

Supplemental Materials

Handouts & Resources

Bacharach, Inc. "Instrument Maintenance."

www.bacharachtraining.com/InstrumentMaint/instrumentmaintenance.htm.

The Energy Conservatory. "Procedure for Field Calibration Check of Digital Pressure Gauges" (January 2007).

The Energy Conservatory. "Operation and Maintenance Tips for Energy Conservatory Test Instruments" (Oct. 2004).

Krendl Machine Company. "Blower Maintenance Guide."

Thomson, Jeff, Bob Pfeiffer, Suzanne Harmelink, and Martha Benewicz. "Pressure Testing Insulation Blower and Hoses." WI Weatherization Program (Dec. 1999).

U.S. Department of Energy. Weatherization Assistance Program. *WPN 10-1. Program Year 2010 Weatherization Grant Guidance*. December 18, 2009. www.waptac.org.

Class Overview

- Begin the training session by asking participants if they have conducted in-progress monitoring or inspection of WAP units. If yes, ask those participants to provide a brief overview of their experiences to the group.
- Consider using demo props (e.g., blower door apparatus, insulation blower machine, pressure pan, gas leak detector, combustion appliance zone equipment) to conduct hands-on testing. The trainer can show participants how to make sure the equipment is functioning properly and in accordance with WAP best practice specifications.
- If possible, make available demo props that have been "rigged" with problems. Try to vary the problems to prevent word spreading through the class about how to identify them. Participants should identify the problems with each piece of equipment (e.g., insulation blower does not have enough pressure, blower door hose has slices in it, carbon monoxide draft analyzer is out of calibration). Ask participants to examine each demo prop and take notes. Following this exercise, have trainees discuss their findings as a class.

Site Monitoring: In-Progress Monitoring and Inspecting

Technical Monitor/Inspector

Key Terminology

American Recovery and Reinvestment Act (ARRA)

Call-backs

Grantee

Health and Safety (H&S)

In-progress units

Inspector

Lead Safe Weatherization (LSW)

Material Safety Data Sheet (MSDS)

Monitor

Occupational Safety and Health Administration (OSHA)

Personal Protective Equipment (PPE)

Subgrantee

Weatherization Program Notice (WPN)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will gain an understanding of:

- Who should visit in-progress WAP units.
- The reasons for monitoring and inspecting in-progress WAP units.
- The areas of examination during an in-progress inspection.

In-Progress Monitoring & Inspecting (Slide #3)

- A **monitor** or **inspector** arrives on a job site while the weatherization installers are on the same site performing their assigned duties. Monitors and inspectors observe the crew/contractors as they work on **in-progress units**.
- A monitor or inspector may test equipment and make observations and recommendations, but will not assist the installers in completing work tasks.
- Arrival at the job site can be announced or unannounced.
 - If a monitor or inspector has reason to suspect poor workmanship, an occasional unannounced visit may be warranted.

Three entities conduct in-progress monitoring visits and inspections:

- Local agency Weatherization Assistance Program (WAP) inspectors
 - Local agency inspectors are not *required* to perform in-progress inspections, but they are allowed. However, they *must* perform final inspections on all weatherized units.
- **Grantee** WAP monitors
 - Grantee monitors are not required to conduct in-progress visits, but they may. Grantee monitors usually monitor 5%-20% of the units completed in a grantee's service territory. Under the 2009 ***American Recovery and Reinvestment Act (ARRA)***, a grantee monitor must monitor at least 5% of each ***subgrantee***'s DOE-funded completed units per WPN 10-9.
- WAP project officers
 - ARRA funding requires DOE project officers to be in the field more frequently. Project officers visit a mix of in-progress and completed units.

Reasons to Monitor and Inspect In-Progress Units (Slide #4)

- Provides an opportunity to discuss and finalize the work scope.
- Ensures equipment is functional.
- Ensures program policies and procedures are followed.

In-progress visits allow dialogue between the field staff and the monitors/inspectors. Good communication helps ensure that the right work is done and that best practices are followed.

Reasons to Monitor and Inspect In-Progress Units (Slide #5)

- Ensures appropriate measures are installed correctly.
- Helps reduce ***call-backs***.
- Helps identify training needs.

In-progress visits improve the quality of workmanship and make the weatherization process operate more efficiently.

Discuss and Finalize Work Scope (Slide #6)

In-progress monitoring and inspecting provide an opportunity for the monitor/inspector to:

- Review the auditor's report with installers and arrive at agreement on the work scope.
- Discuss the best methods of handling difficult situations.
 - Many dwellings present unique insulating and air sealing problems. Discussing difficult situations with a monitor or inspector on site will help the work get done properly the first time.
- Identify any opportunities the auditor missed.
 - Sometimes a crew or contractor discovers something the auditor missed.

A crew or contractor can always request an on-site visit from a monitor or auditor to discuss the entire work scope or a specific issue within it.

Ensure Equipment Is Functional (Slide #7)

- Installers can get an independent assessment of their equipment's functionality.
 - Field staff may not realize that their equipment is not performing to specification.
- Monitors/inspectors can ensure that equipment performs to program specification.
- Monitors/inspectors can ensure that there is uniformity in the expected use and proper operation of equipment across crews and contractors.

Before visits to perform equipment testing, monitors and inspectors should check with the crew or contractor to make sure the equipment is on site.

Monitors and inspectors can note outdated/antiquated equipment and suggest obtaining newer, more advanced equipment (i.e., replace magnehelic gauges on blower doors with digital manometers). The State monitor can act as the advocate for local agencies to get appropriate equipment budgets from the State.

Program Policies and Procedures (Slide #8)

Monitors/inspectors:

- Verify that installers are planning to install cost-effective measures recommended by the audit or priority list.
- Ensure that **health and safety** protocols are being followed.
 - The only way to know if health and safety procedures are being followed is to go to the site when workers are there.

- Verify that installers have the requisite resources with them on site.
 - Weatherization field guides.
 - Weatherization best practices manuals.
 - Installers should carry all applicable reference material with them to the job site. Field guides and best practices manuals are meant for field use.

Monitoring for compliance with program policies and procedures is best done unannounced. If it is announced, the workers will take extra measures to ensure they are doing everything by the book.

Measures Are Performed/Installed Correctly (Slide #9)

- A monitor/inspector can observe a worker's:
 - Thoroughness.
 - Speed.
 - Consistency across projects – Consistency is key. Work should be consistent across jobs and meet all program requirements and technical manual specifications. Likewise, WAP work should be consistent across subgrantee territories.

Help Reduce Call-Backs (Slide #10)

- A monitor/inspector can let field staff know during the job if there is something that wouldn't pass a final inspection, and field staff can correct any deficiencies immediately.
- Reducing call-backs:
 - Saves time.
 - Increases productivity.
 - Increases contractor profit potential.
- A call-back means reduced production totals for a subgrantee if a crew/contractor gets called back to fix a job they thought was done.

Call-backs mean lost time and money. Contractors generally do not get paid for returning to jobs to fix work that has already been billed.

Identify Training Needs (Slide #11)

- A monitor can get a good sense of work quality issues in the field. Recommending training to crews and contractors helps ensure that best practices are implemented throughout the WAP.
 - By noting deficiencies in the field, monitors can recommend targeted training.
- If a monitor observes inconsistency across a grantee's service territory, s/he can make training recommendations to help installers:
 - Adopt best practices for installation.
 - Switch to more appropriate materials.
 - Perform specific diagnostic tests.
- In progress monitoring/inspecting also provides a perfect opportunity for impromptu field training. Let field staff know what standards they will be held to, and show them how to meet those standards. Share best practices among various agencies.

Testing the Equipment (Slide #12)

- There is no requirement within WAP that monitors/inspectors test equipment, but some grantees do so to ensure quality installations. Such spot testing of equipment is recommended and encouraged.
- Monitors/inspectors can ensure that:
 - All parts of certain equipment are present and functional.
 - Equipment is professionally calibrated on a recommended schedule per manufacturer specifications. Accurate calibration of equipment is essential to achieving best practices in testing.
 - Field staff is using the most up-to-date technology whenever possible, and can suggest discontinuing use of older, outdated equipment.

Monitors/inspectors may inspect and test the following while on site:

- Blower door apparatus:
 - The apparatus is properly calibrated. Check the date of last calibration.
 - The appropriate number of rings is available.
 - The appropriate hoses are present and intact.
 - The most up-to-date technology is being used (e.g., digital manometer with functional cruise control).
- Insulation blower machine (in truck):
 - Pressure test the blower (to ensure dense pack capability).
 - Examine hoses for cracks and blockage points.
- Combustion safety equipment:
 - Check that it was properly calibrated and the date of last calibration.
 - Determine the age of the equipment and that it has not exceeded its useful life.

On-Site Insulation Blower Pressure Inspection (Slide #13)

By attaching a tag to the unit, the grantee or subgrantee can easily track the last inspection date.

For more on equipment testing and maintenance refer to the “Equipment Tracking and Maintenance” section of the Crew Chief curriculum.

Health and Safety Protocols (Slide #14)

- Following health and safety training protocols protects both workers and clients.
- The only way to know whether installers are practicing proper health and safety measures is to visit them on site. Monitors and inspectors should consider making unannounced visits.
 - Are workers practicing **lead safe weatherization (LSW)** practices? Performing LSW correctly reduces liability risks, so it’s important to implement the LSW field practices that field staff have been trained to use.
 - Is an EPA Certified Renovator on site?
 - Are installers adequately trained and carrying the proper safety equipment to job sites?
 - Are they wearing the proper safety gear?
 - Is equipment functioning properly?

Personal Protective Equipment (Slide #15)

- In-progress monitoring and inspecting can verify the presence and correct use of **personal protective equipment (PPE)**:
 - Tyvek™ suits.
 - Gloves.
 - Respirators.
 - Booties.
 - Steel-toed boots.
- Personal protective gear is for the worker’s benefit!
 - Insulation, particularly recycled fiberglass, can be an allergen. While a person may not react to insulation at first, s/he will react once his/her personal tolerance level is exceeded.
 - Mold is another toxic substance that affects people differently. Just because a person doesn’t react to a particular mold doesn’t mean s/he won’t react to another. Crew and contractors must always wear respirators when working around any type of mold!
- Monitors/inspectors should also verify that crews and contractors are using equipment to protect the home:
 - Poly tarp.
 - Wet spray applicator.
 - Hazard tape and signage.

- Federal law requires that a **Material Safety Data Sheet (MSDS)** be present and easily accessible at the job site for every material used.
 - Get copies from your supplier or download them from the manufacturers' Web sites. Keep them, preferably in alphabetical order, in a safe place in your vehicle. They will be the first item requested if you are ever inspected by the **Occupational Safety and Health Administration (OSHA)**.

EPA-Certified Renovator (Slide #16)

Weatherization Program Notice (WPN) 10-1, 5.13 (December 18, 2009) requires all monitors/inspectors at the State level to be EPA-Certified Renovators and trained in LSW. Monitors can:

- Ensure that auditors, inspectors, crew members, and contractors have attained Certified Renovator status.
- Verify that a Certified Renovator is assigned to a particular job site.
- Verify that the Certified Renovator is associated with a qualified firm.

Case Study: Massachusetts (Slide #17)

- 20 WAP ARRA subgrantees (CAAs).
- 97 contractors to date.
- 3 grantee technical field monitors.

Case Study: Massachusetts (Slide #18)

- Massachusetts Department of Housing and Community Development (MA DHCD) requires subgrantees to inspect, at minimum, 50% of in-progress units.
- Many subgrantees in Massachusetts inspect 100% of in-progress units.
- MA DHCD technical field monitors also perform in-progress monitoring visits of contractors.
- This seems to be a unique model of in-progress monitoring, but if it can work in Massachusetts, it can work well for other grantees and subgrantees.

Recommendations (Slide #19)

- A 50% minimum inspection rate is a nice starting point, but grantees should not let that number dictate their goal. Grantees could start with a lower or higher percentage—lower if 50% would be so large that it would tax the local agency's existing staff, and higher if the current inspection rate is high.
- If a grantee establishes an in-progress requirement, it should include both local agency auditors and grantee monitors performing the in-progress inspections.
- The grantee may consider establishing a crew/contractor equipment testing requirement for grantee monitors.

Summary (Slide #20)

- Three entities may conduct in-progress monitoring visits and inspections:
 - Local agency WAP inspectors.
 - Grantee WAP monitors.
 - WAP project officers.
- Monitoring or inspecting in-progress units provides opportunities to:
 - Clarify work scope.
 - Ensure equipment is functional.
 - Ensure program policies and procedures are followed.
 - Ensure appropriate measures are installed correctly.
 - Reduce call-backs.
 - Identify training needs.



TECHNICAL MONITOR/INSPECTOR

In-Progress Monitoring and Inspecting

Learning Objectives

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Renewable Energy

IN-PROGRESS MONITORING AND INSPECTING

After attending this session, participants will gain an understanding of:

- Who should visit in-progress WAP units
- The reasons for monitoring and inspecting in-progress WAP units
- The areas of examination during an in-progress inspection

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By attending this session, participants will gain an understanding of:

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In-Progress Monitoring & Inspecting

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IN-PROGRESS MONITORING AND INSPECTING

- A **monitor** or **inspector** arrives on a job site while the weatherization installers are on the same site performing their assigned duties.
- May test equipment, make suggestions, but will not perform work.

Who conducts in-progress monitoring and inspections?

- Local Agency WAP Inspectors.
- Grantee WAP Monitors.
- DOE WAP Project Officers.



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- A **monitor** or **inspector** arrives on a job site while the weatherization installers are on the same site performing their assigned duties. Monitors and inspectors observe the crew/contractors as they work on **in-progress units**.
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- WAP project officers

ARRA funding requires DOE project officers to be in the field more frequently. Project officers visit a mix of in-progress and completed units.

Reasons to Monitor & Inspect In-Progress Units

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IN-PROGRESS MONITORING AND INSPECTING

- Opportunity to discuss and finalize work scope.
- Ensures equipment is functional.
- Ensures program policies and procedures are followed.



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- Provides an opportunity to discuss and finalize the work scope.
- Ensures equipment is functional.
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In-progress visits allow dialogue between the field staff and the monitors/inspectors. Good communication helps ensure that the right work is done and that best practices are followed.

Reasons to Monitor & Inspect In-Progress Units

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IN-PROGRESS MONITORING AND INSPECTING

- Ensures appropriate measures are installed correctly.
- Helps reduce call-backs.
- Helps identify training needs.



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- Ensures appropriate measures are installed correctly.
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In-progress visits improve the quality of workmanship and make the weatherization process operate more efficiently.

Discuss and Finalize Work Scope

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IN-PROGRESS MONITORING AND INSPECTING

Review Auditor's Report

- Discuss best methods of handling difficult situations.
- Identify opportunities missed by auditor.

Discussing what you expect based on the work order will help installers get it right the first time.

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In-progress monitoring and inspecting provide an opportunity for the monitor/inspector to:

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Ensure Equipment is Functional

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IN-PROGRESS MONITORING AND INSPECTING

- Installers can get an independent assessment of their equipment's functionality.
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- Monitors/inspectors can ensure that there is uniformity in the expected use and proper operation of equipment across crews and contractors.

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- Installers can get an independent assessment of their equipment's functionality.
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- Monitors/inspectors can ensure that equipment performs to program specification.
- Monitors/inspectors can ensure that there is uniformity in the expected use and proper operation of equipment across crews and contractors.

Before visits to perform equipment testing, monitors and inspectors should check with the crew or contractor to make sure the equipment is on site.

Monitors and inspectors can note outdated/antiquated equipment and suggest obtaining newer, more advanced equipment (i.e., replace magnehelic gauges on blower doors with digital manometers). The State monitor can act as the advocate for local agencies to get appropriate equipment budgets from the State.

Monitors/inspectors:

- Verify that installers are planning to install weatherization measures recommended by the audit or priority list.
- Ensure that health and safety protocol is being followed.
- Verify that installers have the requisite resources with them on-site.
 - Weatherization field guides.
 - Weatherization best practices manuals.



Photo courtesy of New Mexico Housing

Monitors/inspectors:

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Monitoring for compliance with program policies and procedures is best done unannounced. If it is announced, the workers will take extra measures to ensure they are doing everything by the book.

Measures are Performed/Installed Correctly

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IN-PROGRESS MONITORING AND INSPECTING

A monitor/inspector can observe a worker's:

- Thoroughness.
- Speed.
- Consistency across projects.



Photo courtesy of NRCERT

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- A monitor/inspector can observe a worker's:
 - o Thoroughness.
 - o Speed.
 - o Consistency across projects – Consistency is key. Work should be consistent across jobs and meet all program requirements and technical manual specifications. Likewise, WAP work should be consistent across subgrantee territories.

Help Reduce Call-Backs

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IN-PROGRESS MONITORING AND INSPECTING

A monitor/inspector can let field staff know during the job if there is something that wouldn't pass a final inspection, and field staff can correct any deficiencies immediately.

Reducing Call-Backs:

- Saves time.
- Increases productivity.
- Increases contractor profit potential.

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- A monitor/inspector can let field staff know during the job if there is something that wouldn't pass a final inspection, and field staff can correct any deficiencies immediately.
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- A call-back means reduced production totals for a subgrantee if a crew/contractor gets called back to fix a job they thought was done.

Call-backs mean lost time and money. Contractors generally do not get paid for returning to jobs to fix work that has already been billed.

Identify Training Needs

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IN-PROGRESS MONITORING AND INSPECTING

- A monitor can get a good sense of work quality issues in the field.
- If a monitor observes inconsistency across a grantee's service territory, s/he can make training recommendations to help installers:
 - Adopt best practices for installation.
 - Switch to more appropriate materials.
 - Perform specific diagnostic tests.

By noting deficiencies in the field, a monitor can recommend targeted trainings.

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- A monitor can get a good sense of work quality issues in the field. Recommending training to crews and contractors helps ensure that best practices are implemented throughout the WAP.
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- In progress monitoring/inspecting also provides a perfect opportunity for impromptu field training. Let field staff know what standards they will be held to, and show them how to meet those standards. Share best practices among various agencies.

Testing the Equipment

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IN-PROGRESS MONITORING AND INSPECTING

Monitors/inspectors are not required to, but may inspect and test the following while on-site:

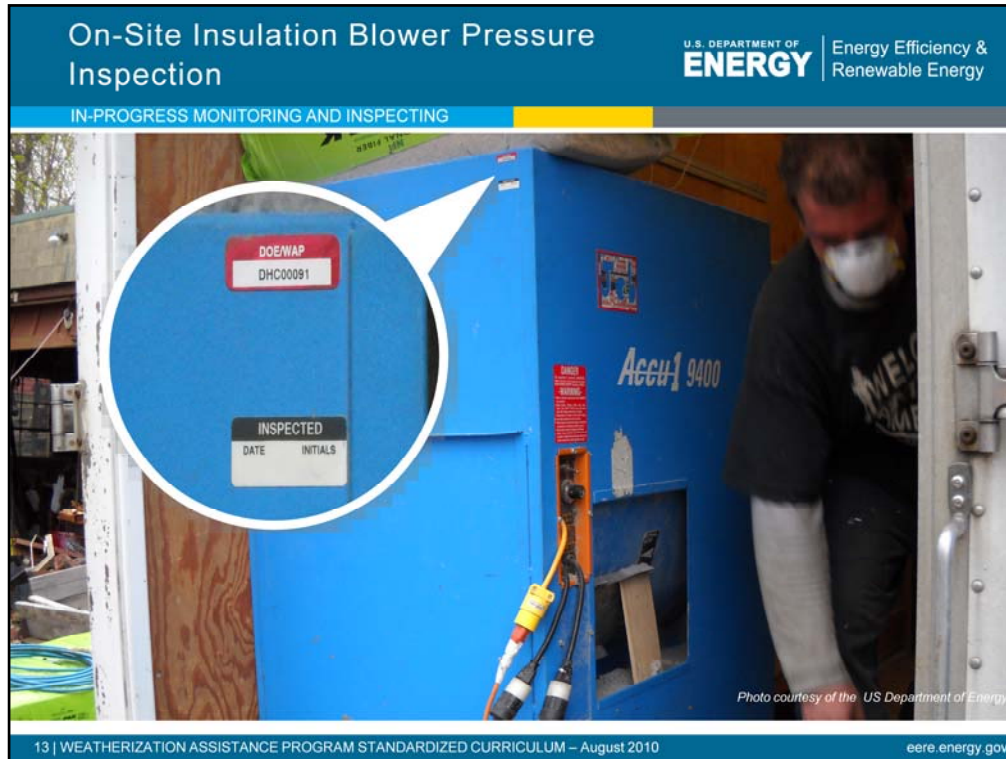
Insulation Blower Machine • Pressure test (to ensure dense pack capability). • Examine hoses for cracks and blockage points. Combustion Safety Equipment • Properly calibrated (date of last calibration). • Not antiquated.	Blower Door Apparatus • Properly calibrated (date of last calibration). • Appropriate number of rings available. • Appropriate hoses present and intact. • Digital manometer preferred (with functional cruise control).
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- There is no requirement within WAP that monitors/inspectors test equipment, but some grantees do so to ensure quality installations. Such spot testing of equipment is recommended and encouraged.
- Monitors/inspectors can ensure that:
 - All parts of certain equipment are present and functional.
 - Equipment is professionally calibrated on a recommended schedule per manufacturer specifications. Accurate calibration of equipment is essential to achieving best practices in testing.
 - Field staff is using the most up-to-date technology whenever possible, and can suggest discontinuing use of older, outdated equipment.

Monitors/inspectors may inspect and test the following while on site:

- Blower door apparatus:
 - The apparatus is properly calibrated. Check the date of last calibration.
 - The appropriate number of rings is available.
 - The appropriate hoses are present and intact.
 - The most up-to-date technology is being used (e.g., digital manometer with functional cruise control).
- Insulation blower machine (in truck):
 - Pressure test the blower (to ensure dense pack capability).
 - Examine hoses for cracks and blockage points.
- Combustion safety equipment:
 - Check that it was properly calibrated and the date of last calibration.
 - Determine the age of the equipment and that it has not exceeded its useful life.



By attaching a tag to the unit, the grantee or subgrantee can easily track the last inspection date.

For more on equipment testing and maintenance refer to the “Equipment Tracking and Maintenance” section of the Crew Chief curriculum.

Health and Safety Protocols

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Energy Efficiency & Renewable Energy

IN-PROGRESS MONITORING AND INSPECTING

Note:

- Are workers practicing lead-safe weatherization (LSW) practices?
- Is an EPA Certified Renovator on site?
- Are installers adequately trained and carrying the proper safety equipment to job sites?
 - Are they wearing the proper safety gear?
 - Is equipment functioning properly?



Photo courtesy of WV Governor's Office of Economic Opportunity

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- Following health and safety training protocols protects both workers and clients.
- The only way to know whether installers are practicing proper health and safety measures is to visit them on site. Monitors and inspectors should consider making unannounced visits.
 - o Are workers practicing **lead safe weatherization (LSW)** practices? Performing LSW correctly reduces liability risks, so it's important to implement the LSW field practices that field staff have been trained to use.
 - o Is an EPA Certified Renovator on site?
 - o Are installers adequately trained and carrying the proper safety equipment to job sites?
 - Are they wearing the proper safety gear?
 - Is equipment functioning properly?

Personal Protective Equipment

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IN-PROGRESS MONITORING AND INSPECTING

In-progress monitoring and inspecting can verify the presence and correct use of:

For Workers

- Tyvek suits
- Gloves
- Respirators
- Booties
- Steel-toed boots

For the Job Site

- Poly tarp
- Wet spray applicator
- Hazard tape and signage
- Accurate MSDS



Photo courtesy of the US Department of Energy

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- In-progress monitoring and inspecting can verify the presence and correct use of **personal protective equipment (PPE)**:
 - Tyvek™ suits.
 - Gloves.
 - Respirators.
 - Booties.
 - Steel-toed boots.
- Personal protective gear is for the worker's benefit!
 - Insulation, particularly recycled fiberglass, can be an allergen. While a person may not react to insulation at first, s/he will react once his/her personal tolerance level is exceeded.
 - Mold is another toxic substance that affects people differently. Just because a person doesn't react to a particular mold doesn't mean s/he won't react to another. Crew and contractors must always wear respirators when working around any type of mold!
- Monitors/inspectors should also verify that crews and contractors are using equipment to protect the home:
 - Poly tarp.
 - Wet spray applicator.
 - Hazard tape and signage.
- Federal law requires that a **Material Safety Data Sheet (MSDS)** be present and easily accessible at the job site for every material used.

Get copies from your supplier or download them from the manufacturers' Web sites. Keep them, preferably in alphabetical order, in a safe place in your vehicle. They will be the first item requested if you are ever inspected by the **Occupational Safety and Health Administration (OSHA)**.

EPA Certified Renovator

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IN-PROGRESS MONITORING AND INSPECTING

- Monitors can ensure that auditors, monitors, crew members, and contractors have attained EPA Certified Renovator status.
- Verify that a Certified Renovator is assigned to a particular job site.
- Verify that the Certified Renovator is associated with a qualified firm.



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Weatherization Program Notice (WPN) 10-1, 5.13 (December 18, 2009) requires all monitors/inspectors at the State level to be EPA-Certified Renovators and trained in LSW.

Monitors can:

- Ensure that auditors, inspectors, crew members, and contractors have attained Certified Renovator status.
- Verify that a Certified Renovator is assigned to a particular job site.
- Verify that the Certified Renovator is associated with a qualified firm.

Case Study: Massachusetts

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IN-PROGRESS MONITORING AND INSPECTING

Background information on Massachusetts:



- 20 WAP ARRA subgrantees.
- 97 contractors to date (would like 50 more).
- 3 grantee technical field monitors.

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- 20 WAP ARRA subgrantees (CAAs).
- 97 contractors to date.
- 3 grantee technical field monitors.

Case Study: Massachusetts

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Renewable Energy

IN-PROGRESS MONITORING AND INSPECTING

Massachusetts Department of Housing and Community Development (MA DHCD):

- Subgrantees are required to conduct, at minimum, 50% in-progress inspections of contractors.
- Many subgrantees in MA conduct 100% in-progress inspections.
- MA DHCD technical field monitors also perform in-progress monitoring visits of contractors.

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- Massachusetts Department of Housing and Community Development (MA DHCD) requires subgrantees to inspect, at minimum, 50% of in-progress units.
- Many subgrantees in Massachusetts inspect 100% of in-progress units.
- MA DHCD technical field monitors also perform in-progress monitoring visits of contractors.
- This seems to be a unique model of in-progress monitoring, but if it can work in Massachusetts, it can work well for other grantees and subgrantees.

Recommendations

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IN-PROGRESS MONITORING AND INSPECTING

- Choose a minimum in-progress inspection rate.
- If a grantee establishes an in-progress requirement, it should include both local agency auditors and grantee monitors performing the in-progress inspections.
- The grantee may consider establishing a crew/contractor equipment testing requirement for grantee monitors.

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- A 50% minimum inspection rate is a nice starting point, but grantees should not let that number dictate their goal. Grantees could start with a lower or higher percentage—lower if 50% would be so large that it would tax the local agency's existing staff, and higher if the current inspection rate is high.
- If a grantee establishes an in-progress requirement, it should include both local agency auditors and grantee monitors performing the in-progress inspections.
- The grantee may consider establishing a crew/contractor equipment testing requirement for grantee monitors.

Summary

IN-PROGRESS MONITORING AND INSPECTING

Three entities may conduct in-progress monitoring visits and inspections:

- Local agency WAP inspectors.
- Grantee WAP monitors.
- WAP project officers.

Monitoring or inspecting in-progress units provides opportunities to:

- Clarify work scope.
- Ensure equipment is functional.
- Ensure program policies and procedures are followed.
- Ensure appropriate measures are installed correctly.
- Reduce call-backs.
- Identify training needs.

- Three entities may conduct in-progress monitoring visits and inspections:
 - o Local agency WAP inspectors.
 - o Grantee WAP monitors.
 - o WAP project officers.
- Monitoring or inspecting in-progress units provides opportunities to:
 - o Clarify work scope.
 - o Ensure equipment is functional.
 - o Ensure program policies and procedures are followed.
 - o Ensure appropriate measures are installed correctly.
 - o Reduce call-backs.
 - o Identify training needs.

Report Writing

Technical Monitor/Inspector

Learning Objectives

By attending this session, participants will learn:

- The purpose of various reports.
- The content to include in specific reports.
- Tips for writing a clear, concise, and useful report.
- To recognize and address patterns and trends.
- How report “tone” can affect worker morale and motivation.

Key Terminology

Call-back

Community Action Agency (CAA)

Cubic Feet per Minute (CFM)

DOE Project Officer (DOE PO)

Grantee

House as a system

Indoor Air Quality (IAQ)

Inspector

Monitor

Priority list

R-value

Savings-to-Investment Ratio (SIR)

Subgrantee

Technical field monitor

Training and Technical Assistance (T&TA)

Supplemental Materials

Handouts & Resources

Handout #1 – Pictures of attic hatches and Report A & Report B

Handout #2 – Pictures of whole-house fan covers

Handout #3 – Sample Report: Site Visits

Handout #4 – Sample Report Summary: Technical Evaluation

Sample audit input report and recommended measures report

Sample audit home diagram

Sample monitoring reports

Class Overview

If possible, provide sample reports before the training session, so trainees can review them prior to attending.

Review each report during or immediately following the appropriate section of the presentation. Lead discussions about:

- Good aspects of the report (i.e., content, format, style, language, diagrams, etc.).
- Bad aspects of the report (i.e., content, format, style, language, diagrams, etc.).
- What could have been added to the report?
- What might have been omitted from the report?

Exercise #1

Distribute Handout #1. Give students 5 minutes to read the reports. Note that both reports present the same information. Ask the following questions, recording class responses on a flip chart, whiteboard, or overhead:

Q. Which report will generate a more positive response?

A. Report B.

Q. Why?

A. It emphasizes positive statements throughout, provides clear instructions about what needs to be done and why, discusses things done right, and doesn't make derogatory remarks about the crew.

Q. Which statement in Report A has absolutely no place in a report of this type?

A. "It is apparent that the time spent to date trying to train these incompetents in weatherization technology has been totally wasted."

Discuss why.

If time allows, ask class members to describe reports written about their work. As a class, discuss what the writer did right and what they might have done better to elicit a more positive response from the recipient in each instance.

Exercise #2

Distribute Handout #2. Allow students 10 minutes to list good and not-so-good points about each pictured treatment, recommend training by position, and suggest training methods.

Whole house fan cover I:

- Good: Effective, inexpensive.
- Not so good: Not durable, one-time use only, appearance is unacceptable.
- Needed training: Auditor and crew chief need training that installed measures must be durable (poly is not) and re-useable (duct tape is one time use only) and must match the quality of the home. The installer needs training on using appropriate materials.

Whole house fan cover II:

- Good: Effective, inexpensive, fairly durable.
- Not so good: Duct tape will have to be replaced every time it is removed. The inconvenience will discourage reuse. The appearance is poor.
- Needed training: Auditor and crew chief need training that installed measures intended for seasonal use must be reusable and must match the quality of the home. Installer needs training on using appropriate materials.

Whole house fan cover III:

- Good: Effective, relatively inexpensive, durable, convenient to remove and replace.
- Not so good: Appearance could be an issue in some homes. The auditor should clear the appearance with the homeowner.
- Needed training: Auditor may need training on choosing cosmetically acceptable measures.

Suggested training methods:

- Discuss training needs at periodic field staff meetings.
- Peer-to-peer training – Have the installers from Scenario III demonstrate methods to the installers from Scenarios I and II.

Return to slide #16, “Creating a Report.”

Exercise #3

Distribute Handout #3. Allow students 30 minutes to review the report, draft a summary of patterns and trends, and recommend necessary training by position. Keep a running list of patterns and trends on a flipchart, whiteboard, or overhead as students report their findings. Complete the outline and create a composite report and a training list as a group.

Trend:

- Underuse of infrared.

Patterns:

- Dense-pack cellulose density not achieved.
- Lack of attic air sealing.
- Lack of attic duct sealing.
- Building envelope poorly defined at furnace closets.

Distribute Handout #4. Allow students 5 minutes to review it. As a group, discuss any differences between this report summary and the training list the class created based on Handout #3.

Site Inspection: Work with a local agency to bring students to a nearby weatherized completed or in-progress unit for a final inspection. Have half the class document the visit as a final inspection, and the other half develop what they would include in a monitoring report. Is there a need for reworks? Are there any recommendations for follow-up training of the crew or auditor? Are both groups in agreement? Have the class discuss the differences in how they approached their report writing. If a site walk through is not possible, this exercise can be done using a video of an audit or final inspection, if one is available.

Report Writing

Technical Monitor/Inspector

Key Terminology

Call-back

Community Action Agency (CAA)

Cubic Feet per Minute (CFM)

DOE Project Officer (DOE PO)

Grantee

House as a system

Indoor Air Quality (IAQ)

Inspector

Monitor

Priority list

R-value

Savings-to-Investment Ratio (SIR)

Subgrantee

Technical field monitor

Training and Technical Assistance (T&TA)

Section Transition

Learning Objectives (Slide #2)

By attending this session, participants will learn:

- The purpose of various reports.
- The content to include in specific reports.
- Tips for writing a clear, concise, and useful report.
- To recognize and address patterns and trends.
- How report “tone” can affect worker morale and motivation.

The Purpose of Reporting (Slide #3)

- Audit, monitoring, and inspection reports are necessary to ensure that WAP operates effectively and efficiently:
 - Measures are implemented correctly.
 - Funds are spent wisely.
- Reports demonstrate that program oversight was conducted per program requirements.
- Reports can recommend **training and technical assistance (T&TA)** where needed.
- Reports can be used to compile data for national program evaluations.

The Purpose of Monitoring Reports (Slide #4)

- Monitoring reports:
 - Help fulfill a WAP requirement.
 - Document findings in the field.
 - Identify and track action items.
 - Can be shared with the many people who need to be informed about a program's performance and production quality.
- Monitoring is required at both the Federal level and the **grantee** level.
- Monitoring reports help confirm that WAP is functioning according to all regulations and guidance in an efficient and effective manner.
- Because Congress is appropriating funds for each State and U.S. Territory, use of these funds must be documented via monitoring reports. Monitoring reports can be used as back-up in investigations to show that program oversight was conducted according to program requirements.

Federal Monitoring Reports (Slide #5)

Reports by a Federal **monitor** should include observations, recommendations, and concerns about office monitoring and in-field monitoring:

- *Observations* about areas in which the grantee is managing the program according to DOE and State regulations, as well as areas where the grantee is being creative in program operations. Observations might include the following:
 - Monthly/quarterly reporting is complete and on time on a regular basis.
 - The grantee is monitoring the number of units required by the State Plan.
 - The grantee requires **subgrantees** to conduct in-progress monitoring of WAP units.
- *Recommendations* on how the grantee can improve its program, along with suggestions for additional T&TA. Recommendations might include the following:
 - All grantee monitors should have their own infrared cameras to check the sidewalls of weatherized units.
 - The grantee may want to consider dense-pack insulation training for all crews/contractors.
- *Concerns* about program rules, regulations, and implementation, along with suggestions for remediation and a timeline for corrective actions. Concerns might include the following:
 - Production of completed weatherized units is behind schedule.
 - Not all crews/contractors have a Certified Renovator assigned to pre-1978 dwellings.

Such reports are generated when a **DOE project officer (DOE PO)** visits a grantee and/or subgrantee on an official monitoring visit.

Federal monitoring reports should contain a tracking list and target resolution timeline for items the grantee needs to address. The DOE PO will follow up on these issues.

Subgrantee Monitoring Reports (Slide #6)

- Reports by a **technical field monitor** should include observations, recommendations, and concerns about office monitoring and in-field monitoring:
 - *Observations* about whether the subgrantee is achieving assigned goals and how it is spending funds, as well as undertaking any creative programs. Observations might include the following:
 - All completed units have been inspected and a subgrantee **inspector** has signed and dated the inspection form.
 - The crews/contractors are doing a solid job performing insulation and air sealing measures.
 - *Recommendations* on how the subgrantee can improve program and technical field performance, along with suggestions for T&TA activities. Recommendations might include the following:
 - Suggestions for an alternative method of performing a task that may be quicker or more efficient.
 - Suggestions for an alternative product for a specific application
 - Monitoring observations indicating that air sealing training might be helpful for all field staff.
 - *Concerns* about program rules, regulations, and implementation, along with suggestions for remediation and a timeline for corrective actions. Concerns might include the following:
 - Items are billed that are not installed in dwellings.
 - Lead-safe work practices are not being followed on site.
- Such reports are generated when a grantee technical field monitor visits a subgrantee on an official visit.

Monitoring Reports (Slide #7)

- Monitoring reports:
 - Usually incorporate information from office and field monitoring.
 - May or may not include a formal monitoring checklist.
 - Are mostly text and usually 5-15 pages long.
- Report writers' report formats may vary in style and content.
- If a checklist is included, the text for the report is mostly based on the important issues in the checklist. The writer can then expand on issues not contained in the checklist.
- Observations from site visits are usually included in the text of the report.
 - Description of dwelling and client.
 - Thoroughness of audit and proper measure recommendations.
 - Observation of measures installed and quality of workmanship.
 - Photos of the dwelling taken during the monitoring visit.

Tips for Monitoring Reports (Slide #8)

- Create an easy-to-read template with clearly labeled sections (including observations, recommendations, and concerns).
- Document each site visit to a dwelling separately.
- Write clearly and concisely.
- Document your observations with digital photos in the report as often as possible.

Refer to sample Monitoring Reports on CD.

Inspection Reports (Slide #9)

- Inspection reports:
 - Fulfill a WAP requirement.
 - Document appropriate and allowable measures installed in WAP units.
 - Confirm that the weatherization work completed in a dwelling was what the auditor recommended or the priority list allows.
- Program regulations require inspections of all weatherized units.
- It is best if the inspector and the auditor are not the same person and the inspector is not inspecting work that s/he called for in the first place. This prevents conflict of interest and retains an independent check and balance process.
- Like the audit report, the local agency's inspection report may be based on a standard form that a subgrantee uses or a grantee requires.

Inspection Reports Should... (Slide #10)

- Inspection reports should:
 - Document post-weatherization test results.
 - Verify that billing was correct and everything billed was actually installed in the dwelling.
 - Confirm quality workmanship on every WAP unit.
 - Identify poor workmanship and maintain a record of **call-backs** and re-inspections by the local agency inspector.
 - Eventually result in a sign-off by the final inspector as a completed weatherized unit that may be counted toward production goals.
- Inspectors should perform post-weatherization testing in areas where pre-weatherization tests were conducted (e.g., blower door, combustion safety, pressure pan).
- Payment can't be made until the inspector puts his/her signature on the inspection report.
- Verifying that the billing is correct is as important as ensuring that quality workmanship was performed.
- The inspector should be able to identify any problems with installations or missed opportunities based on the auditor's recommendations. The inspector should initiate a call-back of a crew or contractor, if necessary.

Inspection Report Format (Slide #11)

- Inspection reports generally follow a structured format.
- Inspectors complete the inspection form, which basically constitutes the report.
- Generally, there is not much text.
- Most inspectors use inspection forms that they complete in the field. Generally, all inspectors for a grantee use the same forms.
- Inspection forms may vary across subgrantees in a State or they may be uniform if a grantee requires them to be so.
- Most inspection reports have notes sections for text. Additional pages can be added if necessary.

Tips for Inspection Reports (Slide #12)

- Review the audit report and address any special issues that the auditor mentions.
- Be as thorough as possible in documenting the work performed.
- Use complete sentences to express thoughts and when providing instructions.
- Inspection reports should detail why any measures the auditor recommended were not implemented.
- Inspection reports should detail the quality of workmanship observed at the dwelling. Issues related to particular measures should be noted individually.
- Because inspection reports are completed in the field, legible handwriting is important to ensure that no one misinterprets the report.

Patterns (Slide # 13)

These photos show the backs of clothes dryer and the walls through which they are vented. Each vent has a problem that was created when the installer pushed the dryer back into position. None of these dryer vents meet the intent of the program:

- Photo I: A minor restriction from the vent duct being squeezed slows air movement through the dryer, increasing drying time.
- Photo II: A major restriction from the vent duct being squeezed further increases drying time. This will shorten dryer life and can create a fire hazard.
- Photo III: A major restriction increases drying time. A hole cut in the vent duct allows moisture and wash chemicals free access to the home's interior, reducing **indoor air quality (IAQ)**.

If a **Community Action Agency (CAA)** final inspector took these pictures during a final inspection, s/he could recommend that the installer get training in proper dryer venting methods and materials, and the crew chief get training in checking the installer's work.

If the pictures came from a State-level monitoring of homes weatherized by a single CAA, the problem is systematic. The auditor, inspector, crew chief, installer, and any other on-site personnel the CAA employs need training in proper dryer venting methods and applicable **house as a system** science.

Your report should be based on *patterns* of unacceptable work. The dryer vent installations pictured are deficient in similar ways. A single error or oversight may simply mean someone had a bad day. If several houses in a sample have similar failings, the problem is most likely either a need for additional training or a lack of understanding of why a particular task is important.

Frequently, there are patterns of improper measures in any sample of houses:

- Multiple missed chimney bypass seals.
- Poor workmanship on attic hatch treatments.
- Repeated improper installation of door weatherstrips.

Generally, these errors can be eliminated by training the installers.

Q. When does a pattern become a trend?

A. Generally, a pattern refers to a series of similar events in a limited sample, while a trend is an entity-wide practice.

Trends (Slide #14)

A trend is more pervasive than a pattern. One example of a problematic trend would be a particular CAA weatherization program installing large numbers of replacement windows and doors rather than insulating walls.

Training to reinforce or discourage trends is generally limited to auditors and inspectors and consists mainly of explaining DOE requirements concerning **savings-to-investment ratio (SIR)** calculations and individual measures prioritization.

The doors pictured, from left to right, are:

- Photo I: An insulated core 2¼" thick wooden door to be replaced because of the hole in the exterior skin below the center window – There will be no appreciable savings from replacing this insulated core door with even the best available replacement door.
- Photo II: A 2" thick pine door being replaced because of the single-pane glass – Note that the doorway has a metal storm door in good condition. Replacing a good primary door/storm door assembly (with an **R-value** of R-2 or R-3) with a typical replacement door (R-5 at best) will produce very little savings at high cost, likely resulting in a negative SIR.
- Photo III: A replacement insulated steel door – This new door has been installed in an exceedingly rundown inner city property. It is quite unlikely the building will stand long enough to achieve a positive SIR.
- Photo IV: A replacement insulated steel door with window – According to the client, this new door replaced a wooden door with an aluminum storm. It appears that like was replaced with like (R-2+ with R-2+), eliminating any possibility of a positive SIR.

The door replacements were ordered by different auditors at the same CAA. The CAA employing the auditors has a reputation for installing at least one door in nearly every home it weatherizes.

- If a CAA inspector took these pictures during a final inspection, s/he could recommend that the auditor get training to understand DOE requirements concerning SIR.
- If the pictures came from a State-level monitoring of weatherized units from a single CAA and is typical of its work, then the pervasive door replacement may be a high-level policy decision. If that is the case, the CAA Weatherization Director needs training in the intent of the DOE Weatherization Program, SIR requirements, and program management.

Report Tone (Slide #15)

All the pictured attic hatches were installed or upgraded by the same CAA crew.

- Photo I: The crew installed molding and a weatherstrip around the hatch opening.
- Photo II: The crew installed a weatherstrip and insulation on the upper side of the hatch, which is a client-installed cabinet door hinged to the ceiling and held closed by a turn button.
- Photo III: The crew built a hatch from scratch using molding supplied by the client to match the existing molding.
- Photo IV: The crew installed a weatherstrip around the existing hatch.

Three of the four pictured hatches failed the Any Town CAA final inspection.

Which hatches failed and why?

- Photo I: Fails – The lid is warped and doesn't contact the weatherstrip. The new molding is not sealed or painted to match the existing molding.
- Photo II: Fails – A recycled cabinet door over a ragged hole is not a proper hatch. The weatherstrip installed by the crew provides an insufficient air seal between the door and the broken plaster ceiling above.
- Photo III: Fails – The client-supplied molding was poorly fitted by the crew. The mitered joints are not air sealed.
- Photo IV: Passes – This looks nice. The weatherstrip is air tight, as determined by a blower door test.

After reviewing these examples of acceptable and unacceptable work, ask the students to think about how they would present that work in their reports. Discuss the appropriate tone for a report and why tone matters.

Be positive.

Be concise.

Don't nitpick.

Write as if you were the recipient.

Refer to Lesson Plan – Exercise # 1.

Creating a Report (Slide #16)

- Review site visit forms, field notes, and pictures.
- Develop an outline.
- Organize by individual units.
- Address units in the order visited.
- List measures installed on each unit.
- List any other pertinent information, such as blower door numbers.
- Flesh out the report. Be brief, using bullet points when possible.
- Start each unit section with a picture of the unit.
- Include a list of installed measures.
 - Note which measures were installed well and which need improvement.
 - Include pictures supporting individual measure observations.
- Record any client comments.
- Summarize important patterns and trends.
- Suggest training needs by title, not by name.
- Note peer training opportunities.
- Record exceptional work.
- File all paperwork, including field notes, pictures, and report drafts in case you need them later.
 - The CAA may question the report's conclusions.
 - If you need to summarize activities during the grant period, they will be a valuable resource.
 - In the event of legal action, these documents will be important evidence.

Exercise #2 (Slide #17)

Refer to Lesson Plan.

What to Look for in Audit Reports (Slide #18)

This course is not designed for auditors, but as final inspectors and monitors work closely with auditors, an overview of audit reports is provided for your convenience.

- Audit reports:
 - Document the auditor's findings during the initial visit to the dwelling.
 - Document any pre-weatherization test results.
 - Recommend measures to be implemented.
 - Explain unique or difficult issues to installation technicians.
- Audit reports are a required element of the Weatherization Assistance Program (WAP).
- A unit can't be weatherized until an auditor has evaluated it.
- The audit report highlights the measures recommended by the auditor based on either the audit or the **priority list**. The auditor's notes become the roadmap to implementation.

- An audit report records all pre-weatherization testing the auditor conducted:
 - Blower door **cubic feet per minute (CFM)** readings.
 - Combustion safety readings.
 - Pressure pan readings.

Audit Reports (Slide #19)

- Audit reports generally follow a pre-determined format. Most auditors use audit forms they complete in the field. All auditors employed by a given subgrantee use the same forms.
- Auditors fill in information on the audit form, which basically constitutes the report. Audit forms may vary across subgrantees in a State or they may be uniform if a grantee requires them to be so.
- Generally, there is not a large amount of text. Most audit reports have notes sections for text. Additional pages can be added if necessary.

Tips for Audit Reports (Slide #20)

- Be as thorough as possible in documenting the dwelling.
- Draw accurate diagrams and note key areas of special concern. It is very useful to code the diagrams with numbers or letters.
- Use complete sentences to express thoughts and provide instructions.
- The more information an auditor can put down on paper about a dwelling, the better.
- Because reports are completed in the field, legible handwriting is important to ensure that no one misinterprets the report.

Summary (Slide #21)

- Audit, monitoring, and inspection reports are necessary to ensure that WAP operates effectively and efficiently.
- Reports provide a record of program performance.
- Organize reports chronologically.
- Keep reports positive.
- Praise good work.
- Summarize patterns and trends.
- Recommend training by title, not name.
- Keep good records!



TECHNICAL MONITOR/INSPECTOR

Report Writing

WEATHERIZATION ASSISTANCE PROGRAM STANDARDIZED CURRICULUM – August 2010

Learning Objectives

U.S. DEPARTMENT OF
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REPORT WRITING

By attending this session, participants will learn:

- The purpose of various reports.
- The content to include in specific reports.
- Tips for writing a clear, concise, and useful report.
- To recognize and address patterns and trends
- How report “tone” can affect worker morale and motivation.

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By attending this session, participants will learn:

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- How report “tone” can affect worker morale and motivation.

The Purpose of Reporting

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REPORT WRITING

Audit, monitoring, and inspection reports ensure that WAP operates effectively and efficiently.

- Measures are implemented correctly.
- Funds are spent wisely.
- Reports verify program oversight.
- Reports can recommend training and technical assistance (T&TA) where needed.
- Reports can be used to compile data for national program evaluations.

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- Audit, monitoring, and inspection reports are necessary to ensure that WAP operates effectively and efficiently:
 - o Measures are implemented correctly.
 - o Funds are spent wisely.
 - Reports demonstrate that program oversight was conducted per program requirements.
 - Reports can recommend **training and technical assistance (T&TA)** where needed.
- Reports can be used to compile data for national program evaluations.

Purpose of Monitoring Reports

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REPORT WRITING

Monitoring Reports:

- Help to fulfill a WAP requirement.
- Document findings in the field.
- Identify and track action items.
- Can be shared with many people who need to be informed about a program's performance and production quality.



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- Monitoring reports:
 - o Help fulfill a WAP requirement.
 - o Document findings in the field.
 - o Identify and track action items.
 - o Can be shared with the many people who need to be informed about a program's performance and production quality.
- Monitoring is required at both the Federal level and the **grantee** level.
- Monitoring reports help confirm that WAP is functioning according to all regulations and guidance in an efficient and effective manner.
- Because Congress is appropriating funds for each State and U.S. Territory, use of these funds must be documented via monitoring reports. Monitoring reports can be used as back-up in investigations to show that program oversight was conducted according to program requirements.

Federal Monitoring Reports

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REPORT WRITING

Federal Reports should include the following:

- **Observations** - What is the grantee excelling at, in terms of managing the program? Are they incorporating creative efforts? Are they falling short in some areas?
- **Recommendations** – How can the grantee improve their program, correct mistakes, or best target T&TA efforts?
- **Concerns** – Any concerns regarding WAP Program rules, regulations, and implementation must be documented along with remediation suggestions and a definitive timeline for corrective actions.

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Reports by a Federal **monitor** should include observations, recommendations, and concerns about office monitoring and in-field monitoring:

- *Observations* about areas in which the grantee is managing the program according to DOE and State regulations, as well as areas where the grantee is being creative in program operations. Observations might include the following:
 - Monthly/quarterly reporting is complete and on time on a regular basis.
 - The grantee is monitoring the number of units required by the State Plan.
 - The grantee requires **subgrantees** to conduct in-progress monitoring of WAP units.
- *Recommendations* on how the grantee can improve its program, along with suggestions for additional T&TA. Recommendations might include the following:
 - All grantee monitors should have their own infrared cameras to check the sidewalls of weatherized units.
 - The grantee may want to consider dense-pack insulation training for all crews/contractors.
- *Concerns* about program rules, regulations, and implementation, along with suggestions for remediation and a timeline for corrective actions. Concerns might include the following:
 - Production of completed weatherized units is behind schedule.
 - Not all crews/contractors have a Certified Renovator assigned to pre-1978 dwellings.

Such reports are generated when a **DOE project officer (DOE PO)** visits a grantee and/or subgrantee on an official monitoring visit.

Federal monitoring reports should contain a tracking list and target resolution timeline for items the grantee needs to address. The DOE PO will follow up on these issues.

Subgrantee Monitoring Reports

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REPORT WRITING

Subgrantee Reports should include the following:

- **Observations** about how the subgrantee is achieving their assigned goals and spending appropriated funds, as well as undertaking any creative programs.
- **Recommendations** on how the subgrantee can improve program and technical field performance, along with consideration of appropriate T&TA activities.
- **Concerns** regarding Program rules, regulations, and implementation must be documented along with remediation suggestions and a definitive timeline for corrective actions.

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- Reports by a **technical field monitor** should include observations, recommendations, and concerns about office monitoring and in-field monitoring:
 - *Observations* about whether the subgrantee is achieving assigned goals and how it is spending funds, as well as undertaking any creative programs. Observations might include the following:
 - All completed units have been inspected and a subgrantee **inspector** has signed and dated the inspection form.
 - The crews/contractors are doing a solid job performing insulation and air sealing measures.
 - *Recommendations* on how the subgrantee can improve program and technical field performance, along with suggestions for T&TA activities. Recommendations might include the following:
 - Suggestions for an alternative method of performing a task that may be quicker or more efficient.
 - Suggestions for an alternative product for a specific application
 - Monitoring observations indicating that air sealing training might be helpful for all field staff.
 - *Concerns* about program rules, regulations, and implementation, along with suggestions for remediation and a timeline for corrective actions. Concerns might include the following:
 - Items are billed that are not installed in dwellings.
 - Lead-safe work practices are not being followed on site.
- Such reports are generated when a grantee technical field monitor visits a subgrantee on an official visit.

Monitoring Reports:

- Usually incorporate information from office and field WAP monitoring efforts.
- May or may not include a formal monitoring checklist.
- Are mostly text and usually 5-15 pages long.
- Reports vary in both style and content, depending on the author and the issues being addressed.

- Monitoring reports:
 - Usually incorporate information from office and field monitoring.
 - May or may not include a formal monitoring checklist.
 - Are mostly text and usually 5-15 pages long.
- Report writers' report formats may vary in style and content.
- If a checklist is included, the text for the report is mostly based on the important issues in the checklist. The writer can then expand on issues not contained in the checklist.
- Observations from site visits are usually included in the text of the report.
 - Description of dwelling and client.
 - Thoroughness of audit and proper measure recommendations.
 - Observation of measures installed and quality of workmanship.
 - Photos of the dwelling taken during the monitoring visit.

Tips for Monitoring Reports

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REPORT WRITING



- Create an easy-to-read template with clearly labeled sections (observations, recommendations, concerns).
- Document each site visit to a dwelling separately.
- Write clearly and concisely.
- Document observations with digital photos.

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- Create an easy-to-read template with clearly labeled sections (including observations, recommendations, and concerns).
- Document each site visit to a dwelling separately.
- Write clearly and concisely.
- Document your observations with digital photos in the report as often as possible.

Refer to sample Monitoring Reports on CD.

Inspection Reports

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REPORT WRITING

Inspection Reports:

- Fulfill a WAP requirement
- Document that appropriate and allowable measures are installed in WAP units.
- Confirm that the weatherization work completed in a dwelling was what was recommended within the audit or priority list.

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- Inspection reports:
 - Fulfill a WAP requirement.
 - Document appropriate and allowable measures installed in WAP units.
 - Confirm that the weatherization work completed in a dwelling was what the auditor recommended or the priority list allows.
- Program regulations require inspections of all weatherized units.
- It is best if the inspector and the auditor are not the same person and the inspector is not inspecting work that s/he called for in the first place. This prevents conflict of interest and retains an independent check and balance process.
- Like the audit report, the local agency's inspection report may be based on a standard form that a subgrantee uses or a grantee requires.

Inspection Reports Should...

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REPORT WRITING

- Document post-weatherization test results.
- Verify that billing was correct and everything billed was actually installed in the dwelling.
- Confirm quality workmanship on every WAP unit.
- Identify poor workmanship and maintain tracking record of “call-backs” and re-inspections by the local agency inspector.
- Result in sign-off by final inspector as a completed WAP unit to be reported for production goals.

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- Inspection reports should:
 - o Document post-weatherization test results.
 - o Verify that billing was correct and everything billed was actually installed in the dwelling.
 - o Confirm quality workmanship on every WAP unit.
 - o Identify poor workmanship and maintain a record of **call-backs** and re-inspections by the local agency inspector.
 - o Eventually result in a sign-off by the final inspector as a completed weatherized unit that may be counted toward production goals.
- Inspectors should perform post-weatherization testing in areas where pre-weatherization tests were conducted (e.g., blower door, combustion safety, pressure pan).
- Payment can’t be made until the inspector puts his/her signature on the inspection report.
- Verifying that the billing is correct is as important as ensuring that quality workmanship was performed.
- The inspector should be able to identify any problems with installations or missed opportunities based on the auditor’s recommendations. The inspector should initiate a call-back of a crew or contractor, if necessary.

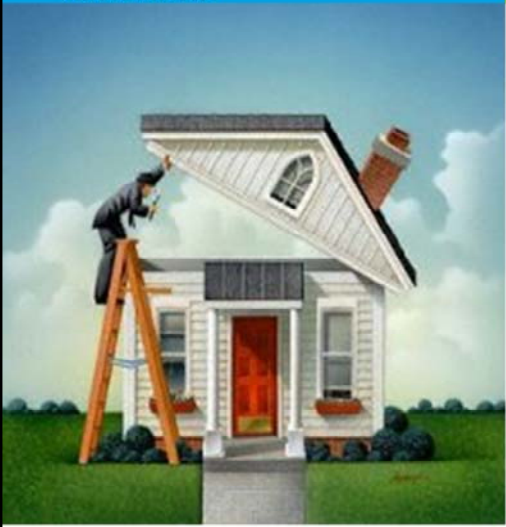
Inspection Report Format

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REPORT WRITING



- Inspection reports generally follow a structured format.
- Inspectors fill-in information on the inspection form.
- Generally not a large amount of text narrative.

The inspection report indicates if measures were installed as required, and if any rework is required.

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- Inspection reports generally follow a structured format.
- Inspectors complete the inspection form, which basically constitutes the report.
- Generally, there is not much text.
- Most inspectors use inspection forms that they complete in the field. Generally, all inspectors for a grantee use the same forms.
- Inspection forms may vary across subgrantees in a State or they may be uniform if a grantee requires them to be so.
- Most inspection reports have notes sections for text. Additional pages can be added if necessary.

Tips for Inspection Reports

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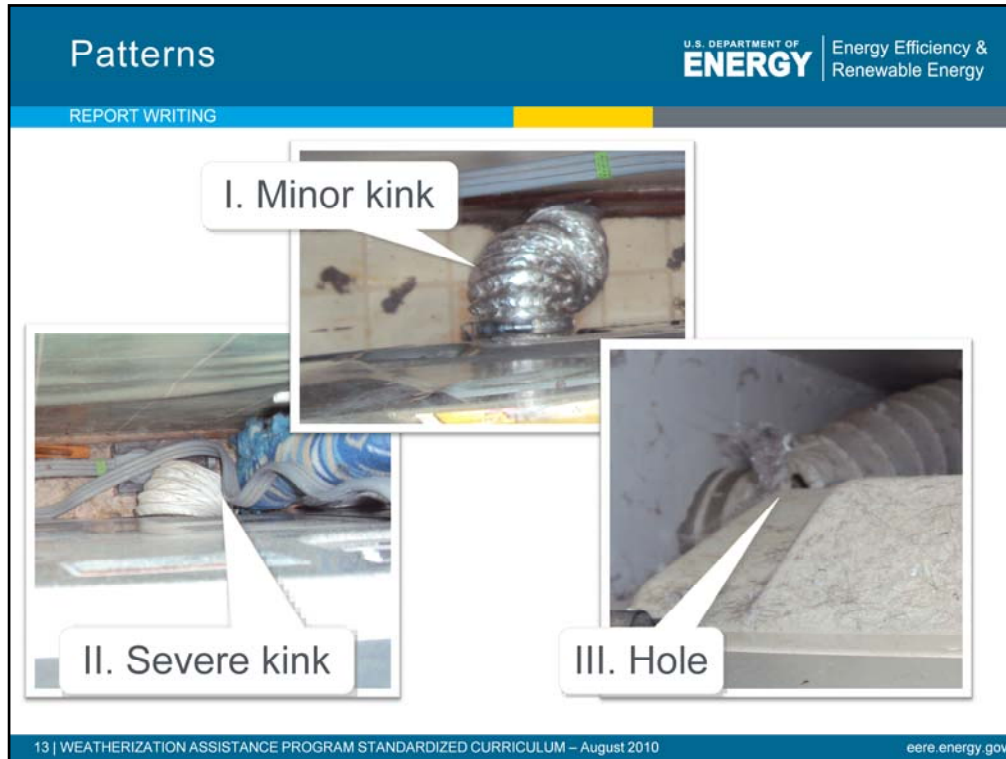
REPORT WRITING

- Review the audit report and address any special issues that the auditor mentions.
- Be as thorough as possible.
- Use complete sentences.
- Detail why any measures the auditor recommended were not implemented.
- Note the quality of workmanship observed at the dwelling. Issues related to particular measures should be noted individually.
- Use good penmanship!

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- Review the audit report and address any special issues that the auditor mentions.
- Be as thorough as possible in documenting the work performed.
- Use complete sentences to express thoughts and when providing instructions.
- Inspection reports should detail why any measures the auditor recommended were not implemented.
- Inspection reports should detail the quality of workmanship observed at the dwelling. Issues related to particular measures should be noted individually.
- Because inspection reports are completed in the field, legible handwriting is important to ensure that no one misinterprets the report.



These photos show the backs of clothes dryer and the walls through which they are vented. Each vent has a problem that was created when the installer pushed the dryer back into position. None of these dryer vents meet the intent of the program:

- Photo I: A minor restriction from the vent duct being squeezed slows air movement through the dryer, increasing drying time.
- Photo II: A major restriction from the vent duct being squeezed further increases drying time. This will shorten dryer life and can create a fire hazard.
- Photo III: A major restriction increases drying time. A hole cut in the vent duct allows moisture and wash chemicals free access to the home's interior, reducing **indoor air quality (IAQ)**.

If a **Community Action Agency (CAA)** final inspector took these pictures during a final inspection, s/he could recommend that the installer get training in proper dryer venting methods and materials, and the crew chief get training in checking the installer's work.

If the pictures came from a State-level monitoring of homes weatherized by a single CAA, the problem is systematic. The auditor, inspector, crew chief, installer, and any other on-site personnel the CAA employs need training in proper dryer venting methods and applicable **house as a system** science.

Your report should be based on *patterns* of unacceptable work. The dryer vent installations pictured are deficient in similar ways. A single error or oversight may simply mean someone had a bad day. If several houses in a sample have similar failings, the problem is most likely either a need for additional training or a lack of understanding of why a particular task is important.

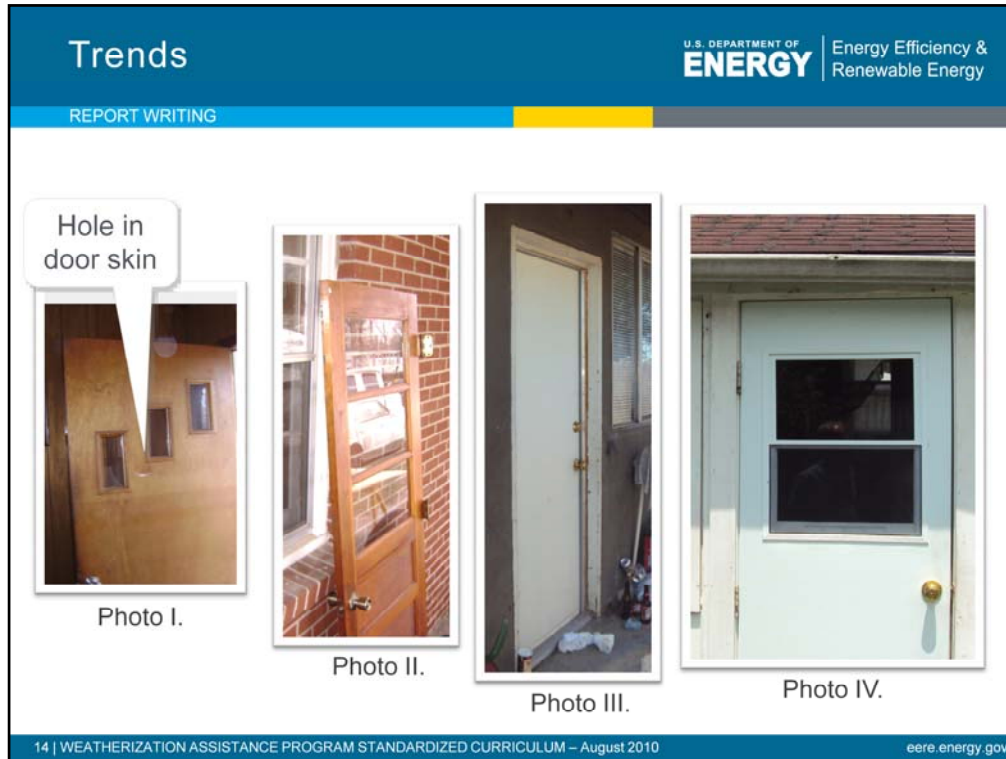
Frequently, there are patterns of improper measures in any sample of houses:

- Multiple missed chimney bypass seals.
- Poor workmanship on attic hatch treatments.
- Repeated improper installation of door weatherstrips.

Generally, these errors can be eliminated by training the installers.

Q. When does a pattern become a trend?

A. Generally, a pattern refers to a series of similar events in a limited sample, while a trend is an entity-wide practice.



A trend is more pervasive than a pattern. One example of a problematic trend would be a particular CAA weatherization program installing large numbers of replacement windows and doors rather than insulating walls.

Training to reinforce or discourage trends is generally limited to auditors and inspectors and consists mainly of explaining DOE requirements concerning **savings-to-investment ratio (SIR)** calculations and individual measures prioritization.

The doors pictured, from left to right, are:

- Photo I: An insulated core 2¼" thick wooden door to be replaced because of the hole in the exterior skin below the center window – There will be no appreciable savings from replacing this insulated core door with even the best available replacement door.
- Photo II: A 2" thick pine door being replaced because of the single-pane glass – Note that the doorway has a metal storm door in good condition. Replacing a good primary door/storm door assembly (with an **R-value** of R-2 or R-3) with a typical replacement door (R-5 at best) will produce very little savings at high cost, likely resulting in a negative SIR.
- Photo III: A replacement insulated steel door – This new door has been installed in an exceedingly rundown inner city property. It is quite unlikely the building will stand long enough to achieve a positive SIR.
- Photo IV: A replacement insulated steel door with window – According to the client, this new door replaced a wooden door with an aluminum storm. It appears that like was replaced with like (R-2+ with R-2+), eliminating any possibility of a positive SIR.

The door replacements were ordered by different auditors at the same CAA. The CAA employing the auditors has a reputation for installing at least one door in nearly every home it weatherizes.

- If a CAA inspector took these pictures during a final inspection, s/he could recommend that the auditor get training to understand DOE requirements concerning SIR.
- If the pictures came from a State-level monitoring of weatherized units from a single CAA and is typical of its work, then the pervasive door replacement may be a high-level policy decision. If that is the case, the CAA Weatherization Director needs training in the intent of the DOE Weatherization Program, SIR requirements, and program management.



All the pictured attic hatches were installed or upgraded by the same CAA crew.

- Photo I: The crew installed molding and a weatherstrip around the hatch opening.
- Photo II: The crew installed a weatherstrip and insulation on the upper side of the hatch, which is a client-installed cabinet door hinged to the ceiling and held closed by a turn button.
- Photo III: The crew built a hatch from scratch using molding supplied by the client to match the existing molding.
- Photo IV: The crew installed a weatherstrip around the existing hatch.

Three of the four pictured hatches failed the Any Town CAA final inspection.

Which hatches failed and why?

- Photo I: Fails – The lid is warped and doesn't contact the weatherstrip. The new molding is not sealed or painted to match the existing molding.
- Photo II: Fails – A recycled cabinet door over a ragged hole is not a proper hatch. The weatherstrip installed by the crew provides an insufficient air seal between the door and the broken plaster ceiling above.
- Photo III: Fails – The client-supplied molding was poorly fitted by the crew. The mitered joints are not air sealed.
- Photo IV: Passes – This looks nice. The weatherstrip is air tight, as determined by a blower door test.

After reviewing these examples of acceptable and unacceptable work, ask the students to think about how they would present that work in their reports. Discuss the appropriate tone for a report and why tone matters.

Be positive.

Be concise.

Don't nitpick.

Write as if you were the recipient.

Refer to Lesson Plan – Exercise # 1.

Creating a Report

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REPORT WRITING

- Review site visit “paper”.
- Create report outline.
- “Flesh out” report.
- Summarize important points.
- Suggest training needs and opportunities .
- Praise exceptional work.
- File all field notes, draft reports, pictures, etc.



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- Review site visit forms, field notes, and pictures.
- Develop an outline.
- Organize by individual units.
- Address units in the order visited.
- List measures installed on each unit.
- List any other pertinent information, such as blower door numbers.
- Flesh out the report. Be brief, using bullet points when possible.
- Start each unit section with a picture of the unit.
- Include a list of installed measures.
 - o Note which measures were installed well and which need improvement.
 - o Include pictures supporting individual measure observations.
- Record any client comments.
- Summarize important patterns and trends.
- Suggest training needs by title, not by name.
- Note peer training opportunities.
- Record exceptional work.
- File all paperwork, including field notes, pictures, and report drafts in case you need them later.
- o The CAA may question the report’s conclusions.
- o If you need to summarize activities during the grant period, they will be a valuable resource.
- o In the event of legal action, these documents will be important evidence.

Exercise #2

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REPORT WRITING

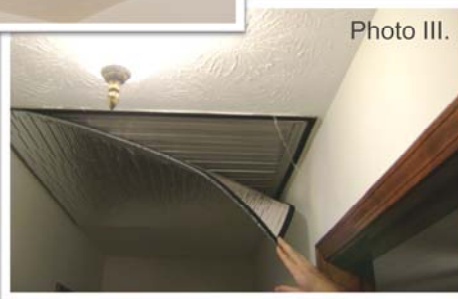
Photo I.



Photo II.



Photo III.



Refer to Lesson Plan.

What to Look for in Audit Reports

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REPORT WRITING

Audit Reports should:

- Document the findings of the auditor during the initial visit to the dwelling.
- Document any pre-weatherization test results.
- Recommend measures to be implemented.
- Explain unique or difficult issues to installation technicians.

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This course is not designed for auditors, but as final inspectors and monitors work closely with auditors, an overview of audit reports is provided for your convenience.

- Audit reports:
 - o Document the auditor’s findings during the initial visit to the dwelling.
 - o Document any pre-weatherization test results.
 - o Recommend measures to be implemented.
 - o Explain unique or difficult issues to installation technicians.
- Audit reports are a required element of the Weatherization Assistance Program (WAP).
- A unit can’t be weatherized until an auditor has evaluated it.
- The audit report highlights the measures recommended by the auditor based on either the audit or the **priority list**. The auditor’s notes become the roadmap to implementation.
- An audit report records all pre-weatherization testing the auditor conducted:
 - o Blower door **cubic feet per minute (CFM)** readings.
 - o Combustion safety readings.
 - o Pressure pan readings.

Audit Reports

REPORT WRITING

- Audit reports generally follow a pre-determined format.
- Auditors fill-in information on the audit form.
- Generally not a large amount of text.

NEAT Recommended Measures

Agency: State: Run On: RunID:
 Client ID: Version: AuditID:
 Auditor Name: Audit Date:
 Client Name: Auditor:
 Weather File: Setup Library Name:
 Comment:

Annual Energy and Cost Savings

Index	Recommended Measure	Component	Heating (MMBtu)	Heating (\$)	Cooling (\$)	BaseLoad (\$)	Total (\$)
1	Weatherization		3.5	27	24	0	3.5
2	Weatherization	WALLS, CEILING, FLOOR, DOORS, WINDOWS	17.2	132	205	0	10.2
3	Refrigerator Appliance		0.0	0	0	714	2.4
4	Low-E Windows	WINDOZ WINDOZ WINDOZ	10.0	54	100	0	11.0

Energy Saving Measure Economics

Index	Recommended Measure	Component	Measure Savings (\$/yr)	Measure Cost (\$)	Cumulative Savings (\$/yr)	Cumulative Cost (\$)
1	Weatherization		29	100	2.9	2.9
2	Weatherization	WALLS, CEILING, FLOOR, DOORS, WINDOWS	156	836	2.9	936
3	Refrigerator Appliance		58	519	1.3	1455
4	Low-E Windows	WINDOZ WINDOZ WINDOZ	100	1518	1.0	2973

Sample NEAT Audit recommended measures produced from auditor's inputs after field assessment.

- Audit reports generally follow a pre-determined format. Most auditors use audit forms they complete in the field. All auditors employed by a given subgrantee use the same forms.
- Auditors fill in information on the audit form, which basically constitutes the report. Audit forms may vary across subgrantees in a State or they may be uniform if a grantee requires them to be so.
- Generally, there is not a large amount of text. Most audit reports have notes sections for text. Additional pages can be added if necessary.

Tips for Audit Reports

REPORT WRITING

- Be thorough.
- Draw accurate diagrams of the dwelling and note key areas of special concern on the diagram.
- Use complete sentences when providing instructions.
- Write legibly if others will need to interpret your handwritten notes!



This diagram of the dwelling makes it very clear what sections or rooms the auditor is referring to in the notes to the installation crew.

- Be as thorough as possible in documenting the dwelling.
- Draw accurate diagrams and note key areas of special concern. It is very useful to code the diagrams with numbers or letters.
- Use complete sentences to express thoughts and provide instructions.
- The more information an auditor can put down on paper about a dwelling, the better.
- Because reports are completed in the field, legible handwriting is important to ensure that no one misinterprets the report.

Summary

REPORT WRITING

- Audit, monitoring, and inspection reports are necessary to ensure that WAP operates effectively and efficiently.
- Reports provide a record of program performance.
- Organize reports chronologically.
- Keep reports positive.
- Praise good work.
- Summarize patterns and trends.
- Recommend training by title, not name.
- Keep good records!

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Acronyms

Weatherization Assistance Program Standardized Training Curricula

ABS	Acrylonitrile Butadiene Styrene
ACCA	Air Conditioning Contractors of America
ACH	Air Changes per Hour
AEE	Association of Energy Engineers
AGA	American Gas Association
AHAM	Association of Home Appliance Manufacturers
AHU	Air-Handling Unit
ANSI	American National Standards Institute
ARRA	American Recovery and Reinvestment Act
ASC	Accredited Standards Committee
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BMS	Building Management System
BPI	Building Performance Institute
BTL	Building Tightness Limit
BTU	British Thermal Units
CAA	Community Action Agency
CAP	Community Action Program, or Community Action Agency
CAZ	Combustion Appliance Zone
CFH	Cubic Feet per Hour
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet per Minute
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CRF	Can't Reach Fifty
CRI	Color Rendering Index
DHW	Domestic Hot Water
DHWT	Domestic Hot Water Tank
DOE	Department of Energy
DOE PO	DOE Project Officer
DTL	Depressurization Tightness Limit
EAI	Energy Audit Institute

EA-QUIP	Energy Audit Using the Queens Information Package
EDL	Equivalent Duct Length
EIA	Energy Information Administration
ELA	Equivalent Leakage Area
EPA	Environmental Protection Agency
FIFO	First-in, First-out System
GFCI	Ground Fault Circuit Interrupter
GVW	Gross Vehicle Weight
H&S	Health and Safety
HDD	Heating Degree Days
HERS	Home Energy Rating System
HRV	Heat Recovery Ventilation
HUD	Housing and Urban Development
HVAC	Heating, Ventilating, and Air Conditioning
HVI	Home Ventilating Institute
IAPMO	International Association of Plumbing and Mechanical Officials
IAQ	Indoor Air Quality
ICC	International Codes Council
IC	Insulating Contact
IFGC	International Fuel Gas Code
IR	Infrared
IRC	International Residential Code
IWC	Inches of water column
LBNL	Lawrence Berkeley National Laboratory (also written LBL)
LEED	Leadership in Energy and Environmental Design
LIHEAP	Low Income Home Energy Assistance Program
LPG	Liquefied Petroleum Gas
LSW	Lead Safe Weatherization
MF	Multifamily
MHEA	Manufactured Home Energy Audit
MRT	Mean Radiant Temperature
MSDS	Material Safety Data Sheet
MVG	Minimum Ventilation Guideline
MVR	Minimum Ventilation Requirement
NEAT	National Energy Audit Tool
NEC	National Electrical Code

NFA	Net Free Area (in reference to ventilation standards)
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NIOSH	National Institute for Occupational Safety and Health
o.c.	On Center
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
Pa	Pascals
PHA	Public Housing Authority or Agency
PMC	Project Management Center
PPE	Personal Protection Equipment
PPM	Parts Per Million
PSI	Pounds Per Square Inch
PV	Present Value
QC	Quality Control
RH	Relative Humidity
SC	Shading Coefficient
SF	Single Family
SHGC	Solar Heat Gain Coefficient
SIR	Savings-to-Investment Ratio
SO ₂	Sulfur Dioxide
T&TA	Training and Technical Assistance
TREAT	Targeted Retrofit Energy Analysis Tool
WAP	Weatherization Assistance Program
WPN	Weatherization Program Notice
WRT	With Reference To
ZPD	Zone Pressure Diagnostics

Glossary

Weatherization Assistance Program Standardized Training Curricula

Absolute humidity	Air moisture content expressed in grains (or pounds) of water vapor per pound of dry air.
Acceptable maximum CFM ₅₀ shell leakage (AMSL)	A guideline of how much air leakage from a building is permitted, measured in cubic feet per minute at -50 Pa. If the building exceeds AMSL, air sealing measures are indicated.
Accredited Standards Committee (ASC)	A group established by the American National Standards Institute to develop standards. The ASC Z223 works with the National Fire Protection Agency to develop and publish the National Fuel Gas Code, also known as ANSI Z223.1 and NFPA 54.
ACH ₅₀	Measure of how often the air is refreshed when the pressure difference is 50 Pa.
Acrylonitrile butadiene styrene (ABS)	A rigid thermoplastic polymer common in piping applications. ABS is the counterpart to off-white PVC pipe; ABS pipes are black. ABS is very durable but breaks down when exposed to acetone.
Action levels	Levels of CO (in ppm, as tested) at which action (mitigation and/or evacuation) is suggested.
Active ventilation	A system of ventilation in which air is forced through ventilation ducts under pressure. Also known as mechanical or forced ventilation.
Air barrier (air boundary)	Any part of the building shell that offers resistance to air leakage. The air barrier is effective if it stops most air leakage. The primary air barrier is the most effective of a series of air barriers. Also called air boundary or pressure boundary.
Air changes per hour (ACH)	The number of times in one hour that all of the air in a home is replaced by outside air through air leakage and/or ventilation.
Air Conditioning Contractors of America (ACCA)	Industry group that works toward improving the air-conditioning industry, promoting good practices, and keeping homes and buildings safe, clean, and comfortable.

Air leakage	Uncontrolled ventilation through gaps in the pressure boundary. Typical sites of air leakage include around windows, pipes, wires, and other penetrations.
Air transport	Movement of moisture vapor by convective air currents.
Air-free CO content	Unit of measurement referring to the level of CO not diluted with oxygen in a flue gas sample.
Air-handling unit (AHU)	An equipment package that includes a fan or blower, heating and/or cooling coils, air filtration, etc. for providing heating, ventilating, and air conditioning to a building.
Albedo	The ratio of reflected to incident light.
Aldehydes	Any class of organic compounds containing the group - CHO, which yields acids when oxidized and alcohols when reduced. Also a toxic byproduct of oil combustion.
Aluminum brake	A tool that is used to produce perfect 90 degree bends in metal.
Aluminum coil stock	A rolled product which is a continuous strip of aluminum, produced in coil form. The coil has both an inner and outer diameter and comes in a variety of finishes and features.
Ambient	Of the surrounding area or environment.
Ambient air	Outdoor or unconditioned air
American Gas Association (AGA)	A trade association representing American natural gas supply companies. AGA collaborates with ASC and NFPA on the National Fuel Gas Code.
American National Standards Institute (ANSI)	A private non-profit organization that oversees the development of voluntary consensus standards.
American Recovery and Reinvestment Act (ARRA)	Bill signed by President Obama in February 2009 as an economic stimulus package.
Amperage	The amount of electrical energy flowing through an appliance at any given time; also called "current."
Anemometer	A device for measuring wind speed, used in weatherization work to determine flow rates at registers.
Angle of incidence	The angle of the sun hitting the roof.
Appendix A	Specifications and standards for weatherization materials as set forth in DOE WAP Rule 10 CFR, Part 440.
Area	Length x width = area.

As-measured CO content	Unit of measurement referring to the level of CO, including oxygen, in a flue gas sample. As-measured values will always be lower than air-free samples.
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers. International technical society which develops standards for those concerned with refrigeration processes and the design and maintenance of indoor environments.
ASHRAE 62.1-1989	Air quality standard developed for large commercial buildings, usually with forced ventilation. Is accepted for use on small residential buildings as of this writing.
ASHRAE 62.2-2007	Air quality standard developed for low-rise residential buildings. Defines the roles of and minimum requirements for mechanical and natural ventilation systems and the building envelope.
ASHRAE guidelines	Standards of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers
Association of Energy Engineers (AEE)	A professional organization for energy engineers. AEE offers many certification programs, including one for residential energy auditors.
Association of Home Appliance Manufacturers (AHAM)	Trade association representing the appliance manufacturing industry.
Atmospheric	Used in reference to combustion appliances. Atmospheric appliances draw combustion air from the room where they are located. The term used in building and safety codes is "natural draft."
Auditory/verbal learners	Auditory learners learn best by hearing information. They can usually remember information more accurately when it has been explained to them orally.
Awning window	Awning windows are essentially casement windows that swing vertically. Awning windows are often used in basements. Jalousie windows, found on older mobile homes, are a type of awning window.
B-vent	A double-wall pipe for gas- or propane-fired combustion appliances.
Backdrafting	Continuous spillage of combustion gases from a combustion appliance.
Baffle	A plate or strip designed to retard or redirect the flow of flue gases.

Balloon framing	In carpentry, the lightest and most economical form of construction in which the studding and corner plates are set up in continuous lengths from the first floor line or sill to the roof plate to which all floor joists are fastened. Wall cavities act as major air leakage pathways in balloon framed homes.
Band joist	The outermost joist around the perimeter of the floor framing. Also known as a rim joist.
Barometric damper	A device installed in a chimney to allow for the adjustment of dilution air.
Base load	The energy used by electric or gas appliances in a home that is not used for space conditioning, thus not a seasonal load.
Belly blow	A process for re-insulating floor cavities with blown-in insulation.
Belly return or belly return system	A type of mobile home air distribution system. The mobile home heating or cooling system receives return air through the belly cavity or plenum.
Bernoulli Principle	Phenomenon in which a sufficient air stream across an opening will create enough of a pressure difference to draw a liquid or gas out of a vessel.
Blower	Used in reference to furnace blowers, also called squirrel cages. The blades should be cleaned for optimal performance.
Blower door	A diagnostic tool used to locate the points of infiltration in the building envelope and help guide air sealing.
Board feet	A measurement of lumber volume. A board foot equals 144 cubic inches of wood.
Body language	The gestures, postures, and facial expressions by which a person manifests various physical, mental, or emotional states and communicates nonverbally with others.
Boot	A duct section that connects a duct to a register or a round duct to a square duct.
Boroscope	An inspection tool; a flexible tube with a light and camera or viewer at one end. Boroscopes can be used to look into wall cavities and other tight spaces that would be otherwise impossible to visually inspect.
Box sill	Common method of framing floor joists, where a header is nailed to the ends of the floor joists.
Branch duct	An air duct which branches from a main duct.

British thermal unit (BTU)	The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
Building envelope	The area of the building that encloses conditioned space. Only the exterior four walls to the ceiling under the attic and the floor above the unheated basement area are considered part of the building envelope. The floor of a unit that is built on stilts or is above an unheated crawl space is considered a part of the building envelope. The roof of a building that has no ceilings (or that is part of the ceiling) is considered part of the building envelope.
Building management system (BMS)	Computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as air handling and cooling.
Building Performance Institute (BPI)	Organization supporting the development of a highly professional building performance industry through individual and organizational credentialing and a quality assurance program.
Building tightness limit (BTL)	A level of air tightness at which indoor air quality and building integrity may be compromised if the residence is any tighter.
Bulk moisture	Large amounts of water intrusion, for example from wind-driven rain or sub-surface water.
Butyl-backed tape	Heavy-duty, pressure-sensitive duct joint rolled sealant.
Bypass	A channel through air and thermal boundaries where air passes, uncontrolled, into or out of the building envelope.
Cad cell	A flame sensor composed of the chemical compound cadmium sulfide. Its purpose is to sense whether a flame is present during a burner cycle. If a flame is not detected, it activates a relay, which shuts the burner down.
Calibration	Comparison of the test results of an instrument to a known reference point.
Call-back	Having a weatherization team return to a job site to perform work not done or redo work done unsatisfactorily.
Can light	A light fixture (or can) that is set into the ceiling. Also called recessed light fixture.
Can't reach fifty (CRF)	A factor that extrapolates air flow at lower pressure differences to air flow at 50 pascals pressure difference. Used in blower door diagnostics when the shell is too leaky to allow the blower door to reach a pressure difference of 50 pascals.

Cantilevered floor	A floor that extends beyond the foundation of the framed structure below it and is exposed to outside conditions.
Capillary action	Movement of liquid water across a material as a function of the surface tension of the water and the porosity of the material.
Carbon dioxide (CO ₂)	One of two main products of complete combustion of a hydrocarbon. (The other is water vapor.)
Carbon dioxide content	A measure of the bicarbonate level in the air. Higher than normal levels of carbon dioxide may induce a number of negative side effects.
Carbon monoxide (CO)	Carbon monoxide is a tasteless, odorless, colorless, and poisonous gas that is a by-product of incomplete combustion of fossil fuels. It is usually caused by a lack of air to support combustion or impingement of the flame.
Carbon monoxide content	A measure of the carbon monoxide level in the air.
Casement window	Casement windows have a single operable sash that swings outward on a horizontal plane. Casement window frames that have gone out of square due to settling can stick and quite possibly render these types of windows inoperable.
Cementitious	Having the properties of cement. Cementitious roof coatings, unlike elastomeric varieties, do not stop water infiltration.
Central HVAC system	Heating, ventilating, and/or air conditioning equipment that serves a building from a main unit. A system generally includes the heat producing or air conditioning appliance, the return and supply system, and ducts or pipes for venting flue gases. Compare to separate equipment for each room or apartment.
Certification	Recognition by an independent person or group that someone can competently complete a job or task, frequently demonstrated by passing an exam.
Certification label	Metal plate fastened to the exterior of a mobile home, showing that it meets all construction requirements under the HUD Code.
Certified renovator	A person authorized by EPA to perform repair and renovation projects that disturb lead-based paint.
CFM ₅₀	Measurement of air leakage in cubic feet per minute at 50 Pa pressure difference.

CFM _{natural}	Amount of air leakage in cubic feet per minute under natural conditions.
Change order	A process through which a business and its client can alter an original business agreement.
Chaseway	Cavity within a building with the purpose of conveying pipes, ducts, etc. through the building. Chaseways, such as plumbing walls, are common sites for air leakage.
Chimney chase	Typically refers to the cavity between the chimney and the framing and other building materials that surround the chimney. Because of fire-safety clearances, there is usually a gap of at least 2" between building materials and the chimney, allowing substantial air leakage.
Classroom testing	Examination of students that takes place in a classroom setting. See also field testing.
Classroom training	Teaching students to perform jobs or tasks in a classroom setting. See also on-site/in-field training.
Clearances	Allowable distances between heat-producing appliances, chimneys, or vent systems and combustible surfaces.
Climate zone	An area with a prevailing climate that distinguishes it from other areas by parameters such as temperature, rainfall, and humidity.
Clothing insulation value (CLO)	CLO is used to measure the thermal insulation of clothes.
Codes	Any set of standards set forth and enforced by a government agency for the protection of public health and safety.
Collar beam	A horizontal piece in roof framing that provides structural strength by connecting opposite rafters.
Color rendering index (CRI)	A measurement of a light source's ability to render colors the same as sunlight. CRI has a scale of 0 to 100.
Color scale	The relation between an incandescent substance's temperature and the color of the light it emits.
Combustible gas leak detector	Device used for finding natural gas or propane leaks.
Combustion air	Air that chemically combines with a fuel during the combustion process to produce heat and flue gases, mainly carbon dioxide and water vapor.
Combustion analyzer	Instrument that measures flue gas samples to determine the safety and efficiency of the combustion process.
Combustion appliance zone (CAZ)	Any area within a house containing a combustion appliance that can be closed off from another area.

Combustion appliance zone (CAZ) testing	Diagnostics performed to ensure that combustion appliances work properly and that pressures in the home allow adequate ventilation for health and safety.
Combustion byproducts	Combustion byproducts are produced whenever carbon-based fuels such as gas, oil, kerosene, wood, or charcoal are burned. Many of these byproducts are pollutants.
Combustion efficiency	Percentage of fuel burned during combustion, also referred to as steady state efficiency.
Combustion gases	Combustion byproducts.
Community Action Agency (CAA)	Community Action Agencies are non-profit private and public organizations established under the Economic Opportunity Act of 1964 to fight America's War on Poverty. Community Action Agencies are designed to help people achieve self-sufficiency. Often used interchangeably with "Community Action Program."
Community Action Programs (CAP)	See "Community Action Agency."
Compact fluorescent lamps (CFLs)	A small fluorescent light bulb that uses 75% less energy than a traditional incandescent bulb.
Competency	Demonstrated ability to perform a job or task.
Concentric flue	A double wall flue pipe allowing the supply of combustion air and the simultaneous evacuation of combustion gases.
Condensation	The conversion of a gas to a liquid. Typically used here in relation to water when discussing moisture dynamics in the home.
Condensing furnace	A high-efficiency furnace that also removes latent heat from combustion products.
Conditioned air	Air that has been heated, cooled, humidified, or dehumidified to maintain an interior space within the "comfort zone."
Conditioned space	Intentionally heated or cooled areas of a building.
Conduction	The transfer of energy through matter from particle to particle. When a teaspoon handle becomes hot while stirring hot tea, that is an example of heat transfer through conduction.
Conductive heat loss	The transfer of heat through a material.
Consumption analysis	A method to determine how energy is used in the home, what the main base loads are, and if a home's utility bills make sense after a site survey.

Convection	The transfer of heat caused by the movement of a fluid like water or air. When a fluid becomes warmer, it becomes lighter and rises. The stack effect is an example of convective currents at work.
Convective losses	Heat loss in a building resulting from air movement.
Core competencies	Essential skills for weatherization workers, defined by the Weatherization Trainers Consortium.
Corrective action	Typically used in reference to deferral of services, the action a prospective client must take to allow weatherization work to proceed on the home. Having a roof repaired and removing a threatening animal from the premises are both example of corrective actions.
Cost averaging	Costing method in which the value of new purchases is averaged with the value of existing stock for like items.
Crackage	Small gaps around doors, windows, and other parts of a building envelope through which ventilation air may pass.
Crawl space	The low space beneath the ground floor of a building that gives workers access to wiring and plumbing.
Crawl space conditioning	The method by which a crawl space is intentionally heated or cooled.
Crosswise floor joist configuration	Mobile home joist configuration where the main duct is located beneath the floor joists and connected by boots to the sub-floor.
Cubic feet per hour (CFH)	A measurement of air-transported heat loss. Calculated in BTU.
Cubic feet per minute (CFM)	A measurement of air movement past a certain point or through a certain structure. Used in pressure diagnostics to quantify air leakage.
Cure	Used in reference to spray foam insulation: The process of expanding and hardening. Many manufacturers consider the insulation cured when residue-free trimming is possible. Off-gassing can occur for many days after this.
Daily sign-out sheet	Source document for the weatherization program material inventory system. It documents all materials removed from the warehouse, all materials installed on the job, and the material expenditures on the job.
Data plate	Mobile home label permanently affixed to the home, usually in a bedroom closet, the electrical panel box cover, or kitchen cabinet, which contains the name and address of the manufacturer, serial and model numbers, date of manufacture, and certification label numbers.

Decommissioning	Removing or retiring from active service. In reference to refrigerators and air conditioners, includes the safe removal and storage or recycling of the coolant.
Deferral of services	Postponement or denial of weatherization services to the client.
Dehumidification	The removal of water from the air. Excess humidity can cause mold.
Delta T	Temperature difference.
Dense-pack insulation	Loose-fill insulation that is blown into building cavities to a specific density that substantially reduces air leakage while providing recommended R-value. Easy to use for irregularly shaped areas and around obstructions.
Depressurization	A condition that occurs when the air pressure inside a structure is lower than the air pressure outdoors.
Depressurization tightness limit (DTL)	A test for back drafting.
Desk monitoring	Monitoring activities performed through review of paperwork. See also On-site monitoring.
Dew point	The warmest temperature of an object in an environment where water condensation from the surrounding air would form on that object.
Diffusion	Movement of water vapor through a material as a function of the driving force across and the porosity of the material.
Digital probe thermometer	Device for testing temperature rise and fan operating temperatures.
Dilution	Relying on adequate ventilation to reduce the concentration of pollutants to acceptable levels.
Dilution air	Room air that mixes with flue gases.
Dilution rate	Used in context to mean the rate at which indoor air is diluted with outdoor air.
Direct leakage	Air enters and exits at same location; occurs at direct openings to outdoors.
Direct penetration	Those leaks associated with the exchange of indoor and outdoor air through exterior openings, such as windows and doors.
Direct-vented appliance	Appliances that draw combustion air directly from the outdoors, e.g., most 90+ condensing furnaces.

Discount rate	The interest rate at which expected future cash flows can be discounted. It includes both the present value and fuel escalation rate, and is used to account for the time value of money and the changing price of fuels.
DOE Knob and Tube Memorandum 1988	This memorandum discusses WAP's policy on insulating homes that contain knob and tube wiring.
DOE project officer (DOE PO)	A DOE representative responsible for monitoring grantees to ensure compliance with current, approved annual plans.
Domestic hot water (DHW)	A separate, closed system to heat potable (drinkable) water and supply it to the dwelling unit for washing, bathing, etc.
Domestic hot water tank (DHWT) access door	Portal allowing access to the domestic hot water tank in a mobile home.
Dominant duct leakage	To measure either dominant supply or return leaks.
Door casing	A wooden trim around doors that covers the seam between the jamb and the wall.
Door stop	The wood trim fastened to the inside of the jamb that positions the door within the jamb and into the latching mechanism.
Double-hung window	Double-hung windows have operable upper and lower sashes that slide vertically in a channel. Upper sashes are often painted shut.
Downflow	Air flow configuration in a furnace where cool air is taken from above and discharged as warm air from the bottom.
Downflow air distribution system	Air distribution system where air is forced downward.
Downflow furnace	Furnace type where the blower is located at the top of the furnace cabinet and air is forced downwards across the heat exchanger and into the ducts located in the belly cavity
Draft	A measurable pressure difference caused by combustion byproducts exhausting through a chimney flue as influenced by temperature difference, height of the flue, and the Venturi effect (the reduction in pressure that results when flow occurs through a constricted section of pipe).
Draft diverter	An intentional opening in the vent system serving an atmospheric furnace or water heater where dilution air is drawn from the surrounding room to mix with the flue gases in the chimney.
Draft gauge	Device for testing chimney draft.
Draft hood	See draft diverter.
Draft reversal	See backdrafting.

Drainage plane	A combination of water-resistant materials like building paper or house wrap, plus a physical space to allow water to flow.
Dropped down belly	Mobile home configuration where a hump is formed in the floor by the main duct running in the center.
Dropped soffit	A lowered part of the ceiling in a home.
Dry bulb	Part of one in a pair of thermometers used in a hygrometer. See also Wet bulb.
Dual fuel	The ability of an HVAC system to use either of two fuels (e.g., natural gas or fuel oil). The decision is frequently based on cost or availability.
Duct blaster	Combination of a small fan and a pressure gauge to pressurize a house's duct system and accurately measure air leakage of the ductwork.
Duct blower	A device for testing duct leakiness and airflow.
Duct boot	Transition piece that connects the main duct to the floor and is often vulnerable to failure.
Duct-induced pressure differences	Pressure differences between rooms in a building caused by the ducted air delivery system, can be due to supply ducts, return ducts, or both.
Eave chute	Device that maintains air space between the insulation blanket and the roof sheathing and prevents insulation from clogging eave vents.
Eave vent	Vent opening located in the soffit under the eaves of a house to allow the passage of air through the attic and out the roof vents.
Elastomeric	A characteristic of a material that is flexible and permits movement.
Elastomeric coating	Polymeric material, such as acrylic, that is used to solve roof leaks and can be used to restore virtually all types of roofs. Used mainly in reference to cool roof coatings that reduce solar heat gain.
Elimination	Removing the source of the pollution.
Emittance	The ability of a material to emit radiant energy from its surface. Also called emissivity.
Encapsulation	Containing the pollutant so it will not affect air quality.
Energy Audit Institute (EAI)	A company offering online energy audit training and certification.
Energy Audit using the Queens Information Package (EA-QUIP)	A tool that determines the economically optimal mix of energy-saving measures for a building.

Energy burden	The percentage of a household's income that must be used for energy bills. The energy burden for low-income households is over four times that of other households.
Energy conservation measures (ECM)	Building components or products installed to reduce the building's energy consumption.
Energy Information Administration (EIA)	Section of the U.S. Department of Energy providing statistics, data, and analysis on resources, supply, production, and consumption for all energy sources.
Equivalent duct length (EDL)	A measure of how much static pressure an exhaust fan has to overcome.
Equivalent leakage area (ELA)	Calculation, in square inches, of the total area of all holes and cracks in a structure. The leakage area is then combined to represent one total leakage point.
Evaporation	The change that occurs when a liquid becomes a gas. Evaporation is the key process in the operation of air conditioners and evaporative coolers.
Excess air	Air in excess of what is needed for combustion.
Exfiltration	This term describes the movement of air out of a building. Often refers to warm air leaving a building due to pressurization, infiltration, wind, stack effect, and/or convective flow.
Expanding foam	An insulation product designed to expand and harden upon contact with the air. Available in canisters with spray nozzles that make it easy to apply foam in a wide variety of situations.
Fan-off temperature	The furnace combination fan and limit control FAN OFF setting lets the furnace blower continue to run for an interval after the furnace burner has turned off, but will shut the blower off after the heat exchanger has been cooled down and the heat it contained has been sent to the occupied space.
Fan-on temperature	When the designated warm temperature has been reached inside of the furnace warm air plenum chamber the FAN ON switch turns on the furnace blower to deliver warm air to the occupied space.
Fenestration	Window and door openings in a building's wall.
Field guides	Region-specific installation standards for weatherization programs, developed by Saturn Resource Management in collaboration with DOE.

Field testing	Assessment of a trainee's abilities conducted on-site, rather than in a classroom.
Fill tube	Specialized tool for blowing insulation into enclosed cavities such as mobile home bellies or roof cavities.
Fire-tube	Boiler in which hot gases from a fire pass through one or more tubes running through a sealed container of water. The heat energy from the gases passes through the sides of the tubes by thermal conduction, heating the water and ultimately creating steam.
First-in, first-out system (FIFO)	Costing system in which the first items purchased are the first items to be used. Inventory stock is identified by the acquisition cost.
Flame impingement	The striking of flame against an object.
Flame roll-out	Fuel gas combustion process occurring outside the normal combustion area of a combustion appliance.
Flue gas	Gases arising from the combustion of fuels, mainly consisting of carbon dioxide. Fuel gas normally contains pollutants, such as carbon dioxide, nitrogen oxide, sulfur dioxide, and dust.
Fuel escalation rate	Annual escalation rate of fuel prices based on the annual energy price forecasts of DOE's Energy Information Administration.
Furnace blower	A part of the furnace that produces a current of air. Often referred to as the "blower" or "squirrel cage."
Furnace plenum	An air chamber that gets filled directly by a large blower that is above, below, or adjacent to it.
Furred-out walls	Wall construction using furring strips (usually 1 x 3 lumber) to set the materials off from the substrate or existing wall being built upon. Common use of this detail is for rain-screen walls. The air spacing between the walls allows for protection against moisture.
Gable vent	A screened vent installed at or near the peak of a roof gable that allows warm attic air to escape.
Gallons per minute (GPM)	The unit for measuring water flow, frequently for showers.
Glass pane	Sheet glass cut in shapes for windows or doors.
Glazing	Glass installation. Pertaining to glass assemblies or windows.
Grade	The pitch of a slope such as a roof or a hill.
Grantee	The individual or organization that receives a grant.

Gross vehicle weight (GVW)	The total weight of a vehicle, including passengers, fuel, cargo, and attachments.
Ground fault circuit interrupter (GFCI)	An electrical connection device that breaks a circuit if a short occurs. GFCIs are required for all exterior use of electrical equipment and when electrical outlets are located near water sources.
Ground vapor retarder	A material that impedes the passage of water vapor from the ground.
Guarded hot box testing	Process used to determine the R-value of a material.
Hallway return or hallway return system	A type of mobile home air distribution system. The mobile home heating or cooling system receives return air through a central trunk line beneath the hallway.
Hands-on training	Teaching students by having them perform the relevant tasks.
Head jamb	Groove at the top of the window that allows the window sashes to slide into place and sit inside the window frame.
Health and safety (H&S)	Provision included in a 1976 law change for the Weatherization Assistance Program. WAP now considers the health and safety of low-income families, as well as reducing their energy costs.
Heat	Molecular movement.
Heat exchanger	Furnace component that transfers the heat from the combustion gases to the surrounding air. Combustion gases travel from the burner through the heat exchanger and then out the flue in properly functioning furnaces.
Heat pump water heater	System that heats water by using electricity to move heat from surrounding air into a tank of water.
Heat recovery ventilation (HRV)	Most common in cold climates, these are typically whole-house systems that reclaim some of the heat from exhaust air and pass that heat on to the intake air so less energy is needed to heat the home.
Heat rise	The number of degrees of temperature increase that air is heated as it is blown over the heat exchanger. Heat rise is measured as supply temperature minus return temperature.

Heating degree days (HDD)	The number of degrees per day that the daily average temperature (the mean of the maximum and minimum recorded temperatures) is below a base temperature, usually 65 degrees Fahrenheit. Used to determine indoor space heating requirements and heating system sizing. Total HDD is the cumulative total for the year/heating season. The higher the HDD for a location, the colder the daily average temperature(s).
Heating, ventilating, and air conditioning (HVAC) system	All components of the appliances used to condition interior air of a building.
High density fiberglass	Insulation product that has a high R-value. The denser material is intended for insulating areas with limited cavity space.
High limit	Safety feature that causes the burner to shut down if the factory-set maximum temperature in the supply plenum is reached (typically set at 200 degrees F).
Hinges	The metal objects that attach your door to the jamb, normally with screws. They can be made from brass, steel, iron, or other metals.
Home Energy Rating System (HERS)	An index established by the Residential Energy Services Network (RESNET) for assessing the energy efficiency of a home.
Home Ventilating Institute (HVI)	A non-profit association of manufacturers of residential ventilating products offering a variety of services including test procedures, certification and verification programs for products, and market support.
House as a system	The concept that many components of a house (e.g., building envelope, space conditioning and distribution, lighting, appliance) interact, affecting the home's comfort and performance.
House of Pressure	A tool developed by the New River Center for Energy Research and Training for teaching the effects of air flow dynamics in a home.
House wrap	A polyethylene barrier wrapped around a house to protect building materials from moisture and save energy.
HUD code	Standards and specifications applied to mobile home construction as set forth by the U.S. Department of Housing and Urban Development.
Hygrometer	A tool for measuring relative humidity. A psychrometer, which uses two thermometers, one with a dry bulb and one with a wet bulb, is a simple hygrometer.

I-beam	A rolled or extruded metal beam having a cross section resembling an I.
I-Codes	A complete set of coordinated building safety, fire prevention, and energy efficiency codes developed by the International Codes Council.
IC rated	Insulation Contact rating for light fixtures. IC housings must be installed wherever insulation will be in direct contact with the housing.
Ice dam	Ice that forms at the roof eaves during differential freezing and thawing.
In-progress units	Homes where weatherization work is being performed.
Inches of water column (IWC)	A unit used in measuring pressure difference. One inch of water column equals 0.25 kPa; or 0.036 psi.
Incidental repair	Repair necessary for the effective performance or preservation of weatherization materials. Such materials may include framing or limited roof repair, so attic insulation doesn't get wet. It does not cover roof replacement.
Indirect leakage	When air leaks into the home at one point, and out at a different opening. Indirect leakage is more difficult to find, and is associated with interior bypasses or chaseways of a home's interstitial cavities.
Indoor air quality (IAQ)	The quality of indoor air relative to its acceptability for healthful human habitation. Assessing and ameliorating, when necessary, the quality of indoor air is a major concern of the weatherization process. In particular, all by-products of major combustion appliances must be directly evacuated to the outdoors under all operating conditions.
Induced draft furnace	Furnace type that has a chimney vent and a motor.
Infiltration	The movement of air into a building through cracks and penetrations in the building envelope. Cold air often enters the structure due to depressurization, exfiltration, wind, stack effect, and/or convective airflow.
Infrared (IR)	A type of radiation not visible to the human eye, but detectable by thermography.
Infrared (IR) camera	Camera that converts surface temperature patterns into a visible picture.
Infrared (IR) imaging	Use of an infrared camera to generate a visible picture of surface temperature patterns.
Infrared (IR) thermography	The science of using infrared imaging to detect radiant energy or heat loss characteristics of a building.

Inspecting	The process through which a representative of a subgrantee visits completed units to ensure appropriateness and quality of work.
Inspection mirror	A small round mirror on the end of a handle used for viewing inside an inaccessible cavity.
Inspector	A representative of a subgrantee responsible for visiting completed units to ensure appropriateness and quality of work.
Instructional flow	The progression and order of the content of a course.
Instructional pace	The speed at which course material is covered.
Internal gain	The heat generated by bathing, cooking, and operating appliances.
International Association of Plumbing and Mechanical Officials (IAPMO)	The industry trade group that develops the Uniform Mechanical Code and the Uniform Plumbing Code.
International Codes Council (ICC)	An international non-governmental organization for developing building safety, fire prevention, and energy efficiency codes (I-codes).
International Fuel Gas Code (IFGC)	Code that addresses the design and installation of fuel gas systems and gas-fired appliances through requirements that emphasize performance.
International Residential Code (IRC)	A comprehensive, stand-alone residential code that brings together all building, plumbing, mechanical, fuel gas, energy, and electrical provisions for one- and two-family residences three stories or less. The IRC also provides a prescriptive approach (i.e., a set of measures) and a performance approach (i.e., energy modeling) for determining compliance.
Intrusion	Air moving into and out of insulation without going through the wall or ceiling assembly.
Jalousie windows	A type of window usually associated with mobile homes with two or more panes of glass that pivot on a horizontal axis.
Jambs	The wood that surrounds the door unit to which the door is attached on the hinge side.
Job shadowing	Learning a skill or skill set by working closely with an experienced practitioner.
Kelvin temperature	Used in reference to the scale used to define the color of a light source. Abbreviated as "K."

Kilowatt hour	The most commonly used unit for measuring the amount of electricity consumed over time; one kilowatt of electricity supplied for one hour. Equal to 3,600 kilojoules.
Kinetic energy	Moving or transitional energy.
Knee-wall attic	An attic with short walls, usually under three feet in height. Common in Cape Cods and bungalows.
Knob and tube wiring	Early standardized method for electrical wiring in homes consisting of insulated copper conductors supported by porcelain knobs (along their lengths) and tubes (when passing through framing members). Widely used from the 1880s until the 1930s, most States now require replacement of knob and tube wiring before installing any sort of insulation that will come into contact with the wiring.
Knowledge retention rate	The percentage of new information presented that a student remembers.
Known to unknown	Adult learners learn best when they progress in a systematic manner from current knowledge to new knowledge, while relating each new concept or skill to past experience.
Latent heat	The amount of heat absorbed or released in a phase change.
Lawrence Berkeley National Laboratory (LBNL)	Member of the national laboratory system supported by DOE through its Office of Science. It conducts unclassified research across a wide range of scientific disciplines.
Laws of thermodynamics	Statements of basic thermodynamic relationships in a system. The first law states that energy is neither created nor destroyed. The second law states that energy always goes from high to low (absent an outside influence expending other energy).
Lead-safe weatherization (LSW)	Methods, techniques, and engineering controls assuring that workers and home occupants are not exposed to harmful lead-based paint.
Leadership in Energy and Environmental Design (LEED)	A building certification system developed by the U.S. Green Building Council. The Green Building Certification Institute provides a series of exams leading to individual accreditation as a LEED building rater.
Learning styles	Preferred ways in which individuals process new information. Learning styles include visual, auditory/verbal, and tactile/kinesthetic.
Lengthwise floor joist configuration	Mobile home joist configuration where the main duct is located inside the joist cavities.

Logistics	Management of the flow of goods, information, and other resources from the point of origin to the point of consumption.
Loose-fill insulation	Small pieces of insulation that are blown into a home using a blowing machine. Loose-fill insulation is typically installed by a professional and is especially effective at filling small and irregularly-shaped spaces.
Louvered door	A louvered door has fixed or movable wooden fins that permit open ventilation while preserving privacy and preventing the passage of light to the interior.
Low Income Home Energy Assistance Program (LIHEAP)	A program of the U.S. Department of Health and Human Services to help low-income households, primarily in meeting their immediate home energy needs.
Low-e	Short for "low emissivity." In reference to window coatings, the characteristic of a metallic glass coating to resist the flow of radiant heat.
Low-flow rings	Part of a blower door that forces air past the sensors fast enough so that a reliable reading can be obtained.
Lower sash	The bottom portion of the window consisting of a pane of glass set inside a frame. The lower sash is fixed in a single-hung window and slides up and down in a double-hung window.
Lumen	The unit for measuring light output.
Magnehelic differential pressure gauge (aka, Magnahelic gauge)	Device that measures fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems, and pressures in fluid amplifier or fluidic systems.
Make-up air	Air supplied to a space to replace exhausted air.
Manometer	A measuring device for small gas pressure differences.
Manual J	Load calculation that allows the user to properly size HVAC systems for single-family-detached homes, small multi-unit structures, condominiums, town houses, and manufactured homes.
Manufactured home	Transportable homes that are quick and cheap to build. Another name for mobile home.
Manufactured Home Construction and Safety Standards	Part of Title 24 of the HUD Code.

Manufactured Home Energy Audit	A tool to predict manufactured home energy consumption and recommend weatherization retrofit measures, accounting for local weather conditions, retrofit measure costs, and fuel costs.
Master inventory control sheet	Listing of all equipment that shows what is checked out, who has checked it out, and when it will be returned.
Mastic	A thick creamy substance used to seal seams and cracks in building materials.
Material Safety Data Sheets (MSDS)	Designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance. An MSDS includes information such as toxicity, health effects, first aid, disposal, and protective equipment.
Mean radiant temperature (MRT)	The area-weighted mean temperature of all the objects surrounding the body. Sometimes called the globe temperature, as it is measured with a globe thermometer, MRT affects thermal comfort.
Meeting rails	The rail of each sash that meets a rail of the other when the window is closed.
Mildew	A superficial coating or discoloration of organic materials, such as cloth, paper, or leather, caused by fungi, especially under damp conditions.
Minimum ventilation guideline (MVG)	Process used to emphasize the ventilation needed after a building is tightened to the maximum practical extent.
Minimum ventilation requirements (MVR)	Lowest level of ventilation that will be acceptable to human occupants and that will minimize the potential for adverse health effects. This level may be measured using ASHRAE Standard 62.2.
Mobile home belly	Part of a mobile home that contains the insulation, duct system, and plumbing. It is enclosed by the sub- and finished floor, with a rodent barrier underneath.
Mobile Home Energy Audit (MHEA)	Mobile Home Energy Audit software used to evaluate mobile home energy usage and predict cost effective retrofit based on savings to investment ratio.
Moisture meter	An instrument for measuring the percentage of water in a substance.
Mold	A growth of minute fungi forming on vegetable or animal matter and associated with decay or dampness.

Monitor	Frequently a representative of a State or Federal agency, a person responsible for visiting a specified percentage of completed units to ensure that weatherization funding is spent appropriately.
Monitoring	The process through which a person, frequently a representative of a State or Federal agency, visits completed units to ensure that weatherization funding is spent appropriately.
Mud sill	A wood component attached to the foundation of a building that creates a means of attaching various components of the framing to the foundation.
Mullions	Vertical framing members that don't run the full length of the door.
Multifamily (MF) housing	A building with five or more residential units.
Mushroom vent	A vent that has at the top of a vertical shaft a broad rounded cap that can be screwed down to close it.
N-factor	Used to convert readings taken at CFM ₅₀ to CFM _{natural} , the amount of air leakage that occurs naturally. The N-factor depends on climate, building height, and shielding from wind. N ranges from 9.8 to 29.4, but typically averages about 20. A higher N-factor means the blower door is creating more exaggerated conditions. A lower "N" means the blower door reading is closer to the natural leakiness of the home.
National Electric Code (NEC)	A safety code regarding the use of electricity. The NEC is sponsored by the National Fire Protection Institute. It is also used by insurance inspectors and many government bodies regulating building codes.
National Energy Audit Tool (NEAT)	A computerized auditing tool for prioritizing energy conservation measures for houses.
National Fenestration Rating Council (NFRC)	NFRC is a non-profit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products.
National Fire Protection Association (NFPA)	A U.S. organization charged with developing standards for fire prevention and suppression, including the National Electric Code.
National Fire Protection Association (NFPA) code	Codes and standards that are designed to minimize the risk and effects of fire by establishing criteria for building, processing, design, service, and installation in the United States.

National Institute for Occupational Safety and Health (NIOSH)	NIOSH is the Federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH issues recommendations for respirator use.
Natural draft	Used in reference to combustion appliances. Natural draft appliances draw combustion air from the room where they are located. Although the term "atmospheric" is often used to describe these appliances, all building and safety codes refer to natural draft, so practitioners should be familiar with both terms.
Natural driving forces	Wind, stack effect, combustion, and ventilation, which all change the pressure in a building.
Natural gas	A hydrocarbon gas that is usually obtained from underground sources, often in association with petroleum and coal deposits.
Net Free Area (NFA)	The area of a vent after adjusting for insect screen, louvers, and weather covering. The free area is always less than the actual area.
NFPA 211	National Fire Protection Association's <i>Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel-Burning Appliances</i> includes installation procedures for vents and chimneys that serve wood-burning stoves and fireplaces.
NFPA 31	National Fire Protection Association's Standard for the Implementation of Oil-Burning Equipment, dictating that chimneys must be at least 2 feet higher than any portion of the building within 10 feet.
NFPA 54	National Fire Protection Association's National Fuel Gas Code stating that combustion air must be provided for any combustion zone where the collective fuel input exceeds 1,000 BTU per 50 cubic feet.
Non-expanding foam	Spray foam that does not expand. Used in window and door jambs, and other constricted spaces where expanding foam may distort building materials and negatively impact operation.
Oak Ridge National Laboratory (ORNL)	Laboratory where the Mobile Home Energy Audit (MHEA) software was developed.
Occupational Safety and Health Administration (OSHA)	United States government agency that establishes and enforces safety standards in the workplace.

Off-gas	Off-gassing is the evaporation of volatile chemicals in non-metallic materials at normal atmospheric pressure. This means that building materials can release chemicals into the air through evaporation. This evaporation can continue for years after the products are installed.
On center (o.c.)	Term used in carpentry for describing framing spacing. For example, a wall built with 2x4 framing, 16" o.c. means the studs are 2" x 4" lumber spaced so there are 16 inches between the center of one and the center of the next.
On-site monitoring	Monitoring activities conducted at the home being weatherized. See also Desk monitoring.
On-site/in-field training	Teaching students to perform jobs or tasks in a real-life setting. See also Classroom training.
On-the-job training	Learning while engaged in work, rather than in a classroom.
One-on-one training	Learning to a job or task through individualized instruction with one student per instructor.
One-part foam	One-part foam comes in spray cans (e.g., Great Stuff) and spray guns with screw-on cans. One-part foam is best suited for filling gaps and holes less than ¾".
Online/distance learning	Education in which the information and the student are separated by time, distance, or both.
Order point	The count balance of a material in inventory that signals the warehouse manager or crew chief to order more.
Over-fired	In reference to furnaces; when too much fuel is being burned, as a response to over-sized fuel nozzles, over-pressurization from the pump, etc.
Oxidation	The combination of a substance with oxygen.
Oxygen content	A measure of the amount of oxygen in the air.
Packaged terminal air conditioner (PTAC)	A self-contained space heating and/or cooling system, usually powered with electricity, commonly found in hotels and apartment buildings.
Packaged terminal heat pump (PTHP)	A self-contained space heating and/or cooling system, frequently installed in a sleeve through the exterior wall of a building, using heat pump technology.
Panel	Parts of a door between rails and stiles or mullions.
Parts per million (ppm)	Unit for quantifying very dilute concentrations of substances.

Pascals (Pa)	Metric standard for measuring pressure differences. 248 pascals equal one inch of water column, approximately the weight of one Post-it note.
Passive attic venting	Takes advantage of the natural buoyancy of air by providing inlets and outlets low and high on the roof. Warm air rises through higher vents and cooler air is drawn through eave vents as the warm air escapes.
Peer-to-peer training	Learning in which a colleague teaches the trainee a job or task.
Performance standard	Specification of the conditions that will exist when a satisfactory job is performed.
Permeance rating	Number that quantifies the rate of vapor diffusion through a material.
Perpetual inventory system	System that documents the flow of materials from purchase to installation, traces the purchase, storage, and final use or disposal of materials, and accounts for all dollars expended for materials.
Personal protective equipment (PPE)	Accessories such as safety glasses, ear plugs, and respirators worn to protect individuals from workplace hazards.
Personal space	The variable and subjective distance at which one person feels comfortable interacting with another.
Phase change	The act of changing from one state of matter to another, e.g., solid to liquid or liquid to gas.
Picture window	Picture windows have no operable sashes and are used primarily for aesthetics.
Pier and beam foundation	Housing base that uses a concrete footing and pier to support wood beams and floor joists.
Platform framing	A system of framing a building in which floor joists of each story rest on the top plates of the story below or on the foundation sill for the first story, and the bearing walls and partitions rest on the subfloor of each story.
Pocket doors	Doors that slide into a wall cavity and are typically very leaky.
Polyurethane foam	A versatile plastic foam insulation, usually yellow in color.
Porosity	Measure of the void spaces in a material, expressed as either a fraction or a percentage of the total volume of material.
Positive displacement blower	Blowing machines used in weatherization to blow insulation into attics and wall cavities.

Positive-pressure, supplied-air respirator	Has its own air compressor to supply fresh air to the worker, and can use a mask or hood.
Potential energy	Stored energy.
Pounds per square inch (psi)	Units of measure for the pressure a gas or liquid exerts on the walls of its container.
Power venting	An active ventilation approach. May be achieved through fans where air is pulled through open windows and exhausted through the attic. Also may be achieved through exhaust fans in air-conditioned homes.
Prescriptive standard	Specifies in detail the requirements and test procedures to be followed.
Present value (PV)	The amount that a future sum of money is worth today given a specified rate of return.
Pressure balancing	To equalize house or duct pressure by adjusting air flow in supply and return ducts. Used on dwellings with forced air heating systems.
Pressure boundary	The surface that separates inside from outside, in relation to conditioned space within the home. Also called air boundary or air barrier.
Pressure pan	A device used to measure pressure differences between ducts and the home during pressure diagnostics.
Pressure pan testing	One method for determining duct leakage. Uses a pressure pan, manometer, and a blower door to quantify pressure differences and verify improvements after duct sealing.
Primary air	Air mixed with fuel before combustion.
Priority list	The list or ranking of installation measures developed by a program to produce the most cost-effective energy savings results based on a savings-to-investment ratio calculation.
Problem-oriented training	Training that focuses on resolving problems using the trainee's own analytical problem-solving skills, rather than simply showing the trainee how to do the task.
Propane (liquefied petroleum gas, or LPG)	A colorless, flammable gas occurring in petroleum and natural gas.
Psychrometer	An instrument for determining atmospheric humidity by the reading of two thermometers, the bulb of one being kept moist and ventilated.

Psychrometric chart	A chart presenting the physical and thermal properties of moist air in graphical form. Used in conjunction with a psychrometer to determine relative humidity, dew point, and other characteristics.
Public Housing Authority (or Agency) PHA	A public/private organization at least partially funded by the U.S. Department of Housing and Urban Development that helps low-income individuals find affordable housing.
Pull-down staircase	Staircase that folds up into the attic until pulled down for use.
Pulley seals	A component of a window sash counterweight system that helps control the movement of the lower sash.
Quality control (QC)	Review of the final work product to ensure that it was correctly done.
R-value	A measurement of thermal resistance for materials and related surfaces.
Radiation	Used in reference to heat transfer, independent of any medium.
Radon	A radioactive gas present in certain soils that decomposes into radioactive particles. In certain areas, radon compromises IAQ when it enters the home through basements or crawl spaces.
Rate of airflow	A measurement of the movement of air over time, frequently measured in cubic feet per minute.
Refrigerant	A special fluid used in air conditioners and heat pumps that heats air when it condenses from a gas to a liquid and cools air when it evaporates from a liquid to a gas.
Refrigerator Info Toolkit	Resource available on WAPTAC full of proper refrigerator metering techniques, tools, databases of existing models' usage, and spreadsheets for determining replacement eligibility.
Relative humidity (RH)	The amount of water vapor in the air, expressed as a percentage of the maximum amount that the air could hold at a given temperature.
Rem/Design	A software tool to model a building for energy-use analysis, designed for buildings with 5-25 individually heated and cooled units.
Return plenum	Used in reference to mobile home furnaces: Part of the belly return system where air is drawn back to the furnace through a louver in the floor of the furnace closet.

Ridge venting	Ridge venting is a continuous vent (or two strips of vents) along the roof ridge. Usually combined with continuous soffit or eave vents as part of an overall attic ventilation system.
Right to appeal	Ability for a client to appeal a deferral of service. The first appeal must go through the agency director. If this does not resolve the issue, the client may appeal to the State.
Rim joist	The outermost joist around the perimeter of the floor framing.
Riser	See duct boot.
Rodent barrier	Guard used to keep rodents from entering a mobile home through the belly.
Roof jack	Chimney assembly that penetrates the roof and includes the flashing and chimney cap assemblies.
Roof vent	A louver or small dome mounted on a roof (often near the ridge) to allow the passage of air through the attic.
Rules	Regulations governing weatherization activities.
Sash	A framework that holds the panes of a window in the window frame.
Saturation	The condition in which the air cannot hold any more moisture, as a function of temperature and vapor pressure.
Savings-to-investment ratio (SIR)	A calculation that determines the cost-effectiveness of a weatherization measure by dividing the estimated savings over its lifetime by the cost. SIR is computed over the lifetimes of the retrofit measures installed. Investment includes materials, labor, and support costs. Savings is expressed in terms of the net present value of the retail cost of the dwelling's fuel. Under some methodologies, other benefits or investments are included. SIRs of greater than one are counted as cost effective under this DOE WAP method of determining cost-effectiveness.
Sealed combustion	A heater that draws air for combustion from outdoors and has a sealed exhaust system.
Secondary air	Air surrounding a flame.
Section 8	The portion of the U.S. Housing and Community Development Act of 1974 that established the Housing Choice Voucher Program for low-income families and individuals. It frequently refers to housing provided under the provisions of the act.

Sensible heat	The heat absorbed or evolved by a substance during a change of temperature that is not accompanied by a change of state.
Set-point	A temperature setting associated with a thermostat control.
Shading coefficient (SC)	A decimal describing how much solar energy is transmitted through a window opening compared to clear, single glass, which has an SC of 1.0.
Shelf life	Length of time under specified conditions that a product retains its usability.
Side jamb	Grooves in window that allow the window sashes to slide up and down or side to side.
Silicosis	A serious lung disease caused by inhaling particulate matter.
Sill	The very bottom of the window. The sill is usually sloped to allow water to run off the bottom of the window in rain or during cleaning.
Single-family (SF) home	A free-standing residential building
Site-built home	Homes that are constructed entirely at the building site. These homes conform to all State, local, or regional codes where the house is located.
Slab-on-grade foundation	Housing base that uses concrete slabs formed from molds set in the ground. Concrete is poured into the mold all at one time, with no space left between the ground and the home.
Slider window	A slider window is essentially a double-hung window turned on its side so the sashes move horizontally.
Sling psychrometer	An instrument used to determine relative humidity. It consists of wet and dry bulb thermometers, with the difference between their readings constituting the measure of moisture in the air.
Smoke tester	Device to test the amount of smoke being produced by an oil burning furnace. High smoke means the fuel-to-air ratio is off, and combustion is less efficient than it should be.
Soffit	The underside of a roof overhang or a small lowered ceiling, as above cabinets or a bathtub.
Solar absorption	Solar absorption is that portion of total solar energy neither transmitted nor reflected.
Solar exposure	The amount of solar energy falling on a horizontal surface.
Solar film	See window film.

Solar gain	Heat from the sun that is absorbed by a building's materials and contributes to the heating and cooling requirements of the dwelling.
Solar heat gain coefficient (SHGC)	SHGC is a measure of the degree of shading incorporated into the glass and is an important factor to consider when selecting windows. Heating climates benefit from a high SHGC. Cooling climates benefits from a lower SHGC.
Solar reflectance	See albedo.
Solar water heater	System in which water is heated by solar radiation.
Spauling	White, chalk-like coating on concrete caused by water picking up salts as it migrates through concrete, then leaving the salts on the surface when it evaporates. Also spelled, "spalling."
Spillage	Temporary flow of combustion gases from a combustion device.
Spot source ventilation	Spot source ventilation includes things like kitchen exhaust fans and bathroom exhaust fans.
Stack effect	The term describes the effect of higher pressure at the top of a structure, lower pressure at the bottom of a structure, and neutral pressure somewhere in between, relative to the ambient (surrounding) air pressure. It is usually the result of different densities of warmer and cooler air (convective airflow).
Standardized curricula	Education materials including PowerPoint presentations, speaker notes, and lesson plans to help instructors train the expanding weatherization workforce.
Standards for conformance	Standards that ensure that safe, code-compliant materials and equipment are installed. Materials must meet the standards described in Appendix A .
Static pressure	Static pressure is the resistance from the inlet grill, duct runs, elbows, and outside termination that a fan must overcome to move air through the system.

Steady-state efficiency	The measurement of heat system balance in the on-cycle when heat into system equals heat out. Generally provided as a percentage of the maximum available heat generation capacity (100%) against the amount of usable heat being sent to the distribution system. This figure can also represent the percentage of heat being used within the system as compared to the heat lost through the flue. The reading is most valid when the stack temperature becomes constant and the distribution pumps or blowers are operating.
Steel chassis	Supporting frame for the mobile home structure exclusive of the body or housing.
Stiles	Full-length vertical framing members of a door.
Stop	A wood trim member nailed to the window frame to hold, position, or separate window parts. The stop is often molded into the jamb liners on sliding windows.
Sub-floor	Rough or structural floor placed directly on the floor joists to which the finished flooring is applied.
Subcooling	The temperature difference between the middle of a condenser and the liquid service valve outside.
Subgrantee	A person or agency that is awarded a sub-grant and is accountable to the grantee for the utilization of resources.
Sulfur dioxide (SO ₂)	A colorless, nonflammable, water-soluble gas.
Superheat	The temperature difference between the evaporator and the compressor inlet.
Tactile/kinesthetic learners	Tactile/kinesthetic learners learn best by doing things. They like to find out how things work and remember through movement and manipulation.
Tankless water heater	Rather than storing hot water, a tankless unit heats water as it is being used.
Targeted Retrofit Energy Analysis Tool (TREAT)	A software tool to model a building for energy-use analysis, designed for buildings with at least 25 units.
Teachable moment	The time at which learning a particular topic or idea becomes possible or easiest.
Technical field monitor	A person responsible for ensuring that testing and work performed is accurate; staff are properly trained; appropriate measures are installed; and appropriate tests are properly conducted before, during, and after weatherization.

Temperature	A measure of the heat present.
Temperature rise	See heat rise.
Thermal boundary/thermal barrier	The continuous layer of building components, such as insulation, that retard conductive heat flow.
Thermal break	A thermal break is an element of low thermal conductivity placed in an assembly to reduce or prevent the flow of thermal energy between conductive materials.
Thermal emittance	The ability of a material to release absorbed heat.
Thermal envelope	See thermal boundary.
Thermal mass	A solid or liquid material that will absorb and store warmth and coolness until it is needed.
Thermal transmittance	See U-factor
Threshold	A beveled wood member fastened to the floor and situated between the side jambs. The threshold seals the space between the bottom of the door and the floor.
Through-the-door	A characteristic of a refrigerator that enables dispensing water and/or ice without opening the appliance door.
Title 10 CFR Part 440	Regulations established by the Energy Conservation in Existing Buildings Act of 1976 directing DOE to provide weatherization services to low-income persons.
Title 10 CFR Part 600	Regulations directing procurement for projects using Federal funds.
Total solar energy rejected	The percent of incident solar energy rejected by a glazing system equals solar reflectance plus the part of solar absorption that is reradiated outward.
Trainee-centered training	Trainee-centered learning activities ensure that the trainee is actively participating, rather than simply observing the supervisor.
Training and Technical Assistance (T&TA)	Program structure that ensures that all work in the field meets State standards. This ensures that there is a feedback loop and accountability within the program.
Training center	A facility with demonstration materials and props for trainees to practice new skills.
Trim	Extends beyond the end of the window frame on the outside of the window opening. This allows the window to fit flush with the exterior wall when the window is installed.

Tuck-under garage	Architectural style in which the garage is situated underneath a room of the house.
Turbine vent	Vent usually mounted on the roof of a building. The vent has at its head a globular, vaned rotor that is rotated by wind, conveying air through a duct to and from a chamber below.
Two-part foam	A triple-expanding foam appropriate for larger and more numerous air leaks, and for insulating crawl space walls and other big jobs. Two-part foam comes in portable two-tank kits and truck-mounted rigs.
Type S fuses	Fuse type with a rejection base that prevents tampering as well as mismatching.
U-factor	U-factor is a measure of non-solar heat flow through all the components of a material, typically used in reference to windows. The lower the U-factor, the better the thermal performance. U-factor allows consumers and energy technicians to compare insulating properties of commercially available windows.
U.S. Department of Agriculture (USDA)	United States government agency charged with rulemaking and enforcement for agricultural programs, USDA also administers some low-income housing programs.
U.S. Department of Energy (DOE)	United States government agency whose mission is to advance energy technology and promote related innovation in the United States.
U.S. Department of Energy Hot Climate Initiative	Training program for whole-house weatherization for hot-climate States.
U.S. Department of Housing and Urban Development (HUD)	United States government agency charged with rule-making and enforcement of the HUD Code.
U.S. Environmental Protection Agency (EPA)	The mission of the U.S. Environmental Protection Agency is to protect human health and the environment.
Unconditioned space	An area within the building envelope that is not heated or cooled.
Under-fired	In reference to furnaces: When too little fuel is being made available for combustion processes.
Uniform Mechanical Code	A model code developed by the International Association of Plumbing and Mechanical Officials to govern the installation and inspection of mechanical systems.

Uniform Plumbing Code	A model code developed by the International Association of Plumbing and Mechanical Officials to govern the installation and inspection of plumbing systems.
Upflow furnace	A furnace in which the heated air flows upward as it leaves the furnace.
Upper sash	The top portion of the window consisting of a pane of glass set inside a frame. The upper sash is fixed in a single-hung window and slides up and down in a double-hung window.
Vapor barrier	A material such as sheet plastic or paint that effectively retards moisture movement by diffusion.
Vapor permeable	Describes a material that permits the passage of water vapor.
Vapor pressure	The ratio of water vapor to a given volume of air (also known as absolute humidity).
Vapor retarder	A material that impedes the passage of water vapor.
Vent	Openings in an HVAC system to allow air flow.
Vent pipe	The pipe carrying combustion gases from the appliance to the chimney.
Vent terminations	Where a vent leaves the building. Vent terminations must prevent intrusion of moisture, detritus, or pests into the building, and allow safe exhaust of vented gases.
Vented crawl space	Crawlspace with grilles or vents installed to allow for passive ventilation beneath the home.
Ventilation	Controlled air leakage usually created with mechanical exhausting devices such as fans and dryers.
Verbal learners	People who understand and retain information best when it is presented in words. Some verbal learners prefer to hear the material (auditory learners); others prefer to see the material (visual learners).
Vermiculite	A heat-expanded mineral once commonly used for insulation.
Visual learners	Visual learners learn best by seeing things. They easily use images, pictures, colors, and maps to organize information.
Voltage drop	The loss of voltage in a circuit caused by resistance.
Volume	The amount of space occupied by a three-dimensional object or region of space, expressed in cubic units.

Water management	Managing water to avoid damage to building components or low IAQ. Includes properly grading the landscape to ensure water flows away from building, installing or repairing gutters and downspouts, clearing perimeter drains, etc.
Weatherization Assistance Program (WAP)	DOE's Weatherization Assistance (Wx) Program is the nation's largest residential energy efficiency program. Its mission is to increase the energy efficiency of dwellings occupied by low-income Americans, thereby reducing their energy costs, while safeguarding their health and safety.
Weatherization program notices (WPN)	Guidance documents issued by the U.S. Department of Energy for the weatherization program.
Weep holes	Holes drilled for the purpose of allowing water to drain out of an area in a building where it has accumulated.
Wet bulb	Part of one in a pair of thermometers used in a hygrometer. See also Dry bulb.
Whole house exhaust ventilation systems	Use of one or more fans and duct systems to exhaust stale air and/or supply fresh air to the house.
Whole-part-whole approach	In this teaching style, the student attempts the whole skill and the coach monitors to identify those parts of the skill that the student needs to improve upon. Part instruction can then be used to address the limitations. Then the student repeats the whole skill with the coach monitoring for any further need for improvement.
Wi-Fi	The means by which a device such as a computer or MP3 player can connect to the Internet wirelessly.
Wind effect	A driving factor of pressure differences. The leeward, or sheltered, side of the home experiences negative pressure. The exposed side, positive pressure.
Wind-washing	Phenomenon particular to fiberglass attic insulation. Air entering and leaving the attic through the attic vent openings is frequently able to blow through fiberglass attic flat insulation, removing heat as it goes.
Window film	Plastic films, coated with a metallic reflective surface, that are adhered to window glass to reflect solar heat gain.
Window stop	A wood trim member nailed to the window frame to hold, position, or separate window parts. The stop is often molded into the jamb liners on sliding windows.

Winter mode	Closing off all exterior openings of a home and opening interior doors. Generally performed prior to doing a blower door test.
With reference to (WRT)	Compared to another measurement. In weatherization, a way to assess pressure differences between ducts and the rest of the home.
Work order	An order authorizing specific work to be done. Sometimes called the work scope.
Worst case CAZ testing	A safety test, performed by specific procedures, designed to assess the probability of backdrafting in the home.
WPN 02-6; Weatherization Activities and Federal Lead-Based Paint Regulations	Program notice from the U.S. Department of Energy concerning activities that disturb lead-based paint.
WPN 08-4; Space Heater Policy	Program notice from the U.S. Department of Energy concerning space heaters and their use. This notice makes the Weatherization program space heater policy consistent with the IRC and IFGC.
WPN 10-1; Program Year 2010 Weatherization Grant Guidance	Program notice from the U.S. Department of Energy concerning grant guidance and management information for the Weatherization program for Program Year 2010.
Zone pressure diagnostics (ZPD)	Using a blower door to determine the interconnectivity of various building components, which helps the practitioner locate the pressure boundary and know if the air and thermal barriers are aligned. Also called zonal pressure diagnostics.



CORE COMPETENCIES FOR THE WEATHERIZATION ASSISTANCE PROGRAM

**DEVELOPED
BY:**

THE WEATHERIZATION TRAINERS CONSORTIUM

FOR:

**U.S. DEPARTMENT OF ENERGY
WEATHERIZATION ASSISTANCE PROGRAM**

**CREATED: MARCH 26, 2007
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OVERVIEW

The Weatherization Trainers Consortium developed this document for the U.S. Department of Energy's (DOE's) Weatherization Assistance Program for Low-Income Persons. The Weatherization Trainers Consortium represents weatherization training centers, independent trainers, state program managers, and state monitors from across the country.

The Weatherization *Plus* Committee is a group the weatherization stakeholders charged with helping DOE to strategically plan the evolution of the Weatherization Assistance Program. A Weatherization Plus subcommittee organized a conference call among a group of weatherization trainers to obtain their input on a Weatherization *Plus* initiative to ensure the consistent delivery of high-quality weatherization services nationwide. The trainers saw the benefit of regular communication to network and share training resources. An initial face-to-face meeting of weatherization trainers was organized at the 2005 National Weatherization Technical Training Conference in Atlanta, Georgia, and monthly conference calls have been conducted ever since.

From these conversations, the Weatherization Trainers Consortium was formalized and the need identified for a set of core competencies for the various staff positions that implement the Weatherization Program. The Consortium believes this working document can:

- Increase awareness of the specialized skills and knowledge that are required to run an effective weatherization program;
- Help state and local weatherization agencies hire staff with a strong potential to perform well and prosper in the program;
- Serve as a foundation in establishing standardized curricula to ensure the consistent delivery of high-quality weatherization services nationwide; and
- Put upward pressure on salaries to reduce staff turnover.

As a working document, suggestions for improvement are continually sought. Please forward suggestions to:

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CORE COMPETENCIES FOR THE WEATHERIZATION ASSISTANCE PROGRAM

INTRODUCTION

Specialized knowledge and skills are required at the local, state, and federal level to run an effective Weatherization Program. While there is a general understanding of the competencies required, these have not been articulated on a national scale.

As part of the Weatherization *Plus* effort to plan the continued evolution of the Weatherization Program, a subcommittee was formed to increase the consistency of quality weatherization services delivered to low-income homes across the country. The goal is that every house that is weatherized receives all appropriate, cost-effective measures installed properly to provide long-term savings.

As a first step, this means recognizing the varying approaches states use to train staff.

- Some states require technical staff at local agencies to obtain certification from an organization such as the Building Performance Institute, while other states have developed their own certification criteria.
- Many states do not have formal certification requirements, but instead require local weatherization staff to attend standardized training courses offered on a regular basis.
- Others have no standardized certification or training requirements, but offer training periodically as the need is perceived and funds allow.

Technical weatherization training for auditors, technicians, and monitors is available from many training centers and independent trainers across the country. Only a few states have developed administrative training for weatherization program managers at the local level. In-depth administrative training for state weatherization staff is even harder to find outside National Association for State Community Services Programs (NASCSP) conference “newcomer” sessions.

The Weatherization *Plus* subcommittee and the Weatherization Trainers Consortium believe that publishing a set of core competencies will increase awareness and raise expectations. Not all the competencies will be appropriate for every state. Workers repairing or replacing heating and cooling systems often require certification or licensing from the state. Therefore, this work may be subcontracted to licensed contractors outside the Weatherization Program. However, just because a heating, ventilation, and air conditioning (HVAC) contractor is licensed by the state does not mean they possess the HVAC competencies required by the Weatherization Program. Someone at the local agency must be competent to specify what work the contractor is to do and to verify that the completed work complies with state and local codes as well as the technical standards of the Weatherization Program.

The competencies that a weatherization worker should possess depend on their position. For example, an auditor needs to conduct diagnostic testing that may not be required of an installer. The point of entry also dictates which core competencies are required. An

entry-level installer requires a minimum set of competencies. This installer must acquire additional skills to become a crew chief, and still more to become an auditor. A new auditor hired off the street must already possess auditor-level competencies as a condition of hire. These increasing levels of competency also provide a career or development path for agency and contractor personnel.

The following core competencies were compiled from course offerings of several weatherization training centers and from the technical program standards of a handful of states. Core competencies for the following topical areas are listed:

- Basic competencies,
- Safe work practices,
- Building evaluation,
- Measure installation,
- Final inspection,
- Consumer education,
- Monitoring,
- Program management, and
- Training.

Definitions

- **Competency** means the possession of a minimum level of knowledge and proficiency required to collect appropriate information, make informed decisions, and physically take the needed actions to deliver the high-quality weatherization service in question.
- **Possess a working knowledge of** means to:
 - ♦ Know how a particular topic impacts the weatherization process;
 - ♦ Have the relevant information committed to memory or be able to locate it in readily available sources; and
 - ♦ Use the knowledge to make informed decisions and guide weatherization work.
- **Demonstrate the ability to** means to:
 - ♦ Physically conduct a test, procedure, or technique on an actual house, a prop, or in a training lab in the presence of someone qualified to assess the particular competency.

BASIC COMPETENCIES

All weatherization workers must possess the following Basic Competencies:

- Ability to read and write legibly;
- Basic verbal and written communication skills;
- Basic construction knowledge;
- Basic math skills (see appendix for a test to verify basic math skills); and
- Basic computer skills (see appendix for a test to verify basic computer skills).

Depending on the position of the weatherization worker, the following Core Competencies help ensure the delivery of effective weatherization services.

SAFE WORK PRACTICES

All field workers must exhibit safe work practices by possess the following competencies.

- Possess a working knowledge of:
 - ♦ U.S. Department of Energy (DOE) program regulations/policy and Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards;
 - ♦ Material Safety Data Sheets; and
 - ♦ Occupational Safety and Health Act (OSHA) standards:
 - Ladder safety;
 - Fall protection;
 - Personal protective equipment;
 - Respiratory protection;
 - Motor vehicles;
 - Power-operated hand tools;
 - Fire prevention;
 - Permit-required confined spaces;
 - Other worker-related OSHA standards.
- Demonstrate the ability to:
 - ♦ Select, fit, and use the appropriate Personal Protection Equipment for a particular task;
 - ♦ Safely use basic hand and power tools;
 - ♦ Use a basic first aid kit to treat common job-site injuries;
 - ♦ Work lead safe;
 - ♦ Identify serious mold conditions; and
 - ♦ Assess work area safety hazards.

INSTALLER

The following competencies are required by workers that install weatherization measures.

- **Prerequisites**
 - ♦ Possess *Safe Work Practices* competencies
- **Air Sealing**
 - ♦ Possess a working knowledge of:
 - Proper materials selection based on location of leakage areas
 - Minimum ventilation rates.
 - ♦ Demonstrate the ability to:
 - Use the blower door to locate leakage sites within the building
 - Seal attic and floor bypasses at penetrations for plumbing, electrical wiring, flue vents, ducts; dropped soffits, and balloon-framed walls;
 - Seal typical bypasses in kneewalls and finished attic spaces;
 - Seal basement band joists;
 - Properly apply caulk and spray foam insulation;

- Identify, select, and install weatherstripping on doors, windows, and attic hatches;
 - Cut glass, replace broken window panes, and apply glazing compound;
 - Repair plaster and sheetrock (drywall); and
 - Modify or install mechanical ventilation to ensure acceptable indoor air quality for post-air-sealing conditions.
- **Duct Sealing**
 - ♦ Demonstrate the ability to:
 - Properly seal duct connections with mastic and fiberglass mesh tape or other approved material; and
 - Repair or modify duct systems as specified in a work order.
- **Insulation**
 - ♦ Possess a working knowledge of:
 - Properties and appropriate application of different insulation materials; and
 - Potential hazards of insulating around knob-and-tube wiring.
 - ♦ Demonstrate the ability to:
 - Install blown and batt attic insulation;
 - Access closed wall cavities and properly install dense-packed wall insulation including removing and replacing siding;
 - Install blown insulation and batt insulation in a floor;
 - Install water heater insulation blankets;
 - Install insulation on ducts, hydronic distribution pipes, and domestic hot water pipes; and
 - Safely operate and properly maintain insulation blowing machines and generators.
- **Base-Load Measures**
 - ♦ Demonstrate the ability to:
 - Replace incandescent light bulbs with compact fluorescent lamps while maintaining or improving lighting levels; and
 - Install low-flow showerheads and faucet aerators;
 - Assess the existing condition of plumbing pipes and faucets that may prohibit these measures.

CREW CHIEF

Personnel that supervise field workers such as *Installers* must possess the following competencies.

- **Prerequisites**
 - ♦ Possess *Safe Work Practices* and *Installer* competencies.
 - ♦ Possess a working knowledge of building science principles.
- **Project Management**
 - ♦ Demonstrate the ability to:
 - Manage a crew of *Installers* so weatherization work is conducted safely, effectively, and efficiently;
 - Ensure that the job site and *Installers* comply with the *Safe Work Practices* described previously;

- Maintain quality control of weatherization work and ensure it meets program standards;
- Understand a work order;
- Order and obtain materials, supplies, and equipment in time to avoid delays and wasted time on the job site; and
- Warehouse materials as necessary to avoid delays in completing weatherization work.
- ***Inspection and Measurement***
 - ♦ Possess a working knowledge of:
 - Air and heat flow in buildings;
 - Factors that affect building heat loss;
 - Construction features and critical junction points of common housing types;
 - Insulation R-values;
 - Different insulation materials and installation techniques;
 - Various air-sealing techniques and appropriate materials;
 - Causes of and remedies for existing and potential moisture problems;
 - Causes of and remedies for other existing and potential indoor air quality problems;
 - Residential mechanical ventilation systems;
 - Minimum ventilation rates/building tightness limits based on the appropriate ASHRAE 62 standard; and
 - Electric base-load usage.
 - ♦ Demonstrate the ability to:
 - Measure the dimensions of floors, walls, ceilings, windows, and doors, and compute surface areas;
 - Compute the volume of conditioned space of a building;
 - Define the thermal envelope of a building; and
 - Assess the effectiveness of existing insulation and the effective R-values.
- ***Diagnostic Testing***
 - ♦ Blower door
 - Possess a working knowledge of:
 - Principles of air movement and how they relate to building heat loss;
 - Typical air leakage problems in common housing types; and
 - Minimum ventilation rates.
 - Demonstrate the ability to:
 - Set up a blower door;
 - Prepare a building for a blower door test; and
 - Take blower door reading and interpret results.
 - ♦ Zone pressure diagnostics
 - Possess a working knowledge of:
 - The air barrier of a building and the importance of aligning it with the thermal barrier; and
 - Primary and intermediate zones of a house.
 - Demonstrate the ability to:
 - Conduct zone pressure diagnostics and interpret results; and
 - Determine the location and effectiveness of the air barrier of a house.

- ♦ Duct testing
 - Possess a working knowledge of:
 - Problems associated with different types of duct leakage.
 - Demonstrate the ability to:
 - Determine dominant duct leakage;
 - Determine the amount of duct leakage or at least the existence of significant duct leakage by conducting pressure pan, duct blaster, or delta Q tests.
 - Measure room pressure imbalances in houses with forced-air systems.
 - Resolve room pressure imbalances.
- **Combustion Appliance Safety**
 - ♦ Possess a working knowledge of:
 - CO action levels;
 - Common code requirements related to:
 - Vent system sizing, materials, clearances, and installation;
 - Safety shut-off devices;
 - Gas line sizing; and
 - Combustion air;
 - Causes of and remedies to common vent system problems.
 - ♦ Demonstrate the ability to:
 - Measure the CO level in ambient air;
 - Measure the CO level of vented and unvented combustion appliances;
 - Measure the CO levels of gas- or propane-fired cook stoves (oven and burners) and remedy high CO levels through basic cleaning and adjustments;
 - Understand the difference between as-measured and air-free CO readings;
 - Detect gas, propane, and fuel oil leaks; and
 - Conduct a worst-case draft test of a combustion appliance zone; and
 - Measure the steady-state efficiency of a vented combustion appliance.
- **Insulation**
 - ♦ In addition to the insulation-related *Installer* competencies, possess a working knowledge of:
 - Local codes relating to attic ventilation.
- **Training**
 - ♦ Possess a working knowledge of:
 - Adult learning concepts; and
 - Benefits of cross training on-site personnel.
 - ♦ Demonstrate the ability to:
 - Provide on-site training to *Installers* in a positive environment to strengthen competency in existing skills and increase the number of skill areas.

AUDITOR

- **Prerequisites**
 - ♦ Possess *Safe Work Practices*, *Installer*, and *Crew Chief* competencies.
 - ♦ Possess a working knowledge of building science principles.
- **Inspection and Measurement**
 - ♦ Possess a working knowledge of:
 - Air and heat flow in buildings;
 - Factors that affect building heat loss;
 - Construction features and critical junction points of common housing types;
 - Insulation R-values;
 - Different insulation materials and installation techniques;
 - Various air-sealing techniques and appropriate materials;
 - Causes of and remedies for existing and potential moisture problems;
 - Causes of and remedies for other existing and potential indoor air quality problems;
 - Residential mechanical ventilation systems;
 - Minimum ventilation rates/building tightness limits based on the appropriate ASHRAE 62 standard; and
 - Electric base-load usage.
 - ♦ Demonstrate the ability to:
 - Measure the dimensions of floors, walls, ceilings, windows, and doors, and compute surface areas;
 - Compute the volume of conditioned space of a building;
 - Define the thermal envelope of a building;
 - Assess the effectiveness of existing insulation and the effective R-values; and
 - Analyze utility bills including breaking out base-load usage from heating and cooling usage.
- **Diagnostic Testing**
 - ♦ Blower door
 - Possess a working knowledge of:
 - Principles of air movement and how they relate to building heat loss;
 - Typical air leakage problems in common housing types; and
 - Minimum ventilation rates.
 - Demonstrate the ability to:
 - Set up a blower door;
 - Prepare a building for a blower door test; and
 - Take blower door reading and interpret results.
 - ♦ Zone pressure diagnostics
 - Possess a working knowledge of:
 - The air barrier of a building and the importance of aligning it with the thermal barrier; and
 - Primary and intermediate zones of a house.
 - Demonstrate the ability to:
 - Conduct zone pressure diagnostics and interpret results;
 - Determine the location and effectiveness of the air barrier of a house; and
 - ♦ Duct testing

- Possess a working knowledge of:
 - Problems associated with different types of duct leakage.
- Demonstrate the ability to:
 - Determine dominant duct leakage; and
 - Conduct pressure tests. Potential tests include:
 - , Pressure pan
 - , Duct Blaster
 - , Delta-Q
 - Seal duct leaks with appropriate materials and good workmanship.
 - Measure room pressure imbalances in houses with forced-air systems.
- ♦ Steam and hot water distribution system testing
 - Possess a working knowledge of:
 - The components of typical steam and hot water distribution systems and the characteristics of their proper operation.
 - Demonstrate the ability to:
 - Test air vents, steam traps, thermostatic radiator valves, and hot water zone valves; and
 - Estimate the energy impacts of existing overheating problems.
- ♦ Base-load systems
 - Demonstrate the ability to:
 - Meter electrical devices to determine their annual energy consumption.
- **Combustion Appliance Safety**
 - ♦ Possess a working knowledge of:
 - CO action levels;
 - Common code requirements related to:
 - Vent system sizing, materials, clearances, and installation;
 - Safety shut-off devices;
 - Gas line sizing; and
 - Combustion air;
 - Causes of and remedies to common vent system problems.
 - ♦ Demonstrate the ability to:
 - Measure the CO level in ambient air;
 - Measure the CO level of vented and unvented combustion appliances;
 - Measure the CO levels of gas- or propane-fired cook stoves (oven and burners);
 - Understand the difference between as-measured and air-free CO readings;
 - Detect and natural gas, propane, and fuel oil leaks;
 - Conduct a worst-case draft test of a combustion appliance zone;
 - Measure the CAZ to assure sufficient volume for combustion air;
 - Clock a gas meter to determine the actual input of a gas-fired combustion appliance;
 - Conduct basic temperature-rise and static-pressure-drop tests on forced-air furnaces;
 - Measure the steady-state efficiency of a vented combustion appliance; and
 - Assess the potential inadequacy of supply and return plenum and duct sizes for forced-air systems.

- **Measure Selection**
 - ♦ Possess a working knowledge of:
 - What materials are allowed to be installed based on 10 CFR 440 Appendix A;
 - The regulatory and policy requirements for selecting weatherization measures using DOE-approved energy audit software or priority lists; and
 - The interaction between typical weatherization measures (e.g., the impact of air-sealing and insulation measures on the potential savings of heating efficiency improvements).
 - ♦ Demonstrate the ability to:
 - Use a DOE-approved energy audit to input accurate building data and recommend appropriate, cost-effective weatherization measures;
 - If required, use a DOE-approved priority list to select appropriate, cost-effective weatherization measures;
 - Prioritize air-sealing efforts;
 - Estimate the heating and/or cooling load of a dwelling to ensure proper equipment sizing if the heating or cooling system is to be replaced;
 - Select the proper CFL to replace an incandescent lamp while maintaining or improving lighting levels; and
 - Meter an existing refrigerator or locate its DOE tested usage in a database to estimate annual energy consumption.
- **Work Scope Development**
 - ♦ Demonstrate the ability to:
 - Accurately estimate the type and quantity of materials required to cost-effectively weatherize an eligible dwelling unit; and
 - Prepare clearly written work orders for work crews or contractors.

CONTRACTOR

Contractors hired by local weatherization agencies to perform weatherization work must possess the following competencies. See *HVAC Installer/Contractor* for the competencies required of these specialty contractors.

- **Prerequisites**
 - ♦ Possess *Safe Work Practices, Installer, and Crew Chief* competencies.
 - ♦ Possess a working knowledge of building science principles.
- **Business Management**
 - ♦ Demonstrate the ability to:
 - Maintain the licenses required by the state and local jurisdiction for the type of work the *Contractor* is hired to perform;
 - Possess adequate insurance;
 - Employ U.S. citizens or properly documented aliens; and
 - Bid, negotiate, and sign contracts, as necessary.

- ***Project Management***

- ♦ Demonstrate the ability to:
 - Manage a crew of *Contractor*-employed *Installers* so weatherization work is conducted safely, effectively, and efficiently;
 - Ensure that the job site and *Contractor*-employed *Installers* comply with the *Safe Work Practices* described previously;
 - Understand a work order;
 - Maintain quality control of weatherization work and ensure it meets program standards;
 - Order and obtain materials, supplies, and equipment in time to avoid delays and wasted time on the job site; and
 - Warehouse materials as necessary to avoid delays in completing weatherization work.

Depending on the type of work the *Contractor* is hired to perform, the following inspection, diagnostic testing, combustion appliance safety, and/or insulation competencies may be required.

- ***Inspection and Measurement***

- ♦ Possess a working knowledge of:
 - Air and heat flow in buildings;
 - Factors that affect building heat loss;
 - Construction features and critical junction points of common housing types;
 - Insulation R-values;
 - Different insulation materials and installation techniques;
 - Various air-sealing techniques and appropriate materials;
 - Causes of and remedies for existing and potential moisture problems;
 - Causes of and remedies for other existing and potential indoor air quality problems;
 - Residential mechanical ventilation systems;
 - Minimum ventilation rates/building tightness limits based on the appropriate ASHRAE 62 standard; and
 - Electric base-load usage.
- ♦ Demonstrate the ability to:
 - Measure the dimensions of floors, walls, ceilings, windows, and doors, and compute surface areas;
 - Compute the volume of conditioned space of a building;
 - Define the thermal envelope of a building; and
 - Assess the effectiveness of existing insulation and the effective R-values.

- ***Diagnostic Testing***

- ♦ Blower door
 - Possess a working knowledge of:
 - Principles of air movement and how they relate to building heat loss;
 - Typical air leakage problems in common housing types; and
 - Minimum ventilation rates.
 - Demonstrate the ability to:
 - Set up a blower door;
 - Prepare a building for a blower door test; and

- Take blower door reading and interpret results.
 - ♦ Zone pressure diagnostics
 - Possess a working knowledge of:
 - The air barrier of a building and the importance of aligning it with the thermal barrier; and
 - Primary and intermediate zones of a house.
 - Demonstrate the ability to:
 - Conduct zone pressure diagnostics and interpret results; and
 - Determine the location and effectiveness of the air barrier of a house.
 - ♦ Duct testing
 - Possess a working knowledge of:
 - Problems associated with different types of duct leakage.
 - Demonstrate the ability to:
 - Determine dominant duct leakage;
 - Determine the amount of duct leakage or least the existence of significant duct leakage by conducting pressure pan, duct blaster, or delta Q tests;
 - Measure room pressure imbalances in houses with forced-air systems; and
 - Resolve room pressure imbalances.
- **Combustion Appliance Safety**
 - ♦ Possess a working knowledge of:
 - CO action levels;
 - Common code requirements related to:
 - Vent system sizing, materials, clearances, and installation;
 - Safety shut-off devices;
 - Gas line sizing; and
 - Combustion air;
 - Causes of and remedies to common vent system problems.
 - ♦ Demonstrate the ability to:
 - Measure the CO level in ambient air;
 - Measure the CO level of vented and unvented combustion appliances;
 - Measure the CO levels of gas- or propane-fired cook stoves (oven and burners) and remedy high CO levels through basic cleaning and adjustments;
 - Understand the difference between as-measured and air-free CO readings;
 - Detect gas, propane, and fuel oil leaks; and
 - Conduct a worst-case draft test of a combustion appliance zone; and
 - Measure the steady-state efficiency of a vented combustion appliance.
- **Insulation**
 - ♦ In addition to the insulation-related *Installer* competencies, possess a working knowledge of:
 - Local codes relating to attic ventilation.

HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) INSTALLER/CONTRACTOR

- ***Heating and Cooling Equipment***

- ♦ Prerequisites:
 - Possess *Auditor/Combustion Appliance Safety* and *Safe Work Practices* competencies; and
 - Possess the HVAC certifications and licenses required by the state and local jurisdiction.
- ♦ Possess a working knowledge of:
 - The components of typical steam and hot water distribution systems and the characteristics of their proper operation.
- ♦ Demonstrate the ability to:
 - Maintain quality control of weatherization work and ensure it meets program standards;
 - Repair or replace heating and cooling equipment in a code-compliant manner;
 - Estimate the heating and/or cooling load of a dwelling per Manual J to ensure proper sizing of replacement heating or cooling systems;
 - Repair or replace vent systems of combustion appliances in a code-compliant manner;
 - Repair or replace a water heater in a code-compliant manner (some states may require a licensed plumber to replace a water heater);
 - Ensure proper sizing of gas lines;
 - Assess the adequacy of supply and return plenum and duct sizes for forced-air systems;
 - Add return and supply plenums and ducts as required;
 - Determine dominate duct leakage;
 - Conduct duct pressure tests, which could include:
 - Pressure pan;
 - Duct Blaster; and
 - Delta-Q;
 - Measure and solve room pressure imbalances in houses with forced-air systems;
 - Test air vents, steam traps, thermostatic radiator valves, and hot water zone valves;
 - Bleed unwanted air from a hot water distribution system;
 - Estimate the energy impacts of existing overheating problems in steam and hot water heating systems;
 - Warehouse materials as necessary to avoid delays in completing weatherization work; and
 - Test out to assure system is operating properly and safely.

INSPECTOR

- Prerequisites:
 - ♦ Inspectors should possess *Safe Work Practices, Installer, and Auditor* competencies.
- Possess a working knowledge of:
 - ♦ Relevant DOE Weatherization Program regulations and policy;
 - ♦ Building science principles; and
 - ♦ Relevant local codes.
- Demonstrate the ability to:
 - ♦ Verify that the weatherized house is safe by conducting all appropriate combustion appliance safety tests;
 - ♦ Evaluate the allowability and appropriateness of the installed weatherization measures taking into consideration program regulations, policy, energy audit results, and/or priority lists;
 - ♦ Assess whether the measures were installed with good workmanship, proper materials, and in such a manner to comply with local code and ensure long-term energy savings over the life of the measures;
 - ♦ Ensure that all measures charged to the job were actually installed; and
 - ♦ Verify the effectiveness of air-sealing efforts by conducting a blower door test and zone pressure diagnostics.

CONSUMER EDUCATION

- Competency
 - ♦ Principles of adult education
- Possess a working knowledge of:
 - ♦ What actions can be taken to reduce energy use in the home;
 - ♦ The basic steps in the Weatherization process from auditing, testing, installation, inspection, and monitoring;
 - ♦ The purpose of the basic equipment involved in weatherizing a house, including a blower door, pressure pan, combustion analyzer, gas leak detector, insulation blowing machine, and generator; and
 - ♦ What actions need to be taken to maintain a healthful indoor environment.
- Demonstrate the ability to:
 - ♦ Estimate the economic impacts of suggested actions to bolster customer commitment to change.

MONITOR (TECHNICAL)

- Prerequisites:
 - ♦ Monitors should possess all *Safe Work Practices, Auditor, and Inspector* competencies.
 - ♦ Monitors should be knowledgeable of *Installer* competencies.
- Possess a working knowledge of:
 - ♦ Principles of building science; and
 - ♦ Principles of adult education.
- Demonstrate the ability to:
 - ♦ Produce written reports that clearly identify weaknesses and provide sound solutions;
 - ♦ Provide on-site training and technical assistance; and
 - ♦ Solve complex technical problems.

MONITOR (ADMINISTRATIVE)

- Possess a working knowledge of:
 - ♦ Principles of adult education;
 - ♦ Enabling legislation governing the U.S. Department of Energy's (DOE's) Weatherization Assistance Program;
 - ♦ DOE program regulations 10 C.F.R. 440;
 - ♦ DOE program guidance and policy issued via Weatherization Program Notice or memoranda;
 - ♦ Federal, state, and local budget processes;
 - ♦ Federal financial assistance regulations 10 C.F.R. 600 and relevant OMB circulars;
 - ♦ Applicable state procurement regulations; and
 - ♦ State and local approaches to monitoring, training, and technical assistance.
- Demonstrate the ability to:
 - ♦ Produce written reports that can clearly identify weaknesses and provide sound solutions; and
 - ♦ Provide on-site training and technical assistance;

PROGRAM MANAGER

- Possess a working knowledge of:
 - ♦ Enabling legislation governing the U.S. Department of Energy's (DOE's) Weatherization Assistance Program;
 - ♦ DOE program regulations 10 C.F.R. 440;
 - ♦ DOE program guidance and policy issued via Weatherization Program Notice or memoranda;
 - ♦ Federal, state, and local budget process;
 - ♦ Federal financial assistance regulations 10 C.F.R. 600 and relevant OMB circulars;
 - ♦ Applicable state procurement regulations;
 - ♦ State and local approaches to monitoring, training, and technical assistance;

- ♦ Applicable computer databases and tracking systems and the importance that they remain up-to-date, are secured and backed-up, and are used effectively to manage the program; and
- ♦ Building science principles.
- For state staff:
 - ♦ Demonstrate the ability to:
 - Prepare an annual state plan;
 - Prepare an annual weatherization grant application;
 - Submit accurate financial and production reports in a timely manner;
 - Develop, maintain, and enforce state technical program standards;
 - Provide adequate technical and administrative training for coordinators, auditors, technicians, and inspectors directly employed by local agencies, and ensure that subcontractors receive appropriate technical training;
 - Develop and manage an effective monitoring program;
 - Coordinate resources;
 - Develop and implement innovative leveraging strategies; and
 - Process reimbursement requests in a timely manner.
- For local agency weatherization coordinators:
 - ♦ Demonstrate the ability to:
 - Effectively communicate and manage weatherization staff and subcontractors;
 - Prepare and track a budget for implementing a local weatherization program;
 - Maintain a purchase order system to track contracted services and materials and tool requisitions;
 - Maintain a coding system to assure expenditures are charged to the correct budget category;
 - Maintain inventory tracking system for materials, tools, and equipment;
 - Submit accurate financial and production reports in a timely manner;
 - Comply with federal limits on administrative expenses;
 - Manage a small construction/production-focused operation;
 - Ensure rigorous, unbiased, and accurate final inspection of all completed units;
 - Provide adequate technical training for auditors, technicians, and inspectors directly employed by the local agency, and ensure that subcontractors receive appropriate technical training;
 - Ensure that weatherization work complies with state technical program standards;
 - Coordinate resources; and
 - Develop and implement innovative leveraging strategies.

TRAINER

- Prerequisites:
 - ♦ Trainers should possess *Safe Work Practices, Auditor, and Inspector* competencies;
 - ♦ Trainers should be knowledgeable of *Installer* competencies;
 - ♦ Completion of adult education training program; and
 - ♦ Certification in subject areas of presented training.
- Possess a working knowledge of:
 - ♦ Principles of building science;
 - ♦ Principles of adult education;
 - ♦ Benefits of cross-training;
 - ♦ Building codes, especially energy and health/safety-related codes;
 - ♦ Allowable activities at the location of training (e.g., knob-and-tube wiring requirements); and
 - ♦ Available resources to aid students in future understanding and application.
- Demonstrate the ability to:
 - ♦ Develop curriculum based on student needs;
 - ♦ Tailor each class to the experience and needs of the students;
 - ♦ Motivate students through inspirational presentations;
 - ♦ Provide hands-on training;
 - ♦ Use technology to enhance the learning experience, especially as related to adult education principles; and
 - ♦ Direct students to other resources to get answers beyond the capacity of the trainer to provide.

Appendix A: Math Pre-Test

You may use a calculator to solve the following questions. Answers may be expressed in decimal or fraction form. (15-minute time limit)

You must score 73% or higher, (answer at least eleven (11) out of fifteen (15) correct). Failure to do so will require additional basic math skills before attending the Initial Inspection course at the OWTC.

$$\begin{array}{r} 1. \quad 8 \frac{1}{2}'' \\ 17 \frac{3}{4}'' \\ + 23 \frac{3}{8}'' \end{array}$$

$$\begin{array}{r} 2. \quad 23 \frac{1}{4}'' \\ - 7 \frac{1}{8}'' \end{array}$$

$$\begin{array}{r} 3. \quad 23.25 \\ \times 12.75 \end{array}$$

4. $350/40 =$ _____

5. $3/8 \times 120 =$ _____

6. How many inches are in 5 feet? _____

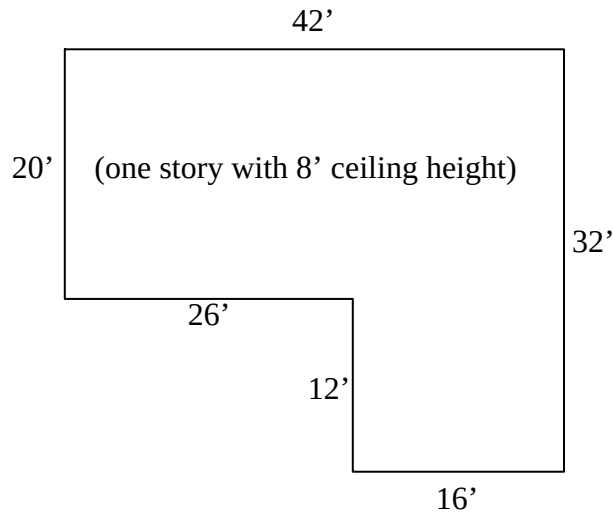
7. One square foot equals how many square inches? _____

8. What is the perimeter of the house diagramed below? _____ feet.

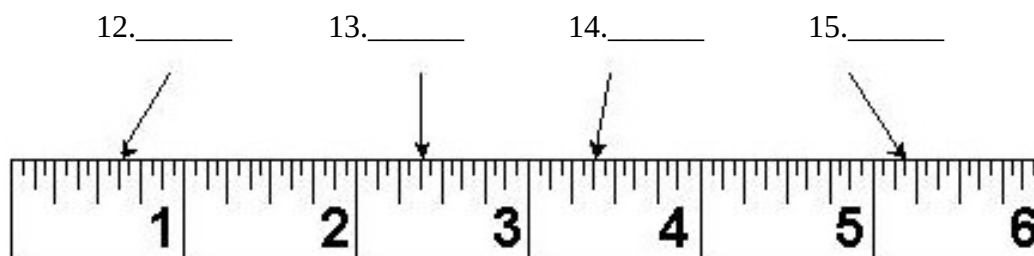
9. What is the area of the house diagramed below? _____ square feet.

10. What is the volume of the house diagramed below? _____ cubic feet.

11. What is 75% of 2400? _____.



12-15. Write in the measurement indicated by the arrow pointing at the tape measure.



Appendix B: Computer Skills Pre-Test

Basic Computer Skills Survey

1. Have you used a computer before? ☐ Yes ☐ No
2. Do you own a computer? ☐ Yes ☐ No
3. How well can you type? ☐ Good ☐ OK ☐ Not Good
4. What software programs have you used?
 - a. Microsoft Word or other word processor? ☐ Yes ☐ No
 - b. Excel or other spreadsheet program? ☐ Yes ☐ No
 - c. Outlook or other email program? ☐ Yes ☐ No
 - d. Internet Explorer or other Internet browser? ☐ Yes ☐ No
 - e. NEAT, MHEA, or other energy audit software? ☐ Yes ☐ No

Windows Basics Test

Perform the following tasks on the computer.

1. Open three different software programs, resize and position the windows so you can see all three applications on the screen at once.
2. Minimize all three programs and create a new folder on the desktop.
3. Create a word-processing file and save it on the desktop
4. Move this new file into the new folder using drag and drop.
5. Open the folder and confirm you successfully moved the file.
6. Using the Windows Help menus locate instructions for cut and paste and drag and drop. Point to what tutorials come with windows for learning file management. (copy, delete, move, rename, view properties)

File Management Basics Test

Nearly everything you'll do with computers revolves around creating content in the form of different types of files using different software programs. You'll need to be comfortable with creating, saving, opening, and editing files. Then you'll need to understand storing, organizing, renaming, moving, copying, deleting and backing up your important files. Plan on learning by doing. Mistakes are considered positive learning experiences and are an essential part of using and learning computers. Trouble-shooting gets easier with practice.

Begin by drafting a personal list of the computer skills you have and the skills you want to learn. Then complete the following tests.

1. Create a new folder on the desktop named “Test Folder #1” and save a simple word processing document to this folder.
2. Create a folder named “Test Folder #2” within “Test Folder #1” and move the word processing file into this new folder.
3. Put a copy of this file into the first folder you created.
4. Rename this file.
5. Create another new folder on the desktop named “Test Folder #3” and move Test Folder #2 into this folder.
6. Delete all these folders and files.

Copy and Paste Basics Test

Perform the following tasks on the computer.

1. Highlight a section of text in a document and copy it to another location.
2. Highlight a section of text in a document and move it to a new location.
3. Highlight an image in a document and copy it to another location. Then, move the image to new location.

Spreadsheet Basics Test

Circle the letter of the best answer.

1. Spreadsheets:
 - a. Are large amounts of information
 - b. Organize text and numbers into columns and rows
 - c. Are usually graphics
2. Columns are:
 - a. Labeled with numbers
 - b. Not labeled
 - c. Labeled with letters
3. Rows are:
 - a. Labeled with numbers
 - b. Not labeled
 - c. Labeled with letters

4. What are the intersection of a column and a row?
 - a. Formulas
 - b. Entries
 - c. Cells
5. The column and row label combined at the point of intersection is known as the:
 - a. Active cell
 - b. Cell name
 - c. Formula
6. What are the sets of instructions that produce a value for a cell?
 - a. Addresses
 - b. Spreadsheets
 - c. Formulas
7. What character should start any formula?
 - a. Plus sign (+)
 - b. Any operator (+,-,*,/)
 - c. Equals sign (=)

8. Which formula will produce the total cost of all weatherization measures?

	A	B	C	D	E	F
1	Measure	Hours	Rate	Labor	Materials	Total
2	Air sealing	4	\$30	\$120	\$200	\$320
3	Attic insulation	3	\$30	\$90	\$324	\$414
4	Sidewall insulation	8	\$30	\$240	\$312	\$552
5	Water heater wrap	0.5	\$30	\$15	\$14	\$29

- a. =SUM(F2:F5)
- b. =F2+F3+F4+F5
- c. =SUM(B5:F5)
- d. Both a and b

Appendix C: Glossary

Air Barrier – The air barrier of a dwelling, also known as the pressure boundary, is the building shell surface that limits airflow between inside and outside. For maximum energy efficiency and comfort, the air barrier and thermal barrier should be continuous and in contact with each other.

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers

ASHRAE 62 – ASHRAE 62 is a group of ASHRAE standards for minimum building ventilation requirements. ASHRAE 62.1-2004, entitled Ventilation for Acceptable Indoor Air Quality, cover general topics and requirements for commercial and high-rise residential buildings. ASHRAE 62.2-2004, Ventilation for Acceptable Indoor Air Quality in Low-Rise Residential Buildings, has a self-explanatory title.

Attic Ventilation – Building codes require attic openings to outside to induce airflow that cools the attic in summer and exhausts moisture. There is a growing consensus that unvented attics have energy benefits and that in hot, humid climates attic ventilation brings in more moisture from outside than it purges.

Auditor – An auditor is a weatherization worker that assesses an eligible dwelling for potential weatherization services. Auditors visually inspect the building shell and mechanical systems; conduct diagnostic, health, and safety tests; record the location, condition, and dimensions of walls, ceilings, floors, windows, doors, and mechanical systems; enter data into computerized energy audit or use a priority list to select cost-effective measures; and prepare clear and accurate work orders to ensure the most appropriate measures are installed properly.

Balloon-Framed Walls – Balloon-framed walls are built without top or bottom plates. This type of framing often provides an air channel from the basement or crawlspace to the attic that allows outside air to flow through the walls resulting in excessive heat loss/gain.

Band Joist – Band joists are the floor joists that run around the perimeter of the house. There are two types of band joists - header joists that run perpendicular to the floor joists and rim joists that run parallel. A typical weatherization measure involves insulating the header joist spaces between floor joists and along the rim joists.

Base Load – Base loads are energy loads from appliances that are on most of the time and do not vary with changing climate. Base loads include refrigerators, water heaters, and lights. Base loads are often thought to be primarily electric loads, but can be fueled by other energy sources.

Batt Insulation – Batts are insulation manufactured in rolls precut to standard widths to fit snugly between framing (joists, rafters, or studs) on 16-inch or 24-inch centers in ceilings, floor, and walls. While often made with a “Kraft” paper facing designed to

retard vapor transmission, batt insulation is also available without the paper facing (unfaced batts).

Blower Door – A blower door is a device for testing the airtightness of a building. A blower door consists of a calibrated fan for measuring an air flow rate and a pressure sensing device to measure the pressure created by the fan flow. The combination of pressure and flow can be used to estimate the airtightness.

Building Performance Institute (BPI) – BPI is an organization that supports the development of a professional building performance industry through individual and organizational credentialing and a quality assurance program. BPI offers certification of individuals in evaluation, mechanical, envelope, mobile home, and multi-family designations, as well as accreditation of organizations committed to using a quality management system.

Building Science – Building science is the collection of scientific knowledge that focuses on the analysis and control of the physical phenomena affecting buildings. This includes the detailed analysis of building materials and building envelope systems.

Building Tightness Limit – Also known as the minimum ventilation rate, the building tightness limit is the least amount of fresh air that must be drawn through a house (by either natural or mechanical means) to ensure acceptable indoor air quality.

Bypass – A bypass is a hole between conditioned and unconditioned space that allows air leakage through the pressure boundary, or air barrier, of a dwelling.

CAZ – A combustion appliance zone, or CAZ, is any zone containing a combustion appliance.

CO – Carbon monoxide

Combustion Air – Complete combustion of fossil fuels such as natural gas, propane, and fuel oil requires an adequate supply of air. Inadequate combustion air causes incomplete combustion, which generates carbon monoxide.

Combustion Appliance – A combustion appliance is a furnace, boiler, space heater, wood stove, water heater, cook stove, or other device that burns wood or fossil fuel such as natural gas, propane, or fuel oil.

Compact Fluorescent Lamp – A compact fluorescent lamp (CFL) is a type of fluorescent lamp that screws into a regular light bulb socket or plugs into a small lighting fixture. In comparison to incandescent light bulbs, CFLs have a longer rated life and use less electricity.

Competency – Competency means the possession of a minimum level of knowledge and proficiency required to collect appropriate information, make informed decisions, and

physically takes the needed actions to deliver the high-quality weatherization service in question.

Consumer/Client Education – Consumer or client education includes discussion, instruction, brochures, and pamphlets that explain the weatherization process, the measures installed in the client’s house, how to use certain measures (such as programmable thermostats), and low-cost/no-cost ways to save energy and reduce energy costs.

Crew Chief – A crew chief is a weatherization worker that supervises a crew of installers and directs their efforts to weatherize eligible dwellings.

Critical Junction Point – Critical junction points are areas in building construction that typically exhibit air leaks or are inadequately insulated. Critical junction points include the intersection of ceilings and walls, cantilevers, and finished-attic kneewalls.

Cross Training – Training every member of a crew to be able to do every job is known as cross training. While certain crew members may specialize in specific tasks, a cross-trained crew understands how their specialty impacts all others and can adjust to staff turnover.

Delta Q – Delta Q is a testing protocol to measure duct leaks to the outside under actual operating conditions.

Demonstrated Ability – A demonstrated ability is the physical performance of a test, procedure, or technique on an actual house, a prop, or in a training lab in the presence of someone qualified to assess the particular competency.

Dense-Packed Insulation – Loose-fill insulation (cellulose or fiberglass) is blown into closed building cavities (usually walls, but also floor and roof/ceiling cavities) to a density of 3½ or 2 ½ pounds per cubic foot¹, respectively, to air seal as well as insulate.

DOE – U.S. Department of Energy

Dropped Soffit – A dropped soffit (or simply drop soffit) is built from framing and drywall over kitchen cabinets to give a more finished appearance than just hanging wall cabinets with a foot or so gap between the top of the cabinet and the ceiling. From the attic, a dropped soffit looks like a big hole in the floor and often causes breaks in the attic thermal and air barriers.

Duct Blaster – A Duct Blaster is a calibrated airflow measurement system designed to test and document the air tightness of forced-air duct systems. Duct Blaster is the trade name of the device manufactured by the Energy Conservatory of Minneapolis,

¹ Guidelines are based on infiltration reduction lab and field results and subject to change as more data becomes available.

Minnesota. Other competing companies such as Infiltec and Retrotec manufacture similar systems.

EPA – U.S. Environmental Protection Agency

HVAC – Heating, ventilation, and air conditioning

HVAC Installer/Contractor – A HVAC installer/contractor is a crew member or contractor trained and licensed to repair and replace furnaces, boilers, air conditioners, and related equipment.

Hydronic Distribution Pipes – Hydronic distribution pipes deliver hot water or steam from a water heater or boiler to baseboard convectors or radiators located throughout a house.

Inspector – An inspector verifies the proper selection, installation, and effectiveness of weatherization measures installed in eligible dwellings through review of documentation, visual inspection, and performance of diagnostic, health, and safety testing.

Installer – An installer is a crew member or contractor that installs weatherization measures in eligible dwellings.

Knob-and-Tube Wiring – Older homes may have “knob-and-tube” electrical wiring, where two separate wires run through ceramic posts (knobs) attached to the top of ceiling joists or through ceramic tubes inserted into holes drilled in the wall or roof framing. Since this type of wiring was designed to dissipate heat to the attic air, insulating over knob-and-tube wiring can cause dangerous overheating.

Lead-Safe Work Practices – Lead-safe work practices are the use of specific precautions in the conduct of weatherization activities designed to avoid contaminating homes with lead-based paint dust and debris, and to avoid exposing the clients, weatherization workers, and their families to this hazard.

Mastic – Mastic is a material used to seal duct leaks. It is the consistency of drywall joint compound when applied, but dries to a hard, durable finish. To seal duct leaks larger than ¼ inch, mastic is applied over a specially made fiberglass mesh tape.

Material Safety Data Sheet (MSDS) – A material safety data sheet or MSDS describes the properties of a particular substance (e.g., caulk, mastic, sealant). An important component of workplace safety, it is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner.

Mechanical Ventilation – Mechanical ventilation is the controlled exhaust of indoor air, intake of fresh outdoor air, or a combination of both through the use of fans, controls, passive air intakes, and sometimes ducts, registers, and air-to-air heat exchangers.

Minimum Ventilation Rate – Also known as the building tightness limit, the minimum ventilation rate is the least amount of fresh air that must be drawn through a house (by either natural or mechanical means) to ensure acceptable indoor air quality.

Monitor (Administrative) – An administrative monitor is someone employed or contracted by a state to review the administrative and programmatic activities of local weatherization agencies (subgrantees) to ensure compliance with applicable laws and programmatic and financial regulations.

Monitor (Technical) – A technical monitor is someone employed or contracted by a state to review the technical and field activities of local weatherization agencies (subgrantees) to ensure compliance with the enacting federal legislation, federal program regulations, and state technical program standards.

NASCSP – National Association for State Community Services Programs is a national association charged with advocating and enhancing the leadership role of states in preventing and reducing poverty. NASCSP's members are state administrators of the U.S. Department of Health and Human Services' Community Services Block Grant (CSBG) and the U.S. Department of Energy's Weatherization Assistance Program. NASCSP keeps its members, the federal government, and other interested parties informed about issues related to CSBG and the Weatherization Program through its publications and training.

OSHA – The Occupational Safety and Health Administration's mission is to assure the safety and health of America's workers by setting and enforcing standards; providing training, outreach, and education; establishing partnerships; and encouraging continual improvement in workplace safety and health.

Personal Protective Equipment – Equipment such as respirators, safety goggles, disposable coveralls, and hard hats worn by weatherization workers to protect them from jobsite hazards.

Plenum – A plenum is the initial duct on the supply and return side of an air handler.

Pressure Pan – A pressure pan resembles a cake pan and is used to locate duct leakage with a digital manometer while a blower door is running.

Priority List – A priority list is a list of weatherization measures appropriate for typical housing stock ordered by descending cost effectiveness. DOE-approved energy audit software is used to verify the cost effectiveness of the measures and account for the interaction between measures.

R-Value – R-value is a measure of resistance to heat flow. Insulation with an R-value of R-38 resists heat loss better than R-19 insulation.

Room Pressure Imbalances – Pressure imbalances happen when the conditioned air supplied to a room does not equal the airflow returned to the furnace or air conditioner. In dwellings with forced-air distribution and a central return system, closing bedroom doors can cause the bedrooms to experience a positive pressure and rooms that are open to the return grille see a negative pressure. Atmospherically vented combustion appliances can backdraft if they are located in a zone with negative pressure.

Steam Trap – Steam traps are automatic valves used in steam heating systems to remove condensed steam (hot water) from the steam pipes and return it to the boiler.

Temperature-Rise Test – A temperature-rise test is conducted on a furnace by measuring the temperature of air entering the furnace and of the air exiting the furnace. The difference between these two temperatures is known as the temperature rise and is compared to the normal range indicated on the nameplate to verify proper operation of the furnace.

Thermal Barrier – The thermal barrier of a dwelling is the building shell surface that limits heat flow. For maximum energy efficiency and comfort, the air barrier and thermal barrier should be continuous and in contact with each other.

Unvented Combustion Appliance – An unvented combustion appliance vents combustion gases to the living space instead of outside as does a vented appliance.

Weatherization Plus – The U.S. Department of Energy’s effort to plan the continued evolution of the Weatherization Program for the next five years through activities designed to expand resources (leveraging and partnerships), share relevant information with the weatherization network, and increase the consistent delivery of high-quality weatherization services nationwide.

Work Order – A work order describes what weatherization measures are to be installed in an eligible dwelling and includes a list of the type and quantity of materials that are required to complete the job.

Working Knowledge – Working knowledge of means to:

- Knowing how a particular topic impacts the weatherization process;
- Having the relevant information committed to memory or being able to locate it in readily available sources; and
- Using the knowledge to make informed decisions and guide weatherization work.

Worst-Case Draft Test – A worst-case draft test is procedure used to verify the ability of a combustion appliance to safely exhaust combustion gases outside even when exhaust fans, pressure imbalances, and the stack effect are fighting its ability to properly draft.

Zone Pressure Diagnostics – Test procedures used with the blower door to locate air leakage are known as zone pressure diagnostics.

**Core Competencies for the
Weatherization Assistance Program**

Companion Matrix to the

March 26, 2007, Narrative Draft

	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
Basic Competencies	X	X	X	X	X	X	X	X	X	X	X
Safe Work Practices	X	X	X	X	X	X		X			X
Understand building science principles		X	X	X		X	X	X		X	X
Air Sealing											
Select proper materials	X	X	X	X		X		X			X
Know minimum ventilation rates	X	X	X	X		X		X			X
Use blower door	X	X	X	X		X		X			X
Seal leaks in attics, floors, etc.	X	X	X	X		X		X			X
Properly apply caulk & foam	X	X	X	X		X		X			X
Weatherstrip doors, windows, etc.	X	X	X	X		X		X			X
Repair broken glass	X	X	X	X		X		X			X
Repair plaster & sheetrock	X	X	X	X		X		X			X
Install or modify mechanical ventilation	X	X	X	X		X		X			X
Duct Sealing											
Seal ducts	X	X	X	X	X	X		X			X
Repair/modify ducts per work order	X	X	X	X	X	X		X			X
Insulation											
Know insulation materials	X	X	X	X	X	X	X	X		X	X
Know hazards of knob-&-tube wiring	X	X	X	X	X	X		X		X	X
Know local attic ventilation codes		X	X	X	X	X		X			X
Install blown & batt insulation	X	X	X	X	X	X		X			X
Access & dense-pack sidewalls	X	X	X	X	X	X		X			X
Install water heater blankets	X	X	X	X	X	X		X			X
Insulate ducts & pipes	X	X	X	X	X	X		X			X
Operate & maintain blowing machine	X	X	X	X	X	X		X			X
Base-Load Measures											
Convert incand. lamps to CFLs, maintain light level	X	X	X	X	X	X		X			X
Install low-flow showerheads/aerators	X	X	X	X	X	X		X			X
Meter energy usage of electrical appliances			X			X		X			X
Determine refrig energy usage w/ meter of database			X			X		X			X
Project Management											
Manage a crew of installers		X		X							
Ensure Safe Work Practices are used		X	X	X		X		X		X	X
Understand a work order		X	X	X		X		X	X	X	X
Know building codes, esp. energy & H&S codes		X	X	X	X	X		X		X	X
Order materials to avoid delays		X		X							
Maintain QC of wx work & ensure it meets pgm stads		X		X	X	X		X		X	

**Core Competencies for the
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	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
Warehouse materials as necessary		X		X	X						
Training											
Know adult learning concepts		X		X			X	X		X	X
Complete adult education training program											X
Know benefits of cross training		X		X				X		X	X
Provide ongoing training		X		X				X			X
Certification in training topic								X			X
Know allowable activities at training location								X		X	X
Know training resources							X	X		X	X
Develop curriculum based on student needs								X			X
Tailor each class based on student needs								X			X
Motivate students							X	X			X
Provide hands-on training							X	X	X		X
Use technology to enhance learning							X	X			X
Diagnostic Testing											
Blower door/zone pressure diagnostics											
Know air & heat movement principles		X	X	X		X	X	X		X	X
Know typical air leakage problems		X	X	X		X	X	X		X	X
Compute minimum ventilation rates		X	X	X		X		X			X
Take blower door readings & interpret results		X	X	X		X		X			X
Know air barrier & its proper alignment		X	X	X		X	X	X		X	X
Know primary & intermediate zones		X	X	X		X	X	X		X	X
Conduct zone pressure diagnostics		X	X	X		X		X			X
Locate air barrier & determine its effectiveness		X	X	X		X		X			X
Duct testing											
Know problems w/ different kinds of leakage		X	X	X	X	X	X	X		X	X
Conduct pressure pan, duct blaster, or Delta Q		X	X	X	X	X		X			X
Determine dominant duct leakage		X	X	X	X	X		X			X
Measure & resolve room pressure imbalances		X	X	X	X	X		X			X
Steam & hot water pipe testing											
Know components & oper of steam & HW sys			X		X	X		X			X
Test air vents, steam traps, t'stat rad valves, etc.			X		X	X		X			X
Bleed air from HW distribution system					X						
Estimate energy impact of overheating problems			X		X	X		X			X
Combustion Appliance Safety											
Know CO action levels		X	X	X	X	X	X	X		X	X
Know code requirements of:											

**Core Competencies for the
Weatherization Assistance Program**

Companion Matrix to the

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	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
Vent sizing, materials, clearances, installation		X	X	X	X	X		X			X
Safety shut-off devices		X	X	X	X	X		X			X
Gas line sizing		X	X	X	X	X		X			X
Combustion air		X	X	X	X	X		X			X
Know causes & remedies of common vent problems		X	X	X	X	X	X	X		X	X
Measure CO in ambient air		X	X	X	X	X		X			X
Measure CO in vented & unvented appliances		X	X	X	X	X		X			X
Measure CO of gas & propane stoves & ranges		X	X	X	X	X		X			X
Clean & adjust ovens/ranges to remedy high CO		X	X	X	X	X		X			X
Understand as-measured & air-free CO readings		X	X	X	X	X		X			X
Detect gas, propane, and fuel oil leaks		X	X	X	X	X		X			X
Conduct worst-case draft test of CAZ		X	X	X	X	X		X			X
Measure CAZ & ensure adequate combustion air			X		X	X		X			X
Clock a gas meter to determine appliance input			X		X	X		X			X
Measure temp rise/drop & static press drop on FA sys			X		X	X		X			X
Measure steady-state efficiency of vented units		X	X	X	X	X		X			X
Assess adequacy of plenum & duct sizes			X		X	X		X			X
Inspection and Measurement											
Know factors that affect heat loss in buildings		X	X	X		X	X	X		X	X
Know critical junction points		X	X	X		X	X	X		X	X
Know R-values of different insulation materials		X	X	X		X		X			X
Know different insulation mtrls & installation techniques		X	X	X	X	X	X	X		X	X
Know air-sealing techniques & appropriate materials		X	X	X	X	X	X	X		X	X
Know causes & remedies of moisture problems		X	X	X	X	X	X	X		X	X
Know causes & remedies of IAQ problems		X	X	X	X	X	X	X		X	X
Know residential mechanical ventilation systems		X	X	X	X	X		X		X	X
Know min ventilation rates per appropriate ASHRAE 62		X	X	X	X	X		X			X
Know electric base-load usage		X	X	X	X	X		X		X	X
Measure building dimensions & compute areas		X	X	X	X	X		X		X	X
Compute volume of conditioned space		X	X	X	X	X		X		X	X
Define thermal envelope of a building		X	X	X	X	X		X		X	X
Assess existing insulation & its R-value		X	X	X	X	X		X			X
Analyze utility bills			X			X		X			X
Measure Selection											
Know materials allowed by 10 CFR 440 Appendix A			X			X	X	X	X	X	X
Know regs & policy affecting measure selection			X			X		X	X	X	X
Understand the interaction between measures			X			X	X	X		X	X

**Core Competencies for the
Weatherization Assistance Program**

Companion Matrix to the

March 26, 2007, Narrative Draft

	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
Properly use DOE-approved energy audit/priority list			X			X		X			X
Prioritize air-sealing measures			X			X		X			X
Estimate heating & cooling load of a building			X		X	X		X			X
Work Scope Development											
Estimate type & quantity of wx materials needed			X			X		X			X
Prepare easy-to-understand work order			X			X		X			X
Business Management											
Maintain required licenses				X	X						
Possess adequate insurance				X	X						
Employ U.S. citizens or properly documented aliens		X		X	X						
Bid, negotiate, & sign contracts as necessary				X	X						
Heating & Cooling Equipment											
Repair/place heating & cooling eqmt per code					X						
Repair/place combustion appliance vent systems					X						X
Repair/place water heater					X						X
Add supply & return plenums & ducts as necessary					X						X
Client Education											
Know actions by occupant that reduce energy use							X			X	X
Estimate savings that can result from occupant actions							X				X
Know actions by occupant that ensure health & safety							X			X	X
Know basic steps involved in weatherization process'							X			X	X
Know basic equipment used to weatherize a house							X			X	X
Monitoring											
Technical Monitoring											
Produce reports, identify weaknesses & solutions						X		X	X		X
Solve complex technical problems						X		X			X
Administrative Monitoring											
Know enabling legislation of Weatherization Pgm									X	X	X
Know DOE program regulations (10 CFR 440)									X	X	X
Know DOE program guidance & policy									X	X	X
Know budget federal, state, & local processes									X	X	
Know 10 CFR 600 & OMB Circulars									X	X	
Know applicable state procurement regulations									X	X	
Know state approached to monitoring & T&TA									X	X	X
Program Management											
Know applicable databases & tracking systems										X	
Submit accurate financial and production reports										X	

**Core Competencies for the
Weatherization Assistance Program**

Companion Matrix to the

March 26, 2007 , Narrative Draft

	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
Provide T&TA for staff & contractors										X	X
Coordinate resources										X	
Develop & implement leveraging strategies										X	

**Core Competencies for the
Weatherization Assistance Program**

Companion Matrix to the

March 26, 2007 , Narrative Draft

	Installer	Crew Chief	Auditor	Contractor	HVAC Installer/ Contractor	Inspector	Client Ed.	Monitor (Tech.)	Monitor (Admin.)	Program Manager	Trainer
State Program Management											
Prepare an annual state plan										X	
Prepare an annual weatherization grant application										X	
Develop, maintain, and enforce tec pgm stds										X	
Develop & manage an effective monitoring program										X	
Process reimbursement requests										X	
Local Agency Program Coordination											
Prepare and track a budget										X	
Maintain a purchase order system										X	
Maintain inventory tracking system										X	
Comply with federal limits on admin expenses										X	
Manage a small construction-focused operation										X	
Ensure rigorous final inspection of all units										X	X

Handouts & Resources

Technical Monitor/Inspector

Suggested handouts and resources are listed by section below. When available, electronic files are provided with the curriculum materials. Please refer to the “Resources” folder in each section. (Note: Some sections do not contain suggested handouts and resources.)

I. Introduction to Weatherization

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. Virginia Program Evaluation Summary
 - ii. Lawrence National Laboratory Estimated Energy Usage by Source chart
 - iii. 2009 Weatherization Works Video
 - iv. Brown, Marilyn., Berry, Linda. “Weatherization Assistance: The Single Family Study.” Home Energy Sept./Oct. 1993. www.homeenergy.org.
 - v. Haywood, Talmon. “More Than Just Patching Holes.” Home Energy Mar./Apr. 2002. www.homeenergy.org

II. House as a System

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. McWilliams, Jennifer A., and Iain S. Walker. “Retrofitting Residential HVAC Systems.” Home Energy Jan./Feb. 2005. www.homeenergy.org.
 - ii. Partnership for Advancing Technology in Housing (PATH). Your House is a System: Tips for the Handy Homeowner Jan. 2006. www.pathnet.org/si.asp?id=1889.
 - iii. Van der Meer, Bill. “Avoiding Moisture Problems.” The Weatherization Training Center Technical Update 1 (Feb. 2003).
 - iv. Lstiburek, Joseph, and John Carmody. “Fundamentals of Moisture in Houses.” Home Energy Nov/Dec. 1995. www.homeenergy.org.

III. Regulations and Standards

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. Appendix A
 - ii. Applicable Codes Handout
 - iii. Lead Paint Decision Chart. July 12, 2002.
 - iv. MSDS for two-part foam
 - v. Occupational Safety and Health Administration. “Fall Protection Tips QuickCard™.” OSHA 3267 – 2005. www.osha.gov/Publications/fall_protection_qc.html.
 - vi. SIR calculator with PV function
 - vii. U.S. Department of Energy. Hot Climate Initiative. Combustion Appliance Safety & Efficiency Testing.
 - viii. U.S. Department of Energy. Memorandum. “Knob-and-Tube Wiring: Revised Policy Superseding Guidance of 7/25/83 and 7/13/88.” Oct. 21, 1988.

- ix. U.S. Department of Energy, Seattle Regional Office and Energy Out West. Energy OutWest Weatherization Field Guide. 2005. Copyright Saturn 2009. www.azcommerce.com/doclib/ENERGY/EOW_WX_Field_Guide.pdf.
- x. U.S. Department of Energy, Weatherization Assistance Program, Midwest Regional Field Office. Midwest Weatherization Best Practices Field Guide. May 2007. www.karg.com/pdf/Midwest_Wx_Best_Practices_May_2007.pdf.
- xi. U.S. Department of Energy, Weatherization Assistance Program. Southeast Weatherization Field Guide. 2002. Copyright Saturn 2002.
- xii. U.S. Department of Energy, Weatherization Assistance Program. WPN 08-4 Space Heater Policy. March 3, 2008. www.waptac.org.
- xiii. U.S. Department of Energy, Weatherization Assistance Program. WPN 09-6: LSW WPN Final. Jan. 7, 2009. www.waptac.com.

IV. Incidental Repairs and Health & Safety Measures

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. US Department of Energy, Weatherization Assistance Program, WPN 10-1. Program Year 2010 Weatherization Grant Guidance. December 18, 2009. www.waptac.org.
 - ii. US Department of Energy, Weatherization Assistance Program, WPN 02-5. Health and Safety Guidance. July 12, 2002. www.waptac.org.

V. Purpose of Monitoring and Inspecting

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. U.S. Department of Energy. Weatherization Assistance Program. WPN 01-6 Updated Weatherization Assistance Program Monitoring Policy. January 3, 2001. www.waptac.org.
 - ii. U.S. Department of Energy. Weatherization Assistance Program. WPN 02-5 Health and Safety Guidance. July 12, 2002. www.waptac.org
 - iii. U.S. Department of Energy. Weatherization Assistance Program. WPN 10-9 Amendment to Weatherization Program Notice 09-1B to Clarify Monitoring Requirements (Section 4.0) of the Grant Guidance to Administer the American Recovery and Reinvestment Act of 2009 Funding. January 15, 2010. www.waptac.org
 - iv. U.S. Department of Energy. Weatherization Assistance Program. WPN 10-1 Program Year 2010 Weatherization Grant Guidance. December 18, 2009. www.waptac.org
 - v. Code of Federal Regulations, Title 10 – Energy, Part 440 – Weatherization Assistance for Low-Income Persons (10 CFR 440)
 - vi. Appendix A to 10 CFR 440 – Standards for Weatherization Materials
 - vii. Weatherization Assistance Program Monitoring Plan
 - viii. Technical Monitoring Tools for the Weatherization Assistance Program, including the following Technical Monitoring Checklists:
 - 1. Simplified
 - 2. Standard
 - 3. Comprehensive
 - ix. Purpose of Monitoring & Inspecting Pre-Training Quiz and Key

VI. Desk Monitoring

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. Abridged, highlighted 10 CFR 440 handout
 - ii. Sample client file(s)
 - iii. Blank file review forms

VII. Site Monitoring

Inspector's Toolbox

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. Whole House Weatherization Equipment List

Building Assessment

- a. Handouts & Resources (Folder contains public files as of August 2010)
 - i. Attic air sealing video
 - ii. DOE Hot Climate Initiative. Air Sealing.
 - iii. DOE Hot Climate Initiative. Combustion Appliance Safety & Efficiency Testing.
 - iv. DOE Hot Climate Initiative. Dense-pack Sidewall Insulation.
 - v. NFPA Combustion Clearance Tables
 - vi. Refrigerator Info Toolkit
 - vii. Sample attic insulation certificate
 - viii. Sample Technical Field Rating Sheet
 - ix. Sample insulation coverage chart
 - x. Sample Quality Assurance Form
 - xi. Water Heater Info Toolkit
 - xii. Armanda, Larry. "Ventilation Strategies in Weatherization." WTC Technical Update 1.8 (2006). Weatherization Training Center at Pennsylvania College of Technology. www.pct.edu/wtc/articles.htm.
 - xiii. Beers, Jonathan. "Dryer Venting." Home Energy Nov./Dec. 2003: 14-16.
 - xiv. Florida Solar Energy Center. "Window Orientation and Shading." 2007. www.fsec.ucf.edu/en/consumer/buildings/homes/windows/shading.htm
 - xv. La Rue, Jim. "A Conditioned Crawlspacel Checklist." Home Energy May/June 2004: 24-26. www.homeenergy.org.
 - xvi. Occupational Safety and Health Administration. "Mold Fact Sheet." 2005. www.osha.gov/OshDoc/data/Hurricane_Facts/mold_fact.pdf.
 - xvii. Sterner, Tamasin. "Cooling Measures." In Winter Relief Assistance Program Standards. Pennsylvania Power & Light. 2007.
 - xviii. Turk, Brad. "Crawlspaces, Considering the Options." Home Energy May/June 2004: 30-33. www.homeenergy.org.
 - xix. U.S. Department of Energy. Weatherization Assistance Program. WPN 08-4, Space Heater Policy. March 3, 2008. www.waptac.org.
 - xx. Van der Meer, Bill. "Air Leakage in Recessed Lighting." Builder Brief (BB0502). Undated. Pennsylvania Housing Research Center, Penn State University. www.engr.psu.edu/phrc.
 - xxi. Van der Meer, Bill. "Air Sealing with Two Part Foam." WTC Technical Update 1.4 (2003). Weatherization Training Center at Pennsylvania College of Technology. www.pct.edu/wtc/articles.htm.
 - xxii. Technical Monitoring Tools for the Weatherization Assistance Program

- xxiii. Van der Meer, Bill. "Avoiding Moisture Problems." WTC Technical Update 1.1 (Feb. 2003). Weatherization Training Center at Pennsylvania College of Technology. www.pct.edu/wtc/docs/articles/WTC-Tech-Update-Moisture.pdf.

Interpreting Infrared

- a. Handouts & Resources (Folder contains public files as of August 2010)
- Collins, Maureen. "IR – Worth a Thousand Words." Home Energy Sept./Oct. 2008. www.homeenergy.org.
 - Snell, John. "Breakthroughs in Infrared Cameras." Home Energy Jan./Feb. 2006. www.homeenergy.org.
 - Snell, John. "Infrared Thermography: (Nearly) A Daily Tool." Home Energy Mar./Apr. 2008. www.homeenergy.org.
 - Snell, John. "Infrared Thermography: What Works, What Doesn't Work." Home Energy May/Jun. 2010. www.homeenergy.org.

In-Progress Monitoring and Inspecting

- a. Handouts & Resources (Folder contains public files as of August 2010)
- Bacharach, Inc. "Instrument Maintenance." www.bacharachtraining.com/InstrumentMaint/instrumentmaintenance.htm.
 - The Energy Conservatory. "Procedure for Field Calibration Check of Digital Pressure Gauges" (January 2007).
 - The Energy Conservatory. "Operation and Maintenance Tips for Energy Conservatory Test Instruments" (Oct. 2004).
 - Krendl Machine Company. "Blower Maintenance Guide."
 - Thomson, Jeff, Bob Pfeiffer, Suzanne Harmelink, and Martha Benewicz. "Pressure Testing Insulation Blower and Hoses." WI Weatherization Program (Dec. 1999).
 - U.S. Department of Energy. Weatherization Assistance Program. *WPN 10-1. Program Year 2010 Weatherization Grant Guidance*. December 18, 2009. www.waptac.org.

VIII. Report Writing

- a. Handouts & Resources (Folder contains public files as of August 2010)
- Handout #1 – Pictures of attic hatches and Report A & Report B
 - Handout #2 – Pictures of whole-house fan covers
 - Handout #3 – Sample Report: Site Visits
 - Handout #4 – Sample Report Summary: Technical Evaluation
 - Sample audit input report and recommended measures report
 - Sample audit home diagram
 - Sample monitoring reports